DISTRICT OF CAMPBELL RIVER

Integrated Stormwater Management Plan for Holly Hills and Perkins Road Drainages

1479.0003.01/ March 2, 2004

URBANSYSTEMS
#2353 13353 Commerce Parkway
Richmond, BC, V6V 3A1
Phone: (604) 273-8700
Fax: (604) 273-8752

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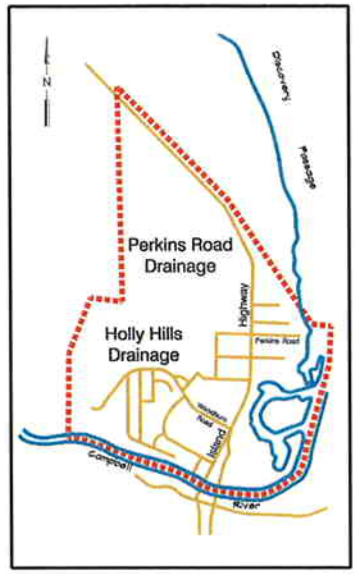

The District of Campbell River has embarked on a process to address stormwater issues within the District, consistent with current guidelines published by the Province for integrated stormwater planning. Ultimately, the planning efforts will cover the entire District, but this current work covers only two areas or drainages, Holly Hills and Perkins Road. These drainages lie within the area of the District known as North Campbell River (see map). The District is responsible for the construction, operation, maintenance and enhancement of stormwater systems in these areas.

In the past, urban runoff has been primarily viewed as a nuisance needing to be conveyed away from private property as quickly as possible, to avoid flooding and erosion damage. More recently, we are learning to see that, if treated wisely, stormwater contributes to the well-being of the natural environment, including fish-bearing water-bodies and groundwater resources. Integrated stormwater planning begins from the premise that stormwater runoff is a resource and as a result uses the perspectives of engineering, planning, hydrogeology, and the fish and wildlife sciences to manage stormwater. Thus, the focus will not only be on the rate of runoff from urban lands, but also on the total volume that runs off as well as the quality of the runoff.

The goals of the District's overall stormwater management planning efforts are:

- Develop stormwater management solutions and policies that maintain, restore and enhance the watershed and meet engineering, environmental and land use needs;
- Protect the community from flooding, erosion and destruction of private and public property;
- Promote community development while recognizing neighbourhood values and unique characteristics of the area; and
- Integrate engineering, planning and environmental solutions for benefit of Campbell River.

For this plan, engineering, hydrogeologic and fisheries studies were applied to the Holly Hills and Perkins Road Drainages. In addition to the development of a traditional surface runoff computer model, a conceptual groundwater model was developed of the drainages. In addition, all ditches and streams within the two drainages were field investigated to determine their condition and suitability for anadromous and resident fish habitat. Existing and future land use conditions were cataloged, particularly with respect to loss of forest cover and increases in total impervious area, as these are primary factors in watershed degradation from poor stormwater practices. Finally, the management tools available to the District for controlling stormwater runoff were identified.

Overriding issues that were identified in the study are:

- Existing development has disrupted the water cycle; in some cases local flooding and erosion are a problem;

- Runoff from new development will exacerbate the current problems, unless adequate management tools are put into place now;
- While a limited-term parcel tax currently raises money for drainage improvements, the District lacks a long-term financing mechanism for stormwater management;
- Baseline data is lacking to fully characterize the catchments' hydrologic and hydraulic conditions;
- Both anadromous and resident fish are present in several ditches and streams, but habitat is often of poor quality throughout the drainages; two areas were identified for potentially high quality fish habitat enhancements;
- Long-term conversion of rural-type roads to urban design standards will exacerbate runoff problems due to the construction of more impervious area; and
- Due to the presence of fish in the local ditches and the Campbell River estuary downstream, stormwater quality is a special concern.

In light of the results of this study, three guiding policies for stormwater management within the Holly Hills and Perkins Road Drainages were formulated:

1. Restore and enhance fish habitat in selected areas of the drainages;
2. Encourage the use of on-site stormwater best management practices to control runoff volume and water quality; and
3. Provide adequate storm sewer systems to avoid flooding and erosion.

These policies are intended to maintain and enhance the local stormwater systems without resorting to significant new capital improvements. Rather the intent is to improve local fish habitat in conjunction with other on-going or upcoming initiatives, such as the conversion of rural roads to urban standards, and introduce the use of on-site controls for stormwater management.

The following table provides a list of recommended plan elements, along with a note about scope (specific to the drainages or district-wide) and about time horizon for implementation (now, longer term or when triggered by proposed development):

Scope and Time Horizon for Plan Element Implementation

Plan Element	Scope		Horizon		
	Planning Area Specific	District-wide	Now	Longer-Term	Development -driven
Stream and ditch monitoring	✓			✓	
Stormwater system inventory update		✓	✓		
Upgrade hydrologic and hydraulic modeling	✓			✓	✓
Adopt a stormwater bylaw		✓		✓	
Adopt a stormwater user charge bylaw		✓		✓	
Revise engineering standards for drainage / stormwater		✓		✓	
Initiate stormwater education program		✓	✓		
Enhance anadromous / resident fish habitat along lower Woodburn Road	✓		✓		
Inlet improvements to culvert under highway near Robinson Road	✓		✓		
Upgrade lower Woodburn Road to low impact standards	✓		✓		
Expanded fish habitat improvements in "bog area"	✓			✓	✓
Enhance resident fish habitat in Vanstone Channel	✓		✓		
Investigate establishing compensation / mitigation banking area(s)		✓		✓	✓
Expanded anadromous fish habitat enhancement in Vanstone area, including removal of access barrier	✓			✓	✓
Implement ditch and culvert maintenance program		✓	✓	✓	
Implement CB & oil/grit chamber cleaning program		✓	✓	✓	
Implement erosion control along upper Woodburn Road	✓		✓		
Seek pilot projects		✓		✓	✓

1.0 INTRODUCTION

Integrated Stormwater Management Planning (ISMP) is a comprehensive, ecosystem-based approach to stormwater planning. The purpose is to provide a clear picture of how to be proactive in applying land use planning tools to:

- Protect property and life from flooding; and
- Protect aquatic habitat from erosion, sedimentation and water-born contaminants.

ISMP involves a two-pronged approach to the issue of stormwater management. First, it means reviewing land use policies for their impact on stormwater and then revising those policies in ways that minimize the impacts. Second, it means developing a scientific understanding of stormwater in the District's context and then applying that understanding to reduce the impacts of changed stormwater hydrology and water quality resulting from land development.

Integrated stormwater management planning requires a community's commitment to:

- A sustainable environment;
- Development that supports the long-term health of the community and the environment;
- Linking land use planning and stormwater management;
- A science-based approach to stormwater management; and
- Flood-risk management as well as Ecosystem-risk management.

Integrated stormwater management planning will often require the joint efforts of technical people such as engineers, planners, ecologists and hydrogeologists to develop an adequate scientific base for the process. Together with local staff and elected officials and with local stakeholders, the resulting plan can provide a balanced approach to stormwater management.

The District of Campbell River has embarked on its own process to address stormwater issues within the District, consistent with guidelines published by the Province for integrated stormwater planning (BCMWLAP 2002). Ultimately, the planning efforts will cover the entire District, but this current work covers only two areas or drainages, Holly Hills and Perkins Road. These drainages lie within the area of the District known as North Campbell River. The District is responsible for the construction, operation, maintenance and enhancement of stormwater systems in these areas. (See Figure 1 for general location map.)

As set forth by the District in the Terms of Reference for this project, the goals of the District's stormwater management planning are:

- Develop stormwater management solutions and policies that maintain, restore and enhance the watershed and meet engineering, environmental and land use needs;
- Protect the community from flooding, erosion and destruction of private and public property;
- Promote community development while recognizing neighbourhood values and unique characteristics of the area; and
- Integrate engineering, planning and environmental solutions for benefit of Campbell River.

District of
Campbell River

Integrated Stormwater
Management Plan

Note:
1. Based on 1:50,000 scale NTS topography map 92K/3

0 — 50 m
1:50,000 — 2.5 km

Legend:

— - — Outline of Study Area

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DATE: July, 2003

General Location Map

Fig: 1

In addition, specific objectives for stormwater planning were also established for the Holly Hills and Perkins Road Drainages:

- Document the existing conditions of the watershed including the stormwater infrastructure, biophysical inventory and existing and future land use patterns.
- Identify the required stormwater management infrastructure, including first stage flows, and land use policies necessary to balance the protection of residents and property with protection of the aquatic environment.
- Establish an achievable and supportable vision for the watersheds that will result in the protection and possible enhancement of the aquatic terrestrial environment.
- Develop decision matrices that will allow the District to analyze and evaluate options that balance the multiple needs of the community.
- Recommend an integrated approach to achieving solutions that will assist the District and its partners in establishing watershed based stormwater policies, a stormwater infrastructure program and financial tools that support the District's land use plan and capital works program.

To meet these objectives the planning process has included several open houses to provide local residents with updates and to solicit input on the stormwater issues in the area as well potential solutions. The basic tasks that are part of the overall planning process are:

- Consultation with District technical staff (engineer; planning; environmental);
- Collection and collation of existing data (including: stormwater infrastructure, water courses, fisheries and fish habitat, groundwater, rainfall and land use);
- Field visits to verify and clarify stormwater, hydrogeologic and fisheries conditions in the area;
- Direct contact with local stakeholders;
- Open Houses (two held to date; a third will be held after review of this draft by District staff);
- Analysis of existing conditions, including computer modeling of stormwater systems;
  - Hydrologic
  - Hydraulic
  - Geohydrologic
  - Fisheries
- Formulation and evaluation of alternative solutions;
  - Technical
  - Management
- Preparation and publication of draft and final plans.

As initially formulated, the planning area was split into two drainages, Holly Hills to the south and Perkins Road to the north (see Figure 2). Within these two drainages there are number of smaller catchments, each with its own outlet(s) to downstream receiving water bodies (see Figure 3). The catchment boundaries conform to the general flow patterns for stormwater runoff in the drainages. The receiving water bodies are the Campbell River, the Campbell River Estuary and the Casey Creek main branch.

The catchments shown on Figure 3 overlap with "Management Areas" identified in the Campbell River Estuary Management Plan (CREMP). All or portions of the following estuary management areas are included:

- Adjacent Area;
- North Riverbank;
- North Outside;
- Campbell River Mills;
- Island;
- Baikie's Slough;
- Ocean Cedar Area;
- North of Freshwater Marina; and
- North Shoreline.

With the exception of two catchments (Casey Creek Tributary and Campbell River), the entire stormwater planning area discharges to the Estuary. Thus there are intersecting interests between this current stormwater management planning effort and the work of the Estuary Management Commission; these will be further discussed later in this report.

District of
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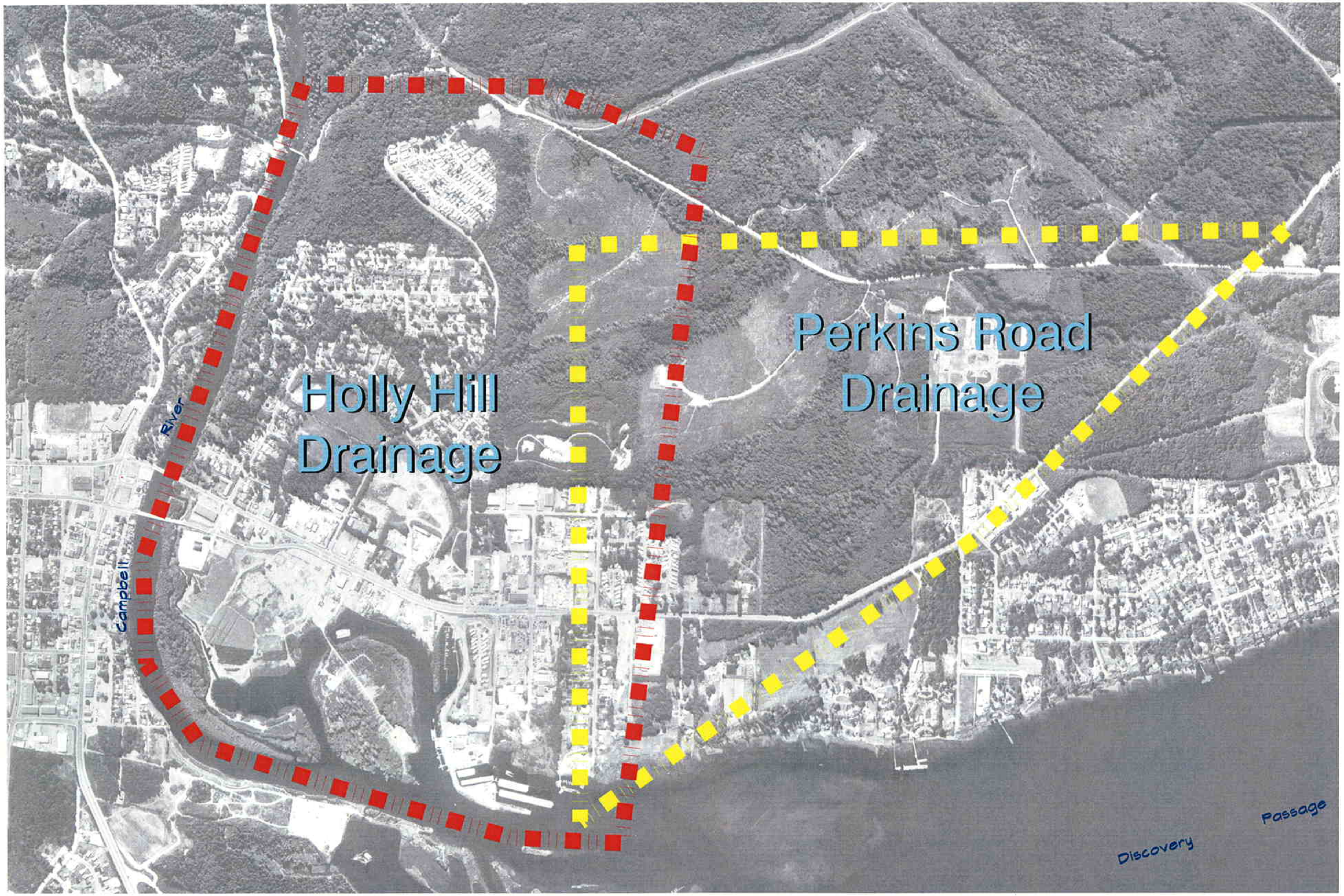
Integrated Stormwater Management Plan



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Legend:

Outline of Holly Hill Drainage Area

Outline of Perkins Road Drainage Area

Fig: 2

Planning Areas

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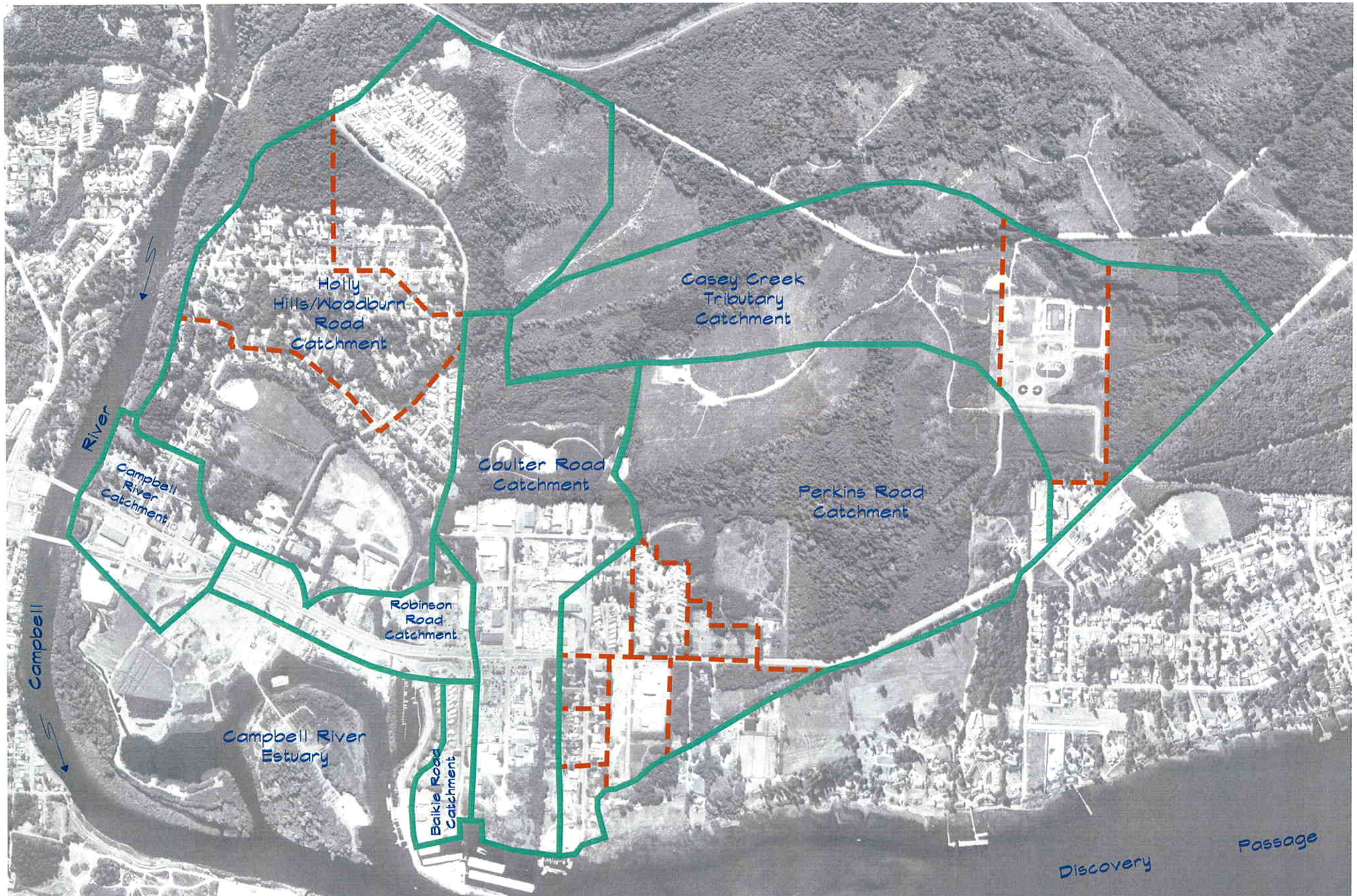
Integrated Stormwater Management Plan



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Legend:

- Catchment Boundary
- Subcatchment Boundary

Fig: 3

Catchment Layout

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2.0 STORMWATER

There was a time when people tended to think publicly about water only during two periods: When there was too little of it (drought) or when there was too much of it (flood). When it came to drinking water, the former was most on people's minds, but when it came to urban drainage, the latter tended to rule. Since the focus was on preventing flooding and thus protecting people and their property, efficiency in removal was the goal. The faster water could be moved away from flood-threatened areas, the sooner people could forget about it.

For millennia, with respect to water supply, water has been treated as a resource, that is, as something to protect and maintain. But in the latter part of the 20th century, many people began to recognize that stormwater represents a resource as well. If treated wisely, stormwater contributes to the well-being of the natural environment, including fish-bearing water-bodies and groundwater resources. But if treated unwisely, stormwater can become a nuisance at best or a serious factor in environmental degradation at worst.

2.1 The Hydrologic Cycle

Rain that falls on any piece of land, whether natural or built, can basically move in only four directions:

- Back into the air via evaporation from surfaces and transpiration from leaves (*evapotranspiration*)
- Into the soil via soaking where it can move slowly to streams (*interflow*)
- Into deep groundwater via seepage (*groundwater recharge*)
- Directly into streams via the land surface or built structures (*surface runoff, or stormwater*)

Surface runoff from a forested or naturally vegetated watershed is very small, representing 10% or less of rainfall volume in many cases. Except during occasional extreme rainfall events, the flow that is observed in streams (commonly called *base flow*) is actually a product of interflow. Land development alters this natural water balance. When natural vegetation and soils are replaced with roads and buildings, less rainfall infiltrates into the ground, less is taken up by vegetation and more becomes direct surface runoff. Runoff volumes increase in direct proportion to impervious area – land uses with extensive roof and paved area create more runoff than land uses with extensive areas of absorbent soils and forest cover. (See Figure 4.)

Example Annual Water Balance

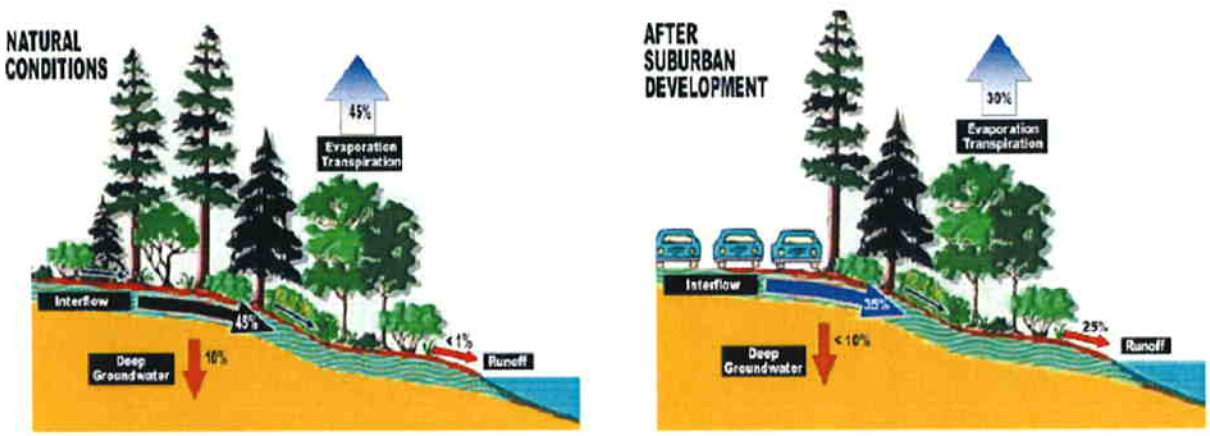


Figure 4: Typical annual water balance for the Lower Mainland British Columbia (Source: BC Guidebook)

Work at the Center for Urban Water Resources (University of Washington) clearly demonstrates that the most important impacts of development (urbanization) on streams, in order of importance, are*:

- Changes in hydrology
- Disturbance of the riparian corridor
- Deterioration of water quality
- Disturbance of the physical habitat within the stream

In addition to these ecological impacts of development, if these impacts are not avoided, there can also be serious legal, financial and political implications.

These impacts are discussed in more detail in the paragraphs that follow.

2.2 Hydrology

One of the major impacts of urbanization on streams is its effect on stream hydrology. Hydrology is defined as the study of the movement (or flow) of water in all its phases. Understanding water balance is essential to understanding the impact of development on the hydrology of streams.

Water balance, as shown in Figure 4, is the concept that the sum total of rainfall is equal to the amount of rain infiltrated (interflow), absorbed (deep groundwater), and evapotranspired, plus the volume of runoff generated from the watershed. In a pre-developed setting, much of the rainfall is absorbed by the surrounding vegetation, soil and ground cover. In a developed setting, the water balance changes and a disproportionate amount of rainfall becomes surface runoff.

* Integrated Stormwater and Stream Corridor Management forums, 2001

The changes in the water balance in urban streams are exemplified by increased flood peaks, increased frequency of bankfull flows, widening of the floodplain and decreased dry weather flows. Bankfull flows are simply runoff events that fill the normal channel of a stream to the top of the banks. Bankfull flows are significant because they are the channel forming flow condition in a stream and they are highly erosive, turbid ("cloudy"), and damaging to the natural morphology of the stream. (See Figure 5.)

Further, traditional pipe and ditch systems were designed to remove runoff from impervious surfaces as quickly as possible, and deliver it to receiving waters. With increased land development, stormwater arrives at the receiving waters much faster, which in turn increases the peak rate of flow.

By the time a watershed is fully developed with buildings, roads and parking lots, 15 to 20 times more runoff can occur as compared to measurements prior to development.

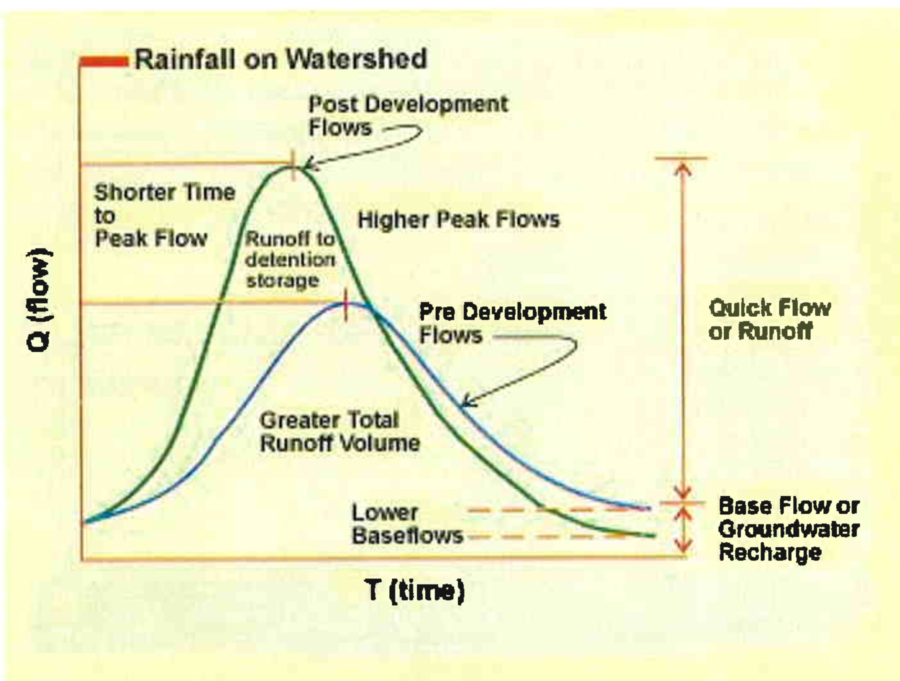


Figure 5: Change in streamflow with urban development

2.3 Disturbance of Riparian Corridor

Generally, most streams begin to enlarge as impervious cover exceeds 10% in the watershed. The enlargement process may take up to 50 years to fully occur, but urban streams with more than about 10% impervious cover are characterized by various degrees of stream enlargement and widening, erosion, downcutting, decreased channel stability, and embeddedness. An undeveloped watershed with less than about 5% impervious cover is characterized by excellent stream conditions— good riparian cover, high quality substrate (stream bottom), and wetted perimeter during low flow conditions.

Even though a developed area does not entirely encompass a watershed, the sections of a stream that are located downstream are likely to experience these changing conditions.

2.4 Deterioration of Water Quality

In addition to hydrologic changes and changes to the riparian corridor of the stream, urbanization directly impacts the quality of the receiving water. Some of the indicators of the impact of urbanization on water quality include increased stream temperature and pollutants.

Stream temperature is a very important habitat parameter for fish and insects, and temperature variability can dictate the growth of aquatic insects and timing of migration and molts. Impervious cover increases air and soil water temperatures and can create an increase of 3-6°C in urban streams.

In addition to increased stream temperature, urbanization can increase the amount of pollutants entering water bodies, such as sediment, nutrients, organic matter, trace metals (copper, cadmium, lead), pesticides, herbicides and hydrocarbons, and others. During storm events, the quality of urban stormwater declines sharply which adversely affects human and aquatic uses of downstream waters.

The sources of pollutants in stormwater are predominately associated with impervious areas. Impervious areas act as a collector and conveyor for pollutants that arrive from many pathways. Pollutants can fall out of the sky during dryfall. They may also arrive in rain or snow as wetfall. Automobiles are also sources of pollutants. Wear of tires (a known source of zinc), deteriorating brake pads, or just leaks, drips and spills of oil and other pollutants from the car can accumulate on impervious surfaces. Pollutants can also be blown in from adjacent pervious areas. Pollutants land on the street where they often stay in curbs, cracks and other areas until the next rain storm where they are washed off the surface and into the storm drain system and ultimately to receiving streams.

Excess nutrients (such as nitrogen and phosphorous) can create eutrophic conditions that can lead to uncontrolled algal growth that consumes oxygen in shallow, slow-moving waters and may create fish kills, odours, and other problems.

Another common pollutant in urban stormwater is sediment. Sediment can smother bottom organisms and it can clog gills of fish and aquatic insects when it is in the water column. Sources of sediment include streambank erosion, construction sites, and the wash off from paved surfaces.

Fecal coliform levels in urban stormwater runoff are typically 15 to 50 times the standard set for water contact recreation. Fecal coliform can be derived from human and nonhuman sources. In fact, research indicates that much of the fecal coliform in urban runoff is from nonhuman sources such as dogs, cats, cattle, horses, squirrels, geese, pigeons, and ducks. However, very high levels of bacteria may be due to leaks of human sewage from sanitary sewer overflows, leaking septic systems, combined sewers or illicit discharge of sewage.

Stormwater hotspots are areas that produce higher concentrations of pollutants than normally found in urban runoff. Certain areas of the urban landscape are known to be hotspots of stormwater pollution. Examples include gas stations, parking lots, and auto recycling facilities. Generally, stormwater hotspots contribute 5 to 10 times higher concentrations of trace metals and hydrocarbons in stormwater runoff. These hotspots merit special management and pollution prevention activities.

Trace metals are frequently found in urban stormwater and sometimes at concentrations that can be acutely toxic to aquatic life. In nearly every stormwater sample, one generally will find zinc, copper and lead. Hydrocarbons, zinc, copper, cadmium, and lead are known to accumulate in the tissue of fish. In some cases, this may make the fish unsuitable for human consumption.

2.5 Disturbance of the Physical Habitat Within a Stream

Along with changes in hydrology, riparian corridor, and water quality, the habitat value of urban streams diminishes with increased impervious cover. There are numerous impacts to the aquatic habitat as well as the riparian corridor, particularly along the stream side zone.

The creation of fish barriers is another impact of urban development. Barriers can prevent the movement of fish. In some cases, the fish barriers are created by culverts that are put in stream crossings for roads and other urban infrastructure. As the stream erodes down, vertical barriers to fish movement are created that cut off spawning areas. Fish that are trying to move up stream to spawn in spring will likely encounter fish barriers that they cannot surmount.

Pipes such as culverts and storm sewers are typically much smoother than a natural stream. Thus, they tend to produce higher velocities of water flowing through them. Further, long culverts and storm sewers do not provide natural resting areas and cut off access to natural light. All of these effects tend to act as barriers or restrictions to fish movement.

2.6 Integrated Stormwater Management

Integrated stormwater management is comprehensive and ecosystem-based; it attempts to take into account the scientific and technical knowledge that has been gained over the last 40 years concerning the impacts of land development on watersheds. As a result, stormwater management has undergone evolutionary growth in its scope and in its perspectives. At first focusing almost exclusively on removing runoff from developed areas quickly and efficiently, we are now coming to know the importance of considering all aspects of the hydrologic cycle, including understanding how land use development decisions can lead to disruption of that cycle. Further, we are beginning to see the value of eliminating causes of stormwater problems, rather than dealing only with the consequences of our land use decisions.

The recently released provincial guidelines for stormwater control represent one approach to integrated stormwater management planning. The guidelines are consistent with recent thinking across North America about urban drainage. As noted in Section 1, the District views the current planning for the Holly Hills and Perkins Road Drainages in the context of these provincial guidelines, which offer the following guiding principles for integrated stormwater management:

1. **A**gree that stormwater is a resource
2. **D**esign for the complete spectrum of rainfall events

3. **A**ct on a priority basis in at-risk drainage catchments
4. **P**lan at multiple scales – regional, watershed, neighbourhood and site
5. **T**est solutions and reduce costs by adaptive management

With respect to the second principle, the general approach is to:

- Capture rainfall from small storms (runoff volume reduction and water quality control);
- Control runoff from larger storms (runoff rate reduction); and
- Manage flood risk for extreme storms (peak flow conveyance).

In the past stormwater management has focused almost exclusively on this final item, extreme event risk management. But from the standpoint of, for example, fisheries, it is the small, frequent storms and water quality that are of much more interest.

3.0 GENERAL DESCRIPTION

3.1 Physical Descriptions of Drainages

The Holly Hills and Perkins Road Drainages are located in an area of the District known as North Campbell River. The Holly Hills Drainage, bounded by the Campbell River on the south and the Campbell River Estuary on the east, covers about 265 ha and generally consists of mixed residential, commercial, industrial and open space land uses. The recently completed Island Highway cuts north to south in the eastern third of the drainage.

The Perkins Road Drainage is a triangular shaped area of approximately 319 ha which lies immediately north of Holly Hills. Although some portions of this area are developed (residential and commercial), the drainage consists largely of forest, wetland and general open space. The District's wastewater treatment plant is located within this drainage. A tributary of Casey Creek drains the western part of this drainage.

Both drainages generally slope from west to east, although the tributary of Casey Creek flows north on the western edge of the Perkins Road drainage. Ground elevations vary from about 70 m at the upper ends to 3 m along the River and Discovery Passage.

3.2 Historical Background

Members of the MacDonald family were the first non-natives to settle in North Campbell River in 1912. Other families, such as the Perkins', Vanstone's and Hudson's, soon arrived to farm in the area. The Baikie family started Raven Industries (called the Beecher Lake Lumber Company prior to 1961), which continues to have a strong presence in the town today. Campbell River grew to a sufficient size to allow them to incorporate in 1947. The town was later incorporated as a District Municipality in 1965, which in turn later grew to include North Campbell River. During this same period, the Campbell River First Nations band was also growing and evolving; the Band became fully self-governing by the 1980's.

During the 1950's, the population in Campbell River rose an estimated 45%. This rapid increase was in response to the openings of the John Hart Hydroelectric Dam in 1949 and the Elk Falls Pulp and Paper Mill in 1952. Both industries created job opportunities that enticed many families to relocate to the town. To accommodate this growth, a few surplus homes from Vancouver were shipped intact to Campbell River, where they were situated on Vargo Road to establish the beginnings of a neighbourhood.

Up to this time, development in North Campbell River was limited by a lack of access, as only a small wooden bridge was in place across the river. Pressure from the mill prompted construction of a new bridge in 1952 to provide access for mill employees. Several homes were built in the area shortly thereafter, with growth continuing until today. The main highway was upgraded and paved as far north as Port Hardy in 1979, and rebuilt in the late 1990's.

The main industries in Campbell River up to the 1950's were fishing and logging. While they are still significant industries today, tourism has also become a major source of income for the town, as Campbell River has become a popular destination for eco-tours.

Archive records on the history of watercourses and streams in North Campbell River (i.e., Holly Hills and Perkins Road Drainages) are incomplete. Most watercourses in the area apparently were drainage ditches for farming activities. Based on discussions with local residents, salmon were often seen in these ditches. Fish sightings in the ditches have dropped off over the years, particularly with the increase in industrial and road development along the water. However, sightings have been reported in the past few years, notably along Perkins and Woodburn Roads.

3.3 Land Use

North Campbell River is a moderately developed section of the District, with significant areas of wooded and open spaces as well as areas with commercial and industrial properties. Within the Holly Hills Drainage, a swath of mixed residential, commercial and industrial development generally lies along, and to either side of, the Island Highway. In the Perkins Road Drainage, these uses give way to open space as the highway proceeds north.

The largest contiguous currently developed residential land in North Campbell River is located in the upland area of Holly Hills Drainage. This area consists of single family residences, including a large trailer home park to the west, adjacent to Elk Falls Provincial Park. A second trailer home park is situated just north of Perkins Road, to the west of the Island Highway, in the Perkins Road Drainage.

Other significant land uses within the two drainages include:

- The District's wastewater treatment plant that covers about a 9 hectare plot along the Casey Creek Tributary;
- An industrial area in the Campbell River Estuary east of the Island Highway that was previously developed, but is currently in transition;
- A large wooded, wetland area on the upper reaches of the Casey Creek Tributary;
- Large open spaces of woods or cut-over woods in the Perkins Road Drainage; and
- Elk Falls Provincial Park, in the southwest part of Holly Hills Drainage.

From a stormwater management perspective, the most significant land use factors to consider are wooded (forest) area and impervious area. Recent studies consistently show that healthy watersheds in this region of North America are characterized by high percentages of forest area (generally >65%) and low percentages of impervious area (generally <10%). Outside these ranges, streams tend to exhibit the variety of hydrologic and ecologic changes described in Chapter 2.

Table 1 shows the percentages of forested area and impervious area within the Holly Hills and Perkins Road Drainages for three periods: "pre-1900's" (i.e., "undeveloped conditions"); existing; and future based on current zoning patterns shown in the District's Official Community Plan (OCP). (See also Figures 6, 7 and 8.)

As shown in Table 1, significant portions of all the catchments, except Perkins Road and Casey Creek Tributary, exceed the 10% impervious threshold. Further, all of the catchments are under the 65% forested area threshold. (However, both Perkins Road and Casey Creek catchments have significant open space areas, about 35% and 55%, respectively, for which the forest canopy has been cleared. These areas are otherwise basically undeveloped and all or part could be reforested or managed in ecologically sensitive ways.)

Table 1: Forested and Impervious Areas, by Catchment

Catchment	Forested Area (%)			Impervious Area (%)		
	Pre-1900's	Existing	Future (Potential)	Pre-1900's	Existing	Future (Potential)
Holly Hills / Woodburn Road	100	35	35	0	25	45
Campbell River	100	15	15	0	50	70
Robinson Road	100	5	5	0	70	80
Baikie Road	100	10	10	0	70	80
Coulter Road	100	10	10	0	60	70
Perkins Road	100	60	15	0	10	45
Casey Creek Tributary	100	45	20	0	5	25

Future conditions based on current zoning (as listed in OCP) and assuming no application of low impact development practices to reduce affects of impervious area on area hydrology.

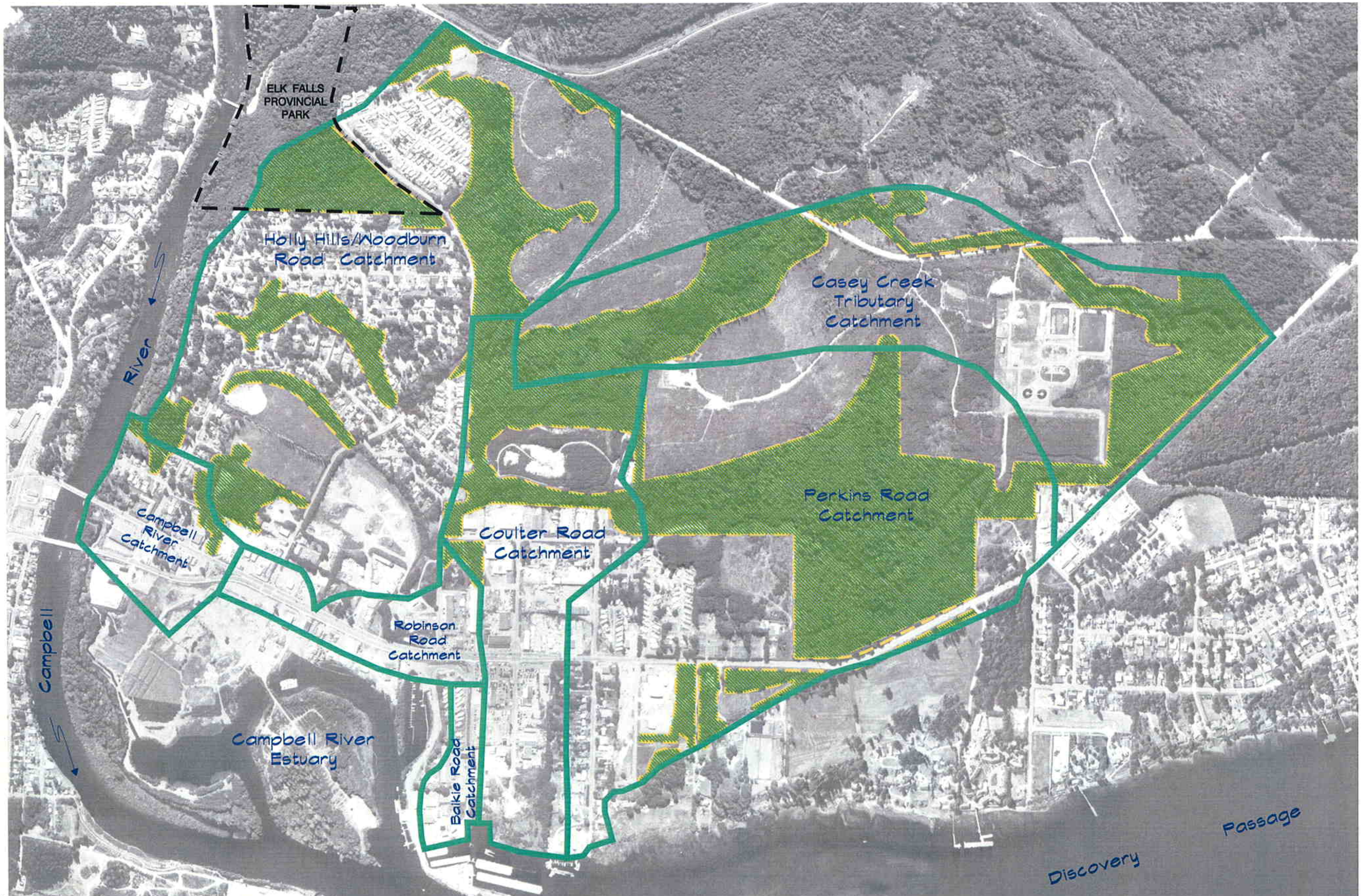
Several features of land use within North Campbell River are particularly significant to the discussion at this point. First, an "urban residential containment boundary" splits the planning area roughly in half (See Figures 7 and 8). West of this boundary, urban residential development is prohibited (the area is generally zoned RI-1 "Residential Infill One") and hence conversion of land to impervious surfaces will tend to be limited. This of course also means that changes in imperviousness will generally occur in the eastern half of the planning area.

Second, the urban uplands area of the Holly Hills / Woodburn Road Catchment is generally fully developed with single family residences and this probably will not change in the foreseeable future. Thus, management is more likely to focus on remedial rather than proactive stormwater controls. Remedial stormwater management will likely predominate in other established areas as well, including:

- Both mobile home developments within the planning area;
- Residential area along lower Park Road;
- Residential area along Perkins Road, east of the highway;
- The commercial / industrial areas west of the highway, between Meredith Road and Perkins Road; and
- The commercial areas along the highway just north of the River.

District of Campbell River

Integrated Stormwater Management Plan



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Scale 1:10 000

Legend:

- Catchment Boundary
- Area of Woods/Forest
- Provincial Park Boundary

Fig: 6

Forested Lands

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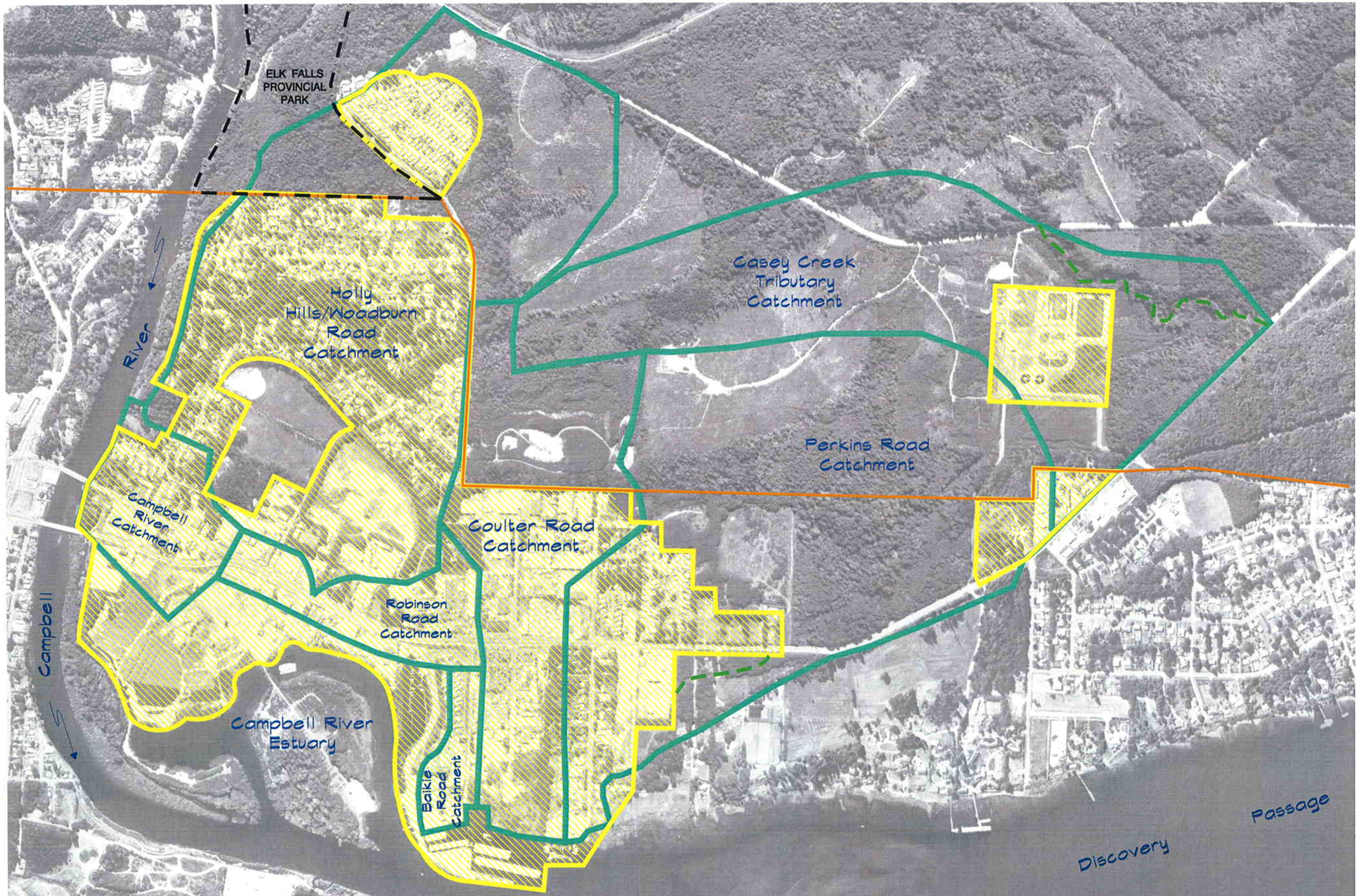
PROJECT No: 1479.0003.01

DATE: July, 2003

District of Campbell River

Integrated Stormwater Management Plan



Legend:

- Catchment Boundary
- Areas Currently Developed
- Provincial Park Boundary
- Urban Residential Containment Line
- Greenways

Fig: 7

Existing Developed Lands

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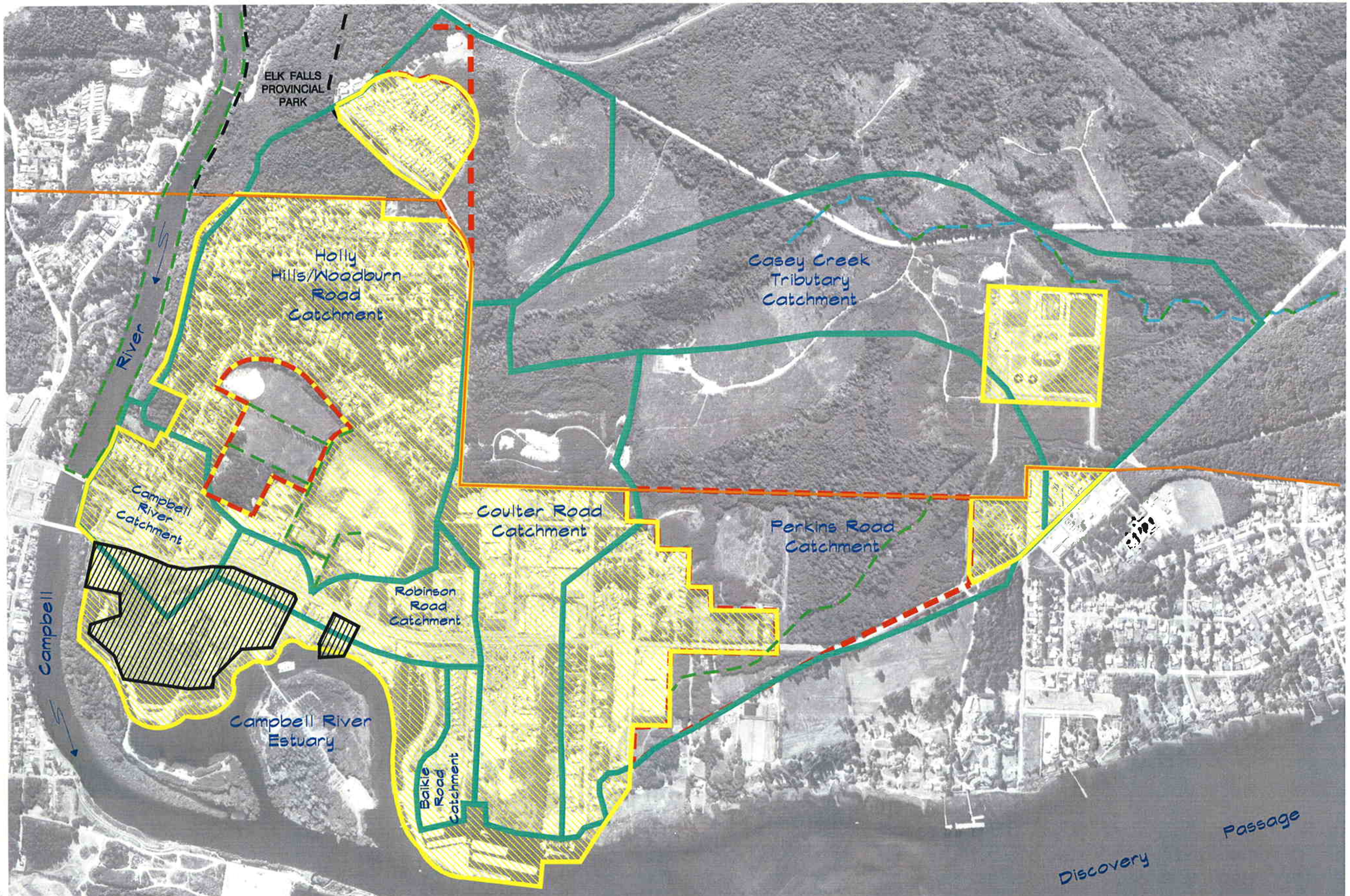

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Scale 1:10 000

Legend:

- Catchment Boundary
- Areas Currently Developed
- Areas of Potential Development
- Areas of Potential Redevelopment ("Raven Plan")
- Provincial Park Boundary
- Urban Residential Containment Line
- Greenway Water Development Permit Areas

Fig: 8

Potential Future Developed Lands

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Third, a significant portion of the land along the Vanstone Channel and contributing upland areas west of the highway is designated "Urban Reserve" in the OCP. This includes essentially all land east of the urban residential containment boundary line and north of both the cemetery and Vanstone Road. Development in this area is not generally anticipated for at least 8 to 15 years. This time horizon represents a window of opportunity for the District to fully implement stormwater controls in this area before development occurs.

Fourth, the OCP explored a variety of approaches for accommodating the growth likely to occur in Campbell River over the next dozen years (to 2014). Within North Campbell River the OCP anticipates that the most significant element of growth (up to 3,050 new households) will be in conversion of lands adjacent to the Estuary from predominantly industrial to commercial / residential use. This conversion presents a challenging opportunity to implement more environmentally responsible stormwater controls. Because runoff in these areas discharges directly to the tidal waters of the estuary (rather to streams or ditches), downstream flooding is generally not an issue. Rather, stormwater quality (including erosion and subsequent downstream sedimentation) will be the primary focus of stormwater management.

Finally, as described in the OCP, pressure for new development in Campbell River generally centers on other parts of the District (notably the south) rather than North Campbell River. Except as noted for the potential conversion of lands near the estuary, in-filling will be the primary mode of growth in the north. Stormwater controls can be applied to such development, but will also need to be carefully integrated with current practices in the surrounding area. For example, the use of swales as a best management practice will be limited in an area otherwise already utilizing storm sewers.

3.4 Hydrologic Conditions

Precipitation in Campbell River is typical of the area, with most falling in the form of rain. The average annual rainfall is 1335 mm per year, with snowfall averaging only about 110 mm/year. The monthly distribution of this rainfall over the course of a year is shown on the chart in Figure 9. From 36 years of record at the Campbell River Airport (1965 through 2000), the Mean Annual Rainfall (MAR) peak storm event is 55 mm per day. Rainfall events tend to be of long duration but relatively low intensity. Over the period of record, about 95% of all rainfall events in the District yielded total rain amounts of less than half the MAR, or 27.5 mm, while only 0.4% exceeded the MAR. This is not atypical for areas within coastal British Columbia. (See Figures 10a and 10b.)

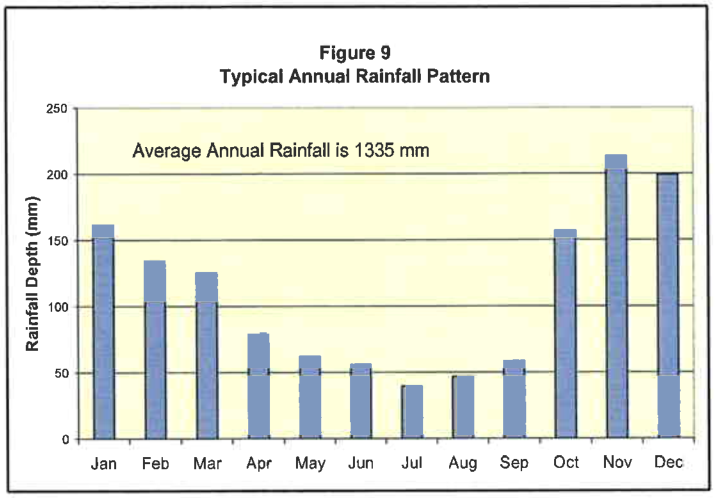
Figure 9
Typical Annual Rainfall Pattern
Average Annual Rainfall is 1335 mm
Rainfall Depth (mm)
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

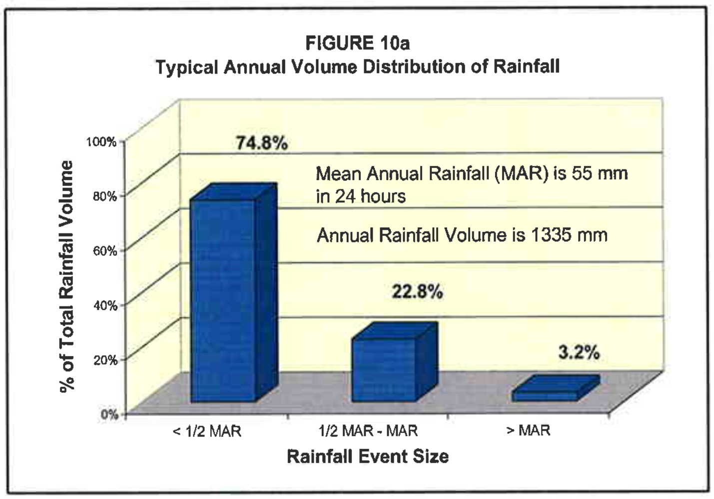
FIGURE 10a
Typical Annual Volume Distribution of Rainfall
% of Total Rainfall Volume
100%
80%
60%
40%
20%
0%
74.8%
Mean Annual Rainfall (MAR) is 55 mm in 24 hours
Annual Rainfall Volume is 1335 mm
22.8%
3.2%
< 1/2 MAR
1/2 MAR - MAR
> MAR
Rainfall Event Size

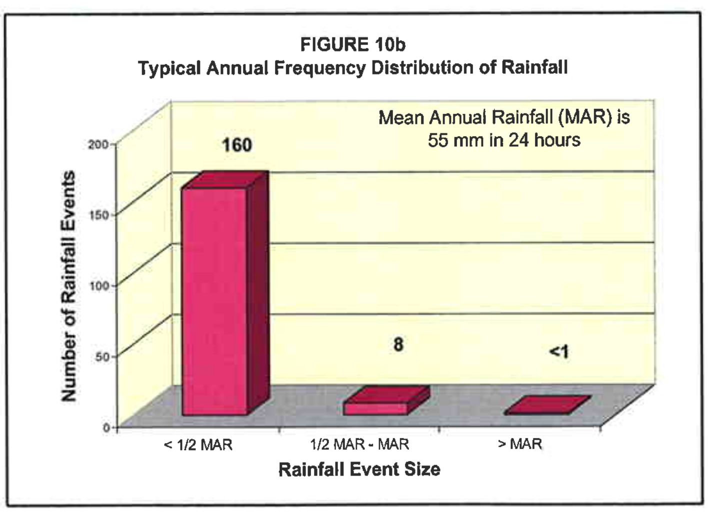
FIGURE 10b
Typical Annual Frequency Distribution of Rainfall
Mean Annual Rainfall (MAR) is 55 mm in 24 hours
Number of Rainfall Events
200
150
100
50
0
160
8
<1
< 1/2 MAR
1/2 MAR - MAR
> MAR
Rainfall Event Size

The rainfall record is of insufficient length to firmly estimate the most extreme storm event conditions, such as the 100-year recurrence storm*. However, based on the records at the airport, Table 2 shows the estimated peak 12- and 24-hour rainfall depths for various recurrences:

Table 2: Design Storm Rainfall Depths

Recurrence (Year)	**12-Hour Rainfall Depth (mm)**	**24-Hour Rainfall Depth (mm)**
2	44	52
5	53	65
10	59	74
25	64	84
100	78	100

Runoff from both drainages typically consists of sheet flow draining to open ditches and through culverts. In general, enclosed storm sewer systems are only located along the southern sections of the Island Highway as it travels through the commercial industrial area just north of the Campbell River. (See Figures 11 and 12.)

Elk Falls Provincial Park and a sliver of land along the Campbell River, in the southwest portion of the Holly Hills catchment, drains directly to the river. Large areas in and around the lower reaches of Campbell River and Baikie Slough (including Baikie Island) drain overland directly into the Estuary.

In the Holly Hills Drainage, storm sewer systems discharge into the Campbell River near the Island Highway crossing (3 separate outfalls), into Baikie Slough near the end of Robinson Road, and into the very lower end of the Estuary at Bakie Road and again between Coulter and Perkins Roads. These systems directly service the highway as well as commercial and industrial areas along the highway.

Stormwater from the large residential area in the uplands of Holly Hills Drainage is conveyed out of the lowland area along Woodburn Road via an old culvert under the Island Highway. This culvert is apparently not connected to the storm sewers along the Highway.

There is only one natural stream of significance within the two drainages, a tributary of Casey Creek. This stream drains the eastern 40% of the Perkins Road Drainage. With the exception of the "industrial use" represented by the District's wastewater treatment plant, the Casey Creek Tributary catchment generally consists of open space (forest or cutover forest). A large wetland area lies at the upper end of the creek, near the divide with the Holly Hills / Woodburn Road catchment to the south.

* The 100-year recurrence event is a storm anticipated to occur on average once in 100 years or, put another way, it is a storm with a 1% chance of occurring in any year. Similarly the 2-, 5- 10- and 25-year recurrence events have 50%, 20%, 10% and 4% chances, respectively, of occurring in any year.

District of Campbell River

Integrated Stormwater Management Plan

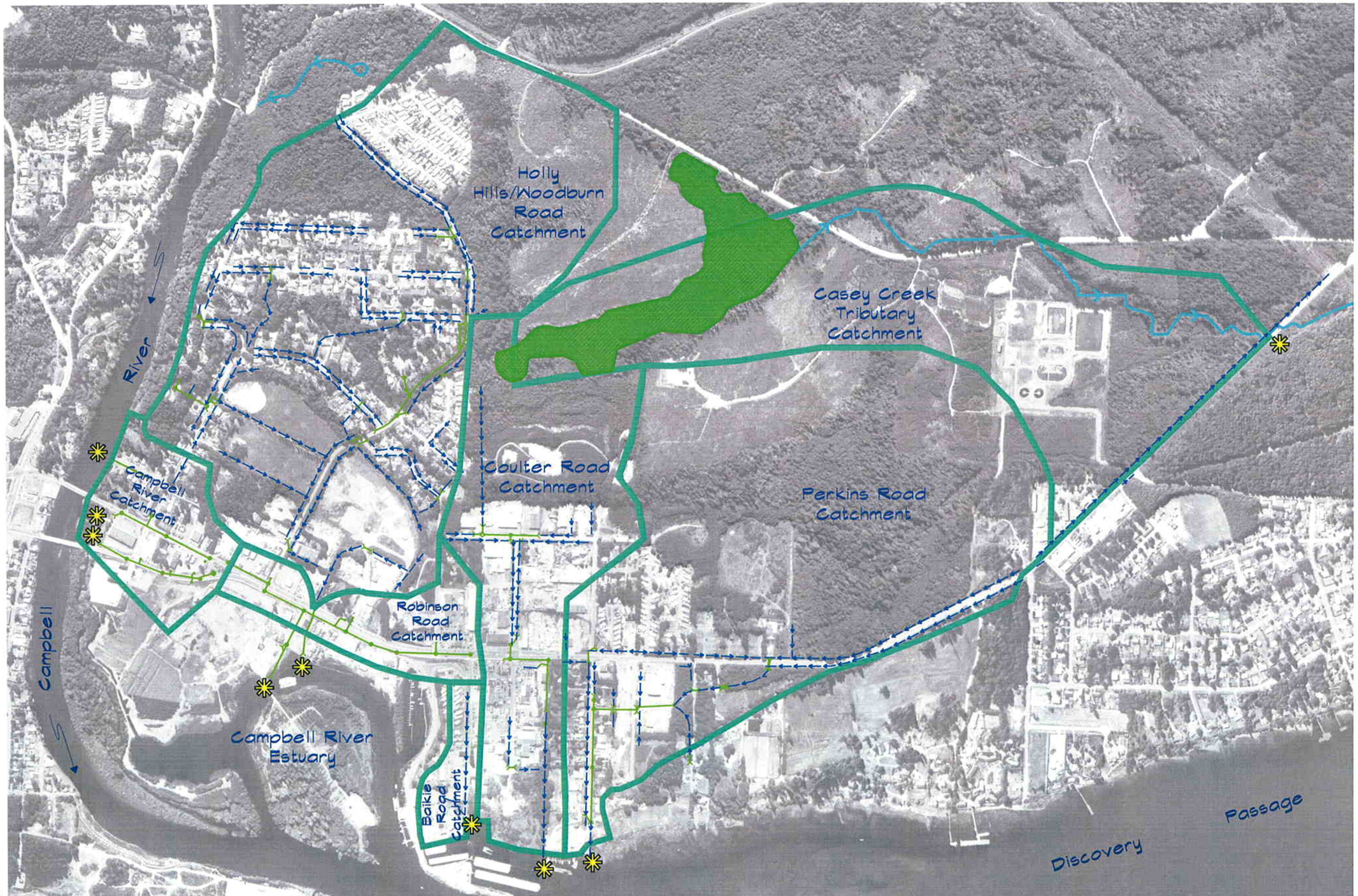

Fig: 11

Existing StormWater Features

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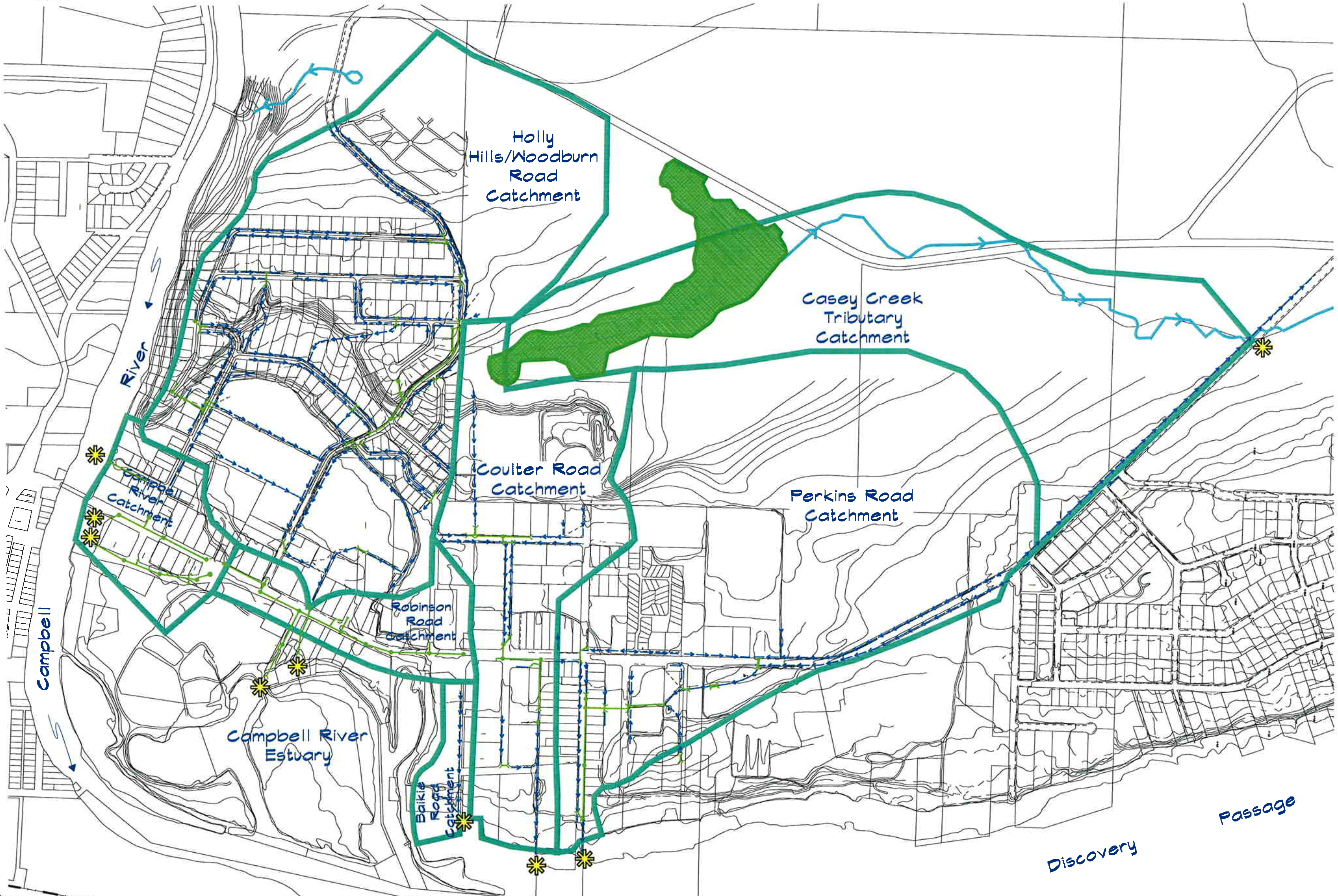
Integrated Stormwater Management Plan



N

Scale 1:10 000

Legend:

- Catchment Boundary
- Storm Sewer/Culvert
- Existing Ditch
- Catchment Outlet
- Wetland
- Stream

Fig: 12

Topography and Stormwater Systems

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An area of mixed residential, commercial and industrial uses located in the southeast part of the Perkins Road Drainage is serviced directly by storm sewer. Most of the uplands away from the Island Highway are similar in character to the Casey Creek Tributary's catchment, with mostly forest and cutover forest. This system discharges into a short section of ditch that flows to the lower Campbell River Estuary at the end of Perkins Road.

Hydrologic modeling using a computer model (XP-SWMM) was undertaken to gain a better understanding of the existing drainage conditions. The attached Figures 11 and 12 show the extent of the modeling, including the general drainage patterns and layout of sub-catchments. These models are based only on readily available land use, topographic, rainfall and drainage system data. No stream flow gauging data was available for model calibration, so the results should be considered preliminary at best. The models were run for both existing and future land use conditions, using "design storm" rainfall. For future conditions, it was assumed that no stormwater controls had been initiated within the catchments. The computed values for the 10-year recurrence storm event at key locations are shown in the following table; Appendix D contains a more complete listing of results.

Table 3: Estimated Storm Discharges

Catchment	Overall Drainage	Area (ha)	12-Hour, 10-year Recurrence Storm (L/s)	
			Existing	Future
Holly Hills / Woodburn	Holly Hills	100	570	680
Campbell River	Holly Hills	13	130	180
Robinson Road	Holly Hills	13	180	200
Baikie Road	Holly Hills	5	70	80
Coulter Road	Holly Hills	38	430	490
Perkins Road	Perkins Rd	89	290	700
Casey Creek Tributary	Perkins Rd	78	350	390

Appendix D also includes a preliminary evaluation of the hydraulic capacity of the various culverts and storm sewers in the area. In many cases, there is insufficient data available to definitively determine and assess current capacity. Nonetheless, based on the modeling completed to date, the existing stormwater infrastructure generally has sufficient hydraulic capacity to meet current District drainage standards for existing land development.

3.5 Campbell River Estuary

A key feature of the planning area is the 100-hectare Campbell River Estuary, which is the receiving water body for most of the runoff generated in the Holly Hills and Perkins Road Drainages. Though located in an area heavily altered and influenced by human activities, the Estuary nonetheless represents a significant natural resource for the area, providing both habitat and passage for fish and for other wildlife including otter, seal, Trumpeter Swans and eagles.

The Campbell River, a Provincial Heritage River, drains an area of 1800 km^2, making it the third largest river system on Vancouver Island. Three impoundments and numerous diversions impact the flow of the river to the Estuary. Average flows in the River are about 100 m^3/s, but can reach over 700 m^3/s. These flows are highly variable on a day to day basis due to the upstream regulation and diversions that occur.

The Estuary lies in and along a single main channel. Older meander beds have generally been abandoned as flows have been regulated and the landscape modified by humans. Though originally a natural slough, Baikie's Slough has been heavily altered by dredging and industrial activities. This highly degraded estuarine area receives nearly all the runoff from the Holly Hills Drainage.

Tidal currents within the Estuary tend to be weak. Thus sediments that enter the waters of the Estuary are likely to remain, particularly if deposited in backwater areas such as Baikie's Slough.

3.6 Hydrogeologic Conditions

Data on geology, surficial soils and groundwater movement within the area is very limited. Based on a review of available test pit data, in-field observations, anecdotal information and comparison with other areas of similar geologic profiles, the following conceptual model has been developed. See Appendix B for the complete hydrogeology report.

Surficial soils in the area typically have a dominant sand and/or loam texture. The drainability of these soils ranges from imperfect (the Boswer soils) to rapidly drained (Qualicum soils). The approximate extent of these units is shown on Figure 13.

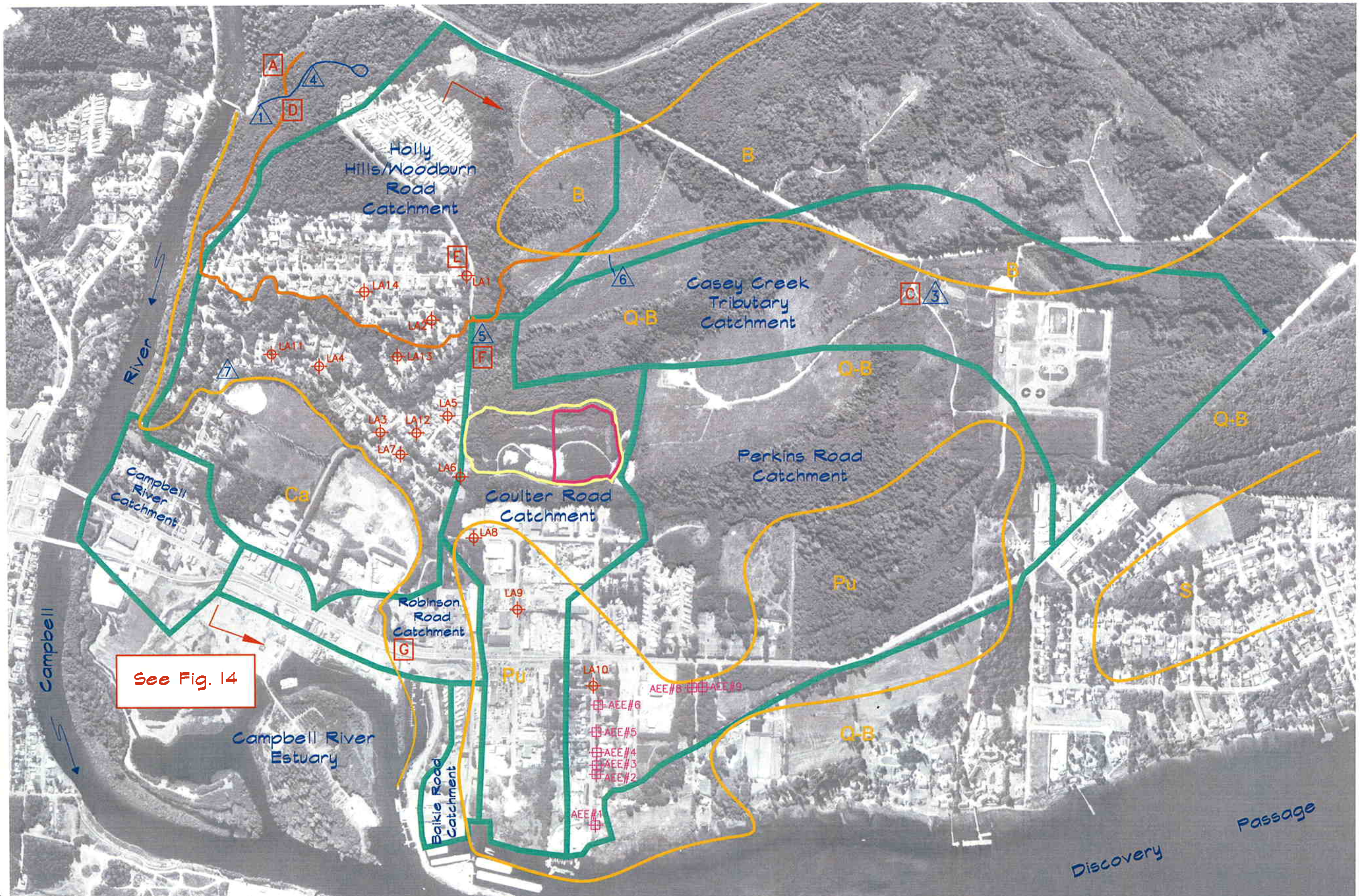
As shown on Figure 14, the study area is underlain by unconsolidated fluvioglacial, glacial and marine sediments. A typical profile for these sediments is: 0.5 to 3 m of marine sand and gravel, atop about 2 to 10 m of glacial till (typically a dense silty clay), overlying a well sorted, fine to coarse grained dense sand unit, known as the Quadra Sand. The Quadra Sand unit consists mainly of sand, but it does have some beds of clay, silt and gravel, generally representing less than 10 per cent of the unit.

The upper silt-clay (till-like) unit is present only in the southwest corner of the planning area (Holly Hills area). This unit appears to have a generally flat contact surface with the underlying Quadra Sand unit. The interpreted elevation of this contact is about 39 m MSL. The Quadra Sand unit then extends down to an elevation between 10 and 20 m MSL. Another silt-clay unit appears to underlie the Quadra Sand, with a potential deep sand aquifer yet below that (below approximately mean sea level).

Precipitation falling on the area tends to runoff the land surface in the capped area where the upper silt-clay unit is present (Holly Hills area), while areas with no cap quite likely experience a more significant infiltration rate. Some of the precipitation falling on the upland area seeps into the ground, and likely flows along the surface of the till cap until it either finds a place where it can seep through, or continues to flow to the outer edge. Either way, it typically flows into and through the Quadra Sand that lies below (see Figure 14). Once water enters the Quadra Sand unit, it likely migrates down to the top of the lower silt-clay unit and then along the surface of the unit. While some of this groundwater continues to seep down through the lower silt-clay unit, there is evidence that most of it migrates onto the slope along Spring Road.

District of
Campbell River

Integrated Stormwater Management Plan



N

Scale 1:10 000

Legend:

- Catchment Boundary
- Test Pit (by others)
- Borehole (by others)
- Soil Observation (See Text)
- Surface Water Measurement Station (See Text)
- Extent of Former Sand Extraction Area
- Landfilled Logging Woodwaste
- Estimated Limit of Silty Clay (Till) Cap
- Approximate Boundaries of Soils Units From Regional Scale Mapping.

B = Bowser Loamy Sand

Ca = Cassidy Gravelly Loam and Loamy Sand

Pu = Puntledge Fine Sandy Loam

Q = Qualicum Loamy Sand and Gravelly Loamy Sand

S = Shawnigan Gravelly Sandy Loam

Fig: 13

Surficial Soils

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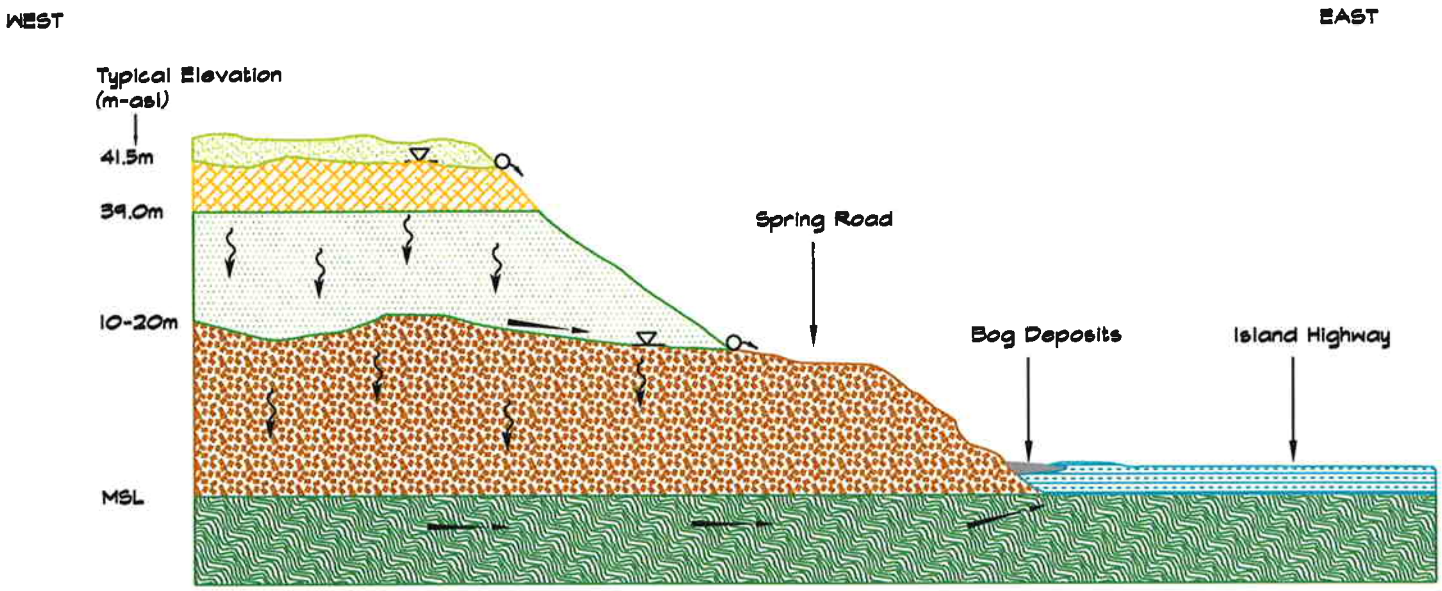
Integrated Stormwater Management Plan



Legend:

- Upper Sand Unit
- Upper Silt-Clay Unit (till like)
- Lower Sand Unit ("Quadra Sand")
- Lower Silt-Clay Unit
- Recent alluvial and marine sediments
- Potential deep sand aquifer
- Inferred groundwater flow parallel to the plane of the section
- Groundwater table
- Spring or seepage discharge line
- Postulated unsaturated groundwater flow

Fig: 14

Typical Soils Profile and Conceptual Groundwater Model

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DATE : July, 2003

Note: Drawing derived from Piteau Associates Report (See Appendix B).

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There is also a potential for a groundwater discharge along the toe of the slope east of Spring Road. This discharge likely comes from permeable units located below sea level. This is illustrated as a potential deep sand aquifer on Figure 14, with a potential discharge into the low-lying boggy area south of Woodburn Road, located below an elevation of about 4 m MSL. Local resident testimony seems to confirm this.

A large sand quarry was developed on property located at the north end of Vargo Road. The bottom of this 11m deep excavation is about elevation 21.5 m MSL. According to a representative of the property owner, the base of the pit has remained relatively dry and there has not been much evidence of groundwater inflow. This observation is consistent with the lower silt-clay zone being below elevation 21.5 m MSL and the Quadra Sand unit being relatively permeable. However, recent comments by one resident suggest that the area "behind" the northern part of this former pit is "wet all the time." This comment suggests that surface and shallow groundwater from the area located northwest of the pit may be flowing into the ditch to the northeast of the log waste landfill, and is contributing to flow in the Vigar Road Ditch drainage network.

The Vancouver Island Health Region cited, among other things, high water tables as a rationale for construction of sanitary sewers along parts of Woodburn, Spring and Rainbow Roads. The conceptual groundwater flow model presented here is consistent with this observation. Since the sewer pipes were installed in the late 1990's some residents have noted that the upland area is better drained. This also is consistent with the proposed conceptual groundwater model. Sewer construction would have resulted in:

- Termination of effluent discharge into shallow perched water tables from drainfields; and
- Creation of improved subsurface flow paths through the relatively permeable sand backfill placed in sewer pipe trenches.

3.7 Fish Habitat Conditions

Campbell River has long been an area known as the "Salmon Capital of the World," but primarily on the strength of the River itself, not the local ditches in the planning area. These ditches were never intended as fish habitat but were constructed to provide drainage to the local farms. Over the years, the conversion of farmland to the current mix of commercial, industrial and residential uses only served to reinforce their drainage function to the detriment of other possible values. Some of the conditions that have in the past or are now restricting the value of the local ditches as fish habitat include:

- Presence of culverts and storm sewers, especially those that are perched, undersized, have steep profiles or are very long;
- Limited or no base flow;
- Poor riparian and bank vegetation;
- Lack of complex stream geometry (pools; riffles);
- Inadequate stream bed substrate; and
- Likely poor water quality.

Nevertheless, a previous field study identified several streams and ditches in the planning area that provide habitat (or potential habitat) for fish. Local residents have generally confirmed the findings of this ditch assessment report that fish (Coho fry) are present in the ditches along Woodburn Road west of the Island Highway in the Holly Hills / Woodburn Road catchment. The fish presumably migrated from Baikie Slough, up the culvert near Robinson Road. Although the likelihood of fish presence is low, there are no significant barriers to fish migration between the location of the fish trap and Holly Hills to the west.

The field study also noted two locations within the Perkins Road drainage where fish were trapped. One Coho fry was caught at a site approximately 100 m north of Vanstone Road along the eastside of the Island Highway. The fish presumably migrated up the series of culverts and ditches commencing with the stormwater outfall at the end of Perkins Road. Elsewhere, one cutthroat and one Coho were caught approximately 100 m southeast of Norske Skog Road on the northeast side of the Island Highway, at the Casey Creek tributary crossing.

Based on these assessments, fish are likely present in several ditches in the planning area, as well as in Casey Creek Tributary. Ditches of particular interest include a reach of stream east of the Island Highway called the "Vanstone Channel" as well as the ditches along either side of lower Woodburn Road.

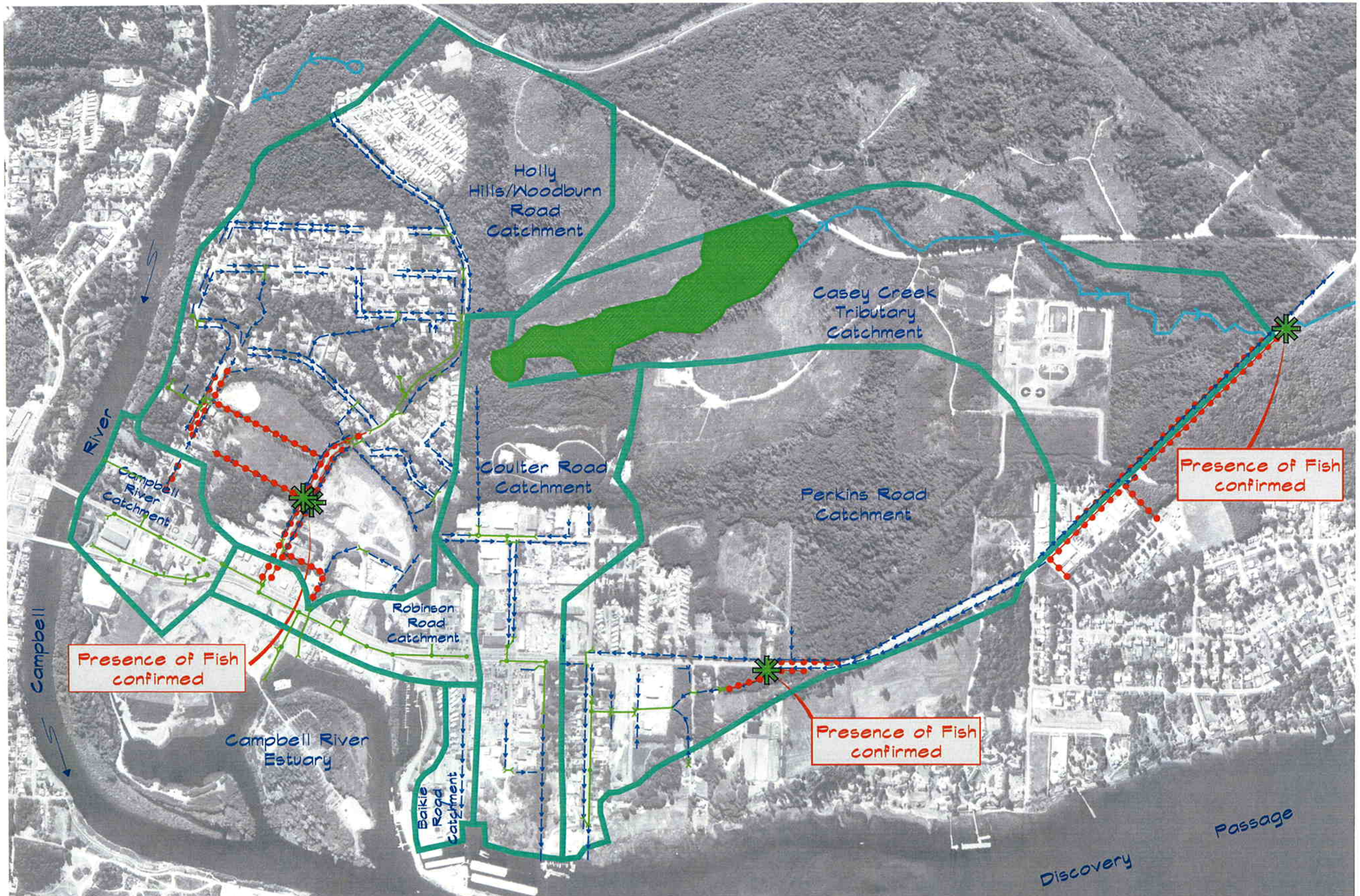
Table 4 summarizes fish habitat observations made during the current study, and Figure 15 shows the location of fisheries streams. The complete fish habitat report is found in Appendix C.

Table 4: Summary of Fish Habitat Assessment

Catchment	Fish Presence Confirmed?	Restrictions	Comments
Holly Hills / Woodburn Road	Yes, in ditch along Woodburn Road west of Island Highway (Coho)	• Undersized culverts and steep slope to uplands areas likely limit fish movement • Base flow in ditches may be limited due to upland development • Significant development along Woodburn Road with highly altered habitat • Long culvert outlet to Estuary (Baikie Slough)	• Open ditches in upland areas provide some water quality treatment of runoff • Wetland area and ditches in lowlands along Woodburn Road are best fish habitat
Campbell River	No	• Except for a few ditches along Park Road, entire area is served by storm sewers	
Robinson Road	No	• Entire area is served by storm sewers	
Baikie Road	No	• Single open ditch is ephemeral with no base flow source	
Coulter Road	No	• Perched culvert outlet • Ditches located in highly commercial / industrial area	
Perkins Road	Yes, in ditch along Island Highway, north of Vanstone Road (Coho)	• Poor habitat in ditches along west side of Island Highway south of cemetery • Mixed areas of habitat and enclosed culverts / storm sewers in southeast areas • Long storm drain, extending from just below Vanstone Road to outlet may restrict fish migration	• Possible, but unlikely, for fish to migrate upland west of Island Highway • Wetland and ditches between Island Highway and Vanstone Road ("Vanstone Channel") are highest value habitat in area • Potential habitat along final ditch from outlet to Discovery Passage • Open ditches provide some water quality treatment
Casey Creek Tributary	Yes, in ditch / wetland immediately east of Island Highway (Cutthroat; Coho)	• Culvert under Island Highway may restrict fish migration	• Streamkeepers manage a fish fence downstream, on Casey Creek near its mouth • Casey Creek is fish bearing stream • Large wetland area at upper end of catchment

District of Campbell River

Integrated Stormwater Management Plan



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Scale 1:10 000

Legend:

- Catchment Boundary
- Storm Sewer/Culvert
- Presence of Fish Likely
- Fish Presence Confirmed
- Existing Ditch
- Wetland
- Stream

Fig: 15

Fish Habitat

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4.0 CURRENT STORMWATER MANAGEMENT TOOLS

4.1 Local Tools for Stormwater Management

The District currently has a number of policy and management "tools" available to address stormwater issues in these (and other) drainages. These include the broad principles adopted in the Official Community Plan (OCP), as well as the District's various land use and development bylaws and engineering standards.

Under the Local Government Act, the Province has granted to the District the authority to address stormwater and drainage issues, but the particulars are left primarily up to the residents and leaders of the community itself. Authority is available to address stormwater through any number of planning, regulation, development approval and servicing provisions of the Act. Some key provisions are:

- Sewers, Storm Drains and Drainage (Division 6, Sections 540 – 549);
- Regional Growth strategy and Official Community Plan Goals (Section 849(2));
- Prohibition of Pollution (Section 725.1);
- Soil Deposit and Removal (Erosion Control) (Section 723);
- Zoning (Section 903);
- Environmental Policies (Section 878);
- Runoff Control (Section 907);
- Landscaping (Section 909);
- Development Permit Areas (Section 919.1); and
- Subdivision Servicing Requirements (Section 938).

The District's OCP contains a number of items of importance to stormwater management. For example several of the Plan's Guiding Principles provide a context for stormwater management. One basic environmental principle is that in order for the "natural life support systems to remain healthy [the District] must reduce [its] negative impact on them."

Several guiding principles for general community decision-making and governance outlined in the OCP may impact the way stormwater planning is approached:

- Balance between development and conservation;
- Cooperation between public and private sectors;
- Proactive management of change; and
- Involved citizenship.

According to the OCP, key elements of the plan must account for a variety of realities, some of which also impinge directly on stormwater issues:

- Significant population for residential growth is anticipated over the next 20 years (although the North Campbell River is generally not identified as part of this trend).

- Environmental stewardship and protection at all stages of development is important to residents.
- Effective environmental stewardship is best achieved when responsibility is shared by all.
- Environmental stewardship can be expensive, thus controlling costs is important.
- Promoting new patterns of growth are required to take maximum advantage of the available land.
- Significant environmental areas can be protected and maintained through greenways.

Several aspects of the OCP directly address stormwater issues. For example, with respect to open space and greenways within the District, Goals #1 ("provide life support for community fish and wildlife") and #2 ("protect water resources") are particularly important. Several objectives were listed to meet these two goals:

- Inventory existing ecosystems;
- Conserve the function of rare or sensitive ecosystems;
- Rehabilitate damaged ecosystems;
- Maintain or restore high quality surface and ground water;
- Regulate the amount and impacts of development on watersheds; and
- Moderate runoff from urban areas to approximate pre-development stream flows.

In addition, a commitment was made to keeping the general intent of the Province's Land Development Guidelines, including:

- Provide and protect leave areas (buffers) along streams;
- Control soil erosion and sediment in runoff;
- Control runoff rates to minimize impacts;
- Control in-stream work, construction and diversions;
- Maintain fish passage for all salmonid life stages; and
- Prevent "deleterious" discharges to streams.

With respect to the District's drainage infrastructure in the District, the primary goal for stormwater management is to maintain post-development flows at pre-development levels. Key aspects of meeting this goal are:

- Installing stormwater detention ponds in developments to reduce peak flows and increase water quality;
- Applying soil erosion and sediment controls during construction; and
- Sizing storm drains to convey the 5- or 10-year recurrence events (depending on broad land use type).

While the OCP provides a framework for some aspects of stormwater management within the District, a number of different bylaws regulate implementation on a daily basis. Some of the critical bylaws include:

- Building Bylaw;
- Subdivision Bylaw;
- Zoning Bylaw;
- Frontage Improvement Bylaw;
- Storm Drain System Connections Bylaw; and
- Engineering Design Standards, Specifications and Approved Products.

Financing of various stormwater improvements is also established through several different bylaws:

- Development Cost Charges Bylaw;
- Frontage Improvement Bylaw;
- Stormwater Management Parcel Tax Bylaw; and
- Local Improvement Charges Bylaw.

The Stormwater Management Parcel Tax is an especially important tool for the District as it generates revenue that is designated exclusively for use in stormwater management. The tax is $12 per non-exempt parcel and is being assessed for only five years (2001-2005). With approximately 10,000 parcels in the District, the tax generates about $120,000 per year for stormwater management purposes.

Table 5 lists key management tools available to the District. The focus is on those aspects of the District's institutional infrastructure that directly impact the volume, rate and quality of stormwater runoff that is generated within the planning area.

4.2 Other Management Tools

Provincial and Federal laws, regulations and guidelines are also significant aspects of stormwater management. In addition to the Local Government Act described above, of particular note are the following:

- Canadian Environmental Quality Guidelines – establishes target conditions in water bodies, including bottom sediments;
- Federal *Fisheries Act* – provides for protection of fish habitat;
- Provincial "Approved Water Quality Guidelines" and "Working Water Quality Guidelines" – establish target conditions in water bodies, including bottom sediments;
- Provincial *Urban Runoff Quality Guidelines* (1992) – describes stormwater quality issues and suggests a variety of BMPs for addressing the issues;
- Provincial *Fish Protection Act* (1997) – establishes guidelines for protecting fish habitat; a major land use component is the use of stream buffers;
- Provincial *Tackling Non-Point Source Water Pollution in British Columbia – An Action Plan* (1998) – identifies tools and strategies for reducing and preventing non-point source pollution (including in stormwater) in rural and urban areas; and
- Provincial *Land Use Planning, Coordination, and Local Action* (1998) – requires a stormwater management component in local Liquid Waste Management Plans.

Table 5: Tools for Stormwater Management

Reference	Title (Date)	Comments
OCP	Official Community Plan (April 2002)	• Defines broad principles, goals, objectives and implementation strategies for community growth and development • Three key elements in strategy: (1) protecting the environment; (2) managing growth; and (3) strengthening neighbourhoods • Strong environmental protection and sustainability components in many provisions • Commits to development of an integrated stewardship bylaw to include provisions related to: (1) erosion control, (2) vegetation management and (3) water quality measures for watercourses • Open & Greenways goals include: (1) provide for life support for community fish and wildlife and (2) protect water resources • Stormwater Management goal is to maintain pre-development flows in streams • Implementation program established (but does not directly include any stormwater management components)
Bylaw 597	Building Bylaw (1974)	• Requirements for plans and specifications for buildings • Permits for installing culverts
Bylaw 692	Soil Removal and Deposition Bylaw (1978)	• Basis for permits to move soil • Prohibits adverse affects from soils movement
Bylaw 1340	Subdivision Bylaw (1983)	• Requires engineering studies and mitigation for flooding, settlement or unusual soil or drainage conditions • References Engineering Design Standards (Appendix A) (see below) • Requires servicing developments with storm drainage systems, based on broad land use types, including storm drains in all but "rural" and "resource" zones • Cost sharing for "higher standard" of service for storm drains disallowed, except where a Development Cost Charge (DCC) has been established • Establishes basis for cost sharing
Bylaw 2341 (inclusive 2564, 2680, 2744 and 2789)	Development Cost Charges Bylaw (1995)	• Establishes purpose and basis for Development Cost Charges (DCCs), specifically including those for stormwater drainage in the Quinsam Area • DCCs in Quinsam Area typically based on number of units (residential) or gross building square footage (commercial, industrial and public assembly)
Bylaw 2700 (and amend-ments)	Zoning Bylaw	• Regulates use of land and structures within District • Siting adjacent to lakes and watercourses • Siting in floodplains • Landscaping requirements in certain zones • Parking requirements • For each zone, typical requirements relate to: permitted uses; lot size; lot coverage/density; minimum dimensions for yards; building heights; usable open space; conditions of use • Establishes streamside protection and enhancement areas

Reference	Title (Date)	Comments
Bylaw 2709	Frontage Improvement Bylaw (1998)	• Requires certain improvements to serve developments, including stormwater-related • Extent of improvements based on general zoning uses (rural/resource; industrial; all others) • Establishes unit costs to be charged for the improvements, including specifically for storm drains, storm drain connections, and trees
Bylaw 2791	Campbell River Estuary Management Commission Bylaw (1999)	• Establishes a commission to advise the District on matters related to implementation of the Campbell River Estuary Management Plan (CREMP) • CREMP sets a number of policies and actions for restoration, enhancement and protection of the estuary, including preparation of a stormwater management plan for areas surrounding the estuary • Commitment to land development and management that (1) meets objectives for protection of aquatic habitat per Provincial "Land Development Guidelines" and (2) minimizes water contamination from runoff per Provincial "Urban Water Runoff Guidelines"
CREMP	Campbell River Estuary Management Plan (1996)	The Plan addresses long-term protection and enhancement of the Estuary including recommendations related to habitat restoration, dredging, industrial relocation and upland development. Among the proposed overall policies are several directly relating to stormwater: • Develop and manage land per Provincial Land Development Guidelines • Minimize water contamination from runoff per Provincial Urban Water Runoff Guidelines • Complete a stormwater management plan for the estuary and surrounding lands Other policies relate to shoreline erosion, upland development clustering to encourage open space and development of greenways
Bylaw 2864	Storm Water Management Parcel Tax Assessment Roll Bylaw (2000)	• Directs preparation of assessment roll for purposes of imposing a parcel tax to cover costs related to stormwater management • Parcel tax to be an amount for each parcel
Bylaw 2865	Storm Water Management Parcel Tax Bylaw (2000)	• Tax to be imposed on all parcels (except exempt properties) within District • Revenues identified for stormwater management purposes • $12/year for five years (2001-2005)
Bylaw 2871	Local Improvement Charges Bylaw (2000)	• Establishes annual charges per frontage foot for various local improvements • Improvements include: curb & gutter; roads; storm sewers; sidewalks and landscaping
Bylaw 2926	Storm Drain System Connections Bylaw (2001)	• Storm drain connections required under a variety of conditions • Establishes connection charges • Not required when adjacent to certain water courses (including Campbell River and Discovery Passage)

Reference	Title (Date)	Comments
Appendix A, Bylaws 1340 & 2709	Engineering Design Standards, (November 2000)	Part I sets standards for roadway designs that affect impervious area and hydraulic connection of impervious area: • Tables I & IA – minimum pavement widths with curb types for various land uses • Table III – sidewalk requirements • Table V – sets pavement designs (materials, etc .) • Sec 13.1 thru 13.7 – requires tree planting along roadways and sets standards Part III directly concerns storm drainage: • Sec 1.1 – systems must meet District's "stormwater management plans" • Sec 1.4.1 – design minor systems for 5-year event, except 10-year for commercial / industrial • Sec 1.4.2 – design major systems for 100-year event; allows flow paths in roadways and walkways • Sec 3 – requires sediment control plans for developments during construction; sets limits on discharge of total suspended solids (TSS) in runoff; requires slope protection; establishes other requirements for sediment controls during construction • Sec 4 – requires conformance with District's approved stormwater management plan where applicable; shows preference for regional stormwater detention facilities and for wet ponds; sets requirements for design of detention facilities
Appendix B, Bylaws 1340 & 2709	Specifications (November 2000)	• References "Master Municipal Construction Documents: Specifications and Standard Detail Drawings" • Includes a variety of items related to construction of stormwater facilities, including erosion control
Appendix, Bylaws 1340 & 2709	Approved Product List (November 2000)	• Describes approved suppliers of certain storm drainage features • Includes: pipe, culverts, fittings, manholes, catch basins and headwalls

5.0 ISSUES, CHALLENGES AND OPPORTUNITIES

A number of issues and concerns surfaced during the course of the project. These were raised or identified by one or more of the stakeholders or participants in the project, who include:

- Individuals contacted by the Project Team for phone interviews;
- Participants at the two open houses;
- Local residents who offered information or who were interviewed in the field;
- District technical staff;
- Representatives of environmental agencies and organizations; and
- Project Team.

Appendices E and F include summaries of comments received at the open houses and a list of those contacted during the project, respectively.

In the Holly Hills and Perkins Road Drainages, the overriding issues for the District appear to be:

- ***Runoff from existing development*** – Loss of forested land and a simultaneous increase in impervious area are two notable trends within the planning area. A related burgeoning problem is the infilling of ditches, usually by replacement with a culvert. A likely result of these activities has been a disruption of natural infiltration of runoff and alteration of base flows in the local ditches. Significant erosion along the north side of Woodburn Road up the hill from Vallejo Road is also, in part, a result of these long-term land changes in the Holly Hills area. The erosion is impacting adjacent properties and may eventually affect the road embankment and surface as well. This problem also highlights the issue of ditch maintenance throughout North Campbell River.

- ***Runoff from new development*** – As the District begins to take a more proactive role in stormwater management, an overall approach to controlling runoff from new development, infilling and redevelopment is needed. Current District bylaws require conformance with the District's approved stormwater plan and favour the use of regional detention facilities and wet ponds to control runoff. This is often impractical for small, infilling development and there are alternatives for larger new and re-development projects. Concern will center on runoff volumes and peaks and runoff quality in upland areas and along fish-bearing streams and ditches, and on runoff quality in areas draining directly into the Campbell River Estuary.

- ***Financing*** – The District currently has a parcel tax in place that will generate about $600,000 over its limited 5-year life. This money is earmarked for planning (including this planning effort) and capital projects throughout the District. Thus, there is a need for a long-term, dedicated financing mechanism for future planning, for capital improvements and for operation and maintenance (O&M) of public stormwater facilities. The financing mechanism must be fair and reasonable, and bear a substantial relationship to the cost of services and facilities.

- ***Baseline Data*** – For these two drainages, there is insufficient baseline data to fully characterize the catchments as a basis for stormwater management decisions. This deficiency in turn affects the development of the hydrologic and hydraulic modeling needed for stormwater decision-making. In particular, mapping and monitoring information is lacking or unavailable in the following areas:

- Stormwater infrastructure, specifically pipe and ditch inverts, ditch cross sections and related information;
- Soils and hydrogeology, especially in the Perkins Road Drainage;
- Base flows in ditches and Casey Creek Tributary;
- Water quality in ditches and Casey Creek Tributary;
- Site by site fish habitat characterization (SHIM);
- Topographic information (contours) for entire drainages; and
- Complete woodland and impervious area data.

As updated mapping and monitoring data become available, modeling can also be upgraded.

- ***Fish Habitat*** – The presence of anadromous and resident fish has been confirmed in several locations, particularly in the ditches along lower Woodburn Road, in and upstream of the "Vanstone Channel" and in Casey Creek Tributary immediately east of the Island Highway. These areas will need protection and/or enhancement in order to maintain the fisheries. Management options must address both the instream conditions where fish live, feed, spawn and migrate, as well as the upland conditions that impact base flow and water quality in the ditches. In addition, long-term protection of the Estuary as aquatic habitat will require addressing stormwater quality issues within the planning area.

- ***Roadway Conversion*** – With the exception of portions of the Island Highway, "rural" roadways (i.e., roadways with no curb and gutter) are the norm in North Campbell River. The District has a long-term commitment to convert these roadways to an urban-type roadway. Under current District design guidelines, this means construction of curb, gutter, storm sewer, sidewalk and a wider road. While this may serve traffic demands, it also increases impervious area, limits base flows in streams and eliminates fish habitat. Finding ways to reduce these impacts will be important.

- ***Runoff Water Quality*** – A significant portion of the stormwater runoff from the planning area goes directly into the Campbell River Estuary. Questions have been raised specifically about the quality of runoff, including wash water, from industrial and commercial properties in the area. For sites not connected to public storm sewers, the District currently has no limits on stormwater quality and lacks any appropriate mechanism to address the need for on-site facilities or runoff control practices. When fish and fish habitat are affected, DFO and MWLAP have authority to address the water quality problems. In practice, this apparently has not happened to date. And while the Estuary Management Plan does target improvement of runoff water quality as part of the larger effort to improve the Estuary, again there is no mechanism to clearly tie this effort to the land-side parcels generating the runoff.

Table 6 lists these primary issues along with associated challenges (problems). It also lists opportunities the District has to advance stormwater management while addressing the issues. Figure 16 shows the locations of some of the specific drainage and fisheries issues identified to date.

Table 6: Issues, Challenges and Opportunities

ISSUE	CHALLENGES / PROBLEMS	OPPORTUNITIES
Runoff from Existing Development		
High level of impervious area within drainages, especially Holly Hills	• Increases peak flows during storm events • Decreases natural infiltration of stormwater, thus limiting base flow in ditches • Increases water temperatures	• Mitigate affects of current development • Manage new, or new development in creative ways
Loss of forest cover • <25% remaining in Holly Hills Drainage • >50% remaining in Perkins Road Drainage	• Decreases natural capacity to attenuate runoff peaks • Decreases natural infiltration and evapotranspiration of stormwater	• Retain or enhance areas of forest cover
Ditch infilling and replacement with culverts, notably in Holly Hills uplands	• Contributes to nuisance flooding • Decreases capacity of ditches to provide contaminant capture • Decreases capacity of ditches to provide retention or detention of stormwater • In lowlands areas, eliminates (potential) fish habitat	• Manage contribution to base flows in lowland streams
Woodburn Road ditch erosion	• Ditch downcutting and bank instability • Loss of land in backyards of houses fronting on Rama Road • Slumping of road shoulder • Road settlement	• Minimize erosion and subsequent deposition in downstream fish habitat along Woodburn Road
Ditches along Vallejo Road frequently fill to street level	• May contribute to roadway deterioration • Nuisance flooding	• Improve fish habitat
Improperly draining ditches: • Along Island Highway • Unspecified areas	• Improper grading • Ditches not maintained	• Improve fish habitat • Minimize more serious flooding
Flooding at back of properties along Island Highway south of Perkins Road	• Low-lying areas lack proper grading • Leaves unwanted standing water	• Eliminate nuisance flooding
Runoff from New Development		
Stormwater quantity (or flow) controls	• Current design criteria focus primarily on flood control (i.e., controlling peak discharges) but do not address maintaining base flow in fish streams • Encourages use of wet detention ponds	• Broaden District's available stormwater tools • Broaden objectives for District control

ISSUE	CHALLENGES / PROBLEMS	OPPORTUNITIES
Performance standards for stormwater management	• No basis for determining whether programs, activities or facilities are providing stormwater benefits • No criteria for developers to meet, creating uncertainty in development market	• To install water quality monitoring stations (in conjunction with flow monitoring) • To provide basis for future adaptive adjustments in stormwater management • To establish baseline conditions within catchments
Long-term conversion of rural roadway sections to urban sections by District	• Wider roads increase total impervious surface within watersheds • Use of curbs, gutters and storm sewers tends to increase peak flows to streams • Concentrates pavement sheet flow, which can lead to erosion of embankments	• To develop an aesthetically pleasing road design that meets transportation as well as environmental objectives • To develop a road design that enhances groundwater recharge and hence base flows
Financing		
Stormwater financing	• Current charge is a tax based solely on parcels • Current charge (tax) does not account for the varying degrees that land uses impact stormwater management	• To establish a stormwater utility that plans and pays for its own system(s) by charging "users" of the stormwater system(s) • To fairly assess costs among various users based on actual impact or contribution to the stormwater management systems • To encourage stormwater "stewardship" through assessment of charges
Future storm sewer systems	• Modeling indicates that new storm sewer system trunks may be required in the two areas: (1) Commercial area along lower Woodburn Road and (2) residentially-zoned areas north of Perth Road	• To integrate storm sewer capital improvements with lower impact development practices, in order to limit size of public facilities • To link public and private stormwater controls

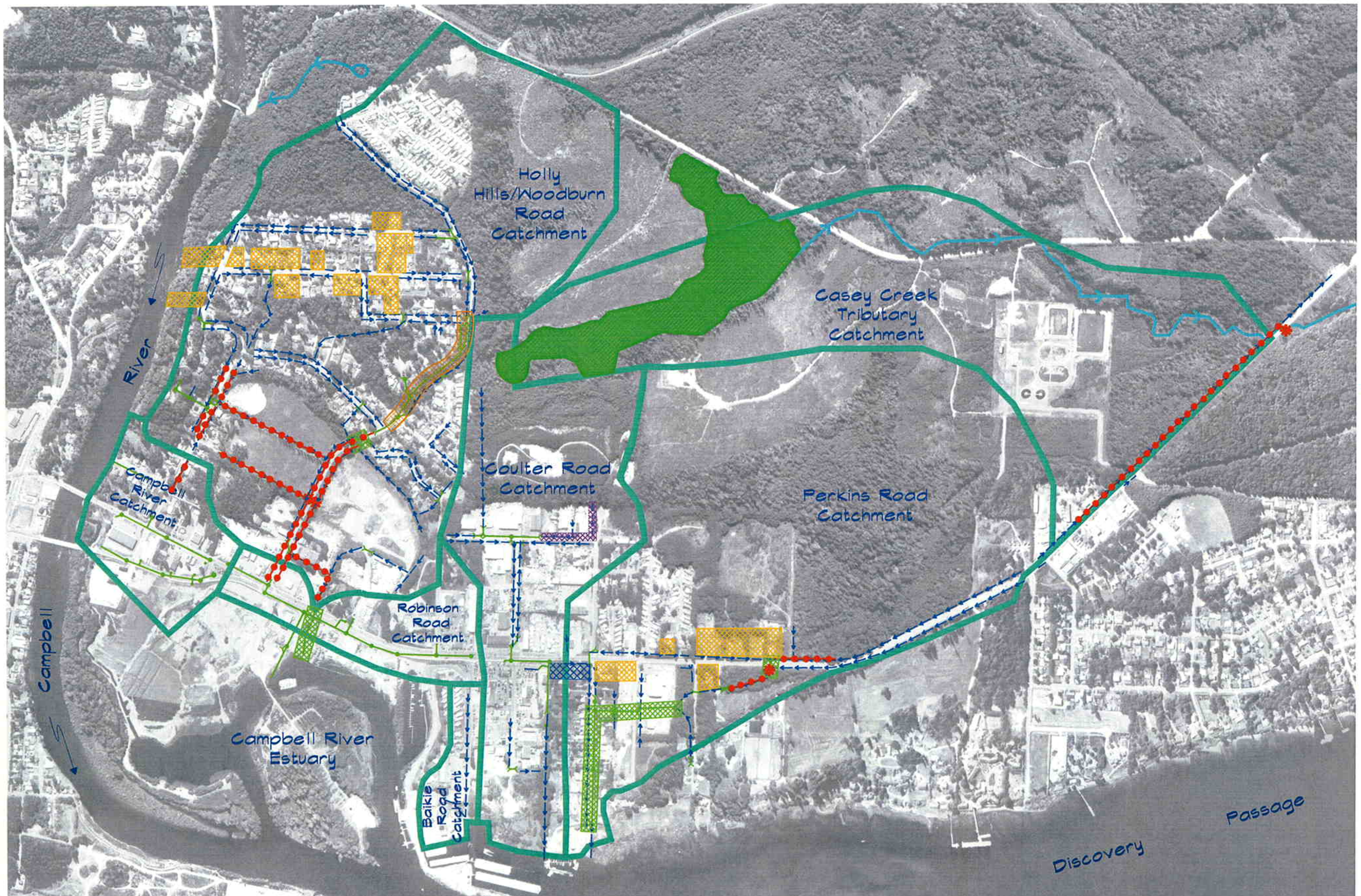
ISSUE	CHALLENGES / PROBLEMS	OPPORTUNITIES
Baseline Data		
Hydrologic and hydraulic modeling of systems in planning area	• Current modeling is event-oriented, thus unable to describe roughly 90% of all rain events • Current model is not calibrated, thus providing limited value to assessing future changes • Incomplete data available for hydraulic modeling (e.g., stream sections; pipe invert data; etc.) • Unable to adequately assess cumulative impact of current and future stormwater controls on either base flows or nuisance flooding	• To define both base and extreme flows through installation of long-term flow monitoring station(s) • To provide a full inventory of District stormwater facilities within the drainages • To develop a calibrated, continuous model that can be used for future stormwater planning and fisheries management
Fish Habitat		
Presence of fish in local ditches and streams, especially: • Lower Woodburn Road • Park Road • Island Highway north of Vanstone Road • Island Highway near Casey Creek Tributary culvert	• Closed pipe systems separate the fish habitat reaches from the ocean • Low or poor quality habitat values • Identifying appropriate stream reaches for protection or enhancement while limiting negative impacts to adjacent properties • Maintaining base flows in streams • Maintaining water quality in streams • Limiting high velocities in pipes	• To enhance the fish habitat in targeted stream reaches • Work with streamkeepers in Casey Creek • To establish greenways consistent with OCP
Limited riparian vegetation along fish-bearing streams	• Limits essential nutrient inputs o streams • Reduces stream shading, thus contributing to higher water temperatures that are less conducive to fish development	• Enhance some reaches with new riparian planting • Work with new District bylaw that establishes riparian corridors
Roadway Conversion		
Long-term conversion of rural roadway sections to urban sections by District	• Wider roads increase total impervious surface within drainages • Use of curbs, gutters and storm sewers tend to increase peak flows to streams • Concentrates pavement sheet flow, which can lead to erosion of embankments	• To develop an aesthetically pleasing roadway standards that meet transportation as well as environmental objectives • To develop roadway standards that enhance groundwater recharge (where feasible) and hence base flows

ISSUE	CHALLENGES / PROBLEMS	OPPORTUNITIES
Runoff Water Quality		
Stormwater quality controls	• Washoff of machinery contaminates streams with oil & grease (and other pollutants), as well contributing to undesirable water temperature changes in streams • Minimal guidance from District	• Encourage or regulate implementation of operational approaches
Future stormwater systems	• Redevelopment of former industrial areas may generate need for stormwater control facilities	• To improve stormwater quality • To improve Estuary water quality
"Orange" discoloration in ditches: • Along Perkins Road near Vargo Road • Along Island Highway, north of Vanstone Road	• Source(s) not positively identified at this time • Likely leaching of iron, which leads to algal growth	• Improve fish habitat • Improve aesthetics

At this time, there does not appear to be significant demand for development within these drainages, whether it is new development, infilling or redevelopment (conversion in use). This is recognized in the current OCP, which does not include North Campbell River among the District's potential "high growth" areas. Further, the presence of salmon (Coho) and other resident fish in some of the local ditches and streams suggests that some level of "health" within the watersheds exists despite the past activities and current state of development. Thus the District has the opportunity to commence implementation of improved stormwater management efforts to enhance and maintain this health while protecting property and life from flooding and erosion. Further, the District has opportunity to introduce new approaches in a measured fashion in order to test and adapt them as necessary.

District of Campbell River

Integrated Stormwater Management Plan



Scale 1:10 000

Legend:

- Catchment Boundary
- Storm Sewer/Culvert
- Existing Ditch
- Stream
- Wetland
- Fish Presence Confirmed
- Presence of Fish Likely
- Low Lying Area/Poor Drainage
- Discolored Runoff in Ditch
- Barrier to Fish Passage (Culvert & Storm Drains)
- Ditch Erosion
- Properties with Ditch Infill

Fig: 16

Locations For Known Drainage Problems

Prepared By URBANSYSTEMS® consulting planners and engineers

PROJECT No.: 1479.0003.01

DATE: August, 2003

6.0 OPTIONS FOR STORMWATER CONTROL

To address the issues that have been identified to date within the Holly Hills and Perkins Road Drainages, the District can apply it's authority to control stormwater at several levels. First, remedial actions can be used to address some or all of the current problems that have been identified. For example, erosion in the ditch running along the north side of upper Woodburn Road has become significant. Re-routing runoff and armouring the ditch are two action options that could address this problem. Second, mitigative actions can be taken to address future stormwater issues. For example, development of the low-lying areas south of Woodburn Road and west of the Island Highway will likely require installation of a trunk storm sewer to serve the area. This sewer could be constructed now in anticipation of development or later in conjunction with actual development.

While current District drainage policies and design guidelines are generally sufficient to support such "action" remedies, some of the area's stormwater issues are better addressed through changes in the District's overall policies and management strategies. For example, there is an increasing awareness across North America that many stormwater and drainage problems can be addressed at the individual site level, using the natural processes of evapotranspiration and infiltration, rather than relying on storm drains. Making this shift to "low impact development" requires a commitment to treating stormwater as a resource to be managed, rather than as a nuisance to be forestalled.

In this section of the plan, both specific action options and more general management options will be explored. The former are directed towards alleviating existing and avoiding future drainage problems, or enhancing the current and future fisheries environment of the area; they typically involve some construction activity. In general, these action options can be implemented under current District bylaws and procedures. The latter are directed towards changing the way the District and its residents think about and control stormwater. These options typically involve changes to current bylaws and management procedures. In addition, these options will generally involve long-term, adaptive management of the stormwater resource. Depending on the approach the District decides to take, the newly adopted principles of stormwater management could also be applied retroactively.

6.1 Alternative Action Options

Table 8 lists a number of specific possibilities for correcting some current drainage problems, by catchment. Most of these alternative actions are feasible under current District policy and can be implemented without changes to bylaws.

As noted previously, significant portions of both drainages have already been converted to impervious surfaces (buildings, parking lots, etc.) and, in a number of areas, ditches have been infilled and replaced with culverts. These past actions disrupt the water balance of the area, specifically altering base flows in the local ditches that support fisheries. As well, commercial and light industrial uses dominate the lowlands areas, especially in the Holly Hills Drainage. This has not only led to a disruption of rainfall infiltration but to potential water quality concerns in the ditches of the area that support fisheries. Most of the options listed in Table 7 are directed towards addressing these issues.

Development of the service / commercial areas south of Woodburn Road in the bog area will require careful attention to providing adequate stormwater controls. At present the design tools are lacking to make good decisions about when and how to provide these controls. Thus options are included on Table 7 that focus on upgrading the mapping, monitoring and modeling available for the area.

The District has also identified erosion along upper Woodburn Road as a significant problem that must be addressed sooner than later. The major hurdle in correcting this problem is the proximity of houses to the small ditch at the base of the road embankment. Due to the tight space, reconstruction of the ditch is very difficult. Five alternatives were examined for correcting the problem; these are presented in more detail in Appendix G.

6.2 Fisheries Habitat Options

A number of specific actions could enhance the fish habitat and fish capacity that exists within the two drainages. In the Holly Hills Drainage, the primary management strategies could be to widen, deepen and consolidate ditches in order to increase usable fish habitat. While this would increase the fish capabilities in the area, it will not address issues of upland runoff nor runoff from nearby industrial and commercial properties. The fish would remain at risk of exposure to oil wastes, excessive suspended solids, possible chlorine from swimming pools or other contaminants. Nor will this address the issues of maintaining adequate base flows in the ditches.

In the Perkins Road Drainage, the uplands areas are relatively undeveloped. Thus, although the total amount of fish habitat and fish capacity may be less than for the Holly Hills Drainage, long-term fish enhancements may have less risk to negative effects of uplands development. In this case, the primary management strategies could also be to reshape and complex ditches, as well as provide upland controls to maintain high quality base flow in the ditches and streams.

For both drainages, a better understanding of the base flow regimes (i.e., groundwater flow systems and interaction with flow in ditches) would boost the likelihood of implementing viable fish habitat improvements. Further, establishing the existing water quality conditions would provide additional data for understanding the habitat.

A significant component of the potential enhancements in both drainages generally involves reshaping and/or complexing ditches, ditch maintenance and culvert improvements:

- ***Ditch reshaping*** – regrading side slopes to 2H:1V, widening bottom to obtain a stable channel, and revegetating banks with appropriate riparian and instream vegetation
- ***Ditch complexing*** – introducing meanders, check dams, pools and large woody debris
- ***Ditch maintenance*** - removing undesirable vegetation and debris, doing minor reshaping, providing streambed and bank erosion protection as needed and providing revegetation as needed
- ***Culvert improvements*** - providing outlet weirs and pools, and installing baffles within the pipe

Table 8 provides a number of specific possibilities for fish habitat enhancements, listed by catchment.

Table 7: Action Options for Stormwater Control

Catchment	Action Option
All Catchments	• Restore ditches to original condition, including appropriate vegetation • Encourage or require additional tree-planting • Perform full inventory of all ditches and culverts • Perform full inventory of storm sewers • Repair culverts, as needed • Implement long-term ditch and culvert maintenance program • Establish rainfall and flow monitoring program to obtain model calibration data • Obtain new base mapping (topography) for entire planning area (1-m maximum contour interval) • Upgrade the current XP-SWMM hydrologic and hydraulic model of the drainages • Seek opportunities to install BMP pilot projects in conjunction with new development or redevelopment
Holly Hills / Woodburn Road	• Retrofit individual sites with infiltration BMPs • Construct runoff infiltration wells in conjunction with conversion of ditches into bioswales • Remove culverts from infilled areas and restore ditch systems • Repair or mitigate the extensive erosion problem along upper Woodburn Road (see Appendix G for additional details and alternatives • Inspect and repair as necessary the outlet culvert under the Island Highway • Design and construct (now or in future) regional stormwater treatment facilities for service / commercial areas along lower Woodburn Road • Design and construct (now or in future) new storm sewer trunk to serve the potential service / commercial development area along lower Woodburn Road • Develop alternate "urban" roadway design for lower Woodburn Road, including incorporation of fish habitat features in ditch
Campbell River	• Inspect existing commercial and industrial facilities to determine potential runoff quality problems; use dye or smoke testing to identify problematic cross-connections of facilities with storm sewers • Encourage retroactive installation of BMPs at properties, as determined by site inspections
Robinson Road	• Inspect existing commercial and industrial facilities to determine potential runoff quality problems; use dye or smoke testing to identify problematic cross-connections of facilities with storm sewers • Encourage retroactive installation of BMPs at properties, as determined by site inspections
Baikie Road	• Inspect existing commercial and industrial facilities to determine potential runoff quality problems; use dye or smoke testing to identify problematic cross-connections of facilities with storm sewers • Encourage retroactive installation of BMPs at properties, as determined by site inspections

Catchment	Action Option
Coulter Road	• Inspect existing commercial and industrial facilities to determine potential runoff quality problems; use dye or smoke testing to identify problematic cross-connections of facilities with storm sewers • Encourage retroactive installation of BMPs at properties, as determined by site inspections • Obtain and analyze samples from ditches experiencing water discoloration; perform detailed investigation to determine sources of contamination and potential impacts, if required
Perkins Road	• Remove culverts from infilled areas and restore ditch systems • Regrade properties along Island Highway to eliminate low areas • Design and construct (now or in future) regional stormwater treatment facilities for potential residential development areas north of Perkins Road • Design and construct (now or in future) regional stormwater retention / detention facilities for potential residential development areas north of Perkins Road
Casey Creek Tributary	• Install pilot stormwater BMPs at the sewage treatment plant, e.g., bioswale or bioretention system

Table 8: Action Options for Maintenance and Enhancement of Fish Habitat

Catchment	Action Options
Holly Hills / Woodburn Road	• Allow vegetation in ditches and swales (biofiltration) • Reshape, add check dams and allow vegetation in ditch on north side of Woodburn Road, near trailer park • Reactivate remnant pond along Woodburn Road, between Dolly Varden and Coho Roads • Reshape ditch along Spring Road • Review existing "shunt" in ravine between Rainbow and Spring Roads, with view to return ravine more "natural" conditions • Maintain ravine stream between Coho and Spring Roads • Investigate potential for removing culvert at bottom of Woodburn Road (south side, opposite Vallejo Road intersection), to allow fish passage to Spring Road ditch • Consolidate ditches to one side along Woodburn Road in lowlands areas and create / enhance for fish habitat; create spawning reach for cutthroat and coho near Vallejo Road • Reshape and restore riparian habitat along ditches feeding Woodburn Road ditch from south lowlands areas • Install low flow and water quality monitors at based of Holly Hills to determine potential for long-term base flow supplement from seepage • Purchase wetter areas in lowlands north and/or south of Woodburn Road to create wetlands (alternatively, could be incorporated into future developments in these service commercial areas)
Campbell River	• Move outfall at Ebert Road back from river and create small detention / wetland complex (similar to the fisheries enhancement project already established for the Island Highway outfalls)
Robinson Road	• Move outfall back from Estuary and create small detention / wetland complex
Baikie Road	• Create small detention / wetland complex at existing ditch outlet to Estuary • Maintain ditches along south side of road
Coulter Road	• Reshape ditches along Vigar and Coulter Roads, especially in areas with existing steepened banks • Reshape and complex the outlet ditch along Coulter Road for nutrient enhancement • Detain and treat (if needed) drainage from the soils / lumber waste stockpiles from Raven property west of Vigar Road near Perkins Road intersection; expand and enhance the small wetland at this location
Perkins Road	• Reshape ditches along Island Highway, north of Vanstone Road; manage for instream and riparian habitat • Perform site specific investigation to establish conditions at wetland area just upstream of Island Highway dual culvert crossing, north of cemetery; develop and implement protection measures based on study • Provide "skylights" along main storm sewer from Perth Road to the outfall at end of Perkins Road • Perform comparative investigation of (1) diversion of the creek above Perth Road to the east to create additional wetland and riparian areas and (2) retrofit of the main storm sewer with baffles to enhance fish passage • Maintain ditches on east side of Island Highway

Catchment	Action Options
	• Protect riparian habitat, provide complexing of stream above Perth Road ("Van Stone Channel"); improve culverts • Investigate potential for opening the storm sewer after it turns east on Perkins Road then constructing detention pond(s) and riparian features in this reach of ditch; may require purchase of one of the currently undeveloped lots along the street • Move Perkins Road outfall back from Discovery Passage and create small detention / wetland complex for fish passage, spawning and rearing of salmonids

6.3 Alternative Management Approaches

In addition to the action options that can generally be implemented by the District now, there are a number of management and policy options that could be adopted as well. These would focus on avoiding and mitigating future impacts of new development (including redevelopment) on the drainages and the fish habitat within them. They range from the fairly common (e.g., establishing a ditch maintenance program) to the more progressive (e.g., capturing on site the total volume of rainfall from the Mean Annual Rainfall event).

The District currently has obligations to maintain various drainage facilities, including the storm sewers along the Island Highway. But shifting from a flood and erosion avoidance mode of drainage control to an integrated stormwater approach will require more attention to management issues and finding dedicated funds to pay for public stewardship of the stormwater systems. Many municipalities in North America have adopted a stormwater utility approach to handling these issues. Among other things, this typically requires identifying just which aspects of an area's stormwater systems are to be included in public care and then establishing a mechanism for generating funds.

Table 9 lists a variety of management and policy options that could be adopted to address the issues in the planning area.

Most of these options are applicable to the District as a whole and not just to the Holly Hills and Perkins Road Drainages. Thus the District will want to review them carefully for their district-wide implications.

6.4 Financing Options

Financing stormwater systems can be done through a number of mechanisms, including Development Cost Charges (DCCs), Local Improvements, borrowing and grants. The District is currently using a parcel tax to raise funds for integrated stormwater management planning and for construction of at least some of the improvements that are recommended. The tax, applied to non-exempt properties only, amounts to $12/year, with a five-year limit (set to expire in 2005). With approximately 10,000 parcels within the District, about $600,000 will be raised over the five-year term.

There are significant drawbacks to using parcel taxes to fund stormwater controls. First, any tax can seem onerous to residents. Second, the amount of the tax has no relation to how much runoff or pollutant load each property produces. Thus, the tax has no relation to the impact each property has on the overall stormwater system and how much the District may spend to maintain the system. Finally, some properties, including public road rights-of-way, are exempt. Thus, even though a property may be a large generator of runoff, the owner may pay very little towards its fair share of the stormwater management load.

One particularly useful financing tool that is gaining interest and acceptance is the use of user fees and charges. In the U.S., there are now over 300 stormwater utilities operating across the country that utilize such fees and charges to generate revenue for stormwater systems. The fees are based on one or more factors, typically related to how much stormwater is generated and ultimately runs off a property. Thus the amount of impervious surface is the most common basis for user charges. Other factors include site slope, soils type, credits for on-site stormwater control structures, type of activity on the site, and percent of tree coverage. Public roads, undeveloped lands and public lands may be exempt. User fees and charges can be collected to cover the operating costs of providing a municipal service (in this case stormwater management) as well as to finance growth-related infrastructure improvements (e.g., a regional stormwater facility). A primary advantage of user fees and charges is that the revenues generated can be dedicated to the stormwater system.

The Holly Hills and Perkins Road Drainages have roughly 450 properties within them. If the total funds available from the current parcel tax were apportioned based on number of properties, the planning area would be assigned a total of only $27,300 over the five years. To raise the same $27,300 would require only $0.0023/m2/year based on the current total impervious surface within Holly Hills and Perkins Road Drainages. An annual user charge of only a penny per square meter of impervious area could potentially raise nearly $300,000 per year within the planning area*. If so allowed by the enabling bylaw, this money could be used for any stormwater management purpose including identifying and correcting runoff quality from "hot spot" commercial / industrial areas and enhancing fish habitat in streams.

Development cost charges are another attractive method of recovering the costs of constructing, altering or expanding municipal infrastructure, including drainage facilities. (Other municipal services for which costs be recovered with a DCC include highways, excluding off-street parking, sanitary sewers, water and parkland acquisition and improvement.) As with a user charge, the basis for the DCC can be related to the impact that each development has on the service provided. For example, since total impervious is often a significant factor in the size of stormwater management systems, it could be used as a basis for the DCC. On the other hand, the DCC can not be used for on-going operation and maintenance or for other District activities related to stormwater management (such as plan reviews or updates to drainage plans), activities which could conceivably be financed by user charges. DCCs can be charged to new development only; if applicable the contribution of existing properties must be taken from property tax revenue only.

* This is only a very rough estimate as it counts all impervious surfaces, including roads. Adoption of stormwater user charges based on impervious surface will require a careful determination of non-exempt impervious surfaces, as well as an assessment of capital and O&M costs that are to be covered by the charge.

Table 9: Alternative Management and Policy Options

Issue	Policy Options
Presence of fish in local ditches and streams	• Apply BMPs and adopt efforts to improve water quality entering fish habitat zones from upstream areas • Define specific watercourses (including ditches) as legally part of the District's "municipal drainage system" • Establish long-term monitoring program (flow; water quality; fish habitat assessment) • Implement long-term fish habitat maintenance program
High level of impervious area within drainages, especially Holly Hills	• Encourage minimizing impervious area for future developments • In areas with storm sewers, require that roof leaders be disconnected • Require replacement of lost infiltration capacity in future developments* • Adopt restrictions on percentage of impervious area allowable on land parcels (by land use type) • Adopt long-term program of retrofitting developed areas with stormwater infiltration practices
Loss of forest cover	• Adopt design standards requiring preservation of woodlands and riparian habitat in future developments (primarily west of Island Highway in Perkins Road drainage and uplands areas of Holly Hills drainage) • Maintain Casey Creek Tributary in "rural" land use and encourage retention of forest cover • Encourage or require reforestation of cleared land tracts
Ditch infilling and replacement with culverts, notably in Holly Hills uplands	• Prohibit ditch infilling without permission from District • Adopt policy of restoring currently infilled ditches to original condition
Hydrologic and hydraulic modeling of systems in study areas	• Require use of appropriate models (compatible with District's drainage-wide models) to verify that future developments satisfy stormwater control objectives
Limited riparian vegetation	• Identify high priority stream corridors, based on fish habitat value, and establish appropriate setbacks and vegetation requirements • Adopt setback by-law to establish scientifically sound, yet flexible, setbacks for all streams (currently under review within DCR Planning Dept.)
Stormwater quantity (or flows) controls	• Require "stormwater management plan" for new developments, to cover installation and use of structural, non-structural and O&M BMPs • Require use of specific BMPs at new developments • Require retaining all rainfall / runoff onsite up to 50% of the Mean Annual Rainfall volume (i.e., 27.5 mm) in future developments
Stormwater quality controls	• Encourage use of BMPs in new developments • Require use of BMPs in new developments, with emphasis on infiltration where feasible • Establish land uses that will be required to implement onsite controls • Require "stormwater management plan" for new developments, to cover installation and use of structural, non-structural and O&M BMPs

Issue	Policy Options
Performance standards for stormwater management	• Adopt target for runoff retention from future developments (e.g., capture 50% MAR onsite, where feasible) • Adopt target for peak runoff from future developments (e.g., post-development peaks to match existing peaks for 2-, 10- and 25-year recurrence events) • Adopt target for total runoff from future developments (e.g., post-development volume not to exceed pre-development volume for the MAR event) • Adopt target for runoff quality from future developments (e.g., annual average removal of 80% TSS) • Adopt restrictions on percentage of impervious area allowable on land parcels (by land use type)
Long-term conversion of rural roadway sections to urban sections by District	• Develop typical "modified urban section" for incorporation into District engineering standards, to include provisions for use of BMPs • Allow use of narrow footprint roadways in lieu of standard urban section • For new roads, retain existing ditch systems where feasible
Stormwater financing	• Establish stormwater utility within District, via by-law (for subject drainages only, initially?) • Develop database for determining utility charges: parcel sizes, parcel impervious area, onsite controls (quantity / quality), presence of existing infrastructure (storm sewer) • Develop long-term stormwater capital program • Determine long-term O&M costs
Future storm sewer systems	• Define specific watercourses as legally part of the District's "municipal drainage system" • Form public / private partnership(s) to develop stormwater quality treatment facilities in redevelopment areas east of Island Highway • Develop long-term stormwater capital program, including trunk sewers, retention, detention and water quality treatment facilities, regional infiltration systems and fish habitat improvements
Woodburn Road ditch erosion	• Establish long-term program for ditch maintenance
Ditches along Vallejo Road frequently fill to street level	• Establish long-term program for ditch maintenance
Improperly draining ditches	• Establish long-term program for ditch maintenance
Flooding at back of properties along Island Highway south of Perkins Road	• Establish long-term program for ditch maintenance
"Orange" discoloration in some ditches	• Establish long-term program for ditch water quality sampling • Adopt in-stream water quality standards for ditches (assumes ditches have been defined per bylaw as legally part of the District's "municipal drainage system")

* "Future developments" includes new development as well as infilling and re-development projects.

6.5 Practices for Stormwater Control

Communities and regions around North America have increasingly applied stormwater "best management practices" (BMPs) to mitigate the potential affects of land development on watersheds. Initially this was primarily done to reduce stormwater runoff peak rates, generally to level occurring prior to development. Over the years, broader objectives have been assigned to BMPs. Specifically, the current ideal is to fully mimic the natural hydrology of an area and protect water quality as well. Thus BMPs may serve to reduce the peak rate of stormwater runoff, reduce the total volume of stormwater runoff, improve the water quality of the stormwater runoff or, typically, meet more than one of these objectives.

The realization among stormwater practitioners that it is important to control runoff at its source as well as deal with consequences of runoff has led to the development of a philosophy called Low Impact Development (LID). Although sometimes used nearly interchangeably, LID and BMPs are not quite the same thing. They can, however, be complementary ways to address stormwater management. Some BMPs fit well within an LID approach and use of LID can reduce the size or need for large, often public, BMPs such as regional detention ponds. For purposes of this discussion, LID methods are included within the list of BMPs discussed below.

BMPs can generally be divided into three broad categories:

- Non-structural / land use-oriented;
- Structural; and
- Operation and maintenance (O&M).

Structural BMPs are probably the most well-known type of stormwater treatment practices. Underground oil and grease traps, detention ponds and constructed wetlands are examples of structural BMPs. A properly designed and constructed roadside ditch, called a vegetated or bio-filter swale, can also be considered a structural BMP.

Non-structural BMPs generally don't involve such visible mechanisms but can be no less effective in addressing stormwater issues. They can range from providing land buffers around developed areas to reducing the total allowed impervious area in developing areas to public education.

Finally, O&M BMPs focus both on maintaining the long-term usefulness of structural BMPs as well as reducing the likelihood of stormwater causing problems. O&M BMPs include street cleaning, detection of contaminant spills, maintenance of vegetation in swales and catch basin cleaning.

BMPs can also be considered either temporary or permanent. Temporary BMPs are used during construction to control the acute conditions that occur when vegetative cover is removed and large areas of soil are directly exposed to rainfall. These BMPs generally focus on controlling soil erosion at the site and preventing subsequent downstream deposition of the sediments. Permanent BMPs are intended to remain in working condition for extended periods of time. They can fulfill multiple functions including reducing the rate of runoff, the volume of runoff as well as the quality of the runoff.

Some BMPs are best owned and maintained by the public, that is, the District. This can guarantee that the practice is properly maintained, repaired or upgraded as needed. Detention ponds serving large tracts of land are an example of a publicly-owned stormwater facility.

Similarly, street sweeping is an activity generally suited for handling by a public agency (e.g., public works department). Other BMPs are better suited for private construction and ownership, often because they are located on private property or are designed to serve only a small land area. Examples include roof-top gardens and bioretention areas.

Appendix H contains a fuller list of BMPs. The District's current engineering design standards indicate a preference for the use of regional wet detention ponds, designed in accordance with stormwater management plans. Where such facilities (existing or proposed) are unavailable, dry detention ponds, pipe-based detention or parking area and roof-top detention may be used.

7.0 EVALUATION OF ALTERNATIVES

At present, the District has the authority to address a broad range of stormwater issues generally as it sees fit. Thus, the District can choose an alternative management approach that matches its interest level with respect to being proactive, assigning responsibility for the costs of stormwater controls to those who generate stormwater and rectifying past land development choices that may have negatively impacted the natural water balance. With this in mind, four alternative management approaches have been formulated that can be adopted as frameworks for actions to address the issues identified in the previous section. These alternatives are:

- Basic commitment to drainage control;
- Basic commitment to stormwater management;
- Moderate commitment to integrated stormwater management; and
- High commitment to integrated stormwater management.

Each alternative management approach includes policy and management options as well as more specific action options. The policy and management options tend to focus on bylaws, guidelines and overall strategies that correct existing problems as well as mitigate or avoid future problems. In the following paragraphs, each of the management approaches will be briefly discussed. Table 7 shows how the various options can address the issues identified for the planning area.

Management Approach #1: Basic Commitment to Drainage Control – This is essentially the District's current commitment to focus on alleviating or avoiding nuisance flooding and avoiding erosion, fixing serious problems, and addressing problems as they arise. It recognizes that development generates increased stormwater runoff and that controls must be addressed on a community-wide basis (e.g., the use of regional detention ponds). Control of sediment-laden runoff during construction that can severely impact fisheries is addressed through the District's current engineering standards.

Given that there appears to be little pressure for growth in North Campbell River, this alternative management approach may be sufficient to maintain watershed health at a level at least as good as at present. Some actions that could be pursued to strengthen this basic commitment include:

- Fix ditch erosion along upper Woodburn Road;
- Evaluate and, if needed, repair the outlet culvert for Holly Hills / Woodburn Road catchment; and
- Clean and maintain ditches and culverts in the area.

Management Approach #2: Basic Commitment to Stormwater Management – This would be a "step up" from the current approach to drainage control in the District. The focus would be on alleviating nuisance flooding and erosion while also providing basic protection of fish habitat in selected areas. Current drainage problems would be addressed (see above) while some basic proactive stormwater management could be initiated, including encouraging the use of permanent BMPs at individual sites undergoing development.

In addition to those items cited for the basic drainage control level, some actions that could be pursued to enhance this broadened stormwater management approach include:

- All items listed for the "basic commitment" level;
- Refine the inventory of the existing stormwater system, through survey of storm sewers, culverts, ditches, etc.;
- Using the refined inventory, update the current hydrologic and hydraulic modeling of the system (developed for this ISMP);
- Establish an on-going maintenance program for the stormwater system, including cleaning and revegetating ditches, cleaning catch basins, and repairing erosion problems;
- Extend the current stormwater parcel tax;
- Define the content and standards for stormwater management plans required by developers;
- Initiate a stormwater awareness campaign, potentially including:
    - Preparing and distributing brochures discussing the importance of stormwater management,
    - Holding additional stormwater "open houses",
    - Painting "blue fish" symbols at catch basins,
    - Funding focused interest group(s), such as streamkeepers, to raise awareness, and
- Undertake fish habitat improvements to Vanstone Channel.

Management Approach #3: Enhanced Commitment to Integrated Stormwater Management – With the recognition that stormwater is a resource and that the presence of fish in local streams and ditches is a desirable community amenity, stormwater objectives could be broadened to place emphasis on control of stormwater at the sources. The focus would be on alleviating nuisance flooding and erosion, enhancing selected fish habitat reaches, finding opportunities to enhance base flow in the ditches via infiltration of stormwater, and improving the quality of runoff ultimately discharged to the Campbell River Estuary. For this level of commitment, low impact development methods that control both stormwater flows and water quality on-site would be encouraged. Without this focus, improving fish habitat is not likely to be very successful in the long run. Opportunities for mitigating the effects of past development on base flow and water quality would be explored.

Actions that could be part of this level of integrated stormwater management include:

- All items listed for the "low commitment" level;
- Establish a long-term monitoring (flow; water quality) program in strategic locations; this could be done in partnership with DFO, MWLAP or other senior agencies such as Environment Canada as well as local focused interest group(s) such as streamkeepers;
- Enhance the technical understanding of the hydrology and hydraulics of the drainages by:
    - Refining the conceptual ground water model developed for this ISMP with additional field investigations throughout the drainages (drilling, test pits, soils testing),
    - Refining the updated model, and
    - Calibrating the model with the monitoring results;
- Require a stormwater management plan for both new and re-developments;
- Develop a fish habitat improvement program, establishing priority improvement reaches, for example:
    - Vanstone Channel,

   - Lower Woodburn Road ditches, and
   - Lower Casey Creek Tributary;
- Adopt water quality standards for runoff from properties;
- See opportunities to implement pilot BMP/LID projects, either as retrofit or in new development areas (e.g., alternative "small footprint" road sections and porous pavement or bioretention in parking areas); implement through:
   - The district alone,
   - A developer, either in partnership with the District or alone as a requirement for a new or redevelopment project, and
   - In partnership with a local focused interest organization willing to undertake such work; and
- Establish a stormwater utility for the drainages (or the entire District), including a user charge system based on impervious area on parcels (either computed for each individual parcel or by land use category).

Management Approach #4: Full Commitment to Integrated Stormwater Management – This alternative management approach represents a complete commitment to sustainable development through application of Low Impact Development (LID) principles. Significant objectives for this level of commitment include: (1) manage runoff to mimic natural water balance; (2) focus on enhancing and expanding high quality fish habitat; (3) manage upland areas for maximum watershed health; (4) require the use of LID methods in all new, infill and redevelopment projects; and (5) seek to apply LID methods in previously developed areas when possible.

In addition to the various actions noted in the other alternative management approaches, these could also be pursued:

- All the items listed for the "medium commitment" level;
- Establish periodic update cycle for this integrated stormwater management plan (ISMP), for example, every 10 years;
- Target holding runoff volumes and peaks to "existing conditions" for all new and re-developments;
- Require use of low impact development (LID) methods in new and re-developments;
- Revise District development by-laws, including the OCP, to incorporate LID methods;
- Retrofit selected elements of the public stormwater system with BMPs for water quality control;
- Require retrofit of selected private existing "hot spot" sites with BMPs for water quality (and quantity, if needed) control; and
- Refine the stormwater user charge system so that it is based on connected impervious area, with credits applied for the use of BMPs and LID methods (e.g., bioretention systems, downspout disconnection, and tree plantings)

The preceding presentation of alternative management commitment levels is not intended to limit adoption of any of the options described. It is rather intended to offer and suggest a range of options that can be implemented to meet the District's commitments to stormwater management. There is of course nothing that limits a "basic level" of commitment to the listed items; the same holds true for the "high level" of commitment.

To assist the District with sifting through the options, making choices and setting priorities, some evaluation criteria are helpful:

- ***Technical feasibility*** – Can the element be reasonably expected to work in the District? Will implementation likely achieve the desired results? What is the level of complexity to undertake the action?
- ***Flooding and erosion*** – Does the action provide significant benefits in protecting life and property from flooding? From destructive erosion?
- ***Water quality impact*** – Does the action provide significant benefits to stormwater quality? Are there special considerations if the discharge is directly to the Estuary?
- ***Fisheries impact*** – Does the action protect and/or enhance the fisheries in the local streams or estuary, either directly (e.g., removal of barriers to fish passage) or indirectly (e.g., increase in reliable base flow in a stream)?
- ***Environmental impact*** – Does the action eliminate or generate erosion? Does the action add or remove riparian habitat?
- ***Cost(s)*** – What are the initiation costs (studies; preliminary and final design)? What is the construction cost? What long-term costs will the District assume for administration and oversight? For operation and maintenance (O&M)?
- ***Financing*** – Will the action require funds other than those currently available to the District? Are grants or loans available to cover costs? Can the costs be recovered, partially or totally, from the private sector? What will be the basis for any recovery charges?
- ***Authority*** – Does the District have the authority to undertake the action being proposed? Will the effort require partnering with other public or private entities in order to have the authority?
- ***Compatibility with other District policies and plans*** – Does implementing the action work at cross-purposes to other district activities? E.g., narrower "alternative streets" that reduce the impervious surface may limit fire access to a site.
- ***Conformance with other policies*** – Do the proposed efforts comply with or conform to federal and provincial policies, regulations and/or guidelines?
- ***Operation and maintenance*** – Who will own, operate and maintain the facility once it is constructed? Does that entity have the resources and commitment to do so?
- ***Time horizon*** – Is the effort short-term or long-term? If it is long-term, what is the time horizon (5, 10, 20 or 50 years) and what must be done now to guarantee success later? Is it a "one time" or an on-going effort?
- ***Public support*** – Is there support within the community for the proposed action(s)? Are there special educational initiatives that would be helpful?

8.0 RECOMMENDATIONS

The District of Campbell River has embarked on long-term process of enhancing the management of stormwater within the entire District. Holly Hills and Perkins Road Drainages represent a "test case" for this integrated planning. While the areas have issues that can be addressed, fisheries habitat being one important example, there is little pressure at this time for new development or redevelopment within the planning area. This allows the District the opportunity to consider options carefully, attempt pilot projects and proceed intentionally towards a full implementation of the proposed actions recommended below.

A "medium level of commitment" similar to the one described in the previous sections of this report would be consistent with the District's current policies and approaches to stormwater as articulated in its OCP and in the Terms of Reference for this planning effort. It is also consistent with the overall tone of the input from the public at the Open Houses. At those sessions, local residents raised concerns regarding maintaining, protecting and enhancing fisheries values in the area, both in local ditches and streams and in the surrounding Estuary. Attendees and post-Open House respondents generally were concerned with water quality of runoff from local industrial and commercial enterprises, while also recognizing that residential development plays a role in stormwater concerns. Minor flooding in various areas of the drainages was also a noted concern for some residents.

8.1 Guiding Policies

In light of the results of this study and in consultation with District staff, three guiding policies for stormwater management within the Holly Hills and Perkins Road Drainages were formulated:

1. Restore and enhance fish habitat in selected areas of the drainages
2. Encourage the use of on-site stormwater best management practices to control runoff volume and water quality
3. Provide adequate storm sewer systems to avoid flooding and erosion

These policies are intended to maintain and enhance the local stormwater systems without resorting to significant new capital improvements. Rather the intent is to improve local fish habitat in conjunction with other on-going or upcoming initiatives, such as the conversion of rural roads to urban standards, and introduce the use of on-site controls for stormwater management.

8.2 Plan Elements

To implement these policies, we recommend the District adopt the following elements of an integrated plan:

- Establish a monitoring plan for ditches and streams in the drainages:
  - Long-term, automated flow gage on Casey Creek (2 year minimum); could be placed in conjunction with the fish fence maintained by The Streamkeepers organization,
  - Long-term, automated rain gage at District's wastewater treatment plant (term to coincide with the stream gage's), and
  - Short-term, manual base flow and water quality monitoring on several ditches (monthly measurement of flow depths and basic water quality data; 1 year minimum);

- Update current inventory and mapping of the stormwater systems in the drainages, including:
  - Field check pipe inverts, lengths, sizes and materials,
  - Field survey ditch and stream profiles and obtain representative cross sections,
  - Field survey water quality or other stormwater structures, including oil/grit chambers (private or public),
  - Obtain aerial mapping of entire planning area, with minimum 1 m contours, and
  - Update digital database, preferably in GIS (for use in AutoCAD as well);
- Upgrade the current preliminary hydrologic and hydraulic models for the drainages:
  - Calibrate with proposed monitoring data and updated inventory and mapping data,
  - Review hydraulic capacity need for trunk sewer and culvert upgrades (in particular the Holy Hills / Woodburn Road catchment outlet culvert under the Island Highway near Robinson Road),
  - Confirm that detention facilities are generally not needed for attenuating peak runoff in the planning area,
  - Use continuous simulation modeling,
  - Update District IDF curve, and
  - Develop capital improvement plan, if required;
- Draft and adopt a stormwater bylaw to include:
  - Definition of the elements of publicly owned and maintained stormwater systems in the drainages:
    - Streams and ditches
    - Culverts
    - Storm sewers and appurtenances
    - Detention ponds, constructed wetlands and water quality structures,
  - Require stormwater management plans for new developments and for redevelopments of property that is currently commercial or industrial,
  - At industrial and commercial sites where spills or highly contaminated runoff could reach fish habitat or the Estuary, require use of end-of-pipe treatment technology, coupled with appropriate long-term upkeep of the structure as well as risk reduction operational practices at the site,
  - Require use of District-approved Best Management Practices (BMPs) to control runoff rates, volumes and water quality,
  - Target limits for runoff rates, volumes and water quality; for planning area suggest:
    - Where feasible in upland areas, retain on-site all runoff from storms less than 50% of the MAR
    - Where feasible in upland areas, detain on-site all runoff from storms up to the MAR
    - Safely convey all runoff from storms greater than the MAR
    - Remove 80% of the Total Suspended Solids (TSS) in runoff, on an annual average basis
    - Remove substantially all Oil & Grease from runoff,
  - Establish an enforcement mechanism, and
  - Stipulate fines for non-compliance;
- Draft and adopt a stormwater user charge bylaw to include:
  - Description of basis for user charges (either land use classes or actual impervious area on-site), and

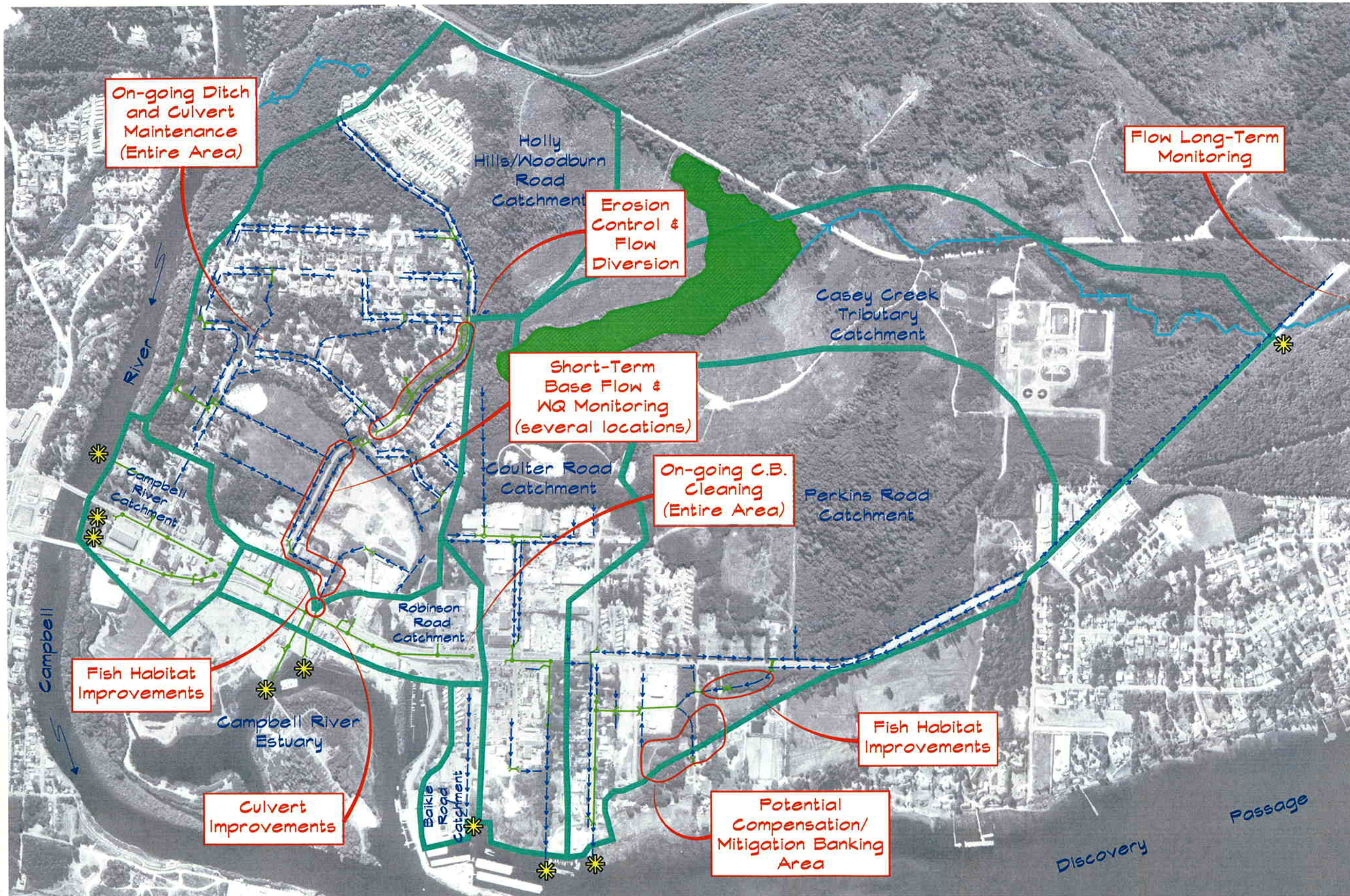
  - User charge rates;
- Revise the Engineering Standards for the District including:
  - Elements of the required stormwater management plans,
  - List of pre-approved BMPs for erosion and sediment control (both temporary and permanent),
  - List of pre-approved BMPs for on-site stormwater control, and
  - Allowance for use of low impact roadway sections when approved by District (see further discussion, below);
- Initiate a District-wide, public stormwater education program;
- Implement anadromous and resident fisheries habitat enhancements along lower Woodburn Road to the outlet of the catchment at the Island Highway;
- In the short-term, undertake improvements at the inlet to the Holly Hills / Woodburn Road catchment outlet culvert to render it more "fish-friendly";
- Upgrade lower Woodburn Road to "low impact" standards (in conjunction with fisheries habitat enhancements);
- Expand fish habitat improvements in bog area south of lower Woodburn Road;
- Implement resident fisheries habitat enhancements in the Perkins Road and Vanstone Channel area;
- Investigate establishing a compensation or mitigation "banking" area in the vicinity of the Vanstone Channel;
- Investigate the potential to enhance anadromous fish habitat in the Vanstone Channel, including bypassing the existing long culvert that serves as an access barrier;
- Develop and implement a long-term ditch and culvert maintenance program;
- Implement an on-going program of cleaning oil/grit chambers and catch basins;
- Implement proposed erosion control project along upper Woodburn Road (Option 3, Appendix G); and
- Undertake pilot projects demonstrating low impact development BMP methods:
  - As opportunities arise, in partnership with new developments,
  - At District's treatment plant site,
  - Along lower Woodburn Road (see further discussion, below), and
  - In Holly Hills (see further discussion, below).

Figure 17 shows the locations for the action elements from these recommendations that can be undertaken now by the District, such as culvert and fish habitat improvements.

The scope of the plan elements may be either specific to the Holly Hills and Perkins Road drainages or more suited for district-wide application. The time horizon associated with implementing each element may also vary. Some elements can and should be implemented now, while others may require additional technical evaluation and / or public discussion prior to implementation. Further, some elements may not need to be addressed until or unless sufficient development is imminent to trigger the need for implementation. Table 10 is a matrix highlighting the scope and horizon of plan implementation.

District of Campbell River

Integrated Stormwater Management Plan



N
Scale 1:10 000

Legend:

- Catchment Boundary
- Storm Sewer/Culvert
- EXISTING DITCH
- CATCHMENT OUTLET
- Wetland
- Stream

Fig: 17

Action Elements of Recommended Stormwater Plan

Prepared By URBAN SYSTEMS® consulting planners and engineers

PROJECT No: 1479.0003.01

DATE: March, 2004

Table 10: Scope and Time Horizon for Plan Element Implementation

Plan Element	Scope		Horizon		
	Planning Area Specific	District-wide	Now	Longer-Term	Development -driven
Stream and ditch monitoring	✓			✓	
Stormwater system inventory update		✓	✓		
Upgrade hydrologic and hydraulic modeling	✓			✓	✓
Adopt a stormwater bylaw		✓		✓	
Adopt a stormwater user charge bylaw		✓		✓	
Revise engineering standards for drainage / stormwater		✓		✓	
Initiate stormwater education program		✓	✓		
Enhance anadromous / resident fish habitat along lower Woodburn Road	✓		✓		
Inlet improvements to culvert under highway near Robinson Road	✓		✓		
Upgrade lower Woodburn Road to low impact standards	✓		✓		
Expanded fish habitat improvements in "bog area"	✓			✓	✓
Enhance resident fish habitat in Vanstone Channel	✓		✓		
Investigate establishing compensation / mitigation banking area(s)		✓		✓	✓
Expanded anadromous fish habitat enhancement in Vanstone area, including removal of access barrier	✓			✓	✓
Implement ditch and culvert maintenance program		✓	✓	✓	
Implement CB & oil/grit chamber cleaning program		✓	✓	✓	
Implement erosion control along upper Woodburn Road	✓		✓		
Seek pilot projects		✓		✓	✓

8.3 Capital Improvements

In the near term, we do not recommend any major capital improvements for either of these drainages, for two key reasons. First, there is insufficient data to fully evaluate the adequacy of several elements of the drainage system. As noted in Section 3.4 of this report, initial modeling indicates that the system generally appears to meet current as well as potential future needs for stormwater conveyance, even without the use of stricter stormwater controls. Second, the use of stricter stormwater controls, including the use of on-site stormwater best management practices and low impact development methods to more fully mimic natural water cycles, can be used to forestall or avoid entirely the need for large trunk storm sewers or detention facilities.

Commercial development of the bog area south of lower Woodburn Road is potentially the most significant land use change that could trigger the need for a trunk sewer in the area. However, if the District adopts the plan elements recommended in this report, including the requirements for on-site stormwater controls by developments, this can likely be avoided. At most, an upgrade to the Holly Hills / Woodburn Road catchment culvert under the highway may be required. This decision can be made in the future when the scope and nature of any development is better defined. (Since this culvert does represent a barrier to anadromous fish passage, the District should consider improving this culvert anyway, as part of its commitment to enhancing fish habitat in this area.)

A second significant potential land use change that could trigger the need for trunk sewer or detention facilities is residential development in the upper Perkins Road area. Again, with the application of on-site stormwater controls as described above, this can be avoided.

Culverts and ditches should be improved as adjacent roads are upgraded, when identified as structurally unsound during routine maintenance, or as part of an overall, long-term maintenance program.

8.4 Woodburn Road and Fish Habitat

Figure 18 shows one alternative roadway design that could be used to improve fish habitat along Woodburn Road while also accommodating an upgraded road. Other alternatives include:

- Develop the bog area south of Woodburn Road (including infilling the adjacent ditches), with compensation developed in back-channel areas of the River instead;
- Pipe the north-south ditches within the bog area, with compensation provided by an upgraded ditch / wetland area at the base of the Holly Hill, thus freeing up the entire bog area for development;
- Construct a wetland / pond at the outlet, at the Ocean Blue property; or
- Retain the existing ditches along Woodburn Road, with short side channels created within the streamside setback corridor

Table 8 (in Section 6 of this report) and Appendix C describe other aspects of fish habitat improvements for this area.

8.5 Alternate Roadway Designs

One of the District's current programs is conversion of rural road sections to urban-style roads. Alternative low impact roadway designs could be used for this purpose in areas where soils and other local conditions permit. (In addition, such low impact designs can become part of future new development as well.) A primary focus of the low impact designs is reduction in the impervious footprint of paved areas. A second focus is the use of runoff infiltration and evapotranspiration rather than surface flow to storm sewers.

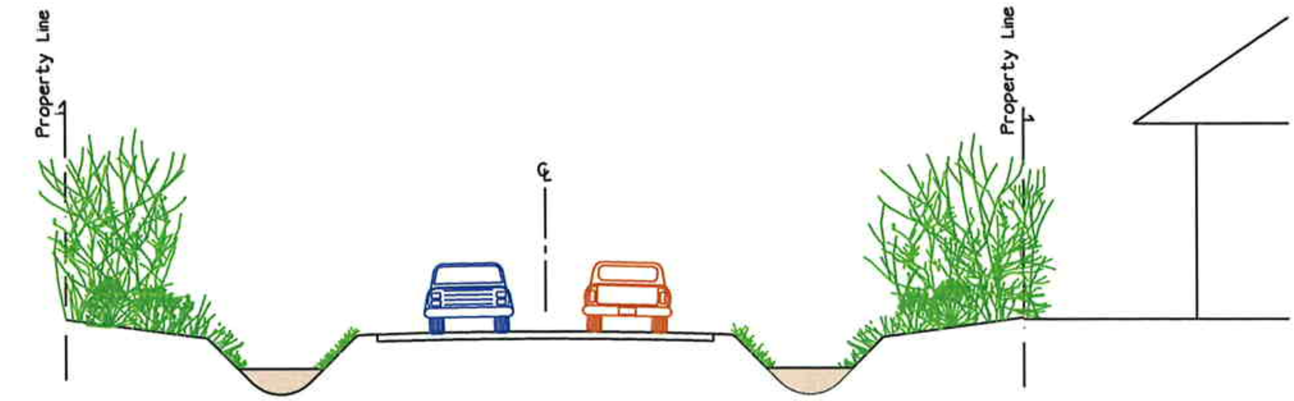
Figure 19 shows one alternative design that uses a narrowed pavement (7 m versus current standard 9 m) coupled with shallow vegetated (grassed) swales to provide stormwater control benefits. In areas with suitable hydrogeologic conditions, infiltration of runoff can be part of the design, otherwise trench drains (as shown in the figure) should be incorporated to carry away runoff. Other components of low impact roadway design can also be considered, including, where conditions permit, permeable pavement and sidewalks, discontinuous parking zones, bioswales that use native vegetation rather than just grass, and subsurface infiltration systems (as shown in Appendix B).

8.6 Stormwater Utility

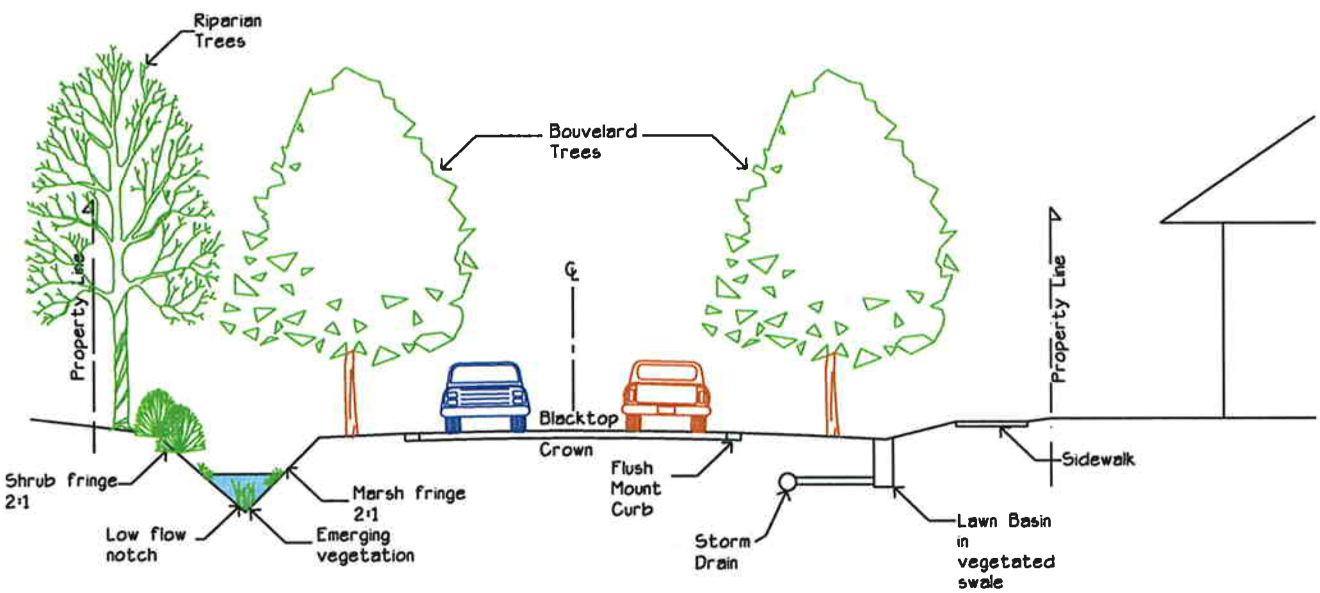
The District could choose to establish a stormwater utility within the planning area only. Subsequently user charges and fees would be applied to properties exclusively in the Holly Hills and Perkins Road Drainages. It would seem preferable for the District to consider District-wide implementation as well. Nonetheless, alternative implementation approaches include:

- District-wide utility with user charges applied District-wide as well
- District-wide utility with user charges initially applied to the Holly Hills/Perkins Road Drainages only; user charges could be introduced in other areas upon completion of integrated stormwater planning in those drainages
- Holly Hills/Perkins Road utility as a pilot project, that could be expanded later to other drainages in the District as integrated planning is completed

The determination of impervious area can be a time-consuming process. Thus one advantage of limiting the extent of the utility (i.e., the area over which charges are initially applied) is that it reduces the time to develop the basis of the charges. Further, it allows the District an opportunity to test the user charge implementation process.



Current Cross Section



Alternate Cross Section
With Fish Habitat Enhancement

Fig: 18
Potential
Woodburn Road
Upgrade

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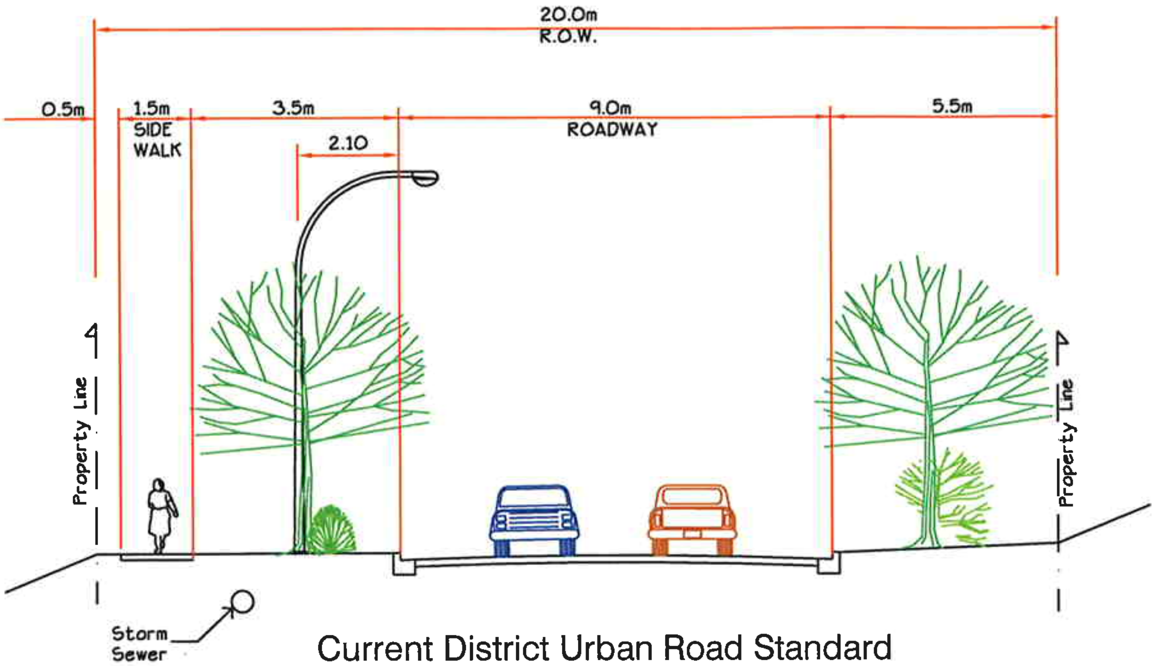
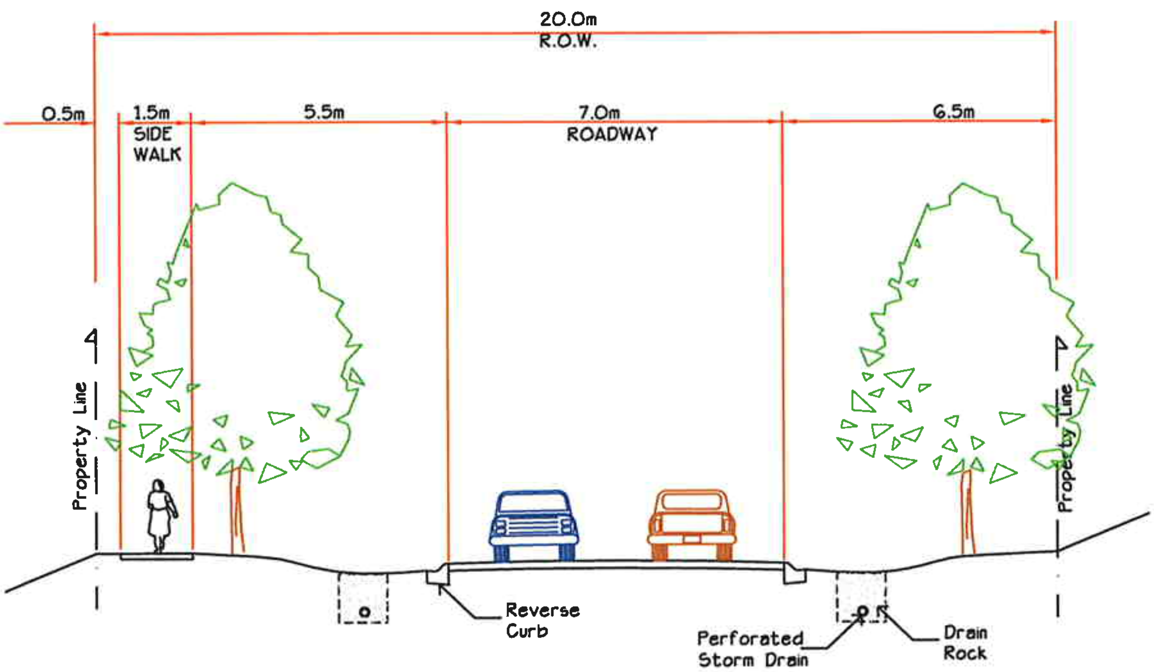
District of Campbell River

Integrated Stormwater Management Plan



Current District Urban Road Standard
(Typical)



Alternate Low Impact
Residential Road

Fig: 19
Low Impact Roads

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