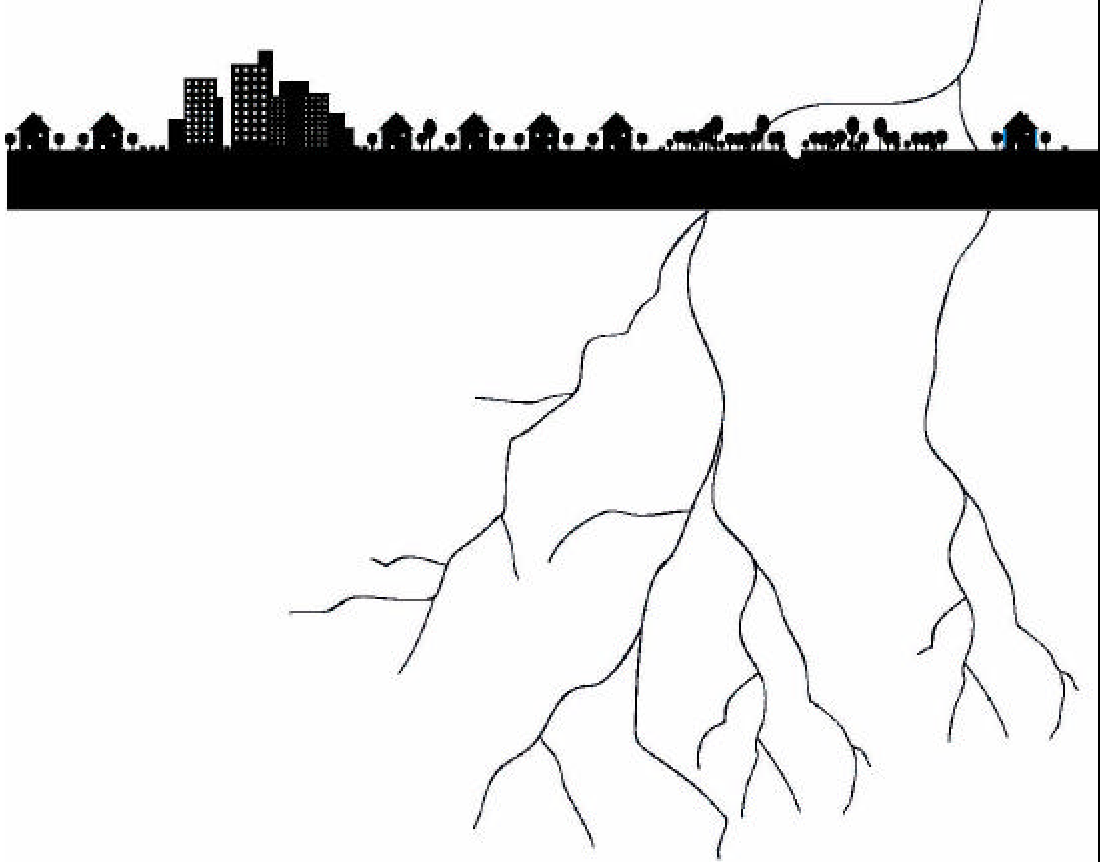
Land Use Change Drives Stormwater Management



Chapter One

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1.1 Impacts Flow Down the Watershed

Figure 1-1 illustrates schematically how water is recycled in nature. Water evaporates from lakes, rivers and oceans. It then becomes water vapour and forms clouds. It falls to the earth as precipitation, then it evaporates again. This 'hydrological cycle' never stops. Water keeps moving and changing phases from solid to liquid to gas, over and over again. In this Guidebook, this process is described as the natural 'Water Balance'.

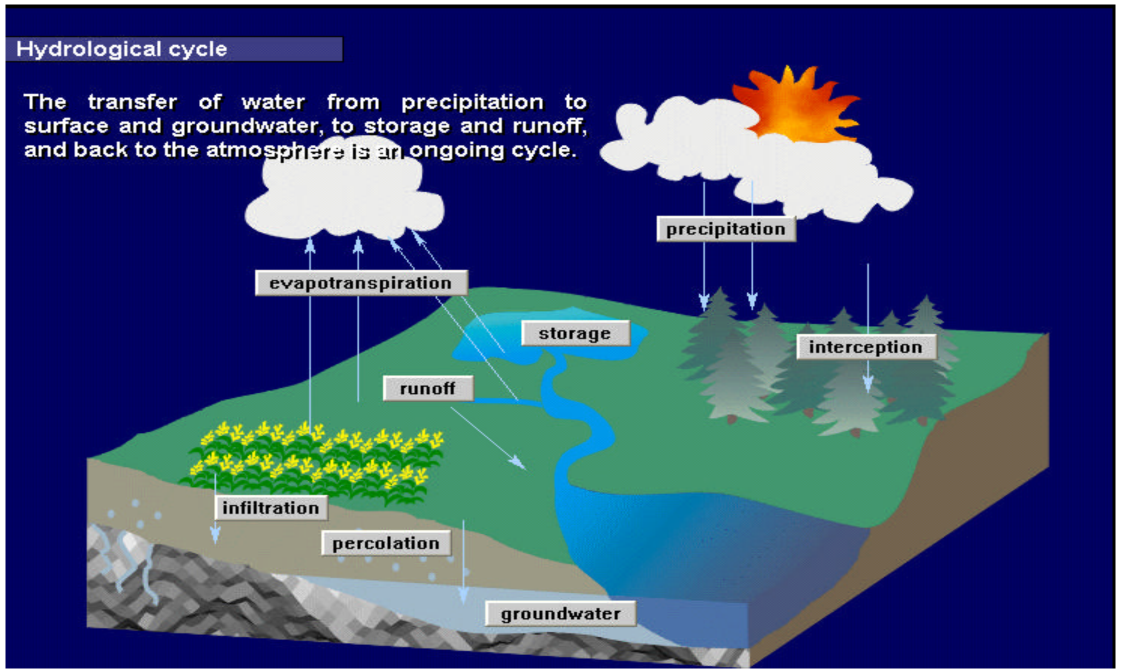


Figure 1-1 Components of the Natural Water Balance

Stormwater

Stormwater is the component of runoff that is generated by human activities. Stormwater is created when land development alters the natural Water Balance. When vegetation and soils are replaced with roads and buildings, less rainfall infiltrates into the ground, less gets taken up by vegetation and more becomes surface runoff.

The biggest increments of change - to the Water Balance in general, and to the surface runoff component in particular - occur when forested land is first cleared, then ditched, and finally paved or roofed over.

Until recently, the traditional approach to drainage has been to remove runoff as quickly as possible from developed areas. As a result, traditional urban design is very efficient in collecting, concentrating, conveying and discharging stormwater to receiving waters.

In British Columbia, stormwater management has traditionally been a function of local government or highway engineers, who have developed an expertise in conveying stormwater efficiently. Increasingly, stormwater management is becoming a shared responsibility with land use planners.

Guidebook Context

To mitigate the cumulative impacts of stormwater resulting from changes to the natural Water Balance, the British Columbia Ministry of Water, Land and Air Protection has developed this Guidebook to assist local governments, engineers and planners in clearly understanding the broader issues and the strategies currently available to correct stormwater-related problems.

A stormwater management component is a requirement for approved *Liquid Waste Management Plans* (LWMPs). The Ministry will encourage any progressive steps a local government may want to take to incorporate stormwater planning into their existing LWMP.

A core concept is that stormwater is a resource to be protected. Achieving this goal requires full integration of stormwater management with land use planning.

Changes to the Natural Water Balance

Runoff volume increases in proportion to impervious area (hard, non-absorbent surfaces). Land uses with extensive roof and paving areas create more runoff than land uses with extensive areas of absorbent soils and forest cover. Figure 1-2 illustrates the Water Balance for a natural forest. The examples on Figures 1-3 and 1-4 then illustrate what happens to the Water Balance when the forest is developed for residential and/or commercial uses, respectively.

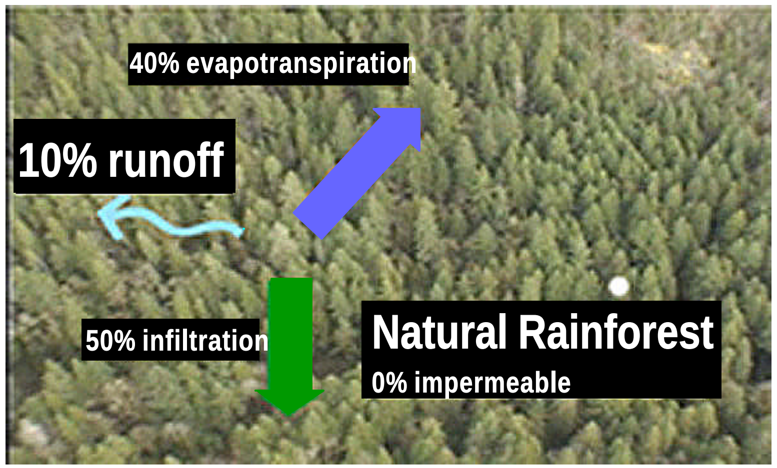


Figure 1-2 Natural Rainforest

Traditional ditch and pipe systems have been designed to remove runoff from impervious surfaces as quickly as possible and deliver it to receiving waters. The resulting stormwater arrives at the receiving waters much faster and in greater volume than under natural conditions. Changes in the natural Water Balance result in four categories of impacts: property, ecological, water quality and financial/political. An overview of each category is provided in the pages that follow.

Failure to manage stormwater resulting from land use change can cause flooding, loss of aquatic habitat and water pollution in downstream receiving waters.

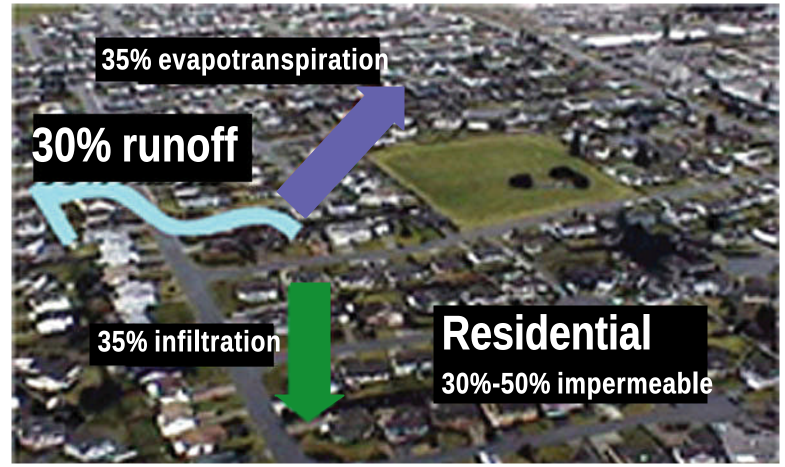


Figure 1-3 Single Family Development

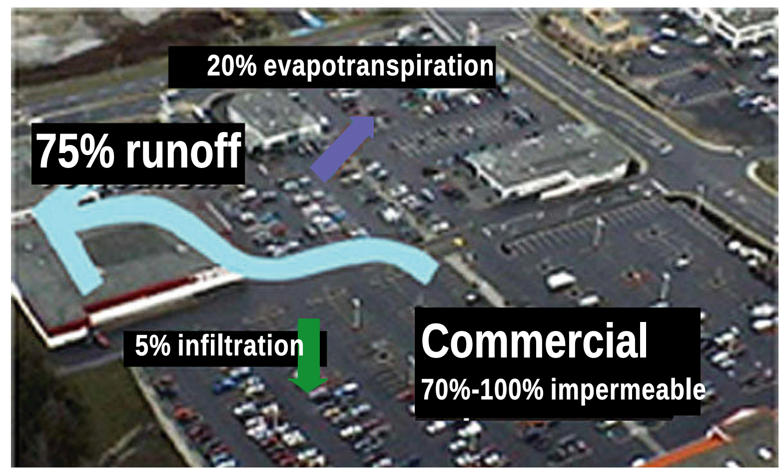


Figure 1-4 Commercial Development

Property Impacts

The width and depth of a stream are determined by the volume and rate of water that it conveys. Therefore, increases in flow volume and peak flow rates resulting from land development cause erosion on the sides and bottom of the channel. Figure 1-5 shows how additional culverts have been installed at a road crossing in order to handle the increased volume after upstream land clearing and ditching has occurred.

The material from these eroding banks (as shown on Figure 1-6) moves downstream as 'bedload', and settles out on the more gentle grades in the stream (Figure 1-7). These gentle grades are often located in the floodplain. These changes in stormwater flows and stream morphology often create both loss of property where erosion takes place, and increased flooding in the floodplain as it is filled in by sediments. This often results in damage to private property and agricultural land, and can pose a potential threat to public safety.

The most common property impact resulting from the increase in runoff is the accumulation of nuisance water on private property and public spaces downstream of development areas.

Figure 1-5 Multiple Drainage Culvert Installations

Figure 1-6 Channel Down-Cutting (due to increased volume)

Figure 1-7 Habitat Destruction (due to bedload deposition)

Ecological Impacts on Species at Risk

Figure 1-8 illustrates how:

- The cumulative effects of increasing impervious area in a watershed combined with loss of riparian corridor integrity (as shown in the first two rows), alter the natural Water Balance and impact stream corridor ecology (as shown in the last two rows).
- The resulting increase in runoff volume causes watercourse erosion and progressive degradation of the channel cross-section (refer to middle row).
- The consequence of these cumulative changes is a progressive decline in stream corridor biodiversity and abundance for cold-water fish and clear water indicators, and a progressive transition to warm-water species and pollutant indicators (as shown in the last two rows).

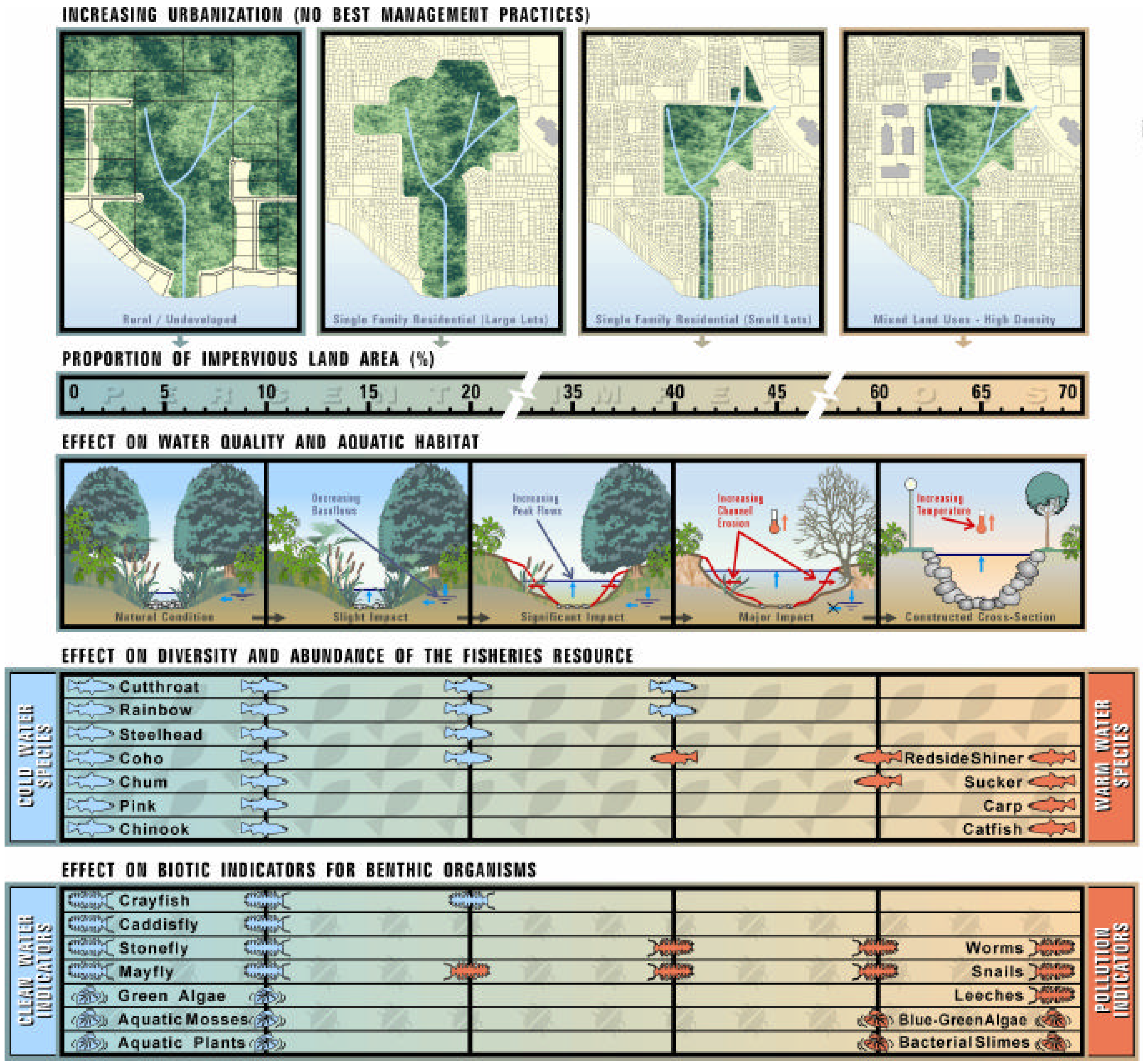
Eroded material (Figure 1-6) creates turbidity, or dirty water, that can irritate fish gills and make it difficult for fish to find their food. Eroded sediments can cover spawning beds, smothering fish eggs and young that reside in the gravel and possibly blocking access to spawning areas for the next generation (Figure 1-7).

The decrease in infiltration (due to replacement of soil and vegetation with hard surfaces) can also have impacts on fish because it reduces the slow, constant groundwater supply that keeps streams flowing in dry weather. This can lead to water levels that are inadequate to provide fish with access to their spawning areas, and can even cause streams to dry up in the summer.

Driving Force for New Approaches

Stemming and reversing the decline of wild salmon populations has led to questioning of the most basic assumptions that used to guide – and in many communities still guide – how we plan and manage development. This questioning has resulted in new approaches to land development and stormwater management. These new approaches are being advanced and implemented throughout the Pacific Northwest, and especially in the Georgia Basin.

The decline of wild fish populations is not limited to the Georgia Basin. In Okanagan Lake, for example, degradation of tributary streams and loss of aquatic habitat have similarly contributed to the decline of the kokanee fishery.



IMPACT OF INCREASING URBANIZATION ON STREAM CORRIDOR ECOLOGY

(WITHOUT BEST MANAGEMENT PRACTICES)

This figure demonstrates the impact of increasing impervious area on species diversity. Although it is based on research findings for lowland streams in the Puget Sound region of Washington State, the figure is intended for conceptual purposes only.

Figure 1-8

Water Quality Impacts

Although of BC's water quality is generally good, people are increasingly aware that the province is experiencing localized water pollution problems. Every year there are reports of public beach closures, contaminated sediments, algal blooms, aquatic weed infestations, fish kills, shellfish harvesting closures, boil-water advisories, outbreaks of waterborne diseases, and contaminated groundwater. BC's efforts to protect water quality by regulating 'end-of-pipe' point discharges from municipal and industrial outfalls have generally been successful.

It is now recognized that the major remaining cause of water pollution is from non-point sources (NPS), including stormwater runoff. Stormwater contains contaminants such as hydrocarbons and heavy metals derived from vehicle exhaust, brakes and leaked fluids, as well as nutrients, pesticides and bacteria from urban and agricultural land uses. When stormwater flows over large paved surfaces on warm days, it can increase to temperatures that are unsuitable for cold-water fish like salmon and trout. The result can be immediate fish kills in receiving streams, or chronic, long-term impairment of fish and other aquatic species.

Financial Impacts

Local governments and developers are finding that drainage costs are becoming a major portion of their capital outlay. The capital cost of land development with traditional piped solutions can be a significant detriment to affordable housing. In recent years, this has been one of the drivers for change. Reducing costs is providing an incentive for innovation. An example of this change in thinking is presented below:

> Although the Greater Vancouver region is spending about $33 million annually on stormwater management, "….in many areas of the region, current approaches to stormwater management and land development do not adequately protect the environment of small streams in watersheds experiencing significant population growth."
>
> *Source: page 1 of Executive Summary*
> *Stage 2 Liquid Waste Management Plan, 1999*
> *Greater Vancouver Regional District*

Finding a Better Way

Installation of drainage pipes without mitigating measures often creates erosion problems and/or flooding downstream in receiving watercourses. These risks can create threats to property and public safety, resulting in exposure to litigation.

To avoid further impacts and litigation, local governments are now beginning to address the cumulative erosion and flooding impacts resulting from development. This creates a further cost burden for additional drainage infrastructure, and for increased staff time devoted to maintenance of at-risk culverts and degraded floodplains.

In many cases, solving downstream problems by piping or armouring creeks is no longer environmentally acceptable, either to senior agencies or to the public.

This set of problems creates both financial and political imperatives to find a better way to develop land.

Lessons Learned

The essence of the foregoing discussion is captured below. These two 'lessons learned' provide a framework for developing land differently:

- **Universal Drivers for Change -** The risks and the impacts associated with stormwater have become drivers for change in the way stormwater is managed in British Columbia and in other jurisdictions around the world (e.g. the United States, Australia and New Zealand). It has been recognised that dealing with flooding and aquatic habitat issues must be integrated with decisions on land use change.
- **Complementary Objectives –** Integrated approaches to stormwater management acknowledge that protection of property, protection of aquatic resources, and protection of water quality are complementary objectives. Integrated approaches address each of these objectives.

1.2 Potential Stormwater Impacts will Accelerate Due to Population Growth Pressure and Climate Change

In the future, there will be more runoff volume to manage due to the combination of:

- **Population Growth** – resulting in more land development plus re-development / densification of existing urbanized areas
- **Climate / Weather Change** – resulting in both increased seasonal rainfall and more frequent 'cloudbursts'

Population Growth Pressure

Only about 5% of BC is suitable and/or available for human development. The majority of the land area – about 90% - is owned by the Crown and is mostly mountainous terrain. The balance (5%) is protected within the Agricultural Land Reserve. The limited supply of developable (and available) land is a driving force for change. The majority of the developable land in BC is located in the southwestern portion of the province.

As regional populations grow, more and more people will need to be accommodated in existing development areas. This will result in some rural areas becoming increasingly suburban. Similarly, suburban municipalities that are close to the major population centres will become more urban as they densify. The rate and scale of development in the 1990s has already transformed most suburban development areas, especially in southern BC.

Population-driven changes are most noticeable in the Georgia Basin, throughout the Okanagan, and in many parts of the Kootenays. The Georgia Basin is a bio-region that includes Greater Vancouver, the lower Fraser Valley east to Hope, and the East Coast of Vancouver Island. The total population has reached 3 million, or about 75% of the provincial total of 4 million, and is projected to double within the next 50 years.

If there were no change in the way that land development addressed stormwater, this increase in population would lead to an increase in impervious area, with resulting stormwater impacts.

The pending land use change brings into focus the need for more effective strategies to reduce stormwater-related impacts on property and aquatic ecosystems.

Need for Early Action

BC is 'land short'. Population growth pressure will lead to increased impervious area and will place pressure on species at risk. For these reasons, there is a need to accelerate the rate of change so that stormwater management is integrated with land use planning sooner rather than later. Figure 1-9 illustrates the potential for flooding in the urban environment.

Figure 1-9 Flooding in the Urban Environment

Climate Change

Rain gauge data for southwestern British Columbia suggest that precipitation frequency, intensity and duration are changing compared to the mid-20th century. Research by the University of British Columbia and Environment Canada implicate global climate change as the primary contributor to these observed trends.

Environment Canada models project increasing fall and winter precipitation, decreasing late spring-early summer precipitation, and more intense rainstorms (i.e. 'cloudbursts').

1.3 Integrating Stormwater Solutions with Land use Change

Many existing older urban areas in BC have been developed without stormwater management, and have suffered the related property and ecological impacts. Local governments in these areas are facing extraordinary costs and difficulties to reduce the impacts.

Recent Approaches Have Only Provided Partial Solutions

Emphasis in recent years has been on provision of community detention storage ponds in new developments. Although these ponds provide a partial solution, they only treat the consequences of increased impervious area, not the source.

Recent research by the University of Washington has shown that, in most cases, detention ponds mitigate flooding but do not prevent the ongoing channel erosion that creates property and fisheries impacts. Detention solutions also often do not support the sustained stream base flow that is critical to many fish populations in dry months.

In some areas of BC, especially in regional districts outside of the Greater Vancouver Regional District and the Capital Regional District, there is as yet little coordinated stormwater planning, even though urbanization and related impacts are accelerating.

Preventing Stormwater History from Repeating Itself

By examining past experience, it is evident that the contemporary approach to drainage is changing, from being reactive to being proactive. Now, the focus is on preventing problems at the source, by integrating stormwater management with land use planning so that:

- Decisions about land use change are made with a full awareness of the potential consequences for stormwater management
- Conversely, stormwater management principles influence the details of land use and site planning

The Stormwater Management Dilemma

Figure 1-10 illustrates the stormwater management dilemma – how can stormwater managers facilitate population growth and land development, while preserving the natural environment and preventing flooding in urban areas at the same time?

Figure 1-10 The Stormwater Dilemma

1.4 Local Government Responsibility for Drainage

The courts see the impact of drainage on property as a 'nuisance', where a landowner's use and enjoyment of his or her lands are interfered with as a result of actions or conduct on neighbouring lands. The courts have established precedents concerning the following:

- Right to drain land (allowing surface water to escape in a way provided by nature)
- Right to block drainage (surface water draining from higher land, as opposed to water in a natural stream)
- Measures of damages (damages will be awarded where liability is established)

In British Columbia, the *Local Government Act* has vested the responsibility for drainage with municipalities. This *Act* also enables local governments to address stormwater management much more comprehensively than in the past. The challenge is to use this legislation to achieve comprehensive goals and objectives in appropriate and effective ways. Division 6 of the Act (Sections 540 – 549) gives local government the direct power to manage stormwater: http://www.qp.gov.bc.ca/statreg/stat/L/96323_15.htm#part15_division6

Liability for Downstream Impacts Due to Changes in the Water Balance

With the statutory authority for drainage, local governments can be held liable for the nuisance caused by drainage to downstream property owners. To assist in understanding the scope of local government liability, three relatively recent cases are presented here. In all three cases, the Court of Appeal in the Province of BC has upheld the decisions. These cases underscore the responsibility of local government for stormwater volume management.

Case 1 - Indexed as: Kerlenmar Holdings v. Matsqui (District) and District of Abbotsford

Judgement - June 1991 (From British Columbia Law Reports 56 B.C.L. R. (2d) p. 377 – 387.)

A creek running through the plaintiff's farmland flooded regularly, and after 1971 the agricultural capacity of the land deteriorated as a result. The plaintiff brought an action in nuisance, attributing the flooding to increased urbanization in the two defendant municipalities, whose storm drains were releasing more and more water into the creek.

The trial judge awarded damages for loss of income and the municipality was required to purchase the plaintiff's lands.

Case 2 - Indexed as: Medomist Farms Ltd. v. Surrey (District)

Judgement – December 1991 (From British Columbia Law Reports 62 B.C.L. R. (2d) p. 168-177.)

The defendant municipality held a road allowance across the plaintiff's land, along which ran a drainage ditch. In 1979, the municipality permitted residential development on lands to the west of and above the plaintiff's land. The development reduced the surface area available to absorb water, causing more runoff into the drainage ditch.

Although the ditch previously overflowed during winter wet weather periods, it now occasionally overflowed during the growing season as well as a result of the upstream residential development. The trial judge awarded damages for crop losses and ordered construction of a permanent pumping station.

Case 3 - Indexed as: Peace Portal Properties Ltd. v. Corporation of the District of Surrey

Judgement - May 1990 (From Dominion Law Reports 70 D.L. R. (4th) p. 525-535.)

The plaintiff operated a golf course in the defendant municipality. A creek bisected the course. The municipality had incorporated the creek into its' drainage system. Because of increased urbanization there was a substantial increase in the flow in the creek, which caused erosion.

The plaintiff attempted to resolve the problem by replacing the natural channel of the creek with a concrete flume in the 1960s. This worked for a time, but with further urbanization and increased flow, new erosion occurred which also damaged the flume. The plaintiff proposed certain remedial work and sought contribution from the defendant. The defendant rejected the request.

The plaintiff completed the remedial work, in the process raising some of the greens and fairways. He then brought action against the municipality to recover the cost. The trial judge concluded that the evidence amply supported that nuisance of the increased flow caused the erosion and the municipality was held responsible.

Authority to Implement Integrated Stormwater Solutions

Local governments have extensive and very specific tools available to them. They also have the discretion to use them or not. Decisions about a local government's appropriate level of involvement in stormwater and stream corridor management must therefore be guided by a set of clear, broadly agreed-upon objectives, as well as an understanding of the need for balance with other competing objectives and interests.

Some key *Local Government Act* planning, regulation, development approval and servicing provisions applicable to stormwater management are summarized below:

Regional Growth Strategy and Official Community Plan Goals

Section 849 (2) provides goal statements for:

- Protecting environmentally sensitive areas
- Reducing and preventing air, land and water pollution
- Protecting the quality and quantity of groundwater and surface water

Prohibition of Pollution

Section 725.1 enables local governments to enact bylaws prohibiting water pollution and to impose penalties for contravening these.

Soil Deposit and Removal (Erosion Control)

Section 723 enables local governments to include erosion control and sediment retention requirements associated with soil deposition and removal.

Zoning

Section 903 enables the prohibition or siting of regulated land uses that, for instance, generate non-point source pollution.

Environmental Policies

Section 879 enables *Official Community Plans* (OCPs) to include "policies of the local government relating to the preservation, protection and enhancement of the natural environment, its ecosystems and biological diversity".

Development approval information areas or circumstances (Section 879.1) enable the designation of areas or circumstances, or areas for which in specified circumstances, development approval information may be required.

Runoff Control

Section 907 enables local governments to set maximum percentages of areas that can be covered by impermeable material and to set requirements for ongoing drainage management.

Landscaping

Section 909 enables local governments to set standards for and regulate the provision of landscaping for the purposes of preserving, protecting, or restoring and enhancing the natural environment (e.g. requiring streamside vegetation).

Development Permit Areas

Development permit areas designated in an Official Community Plan (see Section 919.1) cannot be altered, subdivided, or built on without a development permit. The permit can contain conditions for the protection of the environment.

Subdivision Servicing Requirements

Section 938 enables a local government to "require that, within a subdivision"… "a drainage collection or a drainage management system be provided, located and constructed in accordance with the standards established in the bylaw".

In addition to the above, other stormwater management powers can be found in provisions dealing with building regulations, contaminated sites, development cost charges, ditches and drainage, dikes, development works agreements, flood protection, farming, highways, improvement districts and specified areas, park land, regional district services, sewage systems, subdivision, temporary commercial and industrial use, tree cutting, utilities, water and waste management.

(Note: The section references quoted above are expected to change over time. Some of these changes will result from implementation of the Community Charter process in the near future.)

1.5 History and Evolution of Stormwater Management

The evolution of stormwater practice in North America is set against the backdrop of social change, and changes in stormwater management philosophy.

North American Context

Modern urban stormwater infrastructure was born in the post-World War I era, consisting of efficient drainage systems with catch basins and pipes leading to the nearest stream.

Some time after World War II it became apparent to engineers throughout North America that the fruit of an efficient stormwater system was downstream flooding and channel erosion. By the early 1970s, this resulted in a new idea to solve flooding forever: on-site detention.

In the 1970s, the literature began to reflect a new concept: stormwater master planning. The idea was that engineers could construct a hydrology model (how much water, how often?) and a hydraulic model (how fast and high does the water from the hydrology model go?) of a watershed and then analyze scenarios until they found the perfect solution to flooding problems – whether current problems or those only imagined.

By the mid-1980s, literally hundreds of master plans had been developed. But few were being implemented the way they were planned. The cycle was one where local governments typically proceeded from flooding to panic to planning, and then to procrastination and the next flood.

In the late 1980s, a new breed of approaches emerged as water quality and bio-assessment were added to the mix. Each solved the immediate problem of the past paradigm and created a more insidious problem of its own. Knowledge and technology created a real or perceived need for higher, more demanding levels of stormwater management – and regulation.

The 1990s saw the introduction of 'watershed-based' approaches and 'low impact development'.

Being aware of the changes in approach makes it increasingly less acceptable to do business as usual. The challenge ahead is to define and then actually demonstrate that a healthy watershed approach produces the full range of effective results in an efficient manner.

British Columbia Context

Before the 1970s, comprehensive urban drainage planning was a rarity in British Columbia, in part because there was no senior government funding for drainage projects. By the 1970s, however, drainage had emerged as an issue in the suburban areas because of flooding problems and resulting litigation. In the mid-1970s, the cities of Surrey, Nanaimo, West Vancouver (because of the July 1972 flooding that resulted in a catastrophic washout of the Upper Levels Highway during construction), and Kelowna were among the first municipalities to undertake major municipality-wide drainage studies. The history of modern stormwater management in British Columbia is summarized as follows:

- **A Flows-and-Pipes Approach**
  Master Drainage Plan (MDP) and Stormwater Management Plan (SMP) have tended to be used interchangeably in British Columbia over the past 25-plus years. A number of suburban municipalities (e.g. City of Surrey) continue to use the term MDP. The term SMP became popular in the late 1970s as 'management' became a catch-phrase for all infrastructure planning activities. The basic engineering approach did not materially change. Typically, an MDP was the 'flows-and-pipes' product resulting from a stormwater management strategy.

- **An Environmental Approach**
  In the 1989 through 1990 period, the City of Burnaby was the first municipality to apply what was initially called an 'environmental approach' to master drainage planning. This characterization reflected the evolution from a strictly engineering to an interdisciplinary team approach over a 6-year period for the Western versus Eastern Sectors, respectively, of the Big Bend Area in the Fraser River floodplain. The drivers for change were the impact of construction of the Marine Way arterial highway on existing market gardens, and the landfilling and conversion of undeveloped wetlands to industrial park uses.

- **A Stream Stewardship Approach**
  In 1992, the District of Maple Ridge adapted the Burnaby model in developing both a Stormwater Management Strategy and a Master Drainage Plan for the Cottonwood Area. At about the same time, the federal/provincial *Land Development Guidelines* and the provincial *Urban Runoff Quality Control Guidelines* were both published. Completed in 1994, the Cottonwood process showed how to make both sets of guidelines workable. The environmental agencies described it as a 'stewardship template' because it applied the concepts in the federal/provincial document titled *Stream Stewardship: A Guide for Planners and Developers*, also published in 1994.

- **Higher Levels of Interdisciplinary Integration**
  Integrated, ecosystem-based and watershed-based are terms that came into vogue at the end of the 1990s, and are interchangeable. Table 1-1 describes four case studies that took the Cottonwood template to successively higher levels of integration in terms of an interdisciplinary team approach.

  These case studies illustrate the transition from early environmental drainage to fully integrated stormwater management. They have given meaning to a comprehensive process for addressing hydrotechnical and environmental concerns in order to develop integrated solutions for the protection of property and habitat.

Integrated Stormwater Management Planning

In British Columbia, the term *Integrated Stormwater Management Plan* (ISMP) has gained widespread acceptance by local governments and the environmental agencies to describe a comprehensive, ecosystem-based approach to stormwater planning.

The purpose of an ISMP is to provide a clear picture of how to be proactive in applying land use planning tools to:

- protect property from flooding, and
- protect aquatic habitat from erosion and sedimentation

Use of the ISMP term is unique to British Columbia. The City of Kelowna first used the term in 1998 to make a clear distinction between 'suburban watershed management' and the Province's existing 'integrated watershed management' process for natural resource management in wilderness watersheds. This is an important distinction. Local government typically has control over stormwater in residential, commercial and industrial land uses. It does not necessarily have control over watersheds.

Local governments in British Columbia are changing. Those that are changing are providing models for others to adapt and further evolve.

Table 1-1 Origin and Evolution of Integrated Stormwater Management in British Columbia

Year	Municipality	Project Name and Relevance
1996	City of Kelowna	***Environmental Component of an Integrated Strategy for Stormwater and Stream Corridor Management:*** The term 'integrated stormwater management' originated with the Kelowna study. This distinction was important to the City. It captured the essence of what the City was trying to accomplish through its 'environmental approach' to watershed protection. In the Kelowna context, 'integrated' referred to the linkages between watershed actions and stream corridor consequences. The study was comprehensive in developing a science-based framework for broadly defining watershed management objectives for the City's nine drainage basins.
1997	City of Surrey	***Integrated Stormwater Management Strategy & Master Drainage Plan for the Bear Creek Watershed*** The Bear Creek study was undertaken in parallel with Kelowna. It considered all the runoff events comprising the annual hydrograph. The emphasis was on how to integrate the range of hydrologic criteria for sizing of stormwater control facilities that have different functional objectives. Two components were defined: 'hydro-technical' described the conventional engineering approach to conveyance of large runoff events; while 'enhanced hydro-technical' captured the environmental objectives in restoring the natural hydrology characteristic of the small runoff events.
1998	G.V.R.D City of Burnaby City of Coquitlam City of Port Moody	***Integrated Stormwater Management Strategy for Stoney Creek Watershed*** The Stoney Creek study was an inter-municipal pilot project, and built on the base provided by the Kelowna and Bear Creek experiences. The emphasis was on consensus-building (through a workshop process) to develop a shared vision that integrated a range of diverse viewpoints on the 10-person Steering Committee that also included a community representative. The foundation for strategy development was an assessment of the natural resources to be protected. The deliverables included a 20-Year Vision Plan and a 50-Year Vision Plan for stream preservation and watershed enhancement, respectively. These plans established targets for impervious area reduction.
2000	City of Coquitlam	***Como Creek Integrated Stormwater Management Plan – Flood Risk Management and Watershed Restoration*** Como Creek took the Stoney process to the next level of detail. Como is the first urban drainage study in the Greater Vancouver region to truly integrate the engineering, planning and ecological perspectives through an inter-departmental, interdisciplinary and inter-agency process that was guided by a Steering Committee of senior managers, and that included community involvement in development of the resulting plan. The goal was to develop an integrated plan that resolved a chronic flooding problem while over time restoring aquatic habitat. The focus was on how to implement changes in land use regulation that achieve the 50-year vision for impervious area reduction as the existing housing stock is replaced.

Provincial Enabling Initiatives

In 1992, the (then) Ministry of Environment, Lands and Parks published the *Urban Runoff Quality Guidelines* and the *Guidelines for Developing a Liquid Waste Management Plan* (LWMP).

In February 1994, the Ministry issued a policy statement to local government regarding the need to incorporate a stormwater component in LWMPs.

In July 1997, the Provincial Government enacted both the *Local Government Amendments Act* and the *Fish Protection Act* to give local governments new and improved tools to restore and enhance, as well as to protect, the natural environment.

In 1998, the Ministry published a document titled *Tackling Non-Point Source Water Pollution in British Columbia - An Action Plan*, which identified a series of tools and strategies available to reduce and prevent non-point source pollution in rural and urban areas.

The 1998 Non-Point Source Pollution (NPS) Action Plan

The 1998 Action Plan comprises six initiatives. The one that is particularly relevant to this Guidebook is *Land Use Planning, Coordination, and Local Action.* This initiative addresses both stormwater management and streamside protection. Local governments that have LWMPs are required to incorporate a stormwater management component. LWMPs may themselves be required in critical areas where, for example, NPS pollution affects aquatic resources.

Initiatives at the Regional Level

The Capital Regional District was the first jurisdiction to address stormwater quality in an LWMP for the Saanich Peninsula in 1996.

The Greater Vancouver Regional District formally embraced stormwater management in November 1994. This eventually led to formation of the inter-municipal and inter-agency Stormwater Task Group in 1997 to tackle stormwater quantity and quality issues. The ongoing role of this group is to formulate and guide implementation of a consistent regional approach to stormwater management planning as part of its LWMP.