Water, Air and Climate Change Branch

WATER QUALITY

Tackling Non-Point Source Water Pollution in British Columbia: An Action Plan

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Executive Summary

Although British Columbia's water quality is generally good, people are increasingly aware that the province is experiencing localized water quality pollution. 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 illnesses, and contaminated ground water. British Columbia's efforts to protect water quality by regulating "end-of-pipe" point discharges from industrial and municipal outfalls have been generally successful,

and it is now recognized that the major remaining cause of water pollution is from non-point sources, which pose significant and growing threats to our water resources. Non-point source (NPS) water pollution is subtle and gradual, caused by the release of pollutants from many different and diffuse sources, largely unregulated, and associated with urbanization, agriculture, and other forms of land development.

Given the dramatic population growth predicted for BC, we must act now in a determined way to deal with this pollution, otherwise we can anticipate a continuing, gradual decline in the quality of our waters. This decline will lead to significant future economic impacts and reduced benefits from our water resources.

Sources of Pollution

Major sources of NPS pollution in BC include:

Land Development
Construction projects and urban development which can disrupt natural water flows, generate sediments, toxins, pathogens, and create opportunities for numerous other non-point sources of water pollution.

Agriculture
Fertilizers, manure, pathogens, pesticides, and sediments can enter surface and ground water if agricultural practices are improperly managed.

Stormwater Runoff and Combined Sewer Overflows
Nutrients, sediments, pathogens, and toxins are picked up from yards and streets and enter surface and ground water, in some cases mixed with untreated sewage from combined sewers.

Onsite Sewage Systems
Nutrients and pathogens can seep into ground water and surface water if the systems are improperly sited, installed, or maintained.

Forestry
Soil erosion from road building, and logging activities, fertilizer and pesticide application, and burning are potential sources of water contamination.

Atmospheric Deposition
Pollutants released to the atmosphere from motor vehicles and other emissions eventually settle and enter waterbodies through runoff, rain, and snow.

Marine Activities
Vessel operation, maintenance, and sewage discharges can result in contaminants entering waterbodies.

The quantity of pollutants originating from any one source-such as a home, business, or farm-may

be very small. Nevertheless, the effects of hundreds or thousands of small sources within a watershed can add up to create water pollution.

The water pollution and costs from these non-point sources are significant and can include fish kills, health concerns, degraded drinking water, diminished water-based recreation and tourism opportunities, economic losses to commercial fishing and aquaculture industries and First Nations food harvesting areas, lowered real estate values, damage to habitat of fish and other aquatic organisms, the inevitable costs of clean-up and pollution reduction, and reduced aesthetic values of lakes, streams, and coastal areas.

Non-point source water pollution is difficult to manage using conventional regulatory approaches because it is hard to identify and control the many sources of pollution over a large area. The key to addressing this problem is prevention through planning and coordination, education, and source control. Wide-scale participation in the prevention of NPS pollution is necessary because the actions of so many individuals are part of the problem.

The Action Plan identifies the province's role in addressing NPS pollution and the priority initiatives that should be undertaken. These initiatives have been developed following public consultation, input from several government agencies, and completion of NPS water pollution studies.

Action Plan Initiatives

The Action Plan includes the following initiatives:

A. Education and Training
Inform government, First Nations, community organizations, businesses, industries, and individuals on the sources and risks of NPS water pollution and the options for prevention, and encourage long-term changes in behaviour that causes pollution.

B. Prevention at the Site
Develop and adopt practical "best management practices" to be applied at the source for pollution prevention, and establish water conservation programs.

C. Land-Use Planning, Coordination and Local Action
Identify water quality protection strategies for all forms of land use and at all levels of environmental planning, encourage local "stewardship groups" to participate in water quality protection, and develop organizational structures and partnerships to coordinate efforts.

D. Assessment and Reporting
Prioritize watersheds for NPS pollution control actions, implement pilot projects, to assess effectiveness through monitoring, and report the results to stakeholders.

E. Economic Incentives
Assess the potential for using market-based incentives to motivate NPS water pollution prevention.

F. Legislation and Regulation
Fully implement existing statutes, conduct ongoing analysis of existing legislation, and correct weaknesses and fill gaps in existing statutes and regulations, as necessary.

Implementation Strategy

This broad range of actions can only succeed in protecting water quality with the support and involvement of all levels of government, First Nations, community groups, and the public. The ministry of Environment, Lands and Parks (now Water, Land and Air Protection) will lead this undertaking and has chosen a three-pronged strategy to achieve this. The implementation strategy includes:

- Providing Leadership by building awareness, coordinating existing activities across agencies, leading in policy and regulation development, and prioritizing actions.
- Supporting Others and Building Partnerships by supporting other agencies in developing NPS pollution prevention strategies and initiatives, and by providing technical information.
- Delivery Through Pilot Projects by selecting projects, and developing the strategies for applying the results in other areas.

The Ministry of Environment, Lands and Parks (Water, Land and Air Protection) is implementing the NPS Action Plan in stages, building on Actions already underway and phasing in, over five years, longer term actions that require consultation and new policy. The Action Plan should be viewed as a living document that will be subject to review and improvement over time. Further public and stakeholder comments on the Actions, which are summarized below, are welcome.

Actions Under the Non-Point Source Water Pollution Action Plan

A. Education and Training — *Actions*

1. Implement a Public Awareness Strategy for NPS Pollution

- 1.1 Lead development of a provincial water education program, that includes NPS, aimed at the public, students, and community groups.
- 1.2 Coordinate education efforts across audiences to maximize effectiveness.
- 1.3 Inform local elected officials and administrators about the effect that local decision-making can have on water quality.

2. Promote Prevention of NPS Pollution Through Industry Associations

- 2.1 Work with industry associations to develop and promote NPS pollution prevention through education, training, and operator and technology certification.

B. Prevention at the Site — *Actions*

3. Support Development and Implementation of Best Management Practices

- 3.1 Support development and implementation of guidance manuals and best management practices (BMPs) for major sources of NPS pollution.
- 3.2 Provide advice and support to stakeholders in the effective use of BMPs.

4. Promote Water Conservation

- 4.1 Support implementation of the provincial strategy for water conservation.

C. Land-Use Planning, Coordination and Local Action — *Actions*

5. Incorporate Water Resource Management Objectives into Land-Use Plans

- 5.1 Incorporate NPS pollution prevention strategies into Higher Level Forestry Planning Processes for provincial forest lands.
- 5.2 Support local governments involved with Regional Growth Strategies with technical information on water resources.
- 5.3 Promote the incorporation of NPS pollution prevention strategies and policies into Regional Growth Strategies and Official Community Plans.
- 5.4 Ensure that streamside protection measures incorporated into local government planning processes address NPS pollution.
- 5.5 Support local government in protecting greenways.

6. Promote NPS Pollution Prevention in Waste Management Planning Initiatives

- 6.1 Address NPS Pollution in Liquid Waste Management Plans.
- 6.2 Address NPS issues in Pollution Prevention Plans.

7. Lead Development of Water Management Plans or Liquid Waste Management Plans in Critical Areas

- 7.1 Develop policy and regulations for Water Management Areas and Plans.
- 7.2 Identify critical areas and require Water Management Plans to address NPS pollution.
- 7.3 Develop Liquid Waste Management Plans in critical areas.

8. Support Government Coordination

9. Support Community-Based Waterbody Protection Initiatives

D. Assessment and Reporting — *Actions*

10. Evaluate Performance of NPS Pollution Actions

- 10.1 Measure success of program in terms of water quality and key management objectives.
- 10.2 Modernize field measurement methods.
- 10.3 Seek partnerships to support evaluation programs.

- 10.4 Support community volunteer monitoring initiatives.
- 10.5 Communicate successes and challenges to all stakeholders.

11. Assess Key NPS Pollution Cases

- 11.1 Focus effort on selected pilot areas.
- 11.2 Investigate the relative contribution of pollution from various sources.
- 11.3 Apply and evaluate remedial measures.
- 11.4 Use results to guide pollution prevention efforts elsewhere.

12. Continue Reporting to the Public

- 12.1 Report to the public on provincial water quality issues and trends.
- 12.2 Issue a BC Water Quality Trend Report.

E. Economic Incentives — *Actions*

13. Assess the Potential for Using Economic Incentives to Encourage NPS Pollution Prevention

F. Legislation and Regulation — *Actions*

14. Implement the Water Quality Provisions of the new *Fish Protection Act* and *Local Government Statutes Amendment Act*

- 14.1 Ensure that new provisions of the *Fish Protection Act*, such as streamside protection measures and "sensitive stream" designation, are designed to minimize NPS pollution.
- 14.2 Participate in the development and implementation of model bylaws for new legislative provisions under the *Local Government Statutes Amendment Act*, in support of the *Fish Protection Act*, which enables local governments to improve environmental management activities and prevent NPS pollution.

15. Enhance Agricultural Waste Management

- 15.1 Continue to improve administration of the existing Agricultural Waste Control Regulation under the *Waste Management Act* to reduce water contamination from farming practices.
- 15.2 Consult all stakeholders, including the public and the agricultural industry, to address concerns where water quality problems exist.
- 15.3 Lead and develop a new government-wide policy for improvements in agricultural NPS management.
- 15.4 Implement a new agricultural NPS pollution management policy.

16. Enhance Onsite Sewage Management

- 16.1 Harmonize the requirements of the proposed Municipal Sewage Regulation (*Waste Management Act*) with the Sewage Disposal Regulation (*Health Act*).
- 16.2 Strengthen Liquid Waste Management Planning to maximize prevention of NPS

pollution from onsite sewage disposal systems.

- 16.3 Empower and assist local governments to develop and promote onsite sewage system maintenance bylaws to prevent NPS pollution from new and existing systems.
- 16.4 Investigate the feasibility of alternative domestic sewage disposal systems to minimize and eliminate failing conventional onsite systems.

17. Enable More Effective Stormwater Management

- 17.1 Encourage use of stormwater bylaws for the prevention and management of NPS pollution.
- 17.2 Enhance the provisions for addressing stormwater quality in Liquid Waste Management Planning.
- 17.3 Investigate and promote the use of stormwater utilities.
- 17.4 Promote partnerships between the province, local governments, community groups, and others to raise awareness about urban runoff and to promote grass roots support for stormwater management in community planning and stewardship activities.

18. Manage Boat Sewage

- 18.1 Produce a focused educational program that identifies how boaters can prevent environmental degradation in the nominated waterbodies.
- 18.2 Work with the Coast Guard (Fisheries and Oceans Canada) to accelerate the designation of nominated waterbodies for boat sewage retention under federal legislation.
- 18.3 Review new nominations annually.
- 18.4 Determine the necessary level of infrastructure and enforcement as the program evolves.

19. Address Forestry and Range NPS Impacts

- 19.1 Establish water quality objectives in community watersheds and water supply areas.
- 19.2 Support the application of the Forest Practices Code of BC Act regulations to private forest lands.

20. Propose New Legislation to Fill Gaps

- 20.1 Propose new legislation to fill gaps in existing statutes to improve prevention of NPS pollution.

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The Time to Act is Now!

Although British Columbia's water quality is generally good, people are increasingly aware that the province is experiencing localized water quality pollution. There are swimming closures at public beaches, algal blooms, aquatic weed infestations, fish kills, shellfish harvesting closures, swimmer's itch, serious waterborne illnesses, and contaminated ground water. While our problems are not unique and may not be nearly as bad as in many other parts of the world, they are still serious. They cost millions of dollars annually and, worst of all, lead us gradually but surely towards immense future costs and conflict, and a much reduced quality of our water resource.

The good news, however, is that British Columbia is extremely lucky. Nature has granted us a vast supply of water — 25% of Canada's fresh flowing water is in British Columbia, and compared to many regions, the total water demand of our population is quite small. There is still time to turn this pollution problem around, but it must be given serious attention.

Preserving freshwater ecosystems and the quality and availability of Canada's fresh water is perhaps the most pressing of the many environmental challenges on the national horizon.
The State of Canada's Environment, 1991

Globally, clean water is a life or death issue for one out of every five people. In developing countries, 80% of all disease is spread by unsafe water. Although British Columbia is far from a developing country, we too experience waterborne diseases. In 1996, the cryptosporidium pathogen contaminated the Kelowna drinking water supply for a prolonged period, affecting 10,000 to 15,000 residents with severe diarrhea, weight loss, and fever. In the United States, waterborne infectious diseases cost almost $2 billion annually. Aside from the potential for huge health care costs, polluted water imposes major costs on other economic activities, including fisheries, tourism, and recreation.

In the first public status report on the quality of British Columbia's waters, the Ministry of Environment, Lands and Parks (now Ministry of Water, Land and Air Protection) rated 124 waterbodies throughout the province on attainment of water quality objectives. About 90% had excellent, good, or fair water quality, but 10% were only borderline or poor-and non-point source (NPS) pollution was identified as the major cause. Naturally, we all want top quality water, and if we set this as a clear goal and work together, we can achieve it. This Action Plan describes the ways that the British Columbia government proposes to address NPS water pollution to achieve the goal of clean water for all British Columbians.

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Changing our Approach to Water Pollution

Our approach to water quality management has been to focus on controlling "end-of-pipe" industrial and municipal pollution from obvious, identifiable sources. Permits are issued that allow a specified quantity and quality of discharge from industrial and sewage outfalls to flow into receiving waters and be diluted to safe levels.

Although this is one way of protecting water quality, it is only part of the solution. If we are serious about avoiding the environmental, health, and economic costs of poor water quality, we must emphasize pollution prevention rather than after-the-fact control. We know that cumulative impacts and carrying capacity of the receiving environment are critical factors. We know that we must act strategically by tackling big problems before routine ones, and by applying scarce resources to those solutions that will generate the greatest environmental benefit. And perhaps most importantly, we know that we must approach water pollution in a far more cooperative and coordinated manner. This is because NPS pollution cannot always be traced to a specific, identifiable source. NPS water pollution is subtle, gradual, and cumulative. It is caused by runoff flowing across farmers' fields, active or discontinued logging operations, on site sewage systems, home gardens, and city streets. It is caused by many small acts of pollution, and is therefore elusive and not easily regulated or enforced. We are all responsible and must all be involved in the solution; this will require cooperation and coordination at all levels, from senior governments, to community organizations, to individuals.

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Understanding Non-Point Source Pollution in BC

British Columbia, like most other jurisdictions, has focused primarily on controlling point sources of water pollution, but we are now beginning to understand the extent of NPS water pollution and the risk of not controlling it. Many costs and problems are associated with NPS pollution, including:

- degraded drinking water and potential human risks;
- damage to aquatic ecosystems, including fish, other aquatic organisms, and their habitats;
- economic losses to commercial and recreational fishing and shellfish harvesting and impacts on traditional First Nations food harvesting areas;
- diminished water-based recreation and tourism opportunities;
- reduced aesthetic and market values of lakes, streams and coastal areas;
- costs of remediation (e.g. payments for monitoring, clean-ups and pollution reduction); and,
- reduced real estate values.

POINT SOURCE AND NON-POINT SOURCE (NPS) WATER POLLUTION
Point source pollution is from a single, identifiable source, such as a pipe through which an industrial or municipal treatment plant releases wastewater and pollutants into a waterbody. Point sources are often controlled through effluent standards, water quality guidelines, permitting programs and liquid waste management plans.
Non-point source (NPS) pollution is caused by one or several activities taking place over a broad area. Agriculture, forestry and urban development are examples of activities that contribute to NPS pollution.

Non-point source pollution in aquatic ecosystems can be grouped into five main categories:

Pathogens
These microorganisms-bacteria, viruses, and protozoa-can cause waterborne illnesses. While most pathogens come from human sewage (primarily leaking or aging sewage collection systems, onsite sewage systems, stormwater runoff, and combined sewer overflows), manure from livestock and wild animal droppings are also common sources.

Oxygen Depleting Substances
When organic wastes (e.g., manure, sewage, pulp and paper mill effluent) decay in water, bacteria oxidize the waste, using up oxygen dissolved in the water. If the oxygen is consumed beyond a safe threshold, fish are stressed and will die when lethal levels are reached. Anaerobic decomposition (without oxygen) produces gases, such as hydrogen sulphide, that are lethal to many organisms.

Nutrients
Organic wastes and fertilizers introduce plant-feeding nutrients, such as nitrogen and phosphorus, into runoff. When onsite sewage effluent or runoff enters a waterbody, nutrients can cause algal blooms and dense weed growth that disrupt the balance of aquatic ecosystems and interfere with recreation such as swimming and boating. When an algal bloom occurs, oxygen in the water is depleted, which can cause odour problems as well as kill fish and other organisms.

Sediments
Suspended soil particles make water turbid and unpleasant to drink, and increase water treatment requirements. Sediments also reduce light available to algae and aquatic plants, kill or injure fish

by damaging their gills, cover spawning gravel and smother fish eggs, and reduce the quality of recreational activities such as swimming and boating.

Toxins

Substances as ammonia, nitrate, metals, pesticides and a variety of organic toxins can poison humans, livestock, wildlife, and aquatic organisms. Some toxins cause cancer. In addition, chloramine — a comparatively persistent drinking water treatment chemical — can be very harmful to aquatic life when discharged in fisheries-sensitive areas.

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THE ECONOMIC CONSEQUENCES OF NON-POINT SOURCE POLLUTION
Abbotsford-Sumas Aquifer: ***threats to drinking water supplies from nitrogen leachate have incurred an economic efficiency loss * estimated at $7.8 - $17.4 million.***
Brunette River Basin: ***long-term degradation of water and recreational opportunities by urban development — total annual economic efficiency losses * of $5.4 million.***
Salmon River (Salmon Arm): ***approximately half of the 110 km of streambank requires some degree of remediation. The total cost of riparian zone restoration is estimated at $1.9 million.***
Baynes Sound (Vancouver Island): ***contamination of shellfish through stormwater runoff, on-site sewage seepage and agricultural runoff total annual economic efficiency losses * of approximately $400,000.***
**** Economic efficiency loss: The sum of the range of household risk avoidance expenditures and the wilingness-to-pay estimates to avoid health risks.***

Impacts on Communities

Across British Columbia, NPS water pollutants have produced a range of impacts. In the enclosed marine waters of the Capital Regional District (CRD), NPS water pollution has adversely affected recreational opportunities, degraded aesthetic values, and reduced the abundance and diversity of marine life. Victoria and Esquimalt harbours remain closed to commercial crab harvesting due to dioxin/furan contamination. Beach closures have been common throughout the CRD, primarily

due to fecal matter discharged into stormwater systems. Although recent identification and elimination of sources of pathogens in storm drains that discharge near beaches has allowed beaches to reopen, several dozen storm drains remain a significant concern. In Saanich Inlet, most embayed areas are closed to shellfish harvesting due to fecal contamination from agricultural runoff, onsite sewage systems, and stormwater runoff. High levels of heavy metals have been measured in sediments near stormwater outfalls. These contaminants can cause sublethal toxicity to bottom-dwelling organisms.

In areas of the Lower Fraser Valley, east from Vancouver, the most significant potential for NPS water pollution is the agriculture industry. The Abbotsford-Sumas aquifer is contaminated with nitrate leached from manure and other fertilizers applied to crops and fallow fields. Nitrate contamination is also evident in other aquifers, including Hopington and Brookswood, due to agricultural activities and onsite sewage disposal.

Streams in the eastern Fraser Valley and in less urbanized areas of Langley and Surrey exhibit depressed oxygen levels caused by agricultural runoff. Low oxygen levels have contributed to coho salmon kills in the Nicomekl, Serpentine, and Little Campbell rivers near Boundary Bay in the 1980's. The same conditions exist in Matsqui Slough.

In the more urbanized areas of the Lower Mainland, the negative impacts of stormwater runoff, combined sewer overflows, and occasional toxic spills have been significant. Fish kills have occurred. Nutrients and fecal contamination have reduced aesthetic values and recreational use of urban lakes. Stormwaters and combined sewer overflows contribute a significant contaminant load to Burrard Inlet, where toxic metals and organic chemicals in the sediments are potentially toxic to bottom-dwelling organisms.

Advanced sewage treatment to control point-source phosphorus loading to the Okanagan Lakes over the past 25 years has led to significant improvements in water quality in most lakes. However, phosphorus inputs from non-point sources in this area remain a concern, and account for over 90% of total phosphorus loadings in the Okanagan Basin.

In the Armstrong, Osoyoos, and Grand Forks areas, ground water has been contaminated with nitrates from chemical fertilizers leaching from orchards and other crops. Corrective action should reduce the problem, but unless other NPS pollution from agriculture, forestry and stormwater are also controlled, deteriorating ground water quality from increasing nitrate levels could continue.

In the cattle ranching areas of the Northern and Southern Interior, water pollution from agriculture is widespread. Phosphorus loadings in runoff from cattle over-wintering areas have contributed to the eutrophication of Williams Lake in the Cariboo, with blooms of blue-green algae and critical oxygen depletion in lake bottom waters. Agricultural runoff has also affected the Thompson River and its tributaries-the Bonaparte, Nicola, and Salmon rivers. Where cattle have direct access to streams, bank erosion leads to vegetation loss, bank destabilization, and damaging sedimentation. Cattle manure can contaminate drinking water and harm fish by depleting dissolved oxygen.

In coastal areas, localized discharges from boats and marinas, storm drains, onsite sewage systems, and agricultural runoff affect enclosed, poorly-flushed bays, forcing shellfish harvesting

closures to prevent health risks.

In other areas of British Columbia, NPS pollution tends to be localized rather than widespread, indicating the major role that land development and population growth play in NPS pollution. Land development not only increases NPS pollution directly through erosion and sedimentation from land clearing and excavation, but also increases the opportunities for NPS pollution from other sources.

The cumulative effects of these point and non-point source water pollutants may exceed the carrying capacity of surface and ground waters. Understanding the connection between land use, the degree of development, and water quality is important. Determining the threshold in terms of land development versus the carrying capacity of water resources is required. In many cases, this represents a hidden danger-there may be no warning sign while nature is absorbing the load, then suddenly, as in the case of lake eutrophication, a critical threshold is reached and the waterbody's capacity to accept waste is exceeded. Once the threshold is exceeded, there are no quick-fix solutions. We have to deal with the cause of the problem, and therefore prevention is the key to NPS water pollution management.

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Who Manages Non-Point Source Water Pollution in BC?

The province has overall jurisdiction over land management on Crown lands and thus has a leadership role in managing NPS pollution. Local governments have jurisdiction over land development within their boundaries. However, a complex array of federal, provincial, and local agencies each have a role in managing NPS pollution in British Columbia. Table 1 lists relevant legislation, its purpose, and the agencies responsible. The complexity evident in the table underscores the inherently difficult nature of NPS pollution management. It is an inter-governmental and cross-jurisdictional issue. No one agency is-or can ever be-assigned all responsibility for NPS water pollution management because so many issues are involved. Improving the clarity of our collective direction and sharing commitment among the regulating agencies is essential to managing NPS pollution. This is especially important in dealing with the emerging issues related to land, resource, and growth management.

The specific strategies and actions described later in this Action Plan identify the organizations responsible for managing NPS water pollution in an effort to provide clarity on agency roles, and to encourage coordination of management efforts.

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Causes of Non-Point Source Water Pollution in BC

1. Land Development
2. Agriculture
3. Stormwater Runoff
4. On-Site Sewage Systems
5. Forestry and Range Activities
6. Atmospheric Deposition
7. Boating and Marine Activities

The more contaminants in water, the greater the risk to humans, fish, and animals. Even small amounts of contaminants in small amounts of runoff result in cumulative effects over an entire watershed and, building up over time, can have a significant impact. Locating the sources of pollution and removing contaminants before they reach the water provides the best assurance of clean water in the future.

A RUINED URBAN LAKE
Burnaby's Deer Lake has been closed to public bathing for a number of years due to high fecal coliform counts. Excessive phosphorus and high silt loadings enter the lake directly from stormwater runoff or indirectly through ground water seepage.
The symptoms are murky water from plankton growth and heavy silt loads, unacceptably high fecal coliform levels, prolific weed growth, algal blooms and low trout survival due to high temperatures and low oxygen levels. Efforts are being made to clean up Deer Lake as part of an overall action plan for the Brunette River basin.

The main causes of non-point source water pollution in British Columbia are:

1. **Land Development**: has its greatest effect in the major urban regions -the Lower Mainland, east coast of Vancouver Island, and the Okanagan Valley.

2. **Agriculture**: affects water quality in the Lower Fraser Valley, Cariboo, Thompson, and Okanagan basins, and the east coast of Vancouver Island.

3. **Stormwater Runoff and Combined Sewer Overflows**: stormwater runoff contaminates receiving waters in all urban areas of the province, but is of greatest concern in the Greater Vancouver and Capital Regional Districts. Combined sewer

overflows are a problem in the Burrard Inlet and North Arm of the Fraser River areas of Greater Vancouver.

4. **Onsite Sewage Systems**: primarily affects populated inland lakes, enclosed marine bays, and vulnerable aquifers.

5. **Forestry and Range Activities**: affects fish and fish habitat throughout the province, and may cause concern in designated community watersheds.

6. **Atmospheric Deposition**: includes dustfall, acidic rainfall, and air emissions. Water quality effects are primarily felt down-wind from urban areas, but long-range transport of persistent organic pollutants can occur.

7. **Boating and Marine Activities**: primarily affects waters around major commercial ports, boat yards, and poorly-flushed marine and freshwater anchorages.

1. Land Development

Well planned and properly managed human settlement and industrial development are immensely important to preventing NPS water pollution. Expanding development provides opportunities for numerous non-point sources of water pollution, such as construction site runoff, storm drains, spills and leaks, atmospheric deposition, and onsite sewage systems. New developments may affect previously pristine waters. The cumulative effects of creeping development may push surface and ground waters beyond their capacity to assimilate contaminants, creating impacts that are out of proportion to the size of the newly-developed area.

In its initial stages, land development can result in loss of green space, decreased pervious surface area, diversion and channelization of streams, destruction of aquatic habitat, and removal of riparian vegetation-all elements of natural systems that buffer, filter, and purify water and provide cover and food for fish. One federal report estimates that in the lower Fraser Valley, natural wetlands comprised nearly one-third of all lands converted to urban use between 1967 and 1982. In the Lower Mainland, more than 600 hectares of rural land are converted to urban uses every year. Between 1981 and 1986 the urban area of Greater Vancouver grew by 34 km^2, more than eight times the area of Stanley Park.

Land clearing and excavation can cause extensive erosion. Sediment loads from erosion on construction sites can be 10 to 20 times greater than those from cultivation. When land development is complete, impermeable roads, sidewalks, driveways, parking lots, and rooftops dramatically increase the volume and rate of surface runoff, creating the potential for more severe erosion and flooding.

Some of the more significant impacts caused by poor land development practices include increased water treatment costs, reduced recharge of aquifers, interference with navigation and recreation, flood damage and erosion, and destruction of aquatic habitat for fish and wildlife. Construction activities can also introduce pollutants such as phosphorus, nitrogen, petroleum products, organic chemicals, metals, and sediments, which eventually find their way into adjacent waterbodies. The serious damage that land development can have on aquatic ecosystems is

illustrated by the fact that Vancouver once had more than 60 productive salmon streams, and now has only six.

Another effect associated with expanding urbanization is an increased potential for hydrocarbon spills and leaks into waterbodies, ranging from the very large (a tanker spill) to the very small (dripping gasoline during vehicle and boat refuelling). Chemicals typically spilled (accidentally or deliberately) into storm drains from residential or commercial sources include paint thinners, wood preservatives, engine oil, antifreeze, pesticides, herbicides, and household cleaners. Spills of chloraminated drinking water into small streams can cause major fish kills.

SPILLS HARM FISH
In 1989 an antisapstain chemical applied to wood products was spilled into the Fraser River during the commercial sockeye salmon fishing season. The fishery was delayed for one day and salmon sales dropped after the incident was reported in the media. A lawsuit resulted in a $14 million judgement in favour of the commercial fishers.
From 1991 to 1995, 32 incidents occurred where materials were spilled or discharged into streams in the Coquitlam area — 19 oil/diesel or gasoline spills, five chemical spills and three siltation events. A proposal to build a salmon hatchery on Hay Creek was abandoned when the Department of Fisheries advised the water quality was too unpredictable, due to the history of spills and siltation.

Other sources of contaminants associated with urban land developments include runoff from large impervious areas (e.g., parking lots), sewage leaks and spills from sewer line breaks and illegal residential sewer connections to storm drains, oil from automobile maintenance and leaky underground storage tanks, sump pump discharges, spills from transportation accidents, chloraminated water from urban fire fighting, water main flushing and breaks, dewatering of muddy construction sites, and leachates from landfills and sites contaminated with hazardous materials.

THE CHALLENGE OF RAPID URBAN GROWTH

In 1960, 2.6 million people lived in the Georgia Basin-Puget Sound area. Today more than 6 million people live there, and if present trends continue, by 2020 the population will grow by an additional three to five million people. Growth at this rate challenges our conventional notions of how we manage our resources and plan our communities.

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2. Agriculture

Agricultural operations, if not properly managed, discharge a wide range of contaminants, including those from manure, fertilizers, pesticides, and eroded soil particles. The most worrisome contaminants are ammonia, nutrients, pathogens, and sediments. Ammonia is toxic to fish, while nutrients can impair water quality, as in the Serpentine and Nikomekl rivers, the Okanagan Lakes, and the Abbotsford aquifer. Manure is a significant source of nitrogen, phosphorus, biochemical oxygen demand, and disease-causing organisms, including those responsible for waterborne diseases. Proper management is required to avoid adverse effects to water supplies and human health.

POLLUTED RUNOFF FROM OVER-WINTERING CATTLE

Between 1994 and 1996, helicopter fly-overs of cattle over-wintering in the Thompson River Basin identified 204 potential impact sites. Based on compliance and water quality, 51 sites were given a moderately impacted rating and 44 were given a higher impacted rating.

Environmentally sound sound use of manure from farms is a constant challenge in the agricultural industry, and is not unique to British Columbia. In some parts of the Fraser Valley, nutrients from manure, combined with inorganic fertilizer use, exceed the capacity of local lands to assimilate the available nutrients. In some areas, the excess is between 300 and 400 kilograms of nitrogen per cropped hectare. When too much manure and chemical fertilizer are spread onto fields for crop enhancement, excess nitrogen leaches into ground water or enters adjacent streams. Timing of manure spreading and other management practices can affect the severity of the impact. If spread in the late fall and early winter, when the plants' nutritional needs are the lowest, winter precipitation can carry ammonia, pathogens, and oxygen-demanding materials into waterbodies.

Pesticides can contaminate waterbodies by several routes, including spillage, improper storage, application too near or into ditches and streams, leaching from soils, or washed away in runoff. About $22 million per year is spent on application of 120 different types of pesticides in British Columbia. The area of provincial agricultural cropland treated with pesticides increased from about 425,000 hectares in 1971 to about 550,000 hectares in 1986-about a 30% increase. On Crown land, the use of pesticides has stabilized or decreased in the last few years, suggesting that the promotion of integrated pest management in British Columbia since the 1980's may be paying off. Integrated pest management is an ecological approach to pest management where all available control technologies are consolidated into a unified program aimed at preventing economic damage and adverse effects to human health and the environment.

CONTAMINATION OF THE ABBOTSFORD-SUMAS AQUIFER
The Abbotsford-Sumas aquifer supplies drinking water for nearly 100,000 residents of British Columbia and Washington State. Land use above the aquifer is primarily agricultural and the practice of spreading high nitrogen poultry manure onto low nitrogen using raspberry crops leaves excessive nitrogen in the fields, which then leaches into the ground water. The problem has been increasing over the past 25 years.
Residues of 16 different pesticides have also been detected in the aquifer. Although pesticide residues are well below current Canadian drinking water guidelines and do not pose an imminent threat to human health, their presence is cause for concern.
Two initiatives have been undertaken to address agricultural impacts in the Lower Fraser Valley: ***1. The Ground Water Protection Program, which has achieved success in moving poultry wastes off the Abbotsford-Sumas Aquifer; and*** ***2. A joint federal/provincial study which produced a series of reports and can be used as a basis for delivering new agricultural pollution prevention policies.***

Limited water sampling efforts in the past provide little information about the degree of pesticide contamination of water in the province. However, an assessment of the Lower Mainland's

Abbotsford-Sumas aquifer, which provides drinking water to nearly 100,000 people, found only traces of 16 pesticides in the aquifer. Some of the pesticides detected are either no longer used or their use is restricted. The levels of pesticide were well below current drinking water guidelines and do not pose an imminent threat to human health. A comprehensive inter-ministry ground water quality assessment (Fraser Valley Ground Water Monitoring Project) conducted in 1993/94 indicated ground water quality in the Fraser Valley was generally good, except for elevated concentrations of nitrate-nitrogen in the Abbotsford, Hopington, and Brookswood aquifers.

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3. Stormwater Runoff

Urban development changes the hydrology (water flow amounts and patterns) of an area. Where natural vegetation and soil structure once allowed the gradual absorption and slow through-put of rain and snowmelt, paved streets and buildings speed delivery of both water and pollutants to our waterways. Pollutants from commercial, industrial, and residential activities that may appear insignificant at their source are transported by rain and snowmelt into storm drains that flush the wastes into rivers, lakes, or marine waters. In developed areas, surface runoff is increased by changes in slope due to landscaping and increasing impermeable surface area of pavement and buildings. Contaminants accumulated during dry periods are picked up by the next rainfall and quickly moved to the drainage system. This is when discharges can be most dangerous, because "first flush" concentrations of toxins are high. Some city residents have come to expect regular closure of favourite beaches. Less publicized but equally significant are the effects on aquatic life caused by metals and other toxic compounds that accumulate in sediments.

Ordinary citizens contribute to polluted runoff in many ways, often without realizing it. Car washing and maintenance can release salts, anti-freeze, and oils onto the pavement and then into storm drains and ditches. Pollutants from vehicle exhaust and backyard burning eventually settle to the ground and are washed into adjacent waterbodies by the next rainfall. Households with lawns or gardens use more chemicals on a given area than commercial growers. Half of all households with yards in British Columbia use fertilizers and one-quarter use pesticides. Excess amounts of these compounds find their way into the soil, ground water, and adjacent surface waters.

EXAMPLES OF STORMWATER RUNOFF EFFECTS IN URBAN AREAS
There are an an estimated 1,750 stormwater outfalls in the Greater Vancouver Regional District. Over half of these discharge directly into fish-bearing waters.

In 1998, an estimated 3,000 coho salmon, cutthroat trout and crayfish were killed by an unknown chemical spill to Burnaby's Byrne Creek. The suspected source of contamination was a stormwater outfall discharging to Byrne Creek.

Industrial and commercial businesses also contribute to polluted stormwater runoff through accidental spills and leaks, and through use and discharge of potentially toxic compounds. Many industries are required by their liquid waste management permits to collect, monitor, or treat stormwater. However, uncontrolled runoff from some industries remains a significant problem, and industries that are not required to collect and treat stormwater may require further review and regulation by the ministry. Efforts to replace harmful compounds with environmentally safe, yet effective, alternatives can be challenging. For example, in the timber products industry, lumber mills discontinued the use of pentachlorophenols as an antisapstain after it was blamed for fish kills in the Fraser Estuary and deregistered by Agriculture Canada in 1990. However, tests of runoff from Lower Mainland mills indicate that the replacement chemicals are also toxic to fish and detrimental to fish habitat.

Highway stormwater runoff combines the worst of industrial and residential runoff in the variety and concentration of metals, particulates, and petroleum compounds deposited by vehicles. Although stormwater runoff is generally more contaminated in urban areas, it also poses concerns in towns and rural areas, where erosion and sedimentation from roads, road-dust abatement chemicals, and road salt contribute to pollution.

PHOSPHORUS POLLUTION IN THE OKANAGAN LAKES

A chain of 5 lakes — Wood, Kalamalka, Okanagan, Skaha and Osoyoos — is the focal point of life in the Okanagan Valley. In the 1960s, the lakes had lost much of their clarity and were fouled with algal blooms. Analysis of lake water showed increased levels of phosphorus, caused by sewage from a rapidly growing population, manure and fertilizer from farms, orchards and cattle ranches, and logging practices.

Today, sewage treatment standards and facilities around Okanagan Lake are among the best in the world. Between 1970 and 1994 phosphorus loadings from sewage treatment plants in the Okanagan were reduced by 95% and phosphorus loadings in the Okanagan lakes system have declined or remained stable, even with a doubled population. However, phosphorus inputs from non-point sources to the Okanagan lakes system, as a whole, remain a concern.

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4. On-Site Sewage Systems

There are still about 250,000 onsite sewage systems in British Columbia, despite expansion of municipal sewage collection and treatment facilities. Onsite systems that are poorly planned, constructed, or maintained present substantial threats to water quality in the province.

Discharges from failing onsite sewage treatment facilities are a primary source of fecal contamination containing pathogenic organisms (bacteria, viruses, and protozoa). Nutrients (nitrogen and phosphorus) can also be problematic. The soil around the system removes the nutrients, and the degree of effluent remediation depends on soil texture and chemistry, the depth of unsaturated zone, and the distance of the system from receiving waters. Seepage from onsite systems can infiltrate sources of drinking water (including aquifers, streams, and lakes), cause health risks for swimmers and consumers of contaminated shellfish, and disrupt aquatic ecosystems by poisoning aquatic organisms and causing excessive growth of aquatic vegetation.

The Sewage Disposal Regulation under the provincial *Health Act* sets requirements for the design and construction of septic tanks and other onsite sewage systems of less than 22.7 m3/d, and defines acceptable soil conditions for the location of disposal fields. In 1985, more stringent regulations to control NPS pollution from onsite sewage disposal were introduced in the Okanagan, but these regulations do not apply to systems installed before 1985, or those situated elsewhere in the province. Moreover, the main objective of the Sewage Disposal Regulation is to prevent health hazards, not to address the environmental impacts of nutrient pollution. The Regulation has no enforcement provisions if operators fail to service onsite sewage disposal facilities, and no ongoing inspection efforts are being made.

Alternative sewage disposal systems are available to replace conventional onsite systems. These systems can stand alone or be used in combination with conventional systems. They not only can reduce the impact of the conventional onsite sewage disposal systems on water quality, but can reduce the amount of waste produced. Alternative sewage disposal systems can produce high quality effluent, conserve water through low usage, and recycle grey water (i.e., water from residential sinks and washing machines).

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5. Forestry and Range Activities

British Columbia's forest sector accounts for 7.5% of the province's gross domestic product and 60% of all exports. Much of the land is harvested by clearcutting, a method which can cause substantial soil erosion, particularly in rainy areas, and higher accumulation of snow than if trees were left standing. When warm spring weather arrives, higher-than-normal snowmelt can cause

elevated sediment levels in the water. In addition, there are over 37,000 kilometres of logging roads throughout the province, far exceeding the length of the provincial highway system. Logging road construction, use, and maintenance are the primary causes of NPS water pollution from forestry activities, causing up to 90% of the sedimentation from forestry activities.

LAND DEGRADATION FROM TIMBER HARVESTING
Timber harvesting impacts can include erosion, loss of nutrients and organic matter and physical deterioration such as compaction. A 1988 study of soil degradation by the timber industry estimated that between 1976 and 1985, at least 400,000 hectares of forest land were degraded in some way. This represents 22% of the total area harvested in that period. Appropriate management practices are essential in preventing further environmental degradation.

Prescribed burning, preparation of logged sites for replanting, fertilizer and pesticide application, and burning of logging slash are other potential sources of water contamination. Effects can include sedimentation, nutrient loading, introduction of toxic chemicals and organic debris, temperature changes, and streamflow increases or decreases. Any or all of these can negatively affect drinking water in the approximately 500 designated community watersheds, and numerous other watersheds used for domestic and industrial water supply, and can seriously impact fish and fish habitat.

To address concerns over forestry and range activities in British Columbia, the provincial government legislated the *Forest Practices Code of British Columbia Act* in 1994. The Code includes standards and requirements for forest planning and development, and measures for conserving biological diversity, soil, water, fish, wildlife, scenic diversity, and other forest resources.

With the implementation of the Forest Practices Code, BC is in the forefront of managing forestry-related NPS pollution issues. The Code recognizes water quality, quantity, and timing of flow as principle values in watersheds. The *Act*, and its regulations and standards protect watersheds-and consequently water quality-by guiding and regulating forest resource activities.

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6. Atmospheric Deposition

Gases and particulates released to the atmosphere from combustion sources such as motor vehicle emissions, slash burning, and industrial sources, contain nitrogen, sulphur, and metal compounds, which eventually settle to the ground as dust or fall to the earth in rain and snow.

These pollutants, which may have distant origins, may be deposited directly into waterbodies, filter slowly into ground water, or in urban areas, be washed from roads, rooftops, and parking lots into surface waters. The gradual effect can be acidification of waters to a point where the natural buffering capacity of receiving waters is exceeded and aquatic life is threatened. Toxins, such as dioxins, furans, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons, transported by atmospheric processes eventually accumulate in sediments, to the detriment of bottom-dwelling organisms and fish and their consumers.

Automobile use in an area greatly affects the atmospheric deposition of NPS pollutants, and this is a concern linked to urban sprawl. British Columbia's Lower Fraser Valley, with its characteristic weather patterns and surrounding mountains, now has a serious air quality problem because of ever-increasing motor vehicle use. In the Greater Vancouver area between 1984 and 1991, the number of cars insured for driving to work increased twice as fast as the population. Greater Vancouver now has more cars per capita than Greater Los Angeles.

THE LINK BETWEEN AIR POLLUTION AND WATER POLLUTION
The link between air and water pollution is urban sprawl and the associated use of vehicles. Urban sprawl, with its dispersed development, miles of impervious roads, parking lots and roofs and motor vehicle emissions, is recognized as a major cause of NPS water pollution. Air emissions settling to the ground and rooftops are washed into surrounding waterways.
In 1990, Canadian city dwellers drove, on average, more than 6,300 km per person, while urban Americans drove over 11,000 km. In comparison, European city dwellers drove approximately 4,500 km. The main difference is the way our cities are built. Urban sprawl forces North Americans to do considerably more driving to get around their cities.

An expanding population, expected to reach three million in the Lower Mainland by 2021, could mean a doubling of vehicle-kilometres travelled in the region. Greater congestion will lead to more stop-and-go traffic, increasing the emissions released per trip. From both an air quality and a water quality perspective, the increased risk to human health of these projections is of concern, given that the Lower Fraser Valley airshed is now at or above its capacity to accept contaminants. Significant efforts are being made to address these issues in British Columbia, especially to ensure the use of clean vehicles and fuels. Recent programs include:

- AirCare;
- GVRD Air Quality Management Plan;

- Heavy-duty Vehicle Inspection Program;
- Transportation Demand Management Program; and
- Scrap it Program.

Several legislative initiatives have also been completed:

- Clean Air Provisions amendment to the *Waste Management Act*;
- Motor Vehicle Emissions Reduction Regulation; and
- Cleaner Gasoline Regulation.

On-going efforts to manage point sources of air discharge, regulating toxins in motor vehicle emissions, and above all, reducing overall motor vehicle use are important strategies and will help address this source of NPS water pollution in British Columbia.

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7. Boating and Marine Activities

Boat operation and maintenance, discharge of sewage and grey water from vessels, and aquaculture operations are all sources of fresh and marine water NPS pollution. Although national legislation prohibits the discharge of garbage and pollutants from ships into Canadian waters, the legislation does not apply to sewage discharges in most locations. Sewage discharges in shallow, enclosed waters with poor flushing can impair water quality and recreational water use, and raise health concerns if the receiving waters are used for drinking water, swimming, or support shellfish.

Under the *Canada Shipping Act*, the Pleasure Craft Sewage Prevention Regulation mandates that any pleasure craft with toilet facilities must have sewage retention capabilities (holding tanks) to prevent sewage discharge when operating in designated waterbodies. This designation is important for waterbodies where high quality water is needed for fish/shellfish, swimming, or drinking water. British Columbia has asked the Canadian Coast Guard of Fisheries and Oceans Canada to designate about 60 additional fresh and marine waterbodies under this Regulation to prohibit sewage discharge and it is expected that more waterbodies will be designated in the future.

SEWAGE CAUSES SHELLFISH CLOSURES
There are currently over 200 sanitary shellfish closures in the province, approximately a 30% increase in the last 5 years. Domestic sewage, agricultural runoff and vessel discharges are the main causes, usually in that order.

Shallow intertidal waters are the preferred anchoring ground for most vessels and because they are also the natural habitat for shellfish and fish, this conflict can be expected to continue, unless recreational boaters take responsibility for preventing sewage discharges in unsuitable locations.

Many commercial marinas are sources of NPS pollution caused by discharge of sewage, food waste, fish cleanings, bilge and ballast water release, and other materials associated with boat and ship yard maintenance. Maintenance can cause new paint, old paint scrapings, anti-foulants, solvents, oil and grease, fuels, and cleaning agents to enter surrounding waters. Vessel traffic and dredging activity in marinas and in shallow navigation channels can also churn up sediments, reintroducing metals, nutrients, organic matter and toxins into the water. Creosoted pilings are a source of polycyclic aromatic hydrocarbons that may be significant in such confined areas.

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