Environmental
FACTSHEET

BRITISH COLUMBIA | Ministry of Agriculture

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STORMWATER MANAGEMENT PLANNING FOR AGRICULTURAL FACILITIES

1.0 Introduction

Stormwater is rainfall and/or snowmelt that either seeps into the ground or runs off the land into storm drains, lakes, rivers, and streams. In the natural environment, light rainfall events are usually absorbed by soil or vegetation. Some of the rainfall absorbed by the soil eventually makes its way to the groundwater table, providing nearby water channels with base flow. Part of the precipitation absorbed by vegetation is evaporated and and/or transpired back into the air. As rainfall intensity increases, the vegetation and soil become saturated and can no longer absorb all of the stormwater which causes surface water runoff and overland flow. Even in a natural environment or agricultural setting stormwater can occur for higher intensity rainfall or snowmelt events.

As land is developed, impervious areas are increased by compacted soils, pavement, rooftops, and buildings. Precipitation that previously was taken up by soil or vegetation becomes runoff, which increases the amount of stormwater. Managing stormwater is really about managing rainwater. Agricultural lowlands are often the recipient of increased stormwater flows caused by upstream urban developments. Stormwater runoff from urban areas contains harmful pollutants such as oil, grease, metals, salt, nitrogen, phosphorus, etc. This runoff should be managed to both reduce water quality degradation and prevent flooding of farmlands to a standard of protection that is compatible with agricultural activity. Reducing stormwater impacts requires minimizing impervious coverage and increasing the natural absorption of stormwater (i.e. Low Impact Developments).

Agricultural operations that have large impervious areas also generate stormwater runoff flows that enter municipal drainage systems or natural watercourses, often deteriorating conditions downstream from these facilities. Unless stormwater is properly managed, the increased discharge to waterways can cause flooding, impact water quality, increase erosion, and impact the environment's ability to support aquatic life. Stormwater management is critical to preserving the natural ecosystem and replenishing groundwater that keeps streams flowing during drier weather.

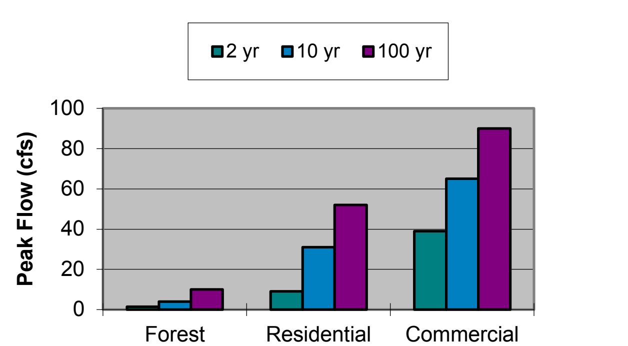
2.0 Stormwater Impacts on the Environment

FLOODING

Land use changes that increase imperviousness modify overland flow characteristics and can result in increased peak flows, which increases the risk of flooding. The impacts of different types of developments on peak stream flows are shown in Figure 1. One example from the figure shows that converting naturally forested land to an impervious commercial development can result in a 10 fold increase in peak runoff.

Farmers have the ability to control the conveyance of most natural flows of water onto their lands by using existing onsite and natural farm drainage systems. However, when water flows are amplified by upland development, farmers have difficulty managing these excess flows. Increased capacity in the regional municipal drainage systems is then required.

Figure 1 Peak Runoff Flow Rates for Different Land Uses

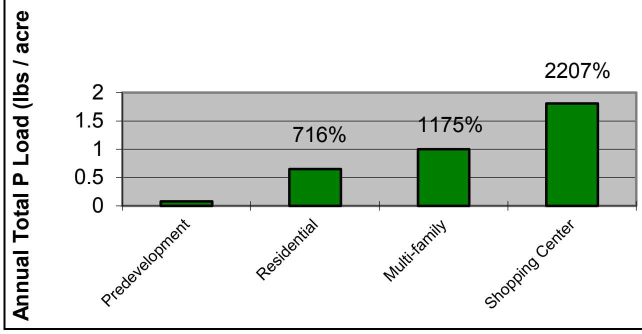


From - Stormwater Management Manual for the Puget Sound Basin

SEDIMENTATION

Increased runoff volume and velocities can result in increased erosion of streambanks, steep slopes and unvegetated areas. Increased sedimentation can degrade aquatic habitat by clogging fish gills, smothering eggs and thereby reducing the effectiveness of watercourses for spawning. The higher turbidity levels can also reduce aquatic plant growth, which diminishes the food source for other aquatic species. Finally, sedimentation reduces the storage and flow capacity of ditches and other watercourses, which can cause flooding.

Figure 2 Increase in Annual Total Phosphorus Loads Over Predevelopment Conditions for Different Land Uses



From - Stormwater Management Manual for the Puget Sound Basin

POLLUTANTS

Urban runoff can contain many different types of pollutants, depending on the source of the runoff. Roads, highways and parking areas contribute oil, grease, lead, cadmium and other pollutants. Industrial and commercial areas can contain PCB's, heavy metals, high pH concrete dust, and other toxic chemicals. Agricultural and residential areas contribute pesticides, fertilizers, and animal wastes.

One example, in Figure 2, shows the increase in phosphorus loading that can occur from various types of development. Phosphorus loads can increase by several hundred to several thousand percent.

AQUATIC HABITAT

Urbanization can increase water temperature, cause algal blooms, which reduces the amount of dissolved oxygen in the water. The loss of dissolved oxygen causes existing organisms and vegetation to die off. Often times the vegetation is replaced by undesirable species that may require more effort to maintain watercourses in proper operating condition.

3.0 Stormwater Governance

Federal and Provincial Government legislation does not explicitly regulate stormwater discharges. However, where stormwater discharges into fish bearing streams or waterbodies, the *Federal Fisheries Act*, the *Provincial Fish Protection Act*, *Water Sustainability Act*, and the *Environmental Management Act* can require protection of the environment.

For the most part, the acts regulate activities that affect water quality or habitat, and do not deal with the impacts of stormwater quantity. It is often the responsibility of local governments to request and implement the requirements for stormwater planning through the municipal bylaw process.

The following is a summary of how various acts pertain to stormwater governance.

3.1 FEDERAL FISHERIES ACT

The *Fisheries Act* empowers the Department of Fisheries and Oceans (DFO) to review any project or work that could result in "harmful alteration, disruption or destruction" of fish habitat or the deposit of a deleterious substance in fish bearing waters. Under the act, new stormwater outfalls may only be approved if effective stormwater management plans are in place to mitigate potential environmental impacts.

Environment Canada is responsible for administering the pollution prevention provisions of the Fisheries Act which prohibit the discharge of deleterious substances to waters frequented by fish. Stormwater discharges are occasionally acutely toxic to fish and therefore may be deemed to be deleterious substances pursuant to subsection 36(3) of the Act. Environment Canada or DFO may carry out inspections to verify compliance, initiate investigations of potential violations or request the discharger to produce plans and specifications for remedial measures to stop the pollution.

3.2 FISH PROTECTION ACT

The *Fish Protection Act* (FPA) empowers the Province to designate sensitive streams, request the development and implementation of recovery plans and water management plans, and enact regulations that will protect fish habitat and riparian areas that contribute to fish habitat.

Riparian area protection under the FPA applies only to residential, commercial and industrial uses.

3.3 ENVIRONMENTAL MANAGEMENT ACT

The *Environmental Management Act* (EMA) provides the Ministry of Environment the authority to regulate stormwater discharges from a water quality perspective to protect the environment.

Under the EMA and the Waste Discharge Regulation, an authorization is not required to discharge stormwater; however, stormwater discharges cannot cause pollution.

EMA allows, and the Minister can require, local governments to develop waste management plans. Liquid waste management plans include the management of stormwater and are approved by the Minister of Environment.

3.4 LOCAL GOVERNMENT ACT

For the most part, the management and control of stormwater is the responsibility of local government. Table 1 provides information on current municipal stormwater bylaws that pertain to agricultural operations as of 2006 for various municipalities in the Fraser Valley. The *Local Government Act* contains development planning, servicing, financing and approval provisions applicable to stormwater management.

These include:

Growth Strategy and Official Community Plans

Section 849 - provides goal statements for the protection of environmentally sensitive areas; maintaining the integrity of a secure and productive resource base, including agricultural land reserves; reducing and preventing air, land, and water pollution; protecting the quality and quantity of groundwater and surface water.

Section 878 - enables official community plans to include "policies of the local government relating to the preservation, protection, restoration and enhancement of the natural environment, its ecosystems, and biological diversity." (see notes on Development Permit Areas and Development Permits on page 4).

Drainage Service Delivery and Cost Recovery

Division 6 under Part 15 of the *Local Government Act,* as amended in Bill 14-2000, enables local governments to provide, regulate and recover costs for drainage services. Note that Section 542 specifies which sections related to drainage are subject to the applicable provisions of the *Water Act*.

Prohibition of Pollution

Section 725 - enables bylaws that prohibit water pollution

Section 903 - regulates or prohibits land uses which generate non point source pollution

Soil Deposit and Removal

Section 723 - enables erosion control and sediment retention requirements

The *Soil Conservation Act* also gives local government permitting authority for soil removal and placing of fill.

Runoff Control

Section 907 - set maximum percentages of areas of land that can be covered by an impermeable surface and to make requirements for ongoing drainage management.

Landscaping

Section 909 - set standards for and regulate provision of screening or landscaping for the purposes of preserving, protecting, restoring and enhancing the natural environment

Development Permit Areas and Development Permits

Development permit areas - Section 879 provides for the designation of development permit areas in an official community plan and for the specification of guidelines for the issuance of development permits in these areas.

Section 920 requires that where a development permit area has been designated and guidelines provided in an official community plan:

- A development permit must be obtained from the local government by an owner before land is altered, subdivided or built on; and
- Requirements and conditions can only be exercised in accordance with the guidelines specified in the official community plan.

These requirements and conditions can relate to:

- The protection of agriculture by requiring screening, landscaping, fencing and siting of buildings or other structures, and
- With respect to fish habitat:
    - Specify areas of land that must remain free from development, except in accordance with any conditions contained in the permit;
    - Require specified natural features or areas to be preserved, protected, restored or enhanced in accordance with the permit;
    - Require natural water courses to be dedicated;
    - Require works to be constructed to preserve, protect, restore or enhance natural water courses or other specified natural features of the environment; and,
    - Require protection measures, including that vegetation or trees be planted or retained in order to: preserve, protect, restore or enhance fish habitat or riparian areas, control drainage, or control erosion to protect banks.

Farm Bylaws

Section 917 - local governments, with approval of the Minister of Agriculture and Lands, can make bylaws with respect to farm operations. However this section does not expressly provide for stormwater management, which is covered in Division 6, and local government powers under that Division are not subject to Provincial approvals other than as provided in the *Water Act*.

Development Approval Information Areas

Section 920.1 enables local governments to designate areas, specify circumstances and make requirements respecting the provision of information in support of applications for zoning, a development permit or a temporary commercial and industrial use permit.

Subdivision Servicing Requirements

Section 938 - requires that a drainage collection or management system be provided, located and constructed for subdivisions in accordance with standards established in a bylaw.

District Municipality Drainage Works

Section 285 – Indicates that there is a six month statute of limitation in which to lay claim to any damages from the works done.

Section 286 – States that notice must be delivered to the municipality in writing within two months from the date on which the damage was sustained.

4.0 Agriculture Stormwater Governance

Agricultural operations often have large impervious surfaces that contribute stormwater to the municipal drainage system. In agriculture the quality of the runoff is often more of a concern than the amount of runoff produced, except for greenhouses and other large roofed facilities and concrete pads, where a larger portion of the property is covered with an impervious surface.

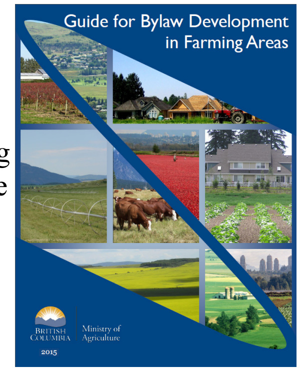
Many of the acts mentioned in the previous section (*Environmental Management Act*, *Fisheries Act* etc.) pertain to agriculture as well. Specific guidance directed to agriculture for stormwater management are as follows.

4.1 CODE OF AGRICULTURAL PRACTICE FOR WASTE MANAGEMENT

The *Agricultural Waste Control Regulation* (AWCR) under the *Environmental Management Act* is administered by the B.C. Ministry of Environment. The AWCR describes the practices for using, storing and managing agricultural waste that results in agricultural waste being handled in an environmentally sound manner.

4.2 GUIDE FOR BYLAW DEVELOPMENT IN FARMING AREAS

The ***Guide for Bylaw Development in Farming Areas*** provides local government flexible standards that can be incorporated into zoning and rural land use bylaws to ensure that bylaws affecting farming areas are fair to farmers and their neighbours. It also provides information on creating new bylaws.



The bylaw guide provides a standard for determining the detention pond for an agricultural facility. The standard method for designing detention ponds is to calculate post-development peak flows using the Rational or Soil Conservation Society (SCS) methods, or an average of the two. Available online.

5.0 Agriculture Stormwater Flow Calculations

BASE FLOW

ARDSA design criteria for farm drainage outlets suggest a freeboard of 1.2 m should be maintained, however, a minimum freeboard of 0.9 m is acceptable. This means the base flow water surface elevation between storms should be at least 1.2 m below the surface of the lowest point on the adjacent land. In order to determine the effect of any changes in the watershed, an estimate of the base flow for summer and winter may be required.

Base flow is calculated for an extremely wet period defined as 20 to 22 days of rainfall during a wet month.

The summer base flow condition is to be based on available stream flow and precipitation data. In the Lower Fraser Valley a base flow of 76 m^3/day/ha should be used in areas with an average monthly precipitation in winter of 175 to 230 mm. This value should be modified for areas with either higher or lower average monthly winter precipitation rates.

How fast the water can be removed from the land depends on the drainage coefficient which is defined as the amount of water that is removed from the drainage area in a day. As the freeboard decreases due to increased stormwater the drainage coefficient is decreased. A low drainage coefficient means the land will not drain as quickly and could result in saturated soil for extended periods of time.

It is in the best interest of a municipality to maintain a large freeboard in the ditches, providing a good outlet for tile drains which will provide good on farm drainage. As the water table is lowered the storage capacity of the soil is increased. During a large storm event the soil would be able to store more water before it becomes saturated, therefore reducing surface runoff. Drains placed at a depth of 1.0 m to 1.2 m have the potential of draining to a deeper depth than drains installed at 0.9 m. However, if the freeboard in the ditch is not available the storage capacity is lost.

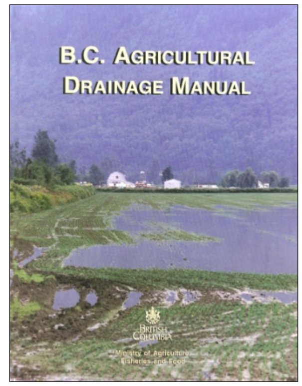
The ***B.C. Agricultural Drainage Manual*** provides comprehensive information on designing a farm drainage system taking into consideration, the crop to be planted, the soil type, depth of water table and other local conditions.

STORM FLOW

Stormwater runoff shall be calculated for summer and winter conditions using a one in 10 year return period for both winter and summer 5 day storms.

For small watersheds, less than 500 ha, the Rational or Soil Conservation Service (SCS) methods, or an average of the two, could be used to determine peak storm flows.

However, it should be kept in mind that both of these methods over simplify a very complex process. Caution should be used when using either of these methods for design purposes. Continuous simulation models are more realistic and take into account rainfall events that last for many days.



The ***B.C. Agricultural Drainage Manual*** contains examples of both the Rational and SCS methods. This manual is available online.

An example of the Rational Method is shown on the next page.

RATIONAL METHOD

$$Q = 0.028\, C\, i\, A$$

where: Q = peak runoff rate [m^3/s]

C = runoff coefficient, for roof and paved area use 0.9

i = rainfall intensity [mm/hr]. This is determined using a 10-year flow return period and rainfall intensity/duration/frequency data for the region. Using the chart requires that the time of concentration (T_c), be determined.

A = the impervious area being contained [ha]

T_c = time of concentration, this is the time it takes water to travel from the furthest point in the watershed, impervious area, to the outlet.

Once the peak flow has been determined, the detention pond must be sized to release water at pre-development rates or otherwise determined rates (R)

$$V_{\text{det}} = \frac{Q}{R} \times d$$

where: V_{det} = required volume of detention pond [m^3]

Q = peak flow [m^3/s]

d = depth of detention pond [m]

R = allowable discharge rate [$m^3/s/m^2$]

The area of the detention pond (A) is calculated using the above depth (d) and volume (V_{det}).

$$A\,[m^2] = \frac{V_{\text{det}}\,[m^3]}{d\,[m]}$$

CULVERT DESIGN

The 1.2 m freeboard will usually provide a deep enough ditch to contain storm water flows in culverts with slopes steeper than 0.001 m/m. When the slope of the land becomes steep enough that drainpipes are not required the ditches and culverts can be sized solely on the basis of containing the storm flow.

Once a culvert size has been chosen, check if the outlet control governs. For surface slopes of less than 0.001 m/m, outlet control will usually govern and the head loss across the culvert should be kept in the range of 0.12 to 0.24 m.

For surface slopes approaching 0.0005 m/m and flatter, it will rarely be feasible to size culverts and ditches to pass the peak storm flow from short duration, high intensity rains. For flat surface slopes backwater effects will predominate causing surface flooding in low areas.

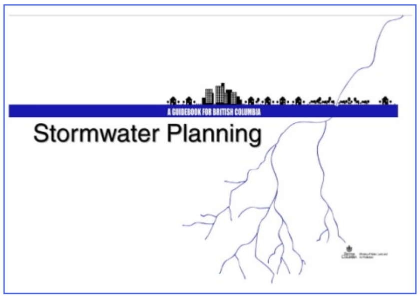
In the Fraser Valley culverts that are sized to pass a flow of 30 l/s per ha with a head loss of 0.06 to 0.12 m, will limit widespread surface flooding to about 5 days during a 10 year - 5 day winter storm.

For agricultural operations it is also important that culverts are designed to accommodate the peak flow calculated.

6.0 Stormwater Management

STORMWATER GUIDEBOOK

The Ministry of Environment developed a ***Stormwater Planning: A Guidebook for British Columbia*** that outlines a strategy on how to integrate stormwater management with land use planning.



The guidebook outlines why integrated stormwater management is important, the science behind stormwater management, setting performance targets, and providing design solutions for achieving those targets.

The GVRD has developed a companion document that provides a template for **Integrated Stormwater Management Planning** (ISMP). The **ISMP's** are used to develop strategies to collect and store stormwater runoff but to reduce detention storage volume by introducing source controls that allow rainwater to infiltrate into the ground. The template has developed a number of clauses that should be followed to develop an ISMP. Clause 19 provides information on conducting an agriculture assessment.

WATER BALANCE MODEL

An intergovernmental partnership in British Columbia developed an **online** tool that can evaluate the effectiveness of implementing source controls on a site. This tool entitled the **Water Balance Model (WBM)** was developed as an extension of ***Stormwater Planning: A Guidebook for British Columbia***.

The **WBM** allows users to compare different source control scenarios to achieve rainwater runoff volume reduction.

The model can be found at www.waterbalance.ca

WATER Balance MODEL

AGRICULTURAL STORMWATER MANAGEMENT

Stormwater runoff from impervious surfaces in farm operations should be allowed to enter the municipal drainage system or natural watercourses. For operations that have large areas of impervious surfaces, most local governments should require both a stormwater management plan and storage areas sized to reduce post-development peak flows to pre-development levels. On-farm detention ponds are most commonly used to reduce peak flows.

For agricultural operations, rainwater or stormwater management plans are often required for large operations where the impervious area exceeds a preset threshold. The objectives of a stormwater management plan are to ensure that the quality and quantity of water leaving a site do not impact on downstream users. This is done by:

- Collecting rainwater from impervious surfaces and mitigating the peak flows that are discharged to a waterway through the use of stormwater retention facilities. The peak flow entering the waterway should be similar to the runoff expected prior to development.
- Where stormwater is clean runoff from buildings or other impervious surfaces, stormwater should be kept separate from waste water collected on the farm. In some cases the stormwater stored can be used as a source for irrigation water.
- Whenever possible, use source controls that allow rainfall to soak back into the ground to recharge groundwater.

Infiltration systems can be an effective alternative to detention ponds. In areas where water normally would recharge ground water and where underlying soils have a fully saturated percolation rate greater than 1.3 cm per hour infiltration can be an effective method of reducing stormwater volumes. In larger applications a series of infiltration basins may be necessary to achieve the source control desired.

In many rural areas of British Columbia stormwater management plans are not a requirement. However stormwater plans should still be implemented whenever a facility is impacting significantly on the natural hydrograph of a watercourse.

ADDITIONAL INFORMATION

Factsheet 535.100-2 ***Agricultural Drainage Criteria*** provides additional information on regional drainage criteria that pertains to the information provided in this factsheet.

Table 1 : STORMWATER MANAGEMENT BYLAWS WITH RESPECT TO AGRICULTURAL OPERATIONS BY MUNICIPALITY IN THE FRASER VALLEY

Municipality	SWMP Required	Objective	Storm Event	Impervious Site Coverage	Detention1 (Dry) Pond	Retention[2] (Wet) Pond	Other Design Criteria
Abbotsford	For all developments of greater than 0.5 ha except for rural or agricultural developments unless otherwise directed by the Engineer.	Control post development Stormwater runoff to prevent or mitigate flooding or environmental impacts	*Minor systems:* 1 in 10 years *Major systems:* 1 in 100 years	---	May not be used where bedrock, impervious ground or max. seasonal water table is within 1.2 m of the prevailing ground surface Min. distances from pond to foundation walls = 5.0 m Max. allowable storage time = 6 hr	Max. side slopes = 3(H):1(V) Min topsoil = 150 mm, and seeded or planted with low maintenance vegetative cover Minimum distance above max. seasonal water table = 0.5 m	Open ditch for rural areas: Max. depth = 1.5 m Min bottom width = 0.5 m Max. side slopes = 1.5(H):1(V) Min grade = 0.5%
Chilliwack	All developments to provide drainage systems that manage the majority of rainfall events within the development site (all but one per year, on average), and safely convey runoff from extreme storms to the outlet of the site.	Control runoff volume so that watersheds behave as though they have less than 10% impervious area	*Minor systems:* 1 in 10 years *Major systems:* 1 in 100 years	---	Detain the next 30 mm of rainfall per day and release to drainage system or water courses at natural interflow rate	Capture the first 30 mm of rainfall per day and restore it to natural hydrologic pathways by promoting infiltration, evapotranspiration or rainwater reuse	All rainfall capture and runoff control facilities must incorporate "escape routes" to allow extreme storms to be routed to downstream watercourses, either as overland flow or via a storm drainage system, i.e., ditched or piped. Flood risk management (conveyance) ensures Stormwater plan can safely convey storms greater than 60 mm (up to a 100-year rainfall) Max. ditch depth = 1.0 m Min. ditch grade = 0.5%
Coquitlam	For all development proponents who seek approvals for rezoning, subdivision and building permits.	Limit post-development peak runoff rate from development site from the two-year design storm to 50% of pre-development peak runoff flow from the two-year design storm	*Minor systems:* 1 in 10 years *Major systems:* 1 in 100 years	Agricultural: 15%	Min. bottom slope = 2.0% Max. depth = 1.0 m	---	---
Delta	For all new developments	---	*Minor systems:* 1 in 5 years *Major systems:* 1 in 10 years	---	Max. depth = 1.0 m Min. grade = 0.5% max. velocity = 1.0 m/s (unlined ditch)	---	---
Kent	For all developments of greater than 0.5 ha, except for rural or agricultural subdivisions or developments, unless otherwise directed by the Engineer.	Mitigate runoff impacts due to change in land use	*Minor systems:* 1 in 10 years *Major systems:* 1 in 100 years	---	Determine in accordance with natural contour of land	---	---

Langley	For all developments except in rural or agricultural areas where lots are 0.405 ha or over, unless otherwise noted.	Mitigate runoff impacts due to changes in land use	*Minor systems:* 1 in 5 years *Bertrand Creek Basin:* 1 in 10 years *Major systems:* 1 in 100 years	Agricultural: 30%	Max. depth up to 1:10 year = 1.5 m Max. depth over 1:10 year = 2.5 m Min. bottom slope = 0.7% Max. pond side slopes = 4(H):1(V) Preferred side slopes = 7(H):1(V)	Min. land requirement = 0.5 to 2% of total catchment area Recommended min. length to width ratio = 2:1 Min. pond depth (normal water level) = 1.0 m Max. pond depth (high water level) = 3.0 m Max. side slopes from pond bottom to low water level = 4(H):1(V) Max. side slopes from low water to high water level = 7(H):1(V) Max. side slope above high water level = 4(H):1(V) Min. freeboard above high water level = 0.5 m	On-site detention: Max. pond depth = 100 mm (1:2 year) 150 mm (1:5 year) 300 mm (1:100 year)
Pitt Meadows	For all subdivision or development except for: - a subdivision or development within an area subject to, and which meets the requirements of, a watershed or integrated stormwater management plan adopted by Council; - a subdivision in accordance with single or two family residential zoning which doesn't require road construction and which can be served by extensions of existing minor and major drainage systems that have adequate capacity; - a building permit for a single or two family dwelling; or - a building permit, other than for a single or two family dwelling, on a parcel no greater than 1,100 m^2	Limit post-development peak runoff rate to pre-development peak runoff rate for the 10-year design storm or to a higher runoff rate approved by the City	*Minor systems:* 1 in 10 years *Major systems:* 1 in 100 years	Agricultural: 30%	Min. freeboard = 0.3 m Max. depth = 1.0 m Max. side slopes = 4(H):1(V)	Min. catchment area = 20 ha	Ditches: Max. water depth = 1 m Max. side slopes = 1.5(H):1(V) Min. bottom width = 0.5 m Min. grade = 0.5% Use safety factor of 1.1 for 20% impervious cover, and 1.5 for 100% impervious cover

[1] A detention pond is normally "dry" and only retains water during severe storm events.
[2] A retention pond is designed to provide temporary detention of severe storm runoff and maintain a permanent minimum water level all year around.

FOR FURTHER INFORMATION CONTACT
Phone: 604.556.3001
Toll Free: 1.888.221.7141

MINISTRY OF AGRICULTURE
1767 Angus Campbell Road
Abbotsford, B.C. V3G 2M3