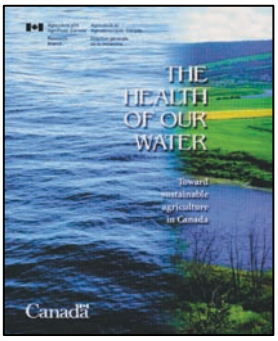
9 WATER

INTRODUCTION

This chapter discusses water management practices for protection of the environment. It contains introductory information on the relationship between agriculture and water quality and quantity. It also contains information on environmental concerns, legislation and beneficial management practices related to:

- water supply systems (domestic and livestock)
- drainage
- leachate
- irrigation
- storm water and runoff
- water conflicts

WATER QUALITY AND QUANTITY FACTORS



The primary water quality factors associated with potential environmental impacts for drinking water are contaminants. For fish and other aquatic life, the primary factors are water temperature, dissolved oxygen and contaminants. For water quantity, the primary factor is water withdrawal.

The Health of Our Water

www.waterbucket.ca

The following water quality and quantity factors are listed alphabetically. While these factors can be influenced by agricultural production, they may also be influenced by many other human activities and natural phenomena.

Contaminants

Total Ammonia. Ammonia (NH_3) and ammonium (NH_4^+) exist in urine, manure, fertilizer and compost. Contaminated runoff from fertilized cropland and uncovered manure or compost piles is characterized by a high total ammonia concentration. Water containing elevated levels of total ammonia may be toxic to fish and other aquatic life. Ammonia is more harmful to aquatic life when compared to ammonium. In the pH range of most natural waters, ammonia nitrogen will exist principally as ammonium.

Micronutrients and Metals. Specific metals of concern include arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc. Although trace quantities of some metals are necessary for life, even low metal concentrations are undesirable. Elevated metal concentrations can directly kill fish and other aquatic life or cause accumulation in tissues, making them unfit for human consumption. Some sources of metals include manure, waste oil,

hydraulic fluids and fertilizers. Woodwaste leachate, by virtue of its acidity, can increase the rate of metal release from soils as well.

Nitrate (NO_3^-). The total ammonium nitrogen in manure or fertilizer converts to nitrate (NO_3^-) form in soil. Because nitrate does not attach to soil particles as does the ammonium form, it is easily leached from the soil. Once out of the root zone, nitrates will continue moving to ground water and surface water.

Nitrates in ground water are often an early indication of contamination elsewhere. Elevated levels of nitrates in drinking water are a particular hazard for infants. The maximum allowable concentration of nitrates as recommended in the Guidelines for Canadian Drinking Water Quality is:

- 10 mg/litre of nitrate plus nitrite nitrogen (with not more than 1 mg/litre being nitrite nitrogen) for human consumption

  Guidelines for Canadian Drinking Water Quality, available at:

  http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf

  British Columbia Approved Water Quality Guidelines, available at:

  http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html

The maximum allowable concentration of nitrates as recommended in the Canadian Water Quality Guidelines for the Protection of Agriculture Water uses is:

- 100mg/litre total nitrate nitrogen (where nitrate and nitrite are determined separately, levels of nitrite should not exceed 10 mg/litre) for livestock consumption

  Canadian Water Quality Guidelines for the Protection of Agriculture Water Uses, available at:

  http://ceqg-rcqe.ccme.ca/download/en/132/

Nutrients. Elevated nutrient levels in watercourses can be caused by manure or fertilizer entering a watercourse directly, by contaminated water flowing from fertilized fields, or by nutrient-rich soil being eroded from croplands. Certain elements, especially nitrogen and phosphorus, accelerate eutrophication (nutrient enrichment of water bodies). Phosphorus is generally the limiting nutrient in lake systems (i.e., the addition of phosphorous alone will accelerate eutrophication); however, both nitrogen and phosphorus can be limiting in streams. The most common effects of eutrophication in surface waters are massive blooms of algae which result in depleted oxygen levels. Blue-green algae in sufficient quantities is toxic to livestock.

Blue-Green Algal Blooms in Lakes

Pathogens. Many organic wastes, including manures, contain microorganisms such as bacteria, viruses and other parasites. Some of these microorganisms may be pathogenic (disease causing) to animals of the same or different species. Many diseases are transmissible between animals and humans and water can be a pathway for the transmission of infection. Pathogen contamination of shellfish beds is not uncommon, rendering shellfish unfit for human consumption.

Pesticides. Pesticides, including fungicides, insecticides and herbicides hold great potential to pollute both surface and ground water. Water polluted by pesticides can be the result of application drift, leaching, erosion of contaminated soil, spills, and direct introduction. Pesticide-contaminated water can have harmful effects on aquatic life, animals and humans.

Petroleum. Petroleum, antifreeze, paints, solvents, hydraulic fluids and other oil-based substances can cause direct and indirect harmful effects on watercourses and ground water. Examples of adverse effects caused by petroleum products include acute toxicity to a variety of aquatic organisms and respiratory distress in fish. Waterfowl, amphibians and insects are sensitive to petroleum pollution as well.

Other negative impacts caused by petroleum products in water include the destruction of fish food organisms such as algae and other plankton, the smothering of fish spawning areas, the reduction in the rate of photosynthesis in plants and poor stream aeration. In addition, petroleum products can taint the flavour of aquatic food products.

Solids. Solids exist either in dissolved or suspended form in water. Bothmay include nutrients and metals, can elevate the biological oxygen demand of water, and cause long-term damage (refer to “Oxygen Demand”, next page). Some types of dissolved solids, such as ammonia, can be toxic to fish.

Suspended solids are larger in size than dissolved solids. Unlike dissolved solids, suspended solids can be removed by settling or filtering. Suspended solids are primarily silts and clays, but can also include oils, pathogens, woodwaste components, and other materials attached to particles in the water. Suspended solids in watercourses can clog the gills of fish, affect fish vision and, upon settling, fill in pore spaces between pebbles, thereby destroying spawning grounds or smothering the eggs of aquatic organisms.

Turbidity is a measure of the cloudiness of water. Turbidity may affect water treatment processes, reducing the appeal of drinking water or the effectiveness of wash water disinfection. As a result, higher levels of chlorine may need to be added to drinking water or wash water to achieve acceptable safety levels. High levels of chlorine are toxic to fish. Turbidity also blocks the sunlight required by photosynthesizing aquatic plants, resulting in decreases in fish food plant biomass and lowered oxygen levels in water. Ultra Violet disinfection of turbid wash water is less effective than disinfection by chlorination. Food safety may be compromised as a result.

Woodwaste Leachate. Woodwaste (e.g., sawdust, shavings, chips, hog fuel, bark) can cause negative impacts on surface and ground water. Exposure to water, air and microorganisms will cause woodwaste to break down and release dissolved compounds. Some of these compounds, particularly tannins, tropolones and resin acids, are not only human health hazards, but are also acutely toxic to aquatic life.

Woodwaste leachate entering surface water also causes indirect effects. Reduced oxygen levels, due to high biological oxygen demand and chemical oxygen demand values, result in lower photosynthesis rates in aquatic plants. The colour of woodwaste leachate will also reduce light transmission and

thereby reduce photosynthesis. In addition, woodwaste leachate is acidic, facilitating the unwanted movement of metals and nutrients out of the soil and into receiving waters. (refer to Oxygen Demand, below)

Contaminant Pathways

Infiltration. Water movement into and through soils is governed by the permeability of the soil. Coarse textured soils or soils with large numbers of macropores will have high infiltration and percolation rates. Rapid water movement through soil can lead to increased risk of leaching loss of nutrients or contaminants to ground water or subsurface drains.

Overland Flow. Farmstead buildings, roads and impermeable farmyards will intensify the effects of rainstorm events. Peak stormwater discharges to watercourses are increased whenever a high proportion of impermeable surfaces exist.

Overland water flow occurs either because the soil is saturated and unable to absorb more water or because water is applied at a rate greater than the soil can absorb. This can result in erosion or the movement of contaminants to surface water.

Wells. The direct entry of overland flow into ground water via poorly constructed wells or well casings is another potential contaminant pathway.

Oxygen

Oxygen Demand. High oxygen-demanding materials such as manure, silage, fruit, vegetables and composting juices use dissolved oxygen in water directly as they decompose. Increased nutrient levels in water can also indirectly cause high oxygen demand by encouraging the growth of aquatic organisms. After these organisms die, natural decay accelerates the depletion of oxygen to levels below that required by fish and aquatic life. The rate of oxygen depletion is measured as Biological Oxygen Demand (BOD).

Dissolved Oxygen. Dissolved oxygen is measured as a percentage of saturation. If wastes with high oxygen demand or high nutrient levels are allowed to enter watercourses, the result is a drop in dissolved oxygen levels. Reduced oxygen levels are harmful to fish and aquatic life.

Temperature

Elevated water temperature has direct and indirect impacts on water quality. As water temperature increases, its oxygen-holding capacity decreases. This will become harmful to fish and aquatic life. Watercourse temperature thresholds are set to protect fish. Indirectly, elevated water temperature contributes to the growth of aquatic organisms which accelerates the depletion of oxygen levels.

Water Withdrawal

The excessive removal of water for uses such as irrigation and livestock watering can result in the insufficient availability of water for fish food production, fish and fish habitat, wildlife abundance, and in elevated water temperatures. Also, reduced water levels will typically exacerbate water quality concerns and may increase the risk of fish predation due to easier access for predators.

Surface water withdrawals require screened intakes to protect fish. They are designed for opening size to prevent fish entry and for low water velocity across the screen to prevent fish loss from being drawn against the screen.

Withdrawal of surface water or ground water may impact users other than those taking direct advantage of the water. Licenses for surface water withdrawals are intended to prevent these conflicts. There is currently no provincial licensing for groundwater to protect against over withdrawal.

WATER SUPPLY

WATER SUPPLY ENVIRONMENTAL CONCERNS

Primary environmental concerns related to water supply systems are:

Water Quantity

- ground water withdrawals that result in
  - lowering of the water table
  - reduced ground water input to surface water
- surface water withdrawals causing low stream flows and velocities that result in impacts to fish and other water users

Water Quality

- cross connection of water supply lines to lines carrying contaminants that results in pollution of supply water
- poor well construction (e.g., lack of sealing), location (e.g., down gradient from contaminate source) or well abandonment, that results in ground water pollution
- disturbances to watercourses during installation of intakes that results in water pollution and habitat loss
- livestock access to watercourses that results in pollution of surface water, habitat disturbances, or trampling of stream banks

For information on these concerns:

➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections

➔ see Impacts to Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

WATER SUPPLY LEGISLATION

The following is a brief outline of the main legislation that applies to farm water supply.

➔ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

The BC Building Code has requirements for backflow prevention and **is enforced only where proclaimed by local governments.**

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving ***more*** than one single-family residence).

- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

The *Drinking Water Protection Regulation* defines potable water as "water from a domestic water system" that has the following characteristics:

- water that meets the standards prescribed by the regulation and that is safe to drink and fit for domestic purposes without further treatment.
- no detectable fecal coliform bacteria or *Escherichia coli* per 100 ml
- no detectable total coliform bacteria per 100 ml for a sample in 30 days
- at least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml for more than one sample in 30 days
- having limits on chemical and physical parameters (such as nitrates and heavy metals)

  📖 **Guidelines for Canadian Drinking Water Quality**

Environmental Management Act

The *Code* under the *Agricultural Waste Control Regulation* allows for access to watercourses by livestock:

- Section 25: livestock in a grazing area may have access to watercourses provided that the agricultural wastes produced by that livestock does not cause pollution
- Section 27: livestock in a seasonal feeding area may have access to watercourses provided the access is located and maintained as necessary to prevent pollution

Fish Protection Act

The *Fish Protection Act* enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.

- Section 4: prohibits new dam construction on specified major rivers
- Section 6 and 7: allows designation of sensitive streams and recovery plans
  - such streams would have restrictions placed on new water licenses or approvals, or amendments to existing ones until the stream has recovered
- Section 9: In the case of drought, for the purposes of protecting the fish population, the minister may make temporary orders regulating the diversion, rate of diversion, time of diversion, storage, time of storage and use of water from the stream by holders of licences or approvals in relation to the stream.

Public Health Act

This Act has conditions under the *Public Health Act Transitional Regulation:*

- Section 18: provides separation distance of wells to be at least 30.5 m from any probable source of contamination

Water Act

This Act and Regulations licence surface water and protects ground water:

- Section 2: vests property and use of water with BC government (i.e., need a licence to use water)
- Section 7: who may acquire licences (issued by Front Counter BC)
- Part 5, Sections 68 to 82: regulate wells and ground water protection, requiring well drillers be qualified, well reports be made, wells be identified, wells be properly deactivated, covered, and operated
- The *Ground Water Protection Regulation*, Part 1 outlines well drillers qualification requirements, and Part 2 outlines well construction requirements and gives a Code of Practice.

Wildlife Act

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has several sections of importance to water supply concerns:

- Sections 20, 21 and 22: may require installation and management of fish ways around obstructions
- Sections 27 and 29: prohibits obstructions to fish passage
- Section 30: requires water intakes to be screened to protect fish
- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include manure, soil, sediment)
- Section 37(4): requires approval for work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

Migratory Birds Convention Act

This Act has a section of importance to water supply:

- Section 35(1): prohibits the deposit of any substance harmful to migratory birds in any waters frequented by migratory birds

Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the 'safety net') could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

WATER SUPPLY BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable water supply related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

Water Quantity Protection

Farm Requirements. Whether farm water originates from surface water, ground water or is supplied by purveyors, all water use should not exceed the following suggested rates:

- for livestock use, volume requirements given as peak daily use for livestock use, volume requirements given as peak daily use per animal
  📖 **Livestock Watering Requirements – Quantity and Quality**
- for irrigation purposes, water requirements given as peak flow rate and as annual volume use ➔ see Irrigation Water Use Checks, page 9-24

It is in the best interest of a farm to use only as much water as is necessary. Where possible, implement the following practices:

- conserve water use, allowing other users access to water
- conserve existing water to reduce the cost of developing new sources
  - reduced water use lowers requirements for water storage or water delivery
  - irrigation typically provides for the greatest opportunities for water conservation on most farms
    📖 **Irrigation Tips to Conserve Water on the Farm**

Ground Water Use. Withdrawal of ground water at rates faster than it can be replaced will lower the water table, and may impact levels and flows in adjacent watercourses. Indications of a lowering water table include:

- the necessity to deepen wells to maintain water flows
- wells running dry during times of the year when they previously had flow
- nearby bodies of surface water experiencing reduced flows or depths

To reduce the overuse of ground water, implement the following practices:

- monitor water tables regularly by measuring the static water level in wells at the same time of the year, each year (note some variations are normal)
- if the water table is lowering progressively over time (note that it may be due to changing climate or off-farm conditions or uses beyond control) reduce withdrawal to a sustainable level where the water table re-stabilizes

Surface Water Use. Producers using surface water must be aware of fish requirements. Excessive peak withdrawals may deplete water volume in a watercourse to the point of impacting fish and fish habitat. Also, removing volumes of water over the course of a season in amounts greater than allowable may deplete systems to such an extent that supply is insufficient for downstream users.

Drought. Hot, dry summers have become more frequent and more intense in certain regions of British Columbia. Drought can result in insufficient water supply or in severe cases, restrictions to water withdrawal for agricultural use. It is important to plan for sufficient water resources in times of drought by

implementing efficient irrigation and watering systems as well as being aware of how water restrictions can affect farming operations.

📖 **Dealing with Drought: A Handbook for Water Suppliers in British Columbia**

Water Quality Protection

Backflow Prevention. Backflow of contaminated water from any farm practice into a water source may occur through pipes that are cross connected. Implement the following practices:

- maintain a 30 cm (suggested) air gap between the water supply line and any tank containing a substance other than potable water to prevent backflow of non-potable water into the water supply
- install a backflow prevention device on water lines that can come into contact with contaminated water

➔ see Chemicals Added to Irrigation Water, page 9-31

Overland Water Flow. Protect the water supply from overland flow of contaminated water.

➔ see Runoff Flow Management, page 9-43

Leachate. Since surface water and ground water sources are often used for drinking water, potential contamination with substances such as pesticides and nitrates poses a serious health hazard. Ground water contamination is particularly difficult and very costly to clean up and needs to be avoided.

➔ see Runoff Flow Management, page 9-43
➔ see Leachate, page 9-48

Springs. Springs are ground water that becomes surface water flows upon exit from the ground. They are defined as watercourses under the *Water Act*. Protect springs from farm impacts by implementing the following practices:

- protect springs with a grassed buffer zone
- where a buffer zone is impractical, berm spring areas to prevent any contaminated runoff from entering
- direct spring flows away from contaminated farm areas

➔ see Changes In and About a Stream, page 7-16

Pumps. Water pumps powered by petroleum-powered engines located near watercourses or water bodies create a risk of water contamination if fuel spills or leaks occur. To minimize the possibility of such contamination use secondary containment for any fuel tanks. Even small quantities of petroleum products can cause extensive water pollution.

Changes In and About a Stream. When planning any work in or near a watercourse, contact the appropriate agencies to ensure that it does not harmfully alter fish habitat or cause a deleterious substance to enter water.

➔ see Changes In and About a Stream, page 7-16

Water Quality Treatment

In cases where water does not meet appropriate water quality standards, treatment for water quality may be an option. The following resources provide some guidance on appropriate water treatment options for several scenarios.

📖 **Treating Irrigation and Crop Wash Water for Pathogens**
📖 **Chemigation Guidelines for British Columbia**
📖 **Enhancing Livestock Water Quality**
📖 **Treatment of Greenhouse Recirculation Water – Biosand Filtration**

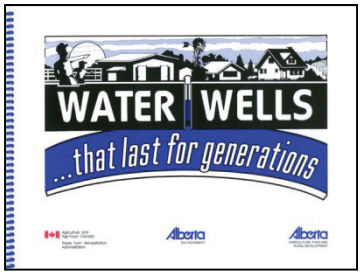
Wells and Ground Water Protection

Environmental concerns related to wells are associated with contaminants entering ground water either because of improper well construction or abandoned wells. Annually test that well water is potable and nitrate levels are acceptable. Possible additional concerns revolve around well water withdrawal rates that could decrease flow of affected watercourses.

Well Construction. Locate and construct wells to prevent seepage of both contaminated runoff and shallow ground water. Water in all wells should be sampled and the necessary field and laboratory tests made so that the ground water chemical and bacteriological quality of the well and its suitability for drinking water can be determined. The following parameters should be analyzed: total alkalinity, calcium, total hardness, total iron, magnesium, fluoride, nitrate, nitrite, pH, dissolved solids, specific conductance, turbidity and total coliforms.

Implement the following practices:

- construct new wells as required by the *Ground Water Protection Regulation*
  - sealing of the well casing surface to prevent entry of contamination
  - capping the well to prevent contamination entering
- locate new wells at least 30.5 m from storage and preparation areas for fertilizer, pesticides, petroleum products, manure, silage, etc (*Public Health Act*)
- locate wells in high areas, wherever possible, to prevent runoff from collecting around the well head and seeping into the water supply
- construct wells with durable materials
- construct well casings 0.3 m (suggested) above the level of surrounding land
- construct well casings above 100-year-flood levels (suggested)
- use a pitless adapter installed in the well casing where water lines may freeze (rather than terminating the casing in the ground below frost level)
- construct upland berms to prevent contamination of wells
- grade land areas near wells to direct surface water flows away
- plant and maintain grass covers around well heads to slow down and filter any nearby runoff



📖 **Guidelines for Minimum Standards in Water Well Construction**
📖 **Water Wells...that last for generations**

Abandoned Wells. Seal wells no longer in use as required by the *Ground Water Protection Regulation* to protect aquifers. Ground water can be easily polluted if runoff flows into or around well casings. Seal materials should not compromise human health or drinking water quality, and should be more impervious than the native soils adjacent to the well. Seek professional advice if there is any doubt about sealant.

Wells Near Watercourses. Of particular concern are wells located near watercourses where water levels are sensitive to water withdrawal rates. Pumping from such wells should be discouraged or minimized during those times of the year when watercourse levels are critically low.

Licencing of Surface Water

The use of surface water requires a licence, issued by Front Counter BC. Water licences specify various conditions such as the purpose of use, the quantity of water, the amount of storage (if any), the time period during which it can be used, and the location of withdrawal and use.

- 🕮 **Understanding a Water Licence**
- 🕮 **Water License Holders Rights and Obligations**
- 🕮 **Water Rights in British Columbia**

Water Withdrawal Rates. Until recently, water licences have not listed water withdrawal rates (e.g., a pumping rate in gallons per minute). If listed the rate is calculated based on proper irrigation methods. When withdrawing water, implement the following practices:

- if the licensed withdrawal rate **is specified**, check that the rate being used does not exceed this amount (*Water Act*)
- if the licensed withdrawal rate **is not specified**, check that the rate does not exceed the calculated peak flow rate for the region (suggested)
- for either of the above ,➔ see Irrigation Water Use Checks, page 9-24
- follow fish clauses listed on the licence, if present (*Water Act*)
- reduce water withdrawal if fish may be negatively impacted (*Fisheries Act*)

Annual Water Use. The licensed annual volume of water use must not be exceeded (*Water Act*), ➔ see Annual Water Use Check 2, page 9-24

Irrigated Area. Although a water licence is mainly concerned with water use, it does specify an acreage that may be irrigated and this should not normally be exceeded (*Water Act*). Some high efficiency irrigation equipment may be able to apply the licensed volume on a larger area.

Water Storage. A water licence may permit water storage, such as in a reservoir. In some regions, dugouts do not need to be licensed if the water stored is collected from on-farm runoff. If the dugout stores water coming from a watercourse, a water licence for storage and use is required. The maximum amount and when it is stored must match the water licence.

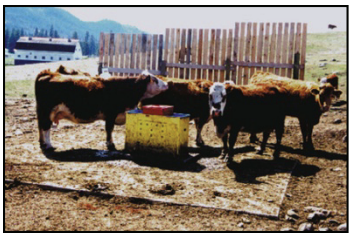
- 🕮 **Farm Water Storage**

Domestic Water

Only use domestic water supplied from protected sources or treat appropriately. Surface water sources are particularly susceptible to contamination and therefore require constant monitoring. Under the *Drinking Water Protection Act*, if a system supplies more than one household or the general public the water provided must be potable. A regional health authority Drinking Water Officer may request that a source-to-tap assessment be done in these cases.

- 🕮 **Guidelines for Canadian Drinking Water Quality, available at:**
  http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf
- 🕮 **Cryptosporidium Infection**
- 🕮 **Giardiasis ("Beaver Fever")**
- 🕮 **How to Disinfect Drinking Water**
- 🕮 **Water-borne Diseases in BC**

Livestock Watering

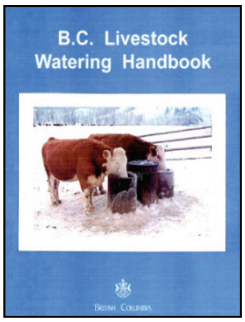


To reduce possible livestock waste and traffic impacts on water quality, various systems are available that supply livestock water away from sensitive watercourse areas. A watering system is required where direct access to watercourses has been denied, such as in confined livestock areas. Systems may also be worthwhile for other outdoor areas experiencing less frequent animal activity. An outdoor watering system may include an intake, energy source, distribution system, and trough. Implement the following practices (refer to Figure 9.1, next page):

- use a watering system that reduces livestock impacts on watercourses
- meet intake regulations
  ➔ see Changes In and About a Stream, page 7-16
- meet water intake fish screen requirements
  ➔ see Water Intakes, page 9-16
- locate troughs 30 m or more (suggested) from a watercourse
- install troughs on a firm base such as concrete, wood, compacted soil or soil and gravel
- install water troughs to prevent the introduction of fecal contamination to the water that could contribute to disease and parasite problems
- use water conservation practices with troughs to minimize water usage
  - maintain a water freeboard of 25 to 50 mm (suggested) to avoid spillage
  - keep all water troughs maintained to eliminate leakage
- where required, ensure adequate drainage for spillage, overflow or leakage
  - contaminated overflow water must not pollute watercourses
- ensure that containment for fuel leaks from petroleum powered pumps
- re-vegetate ground disturbed for pipeline burial and system installation
- operate sites to prevent manure from contaminating watercourses
- in high-use situations, install an extended concrete apron or other suitable hard surface material around the waterer to minimize muddy conditions

  📖 **B.C. Livestock Watering Handbook (series of Factsheets)**

Watering Livestock Directly from Watercourses



Livestock may impact a watercourse by activities in the uplands or the riparian area, or in the watercourse. Direct access to a watercourse by livestock may be either managed or unrestricted. Various factors will determine the preferred choice of access, including:

- livestock management, including timing, duration and intensity of use
- moisture content, and type of soil and vegetation within the riparian area
  - sites with bare soil or with sparse vegetation; sandy soils; saturated soils; clay soils; are more prone to erosion and may require improvements
- stream bottom composition
  - solid, gravely areas, while providing good footing for livestock, are typically ideal for fish habitat (the habitat values of such sites must be known to determine the best type of access, if any)
- watercourses that experience high spring freshet flows may require managed access if their banks are highly eroded
- sensitive riparian areas with easily eroded stream banks
  - such areas may be limited to little or no access for long-term protection
- instream (such as fish) and downstream uses (e.g. domestic water intakes) of the water

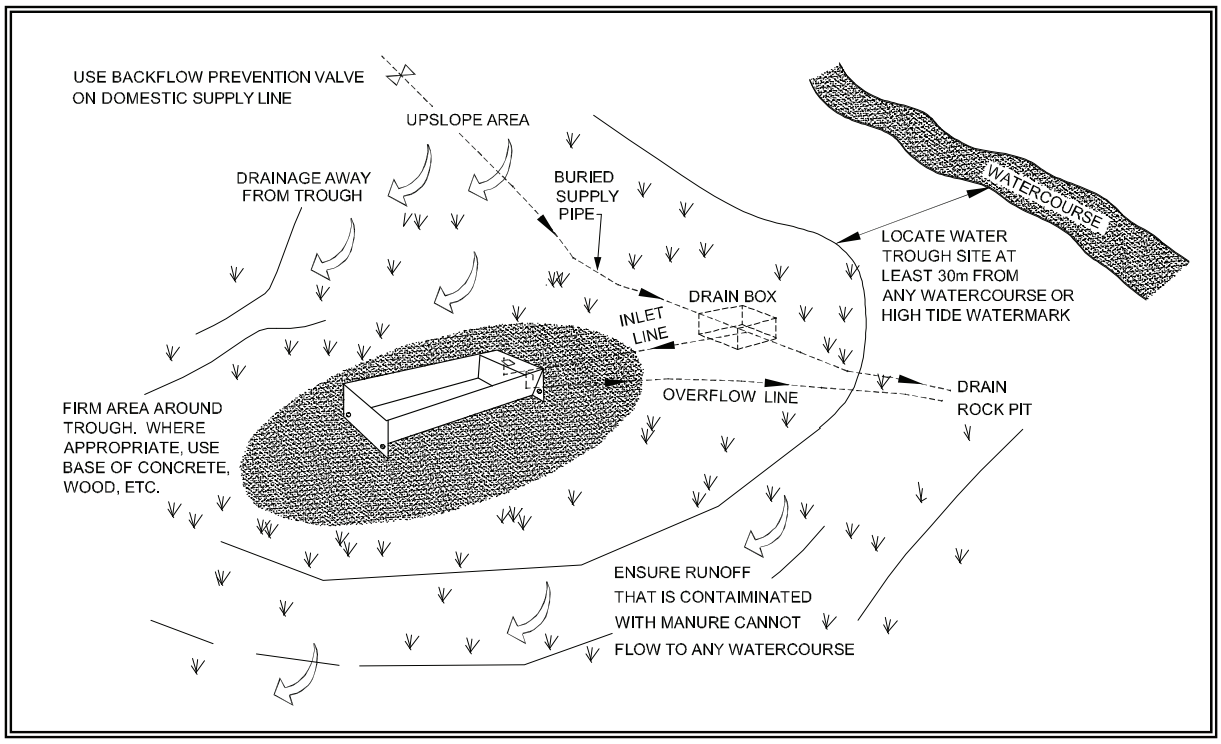


Figure 9.1 An Outdoor Livestock Water Trough Installation

Implement the following practices for livestock access to watercourses:

- do not reduce riparian function ➔ see Riparian Areas, page 11-13
- contact the appropriate agencies when planning any work near or in any watercourse that may impact the water or habitat
  ➔ see Changes In and About a Stream, page 7-16
- place salt, minerals or supplemental feeds away from riparian areas to encourage animal traffic in less sensitive locations
- use berms to prevent upland runoff flows from entering the watercourse at access locations, as shown in Figure 9.2, next page
- provide good footing and grades for livestock at access points
- clean up any accumulated manure from the sloped access from time to time
- for managed access, where possible, enclose the end of the access to prevent livestock from entering the watercourse as shown in Figure 9.2, next page (use removable panels on streams subject to high freshet flows)
- for managed access, fence or otherwise block unneeded access areas

Unrestricted Access. This option may have the greatest risk of pollution unless carefully matched to the livestock use. Evaluate such accesses with the characteristics of the site and degree of expected livestock activity in mind. This type of access is commonly used on sites of low density grazing, such as on dryland pastures. It may not be appropriate for high-use sites, such as summer-long grazing on irrigated pastures.

Managed Access. Restricting access will limit livestock impacts on water quality and sensitive streambank areas but will concentrate impacts onto the access site. Choose low-risk sites as access points. They may require some maintenance depending on the concentration of livestock. Use a fence or other means to control access and a small berm to redirect runoff away from directly flowing into the watercourse at the access location. Figure 9.2, below, illustrates a managed watercourse access.

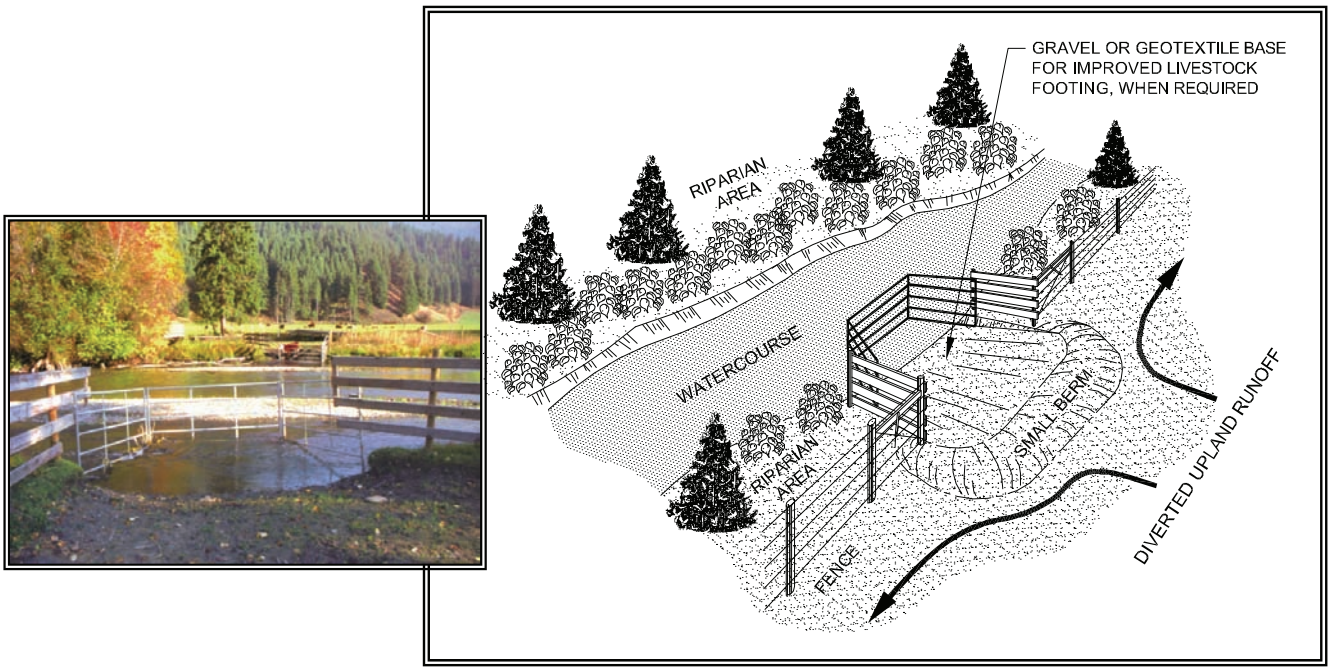


Figure 9.2 A Managed Access to a Watercourse for Livestock

In some cases improvements to the access may be needed because of soil, streambank, or intensity of use on the site. High-use, direct-access locations may benefit from improvements such as added gravel, a combination of added gravel and geosynthetics, or grading to modify slopes.

📖 **Improved Livestock Access to Water Using GeoGrids**

Water Control Structures

The construction of any structures such as dams, ditches, water diversions, bridges, and culverts located in watercourses are subject to fish-protection regulations. These govern such things as fish passage and timing, fish screening, and by-pass facilities. Prior to any work, ensure the fish requirements for the watercourse are known and regulations followed.

Water Intakes

Intake Screen Sizing. While intakes are usually screened to prevent debris from entering pipes, specific guidelines have been developed for fish bearing watercourses. The guidelines contain information on appropriate screen size for the intake flow rate. The following can be used to determine general compliance:

- ensure there is sufficient total screen area to match flow rate
  - use Worksheet #6, page 9-17
- use screen mesh sizes with clear openings that do not exceed 2.54 mm
- use screen mesh with open areas that are not less than 50% of the total screen area, Table 9.1, below

📖 **B.C. Sprinkler Irrigation Manual**

📖 **Freshwater Intake End-of-Pipe Fish Screen Guideline**

Intake Construction. Installing an intake may require working along side or in a watercourse. Any work requiring "changes in and about a stream" requires an approval, licence or compliance with regulations.

➔ see Changes In and About a Stream, page 7-16

Intake Maintenance. The maintenance of intake works authorized by a water licence must be conducted in a manner and during a period that minimizes water quality impacts on existing licensed users and fish. If in doubt, contact MOE or DFO ➔ see Changes In and About a Stream, page 7-16

Table 9.1 Screen Mesh Open Area *Worksheet #6*

Mesh	Wire Diameter		Width of Opening		Open Area %
	[inch]	[mm]	[inch]	[mm]	
4 x 4★	0.063	1.60	0.188★	4.78★	56
6 x 6★	0.035	0.889	0.132★	3.35★	63
8 x 8	0.028	0.711	0.096	2.44	60
10 x 10	0.025	0.635	0.074	1.88	55
12 x 12	0.023	0.584	0.060	1.52	52

Source: B.C. Sprinkler Irrigation Manual

★ Screen mesh size openings exceed the maximum fishery opening size of 2.54 mm (0.1 inch)

Worksheet #6 — Screen Area Check for Fishery Requirements of Water Intakes — Workbook Question 264

Question: An irrigation system with an intake in a fish-bearing stream has a flow rate of 963 US gpm. The intake screen is a four-sided box, each side being 5 ft long and 2 ft wide using 8 x 8 mesh. The ends are solid and not screened.

Does the screen surface area match fishery requirements for the flow rate?

Information:

Reset

Irrigation system flow rate, from Box 9 on Worksheet #7 or #8	963	1	US gpm
Screen mesh size used	8 x 8	2	mesh size
Percent screen open area of mesh size used, Table 9.1	60	3	% open area
Check if end area is screened: ☐	NO		

Calculation:

Step 1 Calculate required screen surface area

Equation:

$$\text{Required Screen Surface Area} = \frac{\text{Flow Rate}}{0.448 \times \%\,\text{Open Area}}$$

$$\frac{963\ (1)\ \text{gpm}}{0.448 \times 60\ (3)} = 35.8\ (4)\ \text{sq. feet}$$

Step 2 Calculate actual screen area using one of the following methods: **(Add end area if screened)**

Method 1: Flat screen

Equation:

$$\text{Flat Surface Area Total} = \text{No. of flat Screen Surfaces} \times \text{Length} \times \text{Width}$$

$$= 4\ (5) \times 5\ (6)\ \text{ft} \times 2\ (7)\ \text{ft}$$

$$= 40.0\ (8)\ \text{ft}^2$$

Equation:

$$\text{End Surface Area} = \text{Length} \times \text{Width}$$

$$= \_\_\_\ (9)\ \text{ft} \times \_\_\_\ (10)\ \text{ft}$$

$$= 0\ (11)\ \text{ft}^2$$

$$\text{Total Area} = 40.0\ (12)$$

Method 2: Cylindrical screen

Equation:

$$\text{Cylindrical Surface Area} = 3.14 \times \text{diameter} \times \text{length}$$

$$= 3.14 \times \_\_\_\ (13)\ \text{ft} \times \_\_\_\ (14)\ \text{ft}$$

$$= 0.0\ (15)\ \text{ft}^2$$

Equation:

$$\text{Circular End Area} = \frac{3.14 \times \text{diameter}^2}{4}$$

$$= \frac{3.14 \times (0\ (13))^2}{4}$$

$$= 0\ (16)\ \text{ft}^2$$

$$\text{Total Area} = 0.0\ (17)\ \text{ft}^2$$

Answer:

Step 3 Is 35.8 (4) sq. feet less than 40.0 (12 or 17) sq. feet?

YES **screen area is OK**

IRRIGATION

Irrigation water intake systems are covered in Water Supply, page 9-9.

IRRIGATION ENVIRONMENTAL CONCERNS

Primary environmental concerns related to irrigation are:

- irrigating with poor quality water that results in contamination of edible crops with pathogens, or in salt build up in the soil
- over irrigation that results in
  - poor conservation of water
  - leaching of contaminants into ground water or surface water
  - overland flow leading to soil erosion
- chemigation materials or other additives that results in water or soil pollution

For information on these concerns:

➔ see Soil Quality Factors, page 8-2, and refer to Contaminants, and to Salts

➔ see Water Quality and Quantity factors, page 9-2, and refer to Contaminants

IRRIGATION LEGISLATION

The following is a brief outline of the main legislation that applies to irrigation.

➔ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

Municipalities, irrigation districts and other water purveyors may have bylaws governing the application of chemicals through irrigation system.

BC Building Code

Part 7 of the BC Building Code addresses plumbing services and provides information on protection from contamination from cross connections.

Wildlife Act

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has two sections of importance to irrigation (chemigation):

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include chemigation water)
- Section 38(4): requires reporting infractions of Section 36

Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the 'safety net') could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

IRRIGATION BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable irrigation related legislation, including the above, and where appropriate, use the following beneficial management practices to protect the environment.

A key objective of irrigation management is the efficient use of water to match the crop's needs while preventing the loss of water due to surface flow, leaching or drift. Appropriate irrigation designs, equipment and good management and scheduling will conserve water supplies while supporting crop growth.

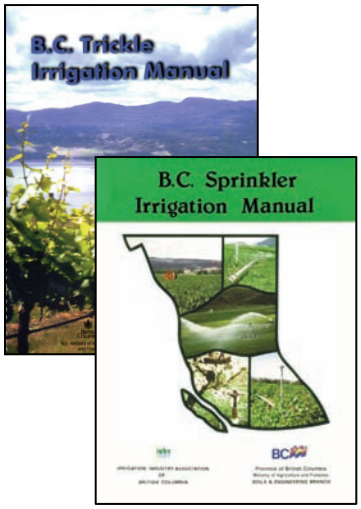
The Role of Soil in Irrigation

Good irrigation practices combine proper irrigation system design, system operation and maintenance and irrigation scheduling. Soil characteristics determine how an irrigation system should be designed and operated:

- coarse textured sandy soils generally have low water holding capacity and high infiltration rates
  - water is therefore unlikely to pond on or run off the surface
  - however, water may be lost beyond the root zone quickly and may carry with it nutrients, posing a hazard to ground water quality
  - irrigate when required and only long enough to fill the root zone
- medium to fine-textured silt and clay soils are very susceptible to surface sealing or puddling of soil, which can lead to very low infiltration rates
  - water droplets from sprinkler systems may damage soil structure on bare soils - protect surface from sealing with crop cover or mulch
  - reduce droplet size and operation time on bare soil (e.g., new seedings)
  - allow soil to dry out between irrigations letting surface cracks to appear which may improve infiltration
- a sealed soil surface discourages infiltration and promotes ponding and runoff flow causing erosion
  - operate sprinkler systems in the spring and fall with a longer time between each irrigation than during periods with peak water use
  - manage trickle systems to keep the soil water level within the optimum range, but definitely not saturated
- poorly drained soils may experience a salt build up when irrigated (from salt already in the soil or in the water) – when the soil dries, 'salty' water is drawn up to the soil surface, the water evaporates and the salt stays
  - over irrigate and drain to remove salt build up

Soil Water Storage Capacity and Available Soil Moisture

Irrigation Water Quality



Irrigating with water of poor quality can not only harm or contaminate the crop, but may also harm the environment. Salts, heavy metals and pathogens make their way into the soil and may be taken up by the crop or build up in the soil to unacceptable levels.

➔ see Salts, page 8-5
➔ see Soil Contamination – Salt Check, page 8-17

Table 9.2, below, provides threshold values for irrigation water quality tests. If these values are exceeded the water quality should be further investigated, treated or not used. For high pathogens levels, producers are encouraged to eliminate potential sources of contamination by implementing beneficial management practices. If on-farm changes in practice do not result in improved water quality then the producer should seek an alternate source or treat the water. For pathogens, test a water sample for E. Coli and fecal coliforms, measured in colony forming units (cfu).

More water quality information can be found in:

- 📖 **B.C. Sprinkler Irrigation Manual**, chapter 10
- 📖 **B.C. Trickle Irrigation Manual**, chapter 12
- 📖 **Treating Irrigation and Crop Wash Water for Pathogens**

Table 9.2 Irrigation Water Quality Guidelines [1]

	Threshold Values to Protect Soil [2]		
Salts	sodium adsorption ration (SAR) less than 3 **and** electrical conductivity (ECw) less than 0.2 dS/m		
Boron	less than 0.5 mg / litre		
Chloride	less than 100 mg / litre		
	Threshold Values for Food Safety [3]		
		E.Coli	**Fecal Coliform**
		cfu / 100ml	**cfu / 100ml**
Pathogens [4]	**Crops Eaten Raw**	less than 77	less than 200
	All Other Crops	less than 1000	less than 1000

[1] If these values are exceeded the water quality should be further investigated, treated or not used
[2] from the Water Encyclopedia 2nd ed. Van der Leeden, Fritz et al. 1990, Lewis Publishers. Chelsea Michigan, USA.
[3] from BC MOE
[4] Note: Pathogen levels for crop washing are 0 cfu / 100ml for both E.coli and fecal coliform

Irrigation Systems

The type of irrigation system most suited to a particular site depends on crop characteristics, climate and soil conditions. When deciding on an irrigation system, implement the following practices:

- consider water and soil conservation issues as well as economics
- when appropriate, select an irrigation system with efficient water use such as trickle or subsurface system
  ➔ see Application Efficiency, page 9-22
- apply water using scheduling techniques
  ➔ see Irrigation Water Scheduling, page 9-23

- where appropriate, install electronic timing devices to automate the system and adjust the device regularly to irrigate according to changing climate conditions over the irrigation season

Trickle. Trickle systems can be the most efficient at using water if managed properly but they are not suited for all cropping systems, soil conditions or water quality. In this guide, trickle refers to frequent, low pressure application of water to crops, including tape, drip emitters and spray emitter systems.

Sprinklers. Some sprinkler systems can be very efficient and make good use of water while others with poor uniformity or poor management will have water and nutrient loses due to deep percolation and overland flow.

Guns. These systems operate at much higher flows and pressures than regular sprinkler systems. They are susceptible to wind drift, resulting in higher evaporation losses and lower operating efficiencies. Stationary guns have a very high application rate requiring short set times that may be difficult to properly manage. Traveling guns also have lower efficiencies, but overcome the short set time by moving the gun over a large area each set.

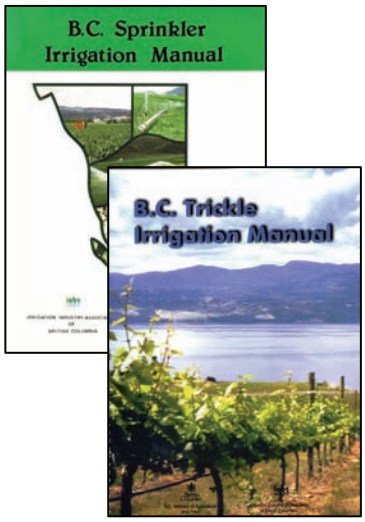
Centre Pivots. These systems are automated and travel in a circle around a field. Those with higher efficiencies use low volume spray heads.

Flood. Flood irrigation is an inexpensive irrigation option. However it is an inefficient method of irrigating, especially when fields are not laser leveled. Flood systems can have water losses due to tail end losses (which are not recycled) and deep percolation if too much water is applied. The excess water can contain nutrients or contaminants that may impact surface or ground water.

Subirrigation. These systems use subsurface drainpipes to irrigate by raising the water table to the crop's roots. Drainpipes require a closer spacing than a system that only provides drainage. Managed properly, these systems can provide an efficient use of water and, if the drainage system is controlled and closed, recycle nutrients that may have leached in to the drain water. These systems are not appropriate for crop cooling or chemigation.

📖 **Controlled Drainage/Subirrigation**

Irrigation System Design



The design of the irrigation system should match the application rate of the irrigation system to the soil type and the crops' water requirements. Proper design and operation should prevent water from being wasted, and minimize surface flow or leachate that may contain fertilizer and pesticide residues. An irrigation system that is not properly designed will be nearly impossible to manage properly. Manage excess water to avoid the following consequences:

- erosion – adjust system or rate of application to reduce overland flow
- transport of nutrients via leaching out of the root zone and into the ground water – this is expensive and can cause pollution
- transport of nutrients into runoff flow
- insufficient water may allow salts to built up in the soil
- match the irrigation flow rate and water use with the recommended values
  - producers should be able to reduce their water use if rates exceed recommended values

    ➔ see Irrigation Water Use Checks, page 9-24
- have secondary containment for fuel tanks on petroleum powered pumps near watercourses

📖 **B.C. Sprinkler Irrigation Manual and**
📖 **B.C. Trickle Irrigation Manual**
💻 www.irrigationbc.com

Application Efficiency. Application efficiency is the percentage of water applied by the irrigation system that is actually available to the crop. A lower efficiency system loses more water during the application process to evaporation, wind drift, or runoff and is not available to the crop. Efficiencies can vary due to:

- the type of irrigation system
- operating conditions, such as wind, system pressure, sprinkler trajectory, etc
- time of day
- hot or cool weather

Table 9.3, next page, gives efficiencies of commonly used systems. When considering irrigation system efficiency, implement the following practice:

- for new systems, choose the most efficient system suitable for the crop
- for upgrading existing systems, choose a system that is at least 15% greater efficiency than the present one (e.g., for tree fruits, going from an undertree solid set sprinkler system, at 75%, to a trickle system, at 92%)

Irrigation System Operation

When operating irrigation systems implement the following practices:

- operate a sprinkler irrigation system at the recommended operating pressure
  - excessive pressure can be inefficient and result in water loss due to evaporation and wind drift
- avoid excess irrigation that causes runoff flow, such as in compacted low areas that are prone to ponding and/or runoff flow
  - runoff flow can cause soil erosion
- avoid excess irrigation that causes leachate movement
- irrigate the crop only
  - avoid applying water to non-productive areas, such as roads
- when possible, irrigate during late night or early morning hours when evaporation and wind losses are generally lower
  - this is usually not possible during peak summer heat conditions as withdrawal rate limits (water licence) require 24 hour irrigation
- use automated systems to apply the amount of water required for the crop during that time period to reduce over and under watering
- avoid irrigating with high volume sprinklers on steep hills (over 10 percent gradient)

  📖 **Irrigation Tips to Conserve Water on the Farm**

Table 9.3 Irrigation System Application Efficiency				*Worksheets #9, #10*
Crop Type★	Irrigation System Type		Application Efficiency (%) range	Application Efficiency (%) typical
Row	**Trickle**	Microjet	80 – 90	85
		Trickle	85 – 95	92
		Drip – Subsurface	85 – 95	95
Row Field	**Sprinklers**	Handmove	60 – 75	72
		Wheel line	60 – 75	72
		Overhead Solid Set	60 - 75	72
		Undertree Solid Set	65 - 75	75
		Microsprinklers	70 - 85	80
Field	**Center Pivot**	Sprinklers	65 – 75	72
		Spray heads	65 – 80	72
		Drop tubes	75 – 85	80
Row Field	**Guns**	Stationary	50 – 65	58
		Travelling	55 – 70	65
Field	**Flood**		30 – 50	50
★ **these are typical crops irrigated with these systems:**			**Row = crops such as tree fruits, grapes**	**Field = crops such as forages, field vegetables**

Irrigation Water Scheduling

Irrigation scheduling is the process used to match the application of irrigation water to the soil and crop needs. The key objective of irrigation scheduling is to reduce water loss due to overland flow or leaching.

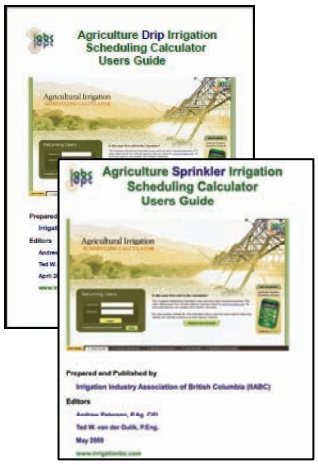
There are a number of ways that the system can be operated to match climate conditions. Some farms alter the operating time throughout the season to match climate conditions and crop growth requirements. Others keep the operating time the same but change the frequency of operation. Either method can be used to match system operation with climate conditions.

Irrigation scheduling requires knowing:

- the soil water holding capacity of the soil
- the amount of evapotranspiration (ET) and precipitation (climate information)
- the application rate of the irrigation system

For appropriate irrigation scheduling implement the following practices:

- irrigate according to crop requirements instead of a rigid time-table
- monitor soil moisture (below)
- monitor climate information and be aware of the forecast (refer below)
- consider recent rainfall events, and evapotranspiration
  - i.e., the amount of water to be added to the soil depends on how much has been removed by the crop and added by rainfall since the last irrigation
  - irrigation begins when a significant amount of water has been removed from the soil in the root zone, 50% for sprinkler systems and 20 to 30% for trickle systems
- use a water budget method to determine when and how long to irrigate



The online Irrigation Scheduling Calculator has been developed specifically for use in British Columbia. The calculator takes the following information into account in the development of an irrigation schedule:

- crop water requirements
- soil water holding capacity
- amount of effective rainfall that is useable by the crop
- how much irrigation water is needed to make up the moisture deficit

http://www.irrigationbc.com/

Agriculture Drip Irrigation Scheduling Calculator Users Guide
Agriculture Sprinkler Irrigation Scheduling Calculator Users Guide
Sprinkler Irrigation Scheduling Using a Water Budget Method
Trickle Irrigation Scheduling Using Evapotranspiration Data

Soil Moisture. The need for irrigation should never be gauged by the moisture content of the soil surface layer alone. It is important to determine the moisture content throughout the root zone to make an educated decision on when to start irrigating by using the hand feel method or monitoring devices such as tensiometers, gypsum blocks or electrical resistance blocks.

Irrigation Scheduling Techniques
Irrigation Scheduling with Tensiometers

Climate Monitoring. The crop's water use is directly related to the climate. Climate information can be gathered on the farm or taken from regional sources such as Farmwest.com on the Internet.

www.Farmwest.com and go to "Evapotranspiration" under the Climate tab

Irrigation System Maintenance

To ensure an irrigation system performs as designed it must be maintained properly. Implement the following practices:

- check irrigation equipment for leaks
  - common faults include leaking gaskets, defective sprinkler bearings and uneven pressure due to incorrect pipe sizes or difference in elevation
- check nozzles annually for wear
  - worn, oversized nozzles will apply excess water to the crop
  - in areas where the water contains sediment check more frequently
- check trickle system emitters annually for signs of clogging
  - plugged emitters cause uneven water distribution
- have a maintenance routine for water pumps, checking for impeller wear

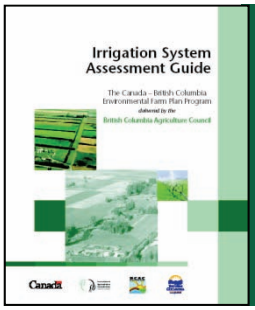
Irrigation System Maintenance

Irrigation Water Use Checks

Two water use checks can be done on **existing systems** to determine if the irrigation water use is appropriate. Implement the following practices:

- do a Peak Flow Rate Check for water withdrawal rate
  - explanatory text on pages 9-25 to 9-26
  - see Worksheet #7 for sprinkler systems, page 9-27
  - see Worksheet #8 for trickle systems, page 9-28
- do an Annual Water Use Check for total water use
  - explanatory text on pages 9-29 to 9-31
  - see Worksheet #9 for sprinkler systems, page 9-32
  - see Worksheet #10 for trickle systems, page 9-34

These Worksheets are available in the **Environmental Farm Planning Workbook** for individuals to use with actual farm numbers. If either check fails, a more detailed system assessment should be done; go to **Irrigation System Assessment Guide** below.



Irrigation System Assessment Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to provide a more detailed assessment that provided by the following Water Use Checks.

These Water Use Checks will indicate which producers should refer to this publication for further assistance. The publication will also be of interest to producers who want to improve irrigation management or have experienced water shortages. Table 9.4, below, will direct producers who have systems that need a more detailed review.

Table 9.4 Steps to Complete an Irrigation System Assessment

1. Do The Two Water Use Checks (using either the Sprinkler or Trickle worksheets)

- check the irrigation system Peak Flow Rate – match farm rate to the licensed rate or the calculated rate
- check the irrigation system Annual Water Use- match farm use to the licensed rate and the calculated rate

If both checks are answered "Yes", the irrigation system water use is appropriate and no further action is necessary.

2. If Either of the Water Use Checks are Answered "No", Assess the System

- do a detailed assessment using the **Irrigation System Assessment Guide** publication
- this publication builds on the Water Use Checks with more detailed information
- it includes additional Worksheets as well as Actions that can be taken to adjust the system to use water appropriately
- this level of assessment is useful for systems that require only minor adjustments

If the irrigation system still does not meet water use requirements, professional assistance is needed.

3. Where Required, Have an Irrigation Management Plan Done by a Professional

- at this level the irrigation system requires significant analysis
- this should be done by a professional certified by Irrigation Industry Association of BC

Irrigation System Peak Flow Rate Check

The irrigation system should be designed and operated so that the peak flow rate of the system matches the climate, crop and soil requirement. This check compares a calculated peak flow rate to the actual irrigation system flow rate. Complete the following three steps as given in Worksheet #7 (Sprinkler), page 9-27 or Worksheet #8 (Trickle), page 9-28.

Step 1: Calculated Peak Flow Rate. The calculated peak flow rate is the rate of water withdrawal determined by using the estimated rate for the farm location in BC. These are established rates, given in Appendix Table B.2, page B-5. The rate is multiplied by the acreage being irrigated to give a Calculated Peak Flow Rate.

Step 2: Actual System Peak Flow Rate. The actual system flow rate can be determined using any one or more of the following methods:

- Water Meter. A system water meter can be used to determine the peak flow rate. If the meter does not directly provide the rate, measure the time the meter indicates a certain amount of water has passed and divide this volume by the time to determine the flow rate.

- Water Purveyor. Water purveyors will allocate a flow rate to the farm based on acreage. Most often these flow rates are regulated using flow control valves. Contact your water purveyor to find out how much water you are allowed to take if you are on a municipal system or in an irrigation district.

- Pump Curve. The system flow rate can be determined by estimating the flows using the pump curve. When using a pump curve to estimate flow, the impellor diameter, pump rpm, and system operating pressure must be known. Contact your pump supplier for pump curve information.

- Sprinkler Nozzle. The irrigation system flow rate can be determined by measuring the flow rate (using a pail and stop watch) from selected sprinklers, averaging the flow and multiplying this number by the number of sprinklers operating. Alternatively, nozzle manufacturer table values can be used once the operating pressure and nozzle sizes are known.

  It is important that all sprinkler nozzles are the same size and operating at close to the same pressure (i.e., they have similar flow rates) or the check will be inaccurate. Loss or gain of pressure is evident if the sprinklers at the end of the lateral do not have the same flow rate as those at the start. The lateral lines should be operated on the contour whenever possible. If the laterals run up or down a steep slope each sprinkler will be operating at a different pressure. For sprinkler system output flow using nozzle flow, use Worksheet #7.

- Trickle Systems. These systems are much more efficient than sprinkler systems and can therefore operate at lower flow rates, if desired. However, to conduct a peak flow rate check, the same estimated peak flow rate is used for the sprinkler check. The reasons for this are:
  - the farm may convert to an alternate crop requiring a sprinkler irrigation system; the farm flow rate should be able to accommodate the change
  - water licences do not incorporate system types into the determination of flow rates; the allowable withdrawal is based on the sprinkler flow rate
  - irrigation districts provide flows based on sprinkler flow requirements
  - an advantage of trickle systems is that the system does not need to operate 24 hours per day if the sprinkler systems peak flow rate is used

For trickle output flow using drip emitter flow, use Worksheet #8.

Step 3: Compare the Flow Rates. To complete the peak flow rate check, compare the calculated peak flow rate or the licenced rate to the actual irrigation system flow rate. If a rate is given on the water licence, the actual use must not exceed it. If no rate is indicated, it is recommended that the actual flow rate be no greater than the calculated flow rate.

Worksheet #7 System Peak Flow Rate Check - Sprinkler Workbook Question 271

Question: A farm in Armstrong irrigates 170 acres. The irrigation pump curve indicates a flow rate of 825 US gpm. The irrigation system has 105 sprinklers with 3/16" x 3/32" nozzles operating at 40 psi.

Does the system flow rate match either the licensed withdrawal rate (if stated) or the calculated peak flow rate for the farm?

Information:

Reset

Irrigated area	170	1	acres
EITHER peak flow rate on water license (if stated)	n/a	2	US gpm
OR, select location to look up peak flow : Armstrong	5	3	US gpm/acre

Calculation:

Step 1: Determine calculated peak flow rate

Equation:

Calculated Peak Flow Rate	=	Estimated Peak Flow Rate Requirement per Acre	x	Irrigated Area

= 5 (3) US gpm/acre x 170 (1) acres

= 850 (4) US gpm

Step 2: Determine actual irrigation system flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district ( ) (5) US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow from pump curve 825 (6) US gpm

Method 3. Determine flow rate using sprinkler nozzles

Nozzle flow rate from supplier's tables 8 (7) US gpm

Number of nozzles 105 (8) nozzles

Equation

Sprinkler System Output Flow Rate	=	Nozzle Flow Rate	x	Number of Nozzles

= 8 (7) US gpm x 105 (8) nozzles

= 840 (9) US gpm

Answer:

Step 3: Check sprinkler irrigation system peak flow rate (methods 1, 2 or 3) with calculated peak flow rate or Water Licence peak flow rate.

Is 850 (2 or 4) greater than 840 (Maximum of 5, 6 or 9) US gpm

NO **Flow rate is not exceeded**

Worksheet #8 System Peak Flow Rate Check - Trickle Workbook Question 271

Question: An orchard in Kelowna has a trickle irrigation system irrigating 14 acres. The largest zone with the most emitters and highest flow rate is zone 4. It has 756 trickle emitters with an emitter flow rate of 5.7 gph.

Does the system flow rate meet either the licensed water withdrawal rate (if stated) or the calculated peak flow rate?

Information:

Reset

Irrigated area	14	1	acres
EITHER peak flow rate on water license (if stated)		2	US gpm
OR, select location to look up peak flow : Kelowna	6	3	US gpm/acre

Calculation:

Step 1 Determine calculated peak flow rate

Equation				
Calculated Peak Flow Rate	=	**Estimated Peak Flow Rate Requirement per Acre**	x	**Irrigated Area**

= 6 (3) US gpm/acre x 14 (1) acres

= 84 (4) US gpm

Step 2. Determine actual irrigation system flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district ( ) (5) US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow from pump curve ( ) (6) US gpm

Method 3. Determine flow rate using trickle emitters

Emitter flow rate from supplier's tables	5.7	7	gph
Number of emitters operating at one time	756	8	emitters

Equation						
Trickle System Output Flow Rate	=	**Emitter Flow Rate**	x	**No. of Emitters**	x	**0.0167**

= 5.7 (7) gph x 756 (8) emitters x 0.0167

= 72.0 (9) US gpm

Answer:

Step 3: Check sprinkler irrigation system peak flow rate (methods 1, 2 or 3) with calculated peak flow rate or Water Licence peak flow rate.

Is 84 (2 or 4) greater than 72.0 (Maximum of 5, 6 or 9) US gpm

NO **Flow rate is not exceeded**

This check compares the annual water use of an existing irrigation system against the licenced amount (surface water use) and against the calculated annual water requirement for the farm location (licenced surface water use, ground water use or purveyor-supplied water). If the check indicates that the annual water use exceeds the licenced rate or the calculated requirement the system design and / or the operation of the system needs to be reviewed.

Complete the following three steps as given in Worksheet #9 (Sprinkler), page 9-32 or Worksheet #10 (Trickle), page 9-34.
If licenced, water volume is checked against both the licence and the calculated water requirement. This double check ensures that the licence is not exceeded and water use meets the expected amount for the location.

It is possible that the water licence allows for more water than the calculated annual water requirement would indicate for either of two reasons:

- water licences are not always issued for the exact amount of water required but may be "rounded off" to the next one-half acre-foot of water
- an old water licence may have been issued for flood irrigation with up to twice as much water as a newer water licence for sprinkler irrigation

Therefore, when checking actual annual water use against older licensed volumes, there may still be opportunities for water savings, even if using less than the amount stated on the licence.

📖 **Understanding a Water Licence**
📖 **Irrigation System Assessment Guide**

For systems that have large conveyance losses between the diversion and the irrigation system intake, the conveyance losses must be determined before the annual water use check can properly be completed.

📖 **BC Irrigation Management Guide**

Step 1: Calculated Annual Water Requirement. The calculated annual water requirement is determined using an estimated value for crop water requirements and irrigation system efficiency factors.

It is accepted that some years are wetter or drier than others and annual water use will vary. Regardless, the annual withdrawal amounts stated on a water licence cannot be exceeded. Farmers using a well or other water source should adhere to the annual water requirement figures calculated in this chapter whenever possible.

- Sprinkler Systems. To calculate the sprinkler annual water requirement use, use Worksheet #9. This calculation requires the system efficiency to be considered. Typical system efficiencies are given in Table 9.3, page 9-23.

- Trickle Systems. The trickle system irrigates less of the crop area than a sprinkler system. The trickle emitters apply water only to the plant roots and not the centre of the crop row. The efficiency of a trickle irrigation system is also much higher than sprinkler systems, which provides additional savings. Table 9.5, next page, provides factors that can be used to adjust the annual crop water requirement values in Appendix Table B.3, page B-7 for trickle irrigation systems. Use Worksheet #10.

Table 9.5 Crop Adjustment Factors for Trickle Irrigation Systems *Worksheet #10*	
Crop Type	**Adjustment Factor**
Tree Fruits – High Density	1.00
Apples - Cherries – Medium Density	0.90
Apricots, Peaches, Pears – Medium Density	0.80
Tomatoes	0.90
Vegetables	0.80
Blueberries	0.80
Strawberries	0.75
Raspberries	0.70
Grapes	0.70

Step 2: Actual System Annual Water Use. The annual water use by an irrigation system can be determined using meter data, pumping information or irrigation system operation information. Any of the following methods can be used to estimate the annual water use. More than one method may be used to determine as accurately as possible the amount of water used each year.

- Water Meter. A water meter will provide accurate information on annual water use. Metered systems are usually on municipal or irrigation district water supplies; however there are very few irrigation systems that are currently metered. Trickle irrigation systems often have a flow meter to monitor system performance but these meters do not provide annual data. The meter reading can be converted into annual water use.

- Pump Operating Hours. The pump operating hours of an electric irrigation pump may be determined from the hydro bill provided by the hydro supplier. The amount of energy used can be converted into operating hours and annual water use.

  To determine the pump horsepower use the pump curve to determine the actual horse power. You will need to know the flow rate, which is calculated in Worksheets #7 or #8, and the pressure at the pump. Relying on the motor face plate information may mean that the horse power used in the calculation is too large.

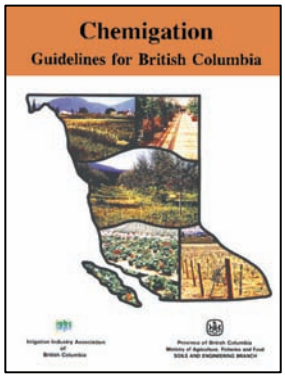
- Sprinkler Systems. Annual water use for a sprinkler system can be estimated by determining how many days it takes the irrigation system to cover the field, the number of irrigations that are applied each year and the peak flow rate of the irrigation system. Use Worksheet #9.

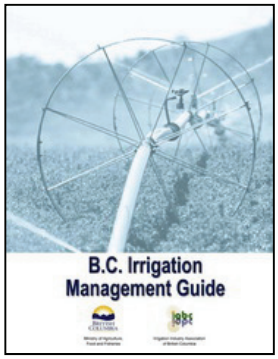
- Trickle Systems. Trickle irrigation systems are more efficient than most other irrigation systems. They are also operated more frequently than other systems, usually every day or numerous times every week. Use Worksheet #10, to convert system information into annual water use.

Step 3: Compare the Water Use Rates. To complete the Annual Water Use Check, compare the calculated annual water requirement to the annual water use. It is recommended that the annual water use be no more than 110% of the calculated annual water requirement (i.e., the requirement is not exceeded by more than 10%).

Step 4: Water Licence Check. Convert the actual annual water use calculated in inches to acre-feet (Worksheets #9 and #10). The acre-foot value is required if the actual annual water use is to be checked against the irrigation licence. The annual water use in acre-feet should not exceed the amount stated on the water licence.

Chemicals Added to Irrigation Water





Chemigation is the practice of injecting chemicals into an irrigation system for application to a crop or field. Chemicals that are injected include fertilizers, herbicides, insecticides, fungicides, nematocides and growth regulators. Chemigation may reduce the amount fertilizers required as nutrients are applied more efficiently.

Uniformity is essential to prevent over application of fertilizer or pesticide. The risk of contamination of the water source due to back-siphonage and back-pressure (as in unexpected shutdown of the irrigation system during injection) is an additional concern. Implement the following practice:

- have an irrigation system designed to ensure uniformity
  - sprinkler systems should have a minimum uniformity of 80%
  - trickle systems should have a minimum uniformity of 90%
  - have new systems designed by a certified irrigation designer
- calibrate equipment and follow proper chemigation procedures to minimize the risk of excessive application and chemical drift
- have a proper backflow prevention device
- follow the information and regulations in the Chemigation Guidelines

Producers who add chemicals to irrigation water should refer to the following publications for system detail required to be able to apply chemicals without impacting the environment.

- **BC Trickle Irrigation Manual,** chapter 14
- **Chemigation Guidelines for British Columbia**
- **Irrigation System Cross Connection Control**
- **B.C. Irrigation Management Guide**

Worksheet #9 — Annual Water Use Check - Sprinkler — Workbook Question 271

Question: A farmer in Armstrong irrigates 170 acres. The 125 hp irrigation pump operates at a flow rate of 825 US gpm. The electric bill indicates there was 140,337 KWh of hydro use. The wheelmove sprinkler irrigation system has an efficiency of 72% and takes 15 days to cover the field. The field was irrigated 4 times during the year. The water licence amount is 262 acre-feet.

Does the annual water use match the calculated annual irrigation water requirement for the farm?

Information:

Reset

Irrigated area	170	1	acres
Water withdrawal amount on water license (if applicable)	262	2	acre - feet
Estimated annual crop water requirement (select site) — Armstrong	12	3	inches
Application efficiency (select irrigation type) — Microjet	85	4	%

Calculation:

Step 1. Determine the calculated annual water requirement.

Equation:

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement}}{\text{Application Efficiency}} \times 100\%$$

$$= \frac{12\ (3)\ \text{inches} \times 100\%}{}$$

$$= 85\ (4)\ \%$$

$$= 14\ (5)\ \text{inches}$$

Step 2. Determine actual annual water use using one or more of the following methods:

Method 1: Metered water use

Meter reading at start of year		6	US gallons
Meter reading at end of year		7	US gallons

Equation:

$$\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year - Meter Reading at Start of Year}}{\text{27027 x Irrigated Area}}$$

$$= \frac{0\ (7)\ \text{US gal} - 0\ (6)\ \text{US gal}}{27027 \times 170\ (1)\ \text{acres}}$$

$$= 0\ (8)\ \text{inches}$$

Method 2: Pump water use

Pump horsepower from supplier's table	125	9	hp
Energy consumption for entire year from hydro bill	140,337	10	KWh
Pump flow rate from pump curve	825	11	US gpm

Equation:

$$\text{Pump Power} = \text{Pump Horsepower} \times 0.746\ \text{KW/hp}$$

$$= 125\ (9)\ \text{hp} \times 0.746\ \text{KW/hp}$$

$$= 93.3\ (12)\ \text{KW}$$

Equation:

$$\text{Pump Operating Hours} = \frac{\text{KWh for Entire Year}}{\text{Pump Power}}$$

$$= \frac{140{,}337\ (10)\ \text{KWh}}{93.3\ (12)\ \text{KW}}$$

$$= 1505.0\ (13)\ \text{hr}$$

Equation:

$$\text{Annual Water Use} = \frac{\text{Pump Operating Hours x Pump Flow Rate x 0.0022}}{\text{Irrigated Area}}$$

$$= \frac{1505.0\ (13)\ \text{hr} \times 825\ (11)\ \text{US gpm} \times 0.0022}{170\ (1)\ \text{acres}}$$

$$= 16.1\ (14)\ \text{inches}$$

Method 3: Sprinkler system annual water use

Sprinkler system output flow rate (max of boxes 5, 6 or 9 on Worksheet 7)	840	15	US gpm
Irrigation Interval	15	16	days
Number of irrigations per year	4	17	

Equation:

Annual Water Use = System Flow Rate x Irrigation Interval x No. of Irrigations x 0.053 / Irrigated Area

= 840 (15) US gpm x 15 (16) Days x 4 (17) Number x 0.053 / 170 (1) acres

= 16 (18) inches

Answer: If there is a Water Licence, 3(a), and as a double check, do step 3(b).
If using ground water or if water supplied by a purveyor (no licence requirement), do step 3(b) only.

Step 3(a). Check annual water use with Water Licence.
Convert annual water use to acre-feet and compare to the licensed annual volume

Equation

Annual Water Use Acre-Feet = Actual Annual Water Use x Irrigated Area / 12

= 16 (8, 14 or 18) inches x 170 (1) acres / 12

= 228 (19) ac-ft

Is 228 (19) ac-ft less than 262 (2) ac-ft?

YES **Water licence is not exceeded**

Step 3(b). Calculate percent difference of peak flow rate. Use the metered water use if available because it is the most accurate method.

Equation

Percent Difference = Actual Annual Water Use / Calculated Annual Water Requirement x 100%

= 16 (8, 14 or 18) inches / 14 (5) inches x 100%

= 114 (20) %

Is 114 (20) % less than 110%?

NO **Refer to the 'Irrigation System Assessment Guide' to find ways to reduce water use**

Worksheet #10 — Annual Water Use Check - Trickle — Workbook Question 271

Question: A high density 14 acre apple orchard in Kelowna has a trickle irrigation system with a flow rate of 58 US gpm. The irrigation system consists of seven zones that have similar flow rates. Each zone operates for 2.5 hours per day. The system operated for 100 days during the irrigation season. A meter on the system indicates readings of 4,510,900 US gallons at the start of the year and 12,116,400 US gallons at the end of the year.

Does the annual water use match the calculated annual irrigation water requirement for the farm?

Information:

Reset

Irrigated area	14	1	acres
Water withdrawal amount on water license (if applicable)		2	ac - feet
Estimated annual crop water requirement (select location)	Kelowna	19	3	inches
Crop adjustment factor (select crop)	Tree Fruits – High Density	1	4	
Application efficiency (select irrigation type)	Trickle	92	5	%

Calculation:

Step 1. Determine the calculated annual water requirement.

Equation:

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times \text{Crop Adjustment Factor}}{\text{Application Efficiency}} \times 100\%$$

$$= \frac{19\ (3)\ \text{inches} \times 1\ (4)}{92\ (5)\ \%} \times 100$$

$$= 21\ (6)\ \text{inches}$$

Step 2. Determine actual annual water use using one or more of the following methods:

Method 1: Metered water use

Meter reading at start of year	100	7	US gallons
Meter reading at end of year	12,116,400	8	US gallons

Equation:

$$\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year - Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}}$$

$$= \frac{12{,}116{,}400\ (8)\ \text{US gal} - 100\ (7)\ \text{US gal}}{27027 \times 14\ (1)\ \text{acres}}$$

$$= 32\ (9)\ \text{inches}$$

Method 2. Pump water use

Pump horsepower from supplier's table		10	hp
Energy consumption for entire year from hydro bill		11	KWh
Pump flow rate from pump curve		12	US gpm

Equation:

$$\text{Pump Power} = \text{Pump Horsepower} \times 0.746\ \text{KW/hp}$$

$$= 0\ (10)\ \text{hp} \times 0.0746\ \text{KW/hp}$$

$$= 0.0\ (13)\ \text{KW}$$

Equation:

$$\text{Pump Operating Hours} = \frac{\text{KWh for Entire Year}}{\text{Pump Power}}$$

$$= \frac{0\ (11)\ \text{KWh}}{0.0\ (13)\ \text{KW}}$$

$$= 0.0\ (14)\ \text{hr}$$

Equation:

Annual Water Use = Pump Operating Hours x Pump Flow Rate x 0.0022 / Irrigated Area

= (0.0 | 14 hr x 0 | 12 US gpm x 0.0022) / (14 | 1 acres)

= 0.0 | 14 inches

Method 3. Sprinkler system annual water use

Sprinkler system output flow rate from Box 9 of Worksheet 8	72.0	16	US gpm
Number of zones	7	17	
Operating hours per zone per day	2.5	18	hr/zone/day
Number of operating days per year	100	19	day

Equation:

Annual Water Use = Zone Flow Rate x No. of Zone x Operating Hours x No. of Days x 0.0022 / Irrigated Area

= 2.5 | 16 US gpm x 7 | 17 Zones x 2.5 | 18 hr/zone/day x 100 | 19 day x 0.0022 / (14 | 1 acres)

= 19.8 | 20 inches

Answer: If there is a Water Licence, 3(a), and as a double check, do step 3(b).
If using ground water or if water supplied by a purveyor (no licence requirement), do step 3(b) only.

Step 3(a) Check annual water use with Water Licence.
Convert annual water use to acre-feet and compare to the licensed annual volume

Equation

Annual Water Use Acre-Feet = Actual Annual Water Use x Irrigated Area / 12

= (32 | 9, 15 or 20 inches x 14 | 1 acres) / 12

= 37 | 19 ac-ft

Is 37 | 19 ac-ft less than 0 | 2 ac-ft?

N/A

Step 3(b) Calculate percent difference of peak flow rate. Use the metered water use if available because it is the most accurate method.

Equation:

Percent Difference = Actual Annual Water Use / Calculated Annual Water Requirement x 100%

= (32 | 9, 15 or 20 inches / 21 | 6 inches) x 100%

= 155 | 21 %

Is 155 | 21 % less than 110%?

NO **Refer to 'Irrigation System Assessment Guide' to find ways to reduce water use**

DRAINAGE

DRAINAGE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to drainage systems are:
disturbances during drain system installation and maintenance that results in impacts to water quality, aquatic life and habitat loss
poor drainage discharge water quality that results in water pollution
drainage discharge water quantity that results in increased watercourse flow and erosion
For information on these concerns:

➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections
➔ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

DRAINAGE LEGISLATION

The following is a brief outline of the main legislation that applies to drainage.

➔ see page A-1 for a summary of these and other Acts and Regulations

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving ***more*** than one single-family residence).

- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act

The *Code* under the *Agricultural Waste Control Regulation* defines "watercourse" to include drainage ditches that flow into surface water such as a lake, river, creek, canal, etc.

Water Act

This Act and its Regulations require surface water use to be licensed and protects ground water. Drainage requires a licence for "land improvement purpose". Approval is required for "works in and about a stream" such as open channels that allow water to flow into watercourses.

Wildlife Act

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area.

Fisheries Act

This Act has several sections of importance to drainage concerns:

- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include drainage water)
- Section 37(4): requires approval for work that may impact fish habitat
- Section 38(4): requires reporting infractions of Sections 35 or 36

Species at Risk Act

This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Species at Risk Act (known as the 'safety net') could be invoked on BC crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

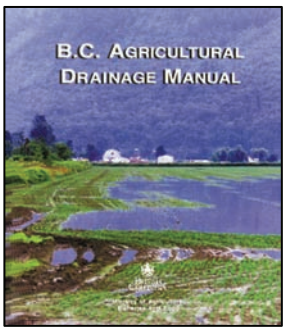
DRAINAGE BENEFICIAL MANAGEMENT PRACTICES

Comply with drainage legislation and, where appropriate, implement the following beneficial management practices.

Crops generally require moderately to well-drained soils for proper growth. Adequate drainage increases soil strength, trafficability and nutrient uptake by the crop. In the BC Interior, drainage serves the important added purpose of controlling soil salinity and alkalinity. In South Coastal BC, most soil and topographic conditions require subsurface drainage to reduce saturation of the crop root zone, to reduce soil compaction, to reduce overland flow and to control erosion.

Generally, improved subsurface drainage reduces overland flow, which in turn can reduce the potential transport of contaminants, including pesticides, fertilizers and soil particles, to surface waters.

Drainage Systems



Plants growing in soils with good drainage are better able to take up nutrients from the soil and water, reducing leaching of nutrients. A drainage system may consist of a combination of land grading improvements, ditches, subsurface drainpipes and pumping systems. A site-specific design produced by a qualified soil and drainage specialist is highly recommended to ensure that subsurface systems are matched to specific soil conditions and plant rooting requirements. A well-designed system will improve the trafficability of soils, reduce the delay time for re-entry to fields after rainfall, and increase the growing season.

Implement the following practices:

- design subsurface drainage systems for the specific soil conditions and plant rooting requirements
- avoid the use of woodwaste as porous backfill around subsurface drains to prevent any potential of leachate contaminating drainage discharge water
- install interceptor drains to reduce concentrated overland flow
- grade land to eliminate low areas where water can pond to improve field access and trafficability (done in a manner that prevents soil degradation)
- grade land to reduce surface ponding (these are not wetlands but rather shallow depressions in a field) which attract unwanted wildlife such as ducks, thus avoiding further soil degradation from puddling by the ducks
- install permanent drop structures in channels to allow water to flow gently without causing erosion

  📖 **B.C. Agriculture Drainage Manual**

  📖 **Agricultural Drainage Criteria**

Subsurface Drainage Systems. Maintenance of subsurface drains and outlets is important for the benefits of drainage. If relying on a subsurface drainage system to improve drainage and reduce surface flow as quickly as possible, any clogging of drains or obstruction of outlets will increase the potential for surface flows that could cause environmental problems.

Subsurface drainage can also be designed and operated to control the water table level within desired ranges. Some of the environmental benefits of controlled drainage are that:

- the system allows drainage water to be held back when drainage is not required, thus the subsurface drainage acts as subsurface irrigation, reducing water requirements and recycling nutrients that would otherwise leach out into the drain water
- drains can be closed if there is a potential for unwanted preferential flow

  ➔ see Preferential Flow, page 9-40

  📖 **Controlled Drainage/Subirrigation**

  📖 **Maintenance & Checking of Performance of Subsurface Drainage Systems**

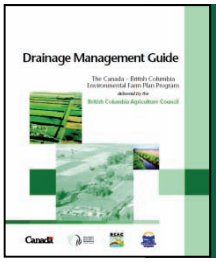
Surface Drainage Systems. To maintain drainage ditches in a free-flowing condition, implement the following practices:

- keep grades shallow to reduce erosion
- slope ditch banks shallow enough to prevent slumping and erosion
  - sandy soils require shallower slopes than clay soils
- protect ditch banks, particularly those in sandy soils, against erosion with crushed rock, gravel or effective, permanent cover crops
  - grasses provide better cover than broadleaf weeds and reduce spread of weeds
- establish buffer strips to filter sediments before they reach the ditch

  ➔ see Buffers, page 11-4
- if despite of implementing the above, sediment and vegetation continue to restrict flow, then clean to remove materials as required to maintain flow

Drainage Systems Operation and Maintenance

The following drainage information covers basic concerns. For more detailed information refer to the **Drainage Management Guide** publication, below.



Drainage Management Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to ensure drainage systems are operated and maintained in an environmentally correct manner. This publication contains more detailed information and is recommended for use by producers with surface drainage systems such as ditches, or with subsurface systems, that drain into areas with fish and fish habitat.

Guidelines have been established between agencies and producers for maintenance of agriculture watercourses, characterized by these steps:

- identify the drainage maintenance needs
- classify the watercourse
- review and determine the agency approval process for the type of work
- determine the timing window when the work will be done
- follow the required conditions for the watercourse and work to be done
- Regional up-to-date guidelines are available on the web.
  www.agf.gov.bc.ca/resmgmt/ditchpol/index.htm

Agricultural Watercourse Classification. Three watercourse classifications, as shown in Figure 9.3, below, are used to define agricultural watercourses. They are based on physical and hydrological parameters. The presence or absence of fish must also be determined.

- **constructed ditches:** have no headwaters, carry water from local surface areas or subsurface drains and may be permanently or intermittently wetted; such ditches are primarily constructed for the purpose of removing excess water from farmland in order to improve crop production and farm viability
- **channelized streams:** have headwaters, are permanent or relocated streams, often situated along property boundaries, that have been diverted, dredged, straightened and/or dyked
- **natural streams:** historic watercourses that have not been altered for extended periods of time,

  📖 **Agricultural Watercourse Classification**

Agency Approvals. The classification of a watercourse and the type of work to be done in the watercourse determines the agency approval required. Approvals may be needed from Fisheries and Oceans Canada or MOE.

📖 **Agency Contact Requirements For Constructed Ditch Maintenance**
📖 **Agency Contact Requirements For Channelized And Natural Stream Maintenance**

Timing Window. An instream work 'Timing Window' is a time when fish species are at a stage in their life cycle when they are least sensitive to disturbances, such as may occur from maintenance work. These windows are set by the type of watercourse, its condition, and its location in BC.

📖 **Fishery Timing Windows For Maintenance Work in Constructed Ditches**

Note: the above four 📖 are in the **Drainage Management Guide**

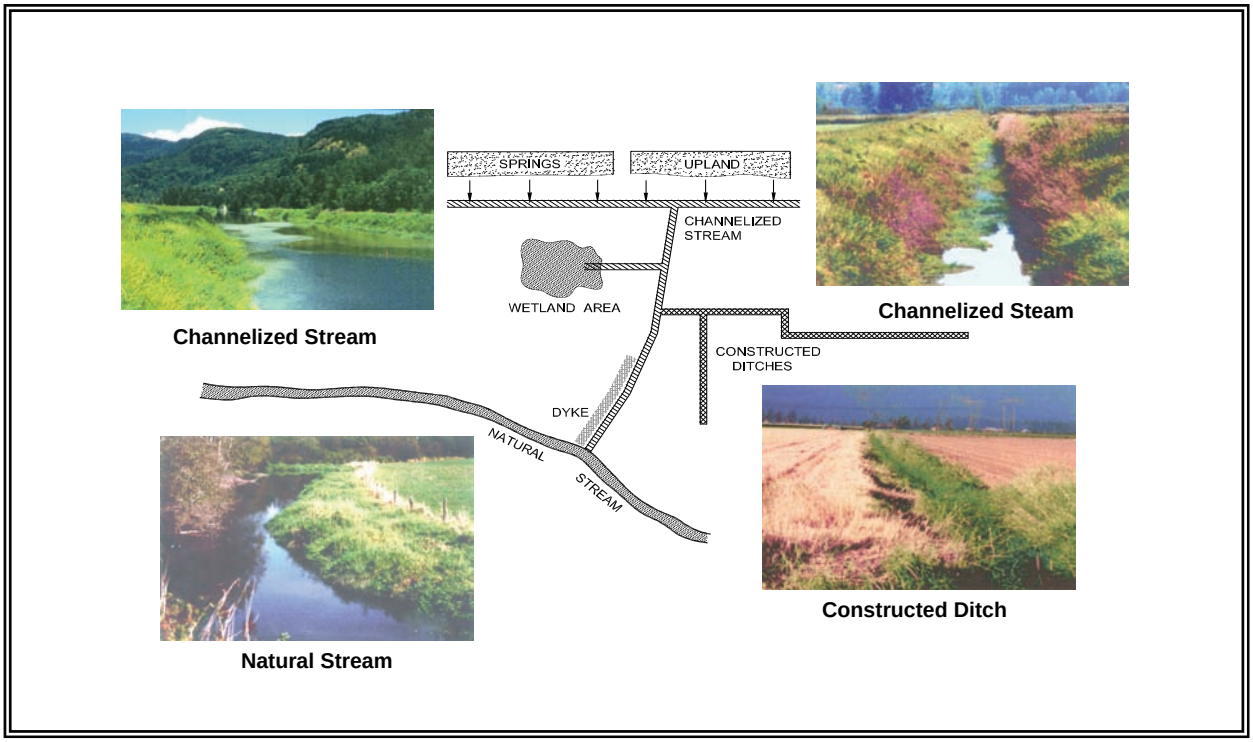


Figure 9.3 Watercourse Classification

Drainage Water Quality

Quality of drainage water in watercourses can be degraded by surface contaminants reaching the drainage discharge through preferential flow pathways to drain tiles (see Preferential Flow, below), by overland flow to surface ditches, by woodwaste leachate used in constructing the drainage system, and by erosion at drain outlets.

Poor-quality drain water can be eliminated or controlled by implementing the following practices:

- keep contaminants from entering drainage systems
- install a controlled drainage system with the capacity of isolating and managing contaminated runoff
  ➔ see Collecting and Storing Contaminated Water, page 9-44
  📖 **Controlled Drainage/Subirrigation**
- plant a vegetative strip along the channel to filter contaminants before reaching the drainage system ➔ see Buffers , page 11-4

Preferential Flow or Macropore Flow. Preferential flow occurs when holes or cavities created by worms, mice, or moles lead directly from the ground surface to subsurface drainage tiles, as shown in Figure 9.4, next page. In this situation, freshly-spread liquid manure may freely flow through the soil, into subsurface drainage tiles and from there to watercourses, causing a risk of pollution.

Where there is a risk of macropore flow, implement the following practices:

- do not spread manure on grass or bare fields when fields are wet and tile drains are running
- cultivate bare fields to break up macropores shortly before spreading manure (preferably within 24 hours)
- reduce one-time manure application rates to 40 m^3/ha or less
- if contamination still occurs, it may be necessary to block the outflow or contain the contaminated drain water in a collection pond

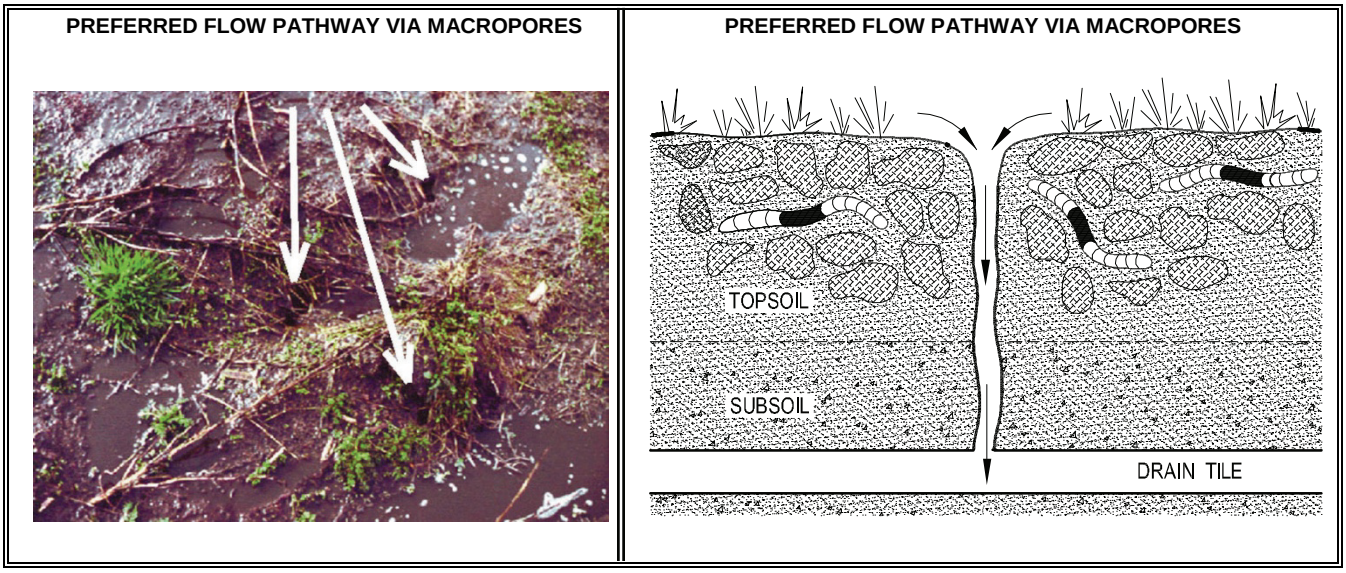


Figure 9.4 Preferred Flow or Macropore Flow (Surface Water Flow Directly to Drain Tiles)

Overland Flow. Do not release contaminated runoff if it will cause pollution of any watercourse. Implement the following practices:

- stop the source of contamination
- capture (or be able to stop ditch discharge) and recirculate
- treat prior to discharge

Woodwaste. Monitor systems that were constructed in the past using woodwaste as backfill during the first few years to determine if woodwaste leachate in the drain water poses a pollution risk. Drainage water containing woodwaste leachate cannot be released into a watercourse. Avoid the use of such backfill as much as possible.

Monitoring. Monitor the water quality in drainage system outlets on a regular basis, particularly after a long dry spell and after manure has been applied. Such monitoring should determine if contaminants such as nutrients and pathogens are causing a pollution risk.

📖 **Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley**

RUNOFF

For the purposes of this publication, stormwater originates as rainfall precipitation and is one source of runoff. Runoff (also called overland flow) is that portion of stormwater, snowmelt or irrigation water that moves across the land as surface water flow.

RUNOFF ENVIRONMENTAL CONCERNS

Primary environmental concerns related to runoff are:

- increased peak stream flow due to on-farm impervious areas that results in flooding downstream, erosion of stream banks, etc
- runoff water that becomes contaminated that results in pollution

For information on these concerns:

➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections

➔ see Impacts on Biodiversity and Habitat, page 7-8, and refer to Farm Activities and Impacts

RUNOFF LEGISLATION

The following is a brief outline of the main legislation that applies to runoff.

➔ see page A-1 for a summary of these and other Acts and Regulations

Local Bylaws

There may be local bylaws concerning stormwater management such as lot coverage or retention/detention pond construction details that need to be met.

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving ***more*** than one single-family residence).

- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act

The *Code* under the *Agricultural Waste Control Regulation* has requirements for agricultural wastes that may be in runoff:

- Section 3: agricultural wastes must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 14: agricultural wastes must not be applied if runoff or escape of agricultural waste
  - causes pollution of a watercourse or ground water, **or**
  - goes beyond the farm boundary
- Section 30: agricultural products must be managed to prevent the escape of agricultural wastes (agricultural products include farm inputs and outputs)

Fisheries Act

This Act has three sections of importance to runoff concerns:

- Section 35: prohibits harmful alteration, disruption or destruction of fish habitat unless authorized
- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substance could include contaminated runoff)
- Section 38(4): requires reporting infractions of Sections 35 or 36

Migratory Birds Convention Act

This Act has a section of importance to runoff concerns:

- Section 35(1): prohibits the deposit of any substance harmful to migratory birds in any waters frequented by migratory birds

RUNOFF BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable runoff related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Producers must ensure that the quality of surface water leaving or passing by the farm is not polluted by farm operations. The most effective practice in preventing water pollution is to eliminate runoff flows from contacting sources of contamination, such as manure. This is often done by diversion of runoff away from these sources, such as upland flow ditched away from yards, or roof water directed away using gutters.

Runoff Flow Factors

The velocity and volume of runoff flows are affected by:

- the length and grade of a slope
- the aspect or direction a slope faces
  - south facing slopes can have quick snow melt events
- the soil surface texture which affects the smoothness of terrain
- the type of crop or volume of crop residue which also affects the smoothness of terrain

Runoff Flow Management

Stormwater Peak Flow. Stormwater originates from rainfall events. Where development on a farm has increased the impermeable areas of roofs and hard-surface roads to greater than 10% of the total land area or 2 ha (suggested), manage stormwater to reduce flows to pre-development levels. On-farm detention ponds are most commonly used to reduce such peak flows.

Snowmelt. Snowmelt runoff risk is increased in the presence of fine-textured soils, frozen soils and low crop residue levels. Also, the risk is higher for south-facing slopes and increases as slopes increase in steepness and length. Limit the amount of agricultural waste spread on land in the fall, where the risk of snowmelt runoff is high.

➔ see Tables 6.11 and 6.12, Monthly Manure Spreading Practices, pages 6-21 and 6-22

Preventing Surface Water Contamination. If runoff water becomes polluted it must be managed as contaminated water. Because the treatment of contaminated water typically entails considerable effort and expense, it is usually preferable to prevent the generation of contaminated water in the first place. Use the following principle:

> **Keep clean water away from sources of contamination;**
>
> **Keep sources of contamination away from clean water**

To protect surface water quality, implement the following practices:

- reduce the volume of contaminated water to be collected by using perimeter diversion ditches to divert clean runoff around outdoor livestock areas, manure, woodwaste, pesticide and fertilizer storage areas, wells and springs
- construct impermeable berms to prevent water that has become contaminated from entering watercourses
- reduce the amount of runoff water by
  - planting cover crops to improve the infiltration rate of water
  - ensuring that subsurface drainage systems work as designed
- establish and maintain adequate vegetative buffers around watercourses to
  - keep suspended or dissolved contaminates from causing pollution
  - reduce nuisance impacts on neighbours
  - intercept quantities of runoff

➔ see Buffers, page 11-4

Contaminated Water Collection, Storage and Use

Water may contain farm contaminates such as manure, soil, pesticides, petroleum and fertilizer. Contaminated water must be handled as a pollutant unless found not to be an environmental concern. To determine the impact of such water entering watercourses, samples may need to be collected upstream and downstream of the source of the runoff for laboratory analysis. Contact the water-testing laboratory to find out how to collect representative samples. For help to determine if contaminated water is negatively affecting stream water quality and polluting, various criteria must be examined.

📖 **British Columbia Approved Water Quality Guidelines**

📖 **Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley**

💻 http://www.env.gov.bc.ca/wat/wq/

Collecting Contaminated Water. Implement the following practices to collect contaminated water from these three common sources:

- from outdoor areas, use berms or grade the area with a 2 to 4% slope to direct water to run into a collection basin or manure pit for reuse (take this extra volume into account when sizing manure pits)

- from drainage systems, be able to isolate and close the drainage system to store water
- from irrigation runoff, divert surface runoff to a reservoir for reuse and improve the irrigation system

Storing Contaminated Water. Contaminated water that cannot be immediately used must be stored in a secure facility until it can be disposed of or used in an environmentally sound manner. For example, it would not be unusual that some winter and spring runoff originating from confined livestock areas would be contaminated. Storage in such cases is essential until the waste can be properly applied to cropland in the spring or summer.

Depending on soil conditions, contaminated water storages may be earth lined if in clayey areas; in coarser soils impervious materials such as plastic or concrete will be required. Siting considerations are similar to those for manure storages:

- locate storages away from ditches, wells and watercourses
  - at least 15 m from a watercourse (Agricultural Waste Control Regulation)
  - at least 30 m from domestic water source (Agricultural Waste Control Regulation)
  - at least 30.5 m from wells (Public Health Act)

➔ see Manure Storage – Storage Facilities, page 3-23

Sizing Contaminated Water Storage. Contaminated water must be stored to avoid application on snow or frozen ground. Under most Southern BC conditions, storage is required during the six months of October to March inclusive. In Northern BC, a minimum seven months of storage, October to April inclusive is recommended to accommodate the shorter season available for spreading. Appendix Table B.1, page B-3, shows the six and seven month precipitation values for areas of BC. Where appropriate, retain the services of a hydrologist to ensure proper sizing of a storage facility.

The size of a collection basin for contaminated runoff depends on:

- the amount of precipitation that occurs during the storage period
- the farm area directly influenced by contamination material
- the type of ground cover on the drainage area
- the amount of offsite runoff entering a contaminated area

To obtain a first approximation for design of storage of contaminated runoff from outdoor livestock areas (where no offsite surface water enters the area), use Worksheet #11, page 9-47:

- design storage capacity is based on the most winter precipitation expected in 25 years (recommended)
- the winter storage period (either 6 or 7 months) depends on when the storage can be emptied in the spring
- during the growing months of May to October, sizing considerations do not come into play as contaminated runoff can be directly applied to cropland

Using Contaminated Water. If contaminated runoff has been collected it must be disposed of so as not to pose a pollution risk to humans, livestock or water quality. The specifics of disposal depend on the types of contaminants in the water. Contact the MOE if you are uncertain of appropriate disposal method.

If the contaminant is **manure or fertilizer**, spread the affected water onto cropland as outlined in Nutrient Application, page 6-8.

If the contaminant is **woodwaste,** spread the affected water onto cropland that readily allows infiltration. Woodwaste leachate should travel through at least 60 m (suggested) of soil prior to entering surface or ground water.

If the contaminant is mainly **eroded soil**, settled solids may be applied to land, with the remaining liquid applied as irrigation water.

If the contaminants are **petroleum and pesticides**, test the water for the degree of contamination. If resulting quality standards are not met, treat the water before reuse or release.

- 📖 **Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley**
- 📖 **Guidelines for Canadian Drinking Water Quality**

Worksheet #11 Confined Livestock Area Workbook Question 284
Determining Volume of Contaminated Runoff from Outside Yard

Question: A farm in Abbotsford has a 300 m^2 hard-surfaced livestock yard.

What volume of contaminated water will need to be stored over the winter?

Information:

Reset

Type of surface: Hard surface, frozen land or roof

Select site: Abbotsford

Area of confined livestock site		
300	1	m^2
Hard		
1.54	2	m

Calculation:

Calculate storage area for type of yard surface

Method 1. For hard surface, frozen land or roof areas

Equation:
Volume = 1.0 x Area x Total Winter Precipitation

= 1.0 x 300 (1) m^2 x 1.54 (2) m

= 462 (3) m^3

Method 2. For soil based yards

Equation:
Volume = 0.9 x Area x Total Winter Precipitation

= 0.9 x 300 (1) **m^2** x 1.54 (2) m

= 416 (3) m^3

Method 3. For crop land (not frozen)

Equation:
Volume = 0.6 x Area x Total Winter Precipitation

Area x Precipitation

= 0.6 x 300 (1) m^2 x 1.54 (2) m

= 277 (3) m^3

Answer: This farm will require a contaminated water storage facility to hold 462 m^3 of contaminated water expected from the outside yard area.

LEACHATE

Leachate is produced from water moving through a material, such as woodwaste or manure, creating a contaminated liquid. Leachate can move over the soil surface to surface water or through the soil to ground water.

LEACHATE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to leachate are:
contamination reaching ground water or surface water that results in water pollution

For information on these concerns:

➔ see Water Quality and Quantity Factors, page 9-1, and refer to all sections

LEACHATE LEGISLATION

The following is a brief outline of the main legislation that applies to leachate.

➔ see page A-1 for a summary of these and other Acts and Regulations

Drinking Water Protection Act

This Act and Regulations have requirements regarding the protection of drinking water quality and regulate domestic water systems (those serving ***more*** than one single-family residence).

- Section 6: requires water suppliers to provide potable water to water users
- Section 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system

Environmental Management Act

The *Code* under the *Agricultural Waste Control Regulation* has a general reference to preventing pollution:

- Section 3: agricultural wastes, woodwaste and mortalities must be collected, stored, handled, used and disposed of in a manner that prevents pollution
- Section 12: agricultural wastes must be applied to land only as a fertilizer or soil conditioner

Public Health Act

This Act has prohibits a person from willingly causing a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard.

- Section 18: provides separation distance of wells to be at least 30.5 m from any probable source of contamination

Fisheries Act This Act has two sections of importance to leachates:

- Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include leachates)
- Section 38(4): requires reporting infractions of Section 36

LEACHATE BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable leachate related legislation, including the above, and where appropriate, implement the following beneficial management practices to protect the environment.

Leachate Sources

Leachate can be generated from water moving through any material that contains soluble components or degrades or decomposes in the presence of water. Materials that can be sources of leachate can be split into two broad classes, those that are mainly organic (e.g., woodwaste, silage, manure, and compost), and those that are mainly inorganic (e.g., fertilizer, pesticides and farm waste). In general, the more rapidly a material releases soluble compounds (or nutrients) to water the greater the risk of an environmental impact. For more information on the sources of material that may produce leachate, see the following sections:

- ➔ see Farm Waste, page 2-13
- ➔ see Chemical Fertilizer, page 2-18
- ➔ see Woodwaste, page 2-27
- ➔ see Compost, page 2-32
- ➔ see Manure, page 3-21
- ➔ see Mortality Disposal, page 3-37
- ➔ see Forage Crop Storage, page 4-10
- ➔ see Greenhouse, Container Nursery and Mushrooms, page 4-12
- ➔ see Pesticides, page 5-11
- ➔ see Leachate Formation in Soil, page 8-14

Leachate Production Factors

Figure 9.5, below, illustrates factors that influence the volume and quality of leachate production and its movement to surface water and ground water:

- water moving through materials or the soil will produce and move leachate
  - high precipitation areas are most at risk, such as the Pacific Coast climatic region (Climatic Information, page B-1)
- structures or farm layout design that
  - keep water from coming in contact with materials will reduce the risk of leachate production
  - have leachate containment
- the type and moisture content of materials through which water percolates
- the pH of water movement in soil
- the degree of leachate capture via soil adsorption
  - ➔ see Leachate Movement in Soil, page 9-50
- the degree of leachate capture in crop uptake

Reduction of leachate production and methods to address management of materials can be found in Chapters 2-6.

- ➔ see Woodwaste, page 2-27, ➔ see Compost, page 2-32
- ➔ see Manure, page 3-21, ➔ see Forage Crop Storage, page 4-10
- ➔ see Mushroom, page 4-17

Leachate Pollution Risk

The threat leachate poses in its ability to cause pollution depends on several factors:

- leachate formation or contaminant solubility (how well the chemicals being leached dissolve in water)
- leachate contaminant capture
  - absorption (whether it will bind to soil particles)
  - crop uptake (whether crop can utilize the dissolved chemicals)
  - degradation (whether it changes characteristics as it is exposed to the soil)
- leachate movement to surface or ground water
- leachate quantity

Leachate Movement in Soil

The degree of movement of leachate in soils is a function of:

- soil infiltration and permeability, and soil capacity to bind contaminants ➔ see Contaminant Movement in Soil, page 8-15
- soil water content

Water Content. The movement of water through the soil is the primary mechanism which moves leachate through the soil. In order to reduce this movement, implement the following practices:

- design and manage irrigation systems to avoid over-application of water
- avoid the use of soil amendments in fields that generate leachate that will cause pollution, if water is moving downward to ground water
- design and manage subsurface drainage systems to capture and treat contaminated water, particularly if macropore flow is estimated to be a risk ➔ see Drainage Water Quality, page 9-40

Leachate Capture in Soil

Nutrients and metals in leachate have the potential to be captured in the soil by adsorption or by uptake into plant roots. Effective use of nutrients can be achieved by collecting leachate in a holding pond for subsequent use as irrigation water on cropland.

Soil Adsorption. If leachate has entered the soil, the possibility for natural "entrapment" or "treatment" by the soil exists. Some leachate will react with the soil and be neutralized, while acidic leachate, for example, has the potential to dissolve and mobilize metals or other substances to create a more hazardous situation. Soil processes such as adsorption, which are dependent on soil pH, organic matter or clay content, can neutralize or capture leached chemicals. Whereas woodwaste leachate, acidic by nature, should travel long distances through soil prior to entering surface water or ground water (more than 60 m, suggested).

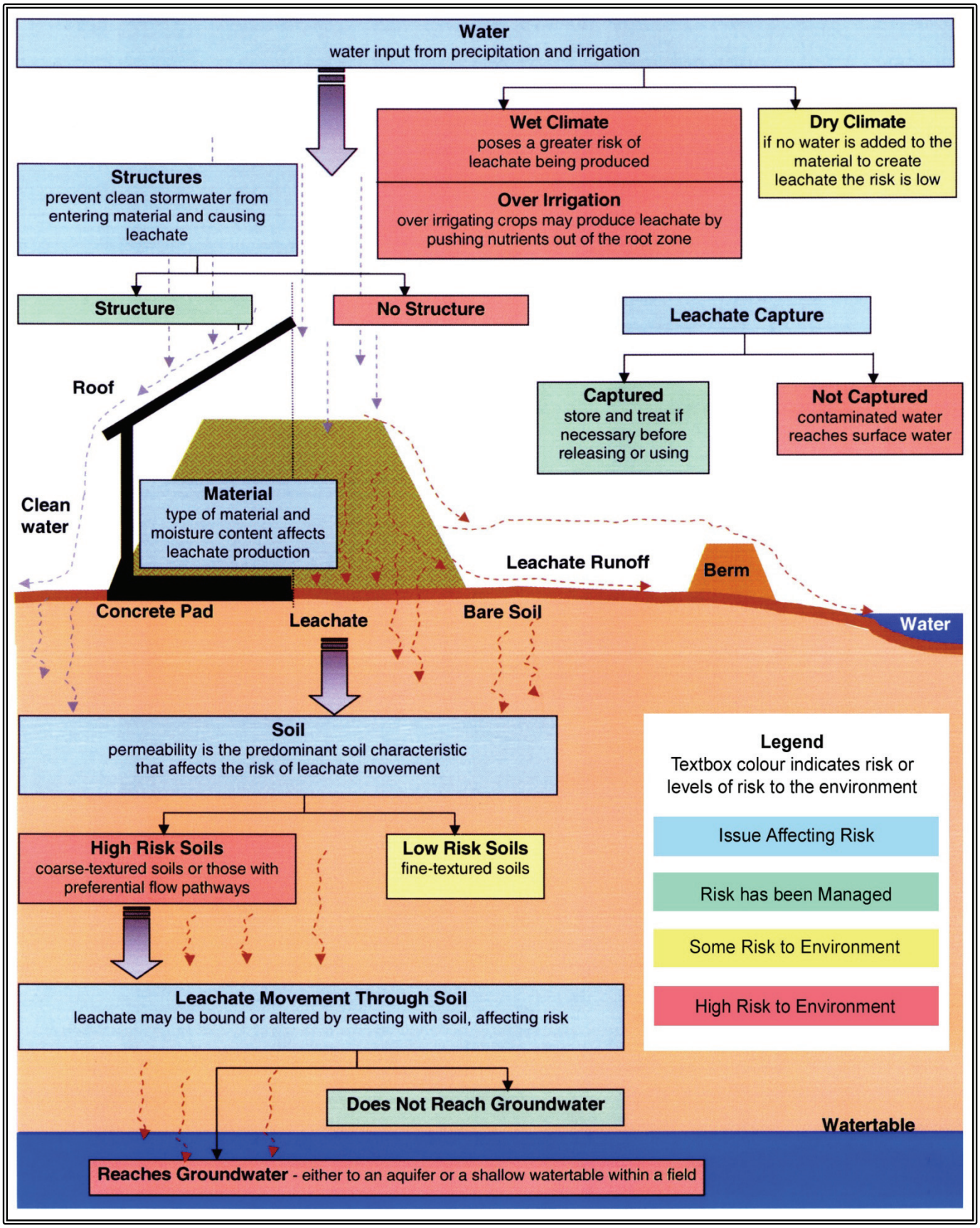


Figure 9.5 Leachate Production, Movement and Environmental Risks

Crop Uptake. If leachate reaches the root zone, the possibility for plant utilization of the dissolved nutrients exists. In order to increase the capture of such nutrients, implement the following practices:

- plant cover crops such as annual ryegrass relay crops on corn land to capture nutrients which become available after cash crop uptake ceases
- design and manage subsurface drainage systems to increase the size of the crop root zone available for nutrient capture
- establish and maintain adequate vegetative buffers to capture leachate moving through the soil to surface or ground water

➔ see Buffers, page 11-4

Contaminant Degradation. Chemicals introduced into soil by agricultural practices such as pesticides or petroleum will naturally degrade to some extent over a variable period of time due to the chemical and biological activity of soil.

Leachate Control

The best alternative to deal with leachate problems is to prevent leachate generation at the onset. Cover leachable materials with tarps or roofs to prevent water from contributing to the formation of leachate.

Leachate Containment. If leachate is generated, containment is the best control method. Implement the following practices:

- contain leachate near its source by ensuring the existance of an impervious barrier between potential leachate sites and the soil (e.g., a concrete pad under stored material)
- construct a containment area sized to hold all leachate produced

Leachate Capture. If leachate cannot be contained, capturing it is the only, often difficult, means to prevent it from reaching surface water or ground water. Implement the following practices:

- capture leachate runoff by
  - constructing berms and ditches to direct it to storage
  - planting buffers to capture contaminants ➔ see Buffers, page 11-4
- store captured leachate in an impervious storage

Leachate that has been contained or captured must be handled and disposed of such that the specific contaminants in it do not pose a pollution risk. In some cases, it is entirely appropriate to recycle leachate as, for example, through irrigation systems in greenhouses or nurseries.

➔ see Collecting and Storing Contaminated Water, page 9-44

Leachate Use

Leachate Use. Leachate collected from sources such as silage, manure or compost can effectively be used as a nutrient source.

➔ see Nutrient Application, page 6-8

Leachate Treatment. If leachate cannot be used in an environmentally sound manner, treat it prior to discharge. Treatment options include biological treatment in lagoons or constructed wetlands, activated carbon adsorption (a filtering method), and other chemical technologies. Most treatment technologies, because they are typically costly to implement, should be avoided where possible. Regardless of the type of treatment, any discharge requires a permit from the MOE.

WATER CONFLICTS

This chapter has outlined environmental impacts that may occur ***to*** water from a farm operation. However, some operations may be affected by impacts ***from*** water.

WATER CONFLICTS CONCERNS

Three primary water conflicts can pose major impacts to farms:

- excess water that results in flooding from
  - runoff water entering the property
  - surface water flooding from streams or lakes
  - ground water flooding from a rise in water tables
- insufficient water that results in
  - reduced access to surface or ground water sources
  - drought from seasonal or climate changes
- water quality that is unfit for domestic, livestock or irrigation uses

WATER CONFLICTS LEGISLATION

Fish Protection Act

The *Fish Protection Act* enables the protection of fish and fish habitats. Four main objectives of the Act are to ensure sufficient water for fish, enable fish habitat to be protected and restored, improve riparian habitat protection and enhancement, and to give local governments greater powers for environmental planning.

- Section 9: In the case of drought, for the purposes of protecting the fish population, the minister may make temporary orders regulating the diversion, rate of diversion, time of diversion, storage, time of storage and us of water from the stream by holders of licences or approvals in relation to the stream

Water Act

The *British Columbia Dam Safety Regulation* is to mitigate loss of life and damage to property and the environment from a dam breach by requiring dam owners to: inspect their dams, undertake proper maintenance, report incidents and take remedial action and ensure that the dams meet current engineering standards.

WATER CONFLICTS RESOLUTIONS

Comply with any related legislation and, where appropriate, implement the following beneficial management practices to protect the environment.

Flooding From Stormwater or Runoff Water

Stormwater or runoff water associated with agricultural conflicts typically originates from surrounding properties and may be contaminated. Neighbouring farm properties should complete and implement an environmental farm plan. Where this is not possible, manage the stormwater to minimize environmental impacts.

Upland urban stormwater management is critical to protect low farm land.

➔ see Farm Building Siting, page 2-4

Flooding From Watercourses

While dyking is intended to protect land from flooding, it also removes that same land as a floodplain buffer for a given watercourse. This may cause downstream impacts such as bank erosion because flows are unable to be reduced by natural spilling onto the floodplain. A farm's flood protection measures may become another farm's bank erosion problems. Consult the MOE, Fisheries and Oceans Canada, and local community flood plans before measures to redirect floodwaters are undertaken. Where appropriate, flooding from neighbouring properties should be addressed in the neighbouring properties Environmental Farm Plan.

➔ see Water Conflict Contingency Plan, next page.

Dam Inspection and Maintenance

Failure of water storage structures, such as dams used for irrigation or stock watering, can result in negative impacts to water quality, downstream habitat and farmland. Regular inspection and maintenance of dams is important in order to detect weakness in the dam before failure occurs. The responsibility to inspect and maintain privately owned dams falls on the dam owner. For more information the requirements of dam owners to inspect and maintain their dam, visit http://www.gov.bc.ca/fortherecord/safety/

Drought

In many cases reduced irrigation water availability can be expected if reservoirs are low in the spring or if a low snowpack levels warn of impending reduced watercourse flows in the subsequent growing season. Good water management in such conditions is more important than ever.

The MOE has implemented a four stage drought response system that can restrict water use during periods of drought. Table 9.6 describes the four stages of drought response and the corresponding potential water use restrictions to agricultural producers.

Table 9.6 Drought Response System			
Stage	**Goals**	**Actions Effecting Agriculture**	**Target**
1 Normal	Prevent entrance to Dry Stage	Preparedness – planning	Ongoing reductions in community water use
2 Dry	Prevent and prepare for Very Dry	Voluntary conservation – recommend changes in practices (cropping and water use)	Minimum 10% reduction (up to 20%)
3 Very Dry	Prevent and prepare for Extremely Dry	Voluntary conservation and restrictions – possible reduced availability from supply – Province may limit the number of, and impose restrictions on, new licences, regulate storage, or invoke conditions on existing licences	Minimum additional 20% reduction (up to 40%)
4 Extremely Dry	Prevent and prepare for possible loss of supplies, maximum possible reductions for all sectors	Voluntary conservation, restrictions and regulatory response - Province may restrict use by lower priority licensees or those with conditional clauses, may assist communities seeking alternative sources	Maximum reduction
Loss of Supply	Ensure health and safety	Potential loss of a community's potable or fire fighting water supply	Emergency water use only

Implement the following practices in drought conditions:

- minimize water consumption
- develop out-of-channel water storage and collect runoff flows
- increase efficiency of water use by
  - using soil moisture measurements to schedule irrigation
  - checking all water systems for leaks and other avoidable losses
  - checking sprinkler nozzles and replacing worn units
- make use of industry crop specialists for specific water management recommendations that will make the best use of available irrigation water

➔ see Irrigation, page 9-18

📖 **Irrigation Tips to Conserve Water on the Farm**

📖 **Key Drought Management Tips**

http://www.env.gov.bc.ca/wsd/public_safety/drought_info/index.html

Water Quality

If a source of farm water is in danger of being or has been degraded because of off-site impacts, implement the following practices to reduce conflicts:

- if possible, locate the source of contamination and put into place measures to reduce or eliminate the contamination
- if practical, treat the water before use
- contact the MOE to investigate any man-made sources of pollution and have the pollution stopped
- change irrigation practices to compensate for poor water quality by, for example, over irrigating to leach out accumulated salts

Water Conflict Contingency Plan

Develop a contingency plan to provide a timely and effective response to any emergencies involving the farm operation, such as obtaining pre-approval from agencies to do changes in or about a stream to protect farmland during flooding emergencies. ➔ see Changes In and About a Stream, page 7-16

📖 **Contingency Plan – Template for On-Farm Planning**