CHAPER 9 METRIC CONVERSIONS

Metric	Imperial Equivalent
2.54 mm	1/10 inch
25 mm	1 inch
50 mm	2 inch
30 cm	12 inch
0.3 m	12 inch
15 m	50 feet
30 m	100 feet
30.5 m	100 feet
60 m	200 feet
100 ml	3.3 oz (US liquid)
1 mg/litre	1 ppm
10 mg/litre	10 ppm
100 mg/litre	100 ppm
1 ha	2.47acre

Conversions in this table are rounded to a convenient number.
See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions

Leachate Capture in Soil 9-50

CHAPTER 9 TABLE OF CONTENTS

CHAPTER 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

A valuable resource for farmers is www.waterbucket.ca, managed by the Partnership for Water Sustainability in BC (PWSBC). There is an "Agriculture and Water" section of the website where resources include the irrigation calculators, and the Agriculture Water Demand Model (AWDM), and other information.

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. Wood residue leachate, by virtue of its acidity, can increase the rate of metal release from soils as well.

Nitrate (NO_3^-). The organic and ammonium nitrogen in manure or fertilizer eventually converts to the nitrate (NO_3^-) form of nitrogen in soil. Because nitrate does not attach to soil particles as ammonium tends to do, nitrate is moved easily by water that moves through soil.

Nitrates in groundwater 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 Canadian Drinking Water Guidelines is:

- 45 mg/litre as nitrate (10 mg/litre as nitrate nitrogen) for human consumption:

Blue-green Algae (Cyanobacteria) Blooms

Canadian Drinking Water Guidelines

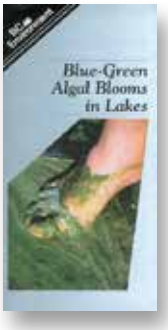
British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report

British Columbia Approved Water Quality Guidelines

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

- 100 mg/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 Agricultural Water Uses:



Phosphorus. Elevated phosphorus levels in watercourses can be caused by manure or fertilizer entering a watercourse directly, by contaminated runoff flowing from fertilized fields, or by nutrient-rich soil being eroded from croplands. 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. The most common effects of eutrophication in surface waters are harmful algal blooms which result in depleted oxygen levels. Blue-green algae (cyanobacteria) in sufficient quantities is toxic to livestock. Phosphorus may be dissolved or suspended as solids (particulates) in water.

Blue-Green Algal Blooms in Lakes

Pathogens. Many organic wastes, including manures, contain microorganisms, such as, bacteria (e.g., fecal coliform, E. coli), 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 groundwater. 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 groundwater. 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. Both may 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, wood residue 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. Ultraviolet disinfection of turbid wash water is less effective than disinfection by chlorination. Food safety may be compromised as a result.

Wood Residue Leachate. Wood residue (e.g., sawdust, shavings, chips, bark) can cause negative impacts on surface and groundwater. Exposure to water, air and microorganisms will cause wood residue 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.

Wood residue 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 wood residue leachate will also reduce light transmission and thereby reduce photosynthesis. In addition, wood residue leachate is acidic, facilitating the unwanted movement of metals and nutrients out of the soil and into receiving waters (refer to Oxygen Demand below).

➔ see Wood Residue, **page 2-40**

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 groundwater or subsurface drains.

Overland Flow. 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. 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.

Wells. The direct entry of overland flow into groundwater 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 may result in a water shortage 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 required intakes to be screened to protect fish. The screens are designed with various opening sizes to reduce the velocity of water flow in order to prevent fish entry and fish loss from being drawn against the screen.

Surface water withdrawals required intakes to be screened to protect fish. The screens are designed with various opening sizes to reduce the velocity of water flow in order to prevent fish entry and fish loss from being drawn against the screen. With increased frequency and severity of drought events, conserving and limiting water use will take on added importance.

This “licensing” sentence doesn’t need to be in its own paragraph. Bring this sentence up, so it is the last sentence of the previous paragraph.

WATER SUPPLY

WATER SUPPLY ENVIRONMENTAL CONCERNS

Primary environmental concerns related to water supply systems are:

Water Quantity

- Groundwater withdrawals that result in:
  - Lowering of the water table.
  - Reduced groundwater input to surface water.
- Surface water withdrawals causing low stream flows and velocities that result in impacts to fish and other aquatic species.
- Surface water or groundwater withdrawals that do not factor in the potential for extended drought events, resulting in less resilience to adapt to changing climate.

Water Quality

- Cross connection of water supply lines to lines carrying contaminants that results in pollution of water supply.
- Poor well construction (e.g., lack of sealing), location (e.g., down gradient from contaminate source) or well abandonment, that results in groundwater 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**
➔ see Impacts to Biodiversity and Habitat, **page 7-7**, 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.**

BC Building Code

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

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.
  - Is within limits on chemical and physical parameters (such as nitrates and heavy metals).

Guidelines for Canadian Drinking Water Quality

Environmental Management Act

The *Code of Practice for Agricultural Environmental Management* requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health.

- The *Code of Practice of Agricultural Environmental Management* has requirements regarding access to watercourses by livestock or poultry:
- SECTION 64 (1): A person responsible for a grazing area, seasonal feeding area or temporary holding area in which livestock or poultry have direct access to a water course must ensure that effective controls are in place to minimize:

  (a) Trampling and erosion of soil into the water course, and

  (b) Contaminated runoff, leachate, and solids entering the watercourse.

Riparian Areas Protection Act

The Riparian Areas Protection Act creates the authority for government to enact Provincial directives to protect areas that border streams, lakes, and wetlands.

With this Act, and through the *Riparian Areas Regulation* (RAR), local governments in certain regions of the Province are able to protect riparian areas during residential, commercial, and industrial development by ensuring that a Qualified Environmental Professional (QEP) conducts a science-based assessment of proposed activities. This includes residential buildings on land zoned for agricultural purposes. SECTION 12 provides Provincial directives on streamside protection.

The RAR only applies to the residential portion of the farm and only in the southern half of BC. The RAR does not apply to *farm practices* as defined in the *Farm Practices Protection Act* (FPPA). In some cases, this can lead to the misunderstanding that the RAR does not apply to lands zoned for agriculture, or in the Agricultural Land Reserve (ALR). The RAR does apply to these lands for activities that are not *farm practices*, for example residential construction. It is important to note that local governments have the ability to establish bylaws that apply to agricultural lands, and some have implemented setbacks for agricultural buildings that complement the setbacks designated under RAR.

Public Health Act

Administered by the Ministry of Health, this Act has a specific prohibition that "a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard". This prohibition would apply to farm practices that may result in a health hazard, such as when nutrients, contaminants or pathogens are discharged to land, water or air that pose a public health problem. Any situation that entails a health hazard will enable health officers to investigate using their powers under the Act. Under the *Public Health Act*, the local Health Authority must investigate any health hazard and has authority to order that a person prevent or stop a health hazard, or mitigate the harm or prevent further harm from a health hazard amongst other powers. Similar regulatory provisions exist for addressing health hazards to drinking water supplies under the *Drinking Water Protection Act*.

This Act has conditions under the *Health Hazards Regulation*:

- SECTION 8(1): provides separation distance of wells to be at least 30 m from any probable source of contamination.

Water Sustainability Act

Water Sustainability Act (WSA) is the principal law for managing the diversion and use of water in British Columbia. The WSA establishes that all water in streams (surface water) and aquifers (groundwater) in British Columbia is owned by the Crown on behalf of the residents of the Province. Surface water is very broadly defined as water in any above ground natural water body or watercourse, including springs, glaciers, lakes, ponds, rivers, creeks, and wetlands. Groundwater is defined as any water that is found naturally beneath the surface of the earth.

Under the WSA, no person may divert water from a stream or from aquifer unless the person holds an authorization or the diversion and use of water is allowed by the Act or under a regulation. An authorization can take the form of a "use approval", which allows for short term use of water for up to 24 months, or a water licence which establishes a long term water right. Authorization holders have some responsibilities including the need to pay water fees and rentals and make beneficial use of the water they are authorized to divert, store and use.

Other key aspects of the WSA include:

- Managing water during scarcity, which involves the regulation of diversion of water use to manage periods when there is insufficient water to meet licensed demand or if a fish population is threatened.
- Changes in and about streams: There are two processes that allow a change to be made in and about a stream. A "Change Approval" is a written authorization to make changes in and about a stream and normally involve a more significant or larger change. A "Notification" is for low risk changes that have minimal impact on the environment or third parties.

The following SECTIONS of the WSA may be of interest to agricultural operators in particular:

- SECTION 6: Prohibits diverting water without a licence except in limited circumstances for fire suppression, domestic use and mineral prospecting.
- SECTION 11: Requires approvals for making changes in and about streams.
- Sections 16 & 17: May require mitigation measures on (sensitive) streams where a water diversion or use is authorized.
- SECTION 45: No new dams on protected rivers.
- SECTION 86: Declarations of significant water shortage.
- SECTION 87: Critical environmental flow protection orders.
- SECTION 88: Fish population protection orders.
- SECTION 128: Regulations respecting sensitive streams.

In the case of low or impending low streamflow, temporary protection orders (Sections 86, 87, 88) may be used. These orders are used for the purposes of protecting environmental flow thesholds or fish populations.

The right to divert and use surface water or groundwater is authorized by a licence or approval. Licences and approvals are granted in accordance with the statutory requirements of the *Water Sustainability Act*.

If you use surface water for any purpose including domestic, or groundwater for any non-domestic purpose, a water licence is required under the *Water Sustainability Act*. The requirement for groundwater licensing came into force on February 29, 2016 which applies to new groundwater users as well as existing groundwater users who began using groundwater prior to February 29, 2016. A water licence may be applied for from FrontCounter BC in person or online. Approval is also required for any work in or about a stream.

Apply for a Water Licence

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

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *2019 Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:

(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;

(b) The conservation and protection of fish or fish habitat; and

(c) The prevention of pollution.

SECTION 34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable.

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

Migratory Birds Convention Act

Under this Act, the federal government is responsible for implementing a Convention between Canada and the U.S. for the protection of migratory birds and nests. The Canadian Wildlife Service of Environment Canada administers the regulations.

Under the Regulations:

- SECTION 6: no person shall: disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird without permit;
- SECTION 24(1): any person may, without a permit, use equipment, other than an aircraft or firearms, to scare migratory birds that are causing, or are likely to cause damage to crops or other property (other control measures require a permit);
- SECTION 35(1): prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any area 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* (SARA) (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.

On private land, unless an order is made by the government, the SARA prohibitions apply only to:

- Aquatic species at risk; and
- Migratory birds listed in the *Migratory Birds Convention Act*, 1994 and also listed as endangered, threatened or extirpated in Schedule 1 of the Act.

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.

Licensing of Water

As per the *Water Sustainability Act*, the use of surface water and groundwater requires a water licence. Application for a licence can be made online at FrontCounter BC (FCBC) or at a FCBC office. Domestic groundwater users (use in one's own home) do not require a licence. Water licences can set terms and conditions, such as, the purpose of use, the quantity of water, the amount of storage (if any), the time period during which it can diverted, and the location of withdrawal and use.

Water Licences and Approvals

Rights and Obligation of a Water Authorization Holder

Water Licensing & Rights

Water Withdrawal Rates. Some water licences have a peak water diversion (withdrawal) rate (e.g., a maximum pumping rate in gallons per minute). For irrigation purposes, this rate is often calculated based on the availability of water in the water source and/or proper irrigation methods. When diverting water, implement the following practices:

- If the licensed withdrawal rate is specified, check that the rate being used does not exceed this amount (*Water Sustainability 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) or established by Irrigation/Improvement Districts or purveyors.
- For either of the above , see Irrigation Water Use Checks, page 9-24, or check with the BC Agriculture Water Calculator.

  BC Agriculture Water Calculator
- Follow fish clauses listed on the licence, if present (*Water Sustainability Act*).
- Reduce water withdrawal if fish may be negatively impacted (*Fisheries Act*).

Annual Water Use. The actual annual water use must not exceed the annual water volume permitted in the water licence. For a more efficient and interactive way to determine the actual water use, please refer to the online tool called the B.C. Irrigation Water Use Calculator.

➔ see Irrigation Water Use Checks, **page 9-30**

BC Irrigation Water Use Calculator

Irrigated Area. In addition to a maximum annual water withdrawal volume, a water licence also specifies a maximum irrigated area that irrigation water is permitted to be applied on.

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 only with snowmelt or runoff water. However, it is uncommon for a dugout to contain only snowmelt and runoff and in most cases some of the water in the dugout will be either surface water or groundwater, which will require a water licence to use or store. If the dugout stores water coming from a watercourse or groundwater, a storage purpose must be identified on the water licence. The maximum storage amount and timing of filling and use of water from storage will generally be defined on the water licence.

- Factsheet 510.100-1 Farm Water Storage
- BC Farm Practices and Climate Change Adaptation: Water Storage
- Cowichan Agricultural Water Storage and Management Knowledge Transfer Project

Rainwater Collection and Storage. A water licence is not required to collect or harvest rainwater from the roof of a building. Rainwater harvesting systems have gained popularity in commodities with large rooftop structures, e.g., greenhouse, nursery, poultry, swine and dairy. These large structures allow rainwater harvesting systems to be economically viable for smaller water uses, such as, stock water, wash water, and supplemental irrigation during peak season. Keep in mind that at least 10% of the operation land base will be required for building a pond/dugout to store the captured rainwater. Whether it is cost effective to specific regions will depend on the amount of rainfall in the regions, (e.g., Vancouver Island and Lower Mainland that receive at least three times as much rainfall as in the Interior may have a shorter payback period of investment). Many greenhouses and nurseries already have rainwater harvesting systems.

While there has been a shortage of water supply across various drier/driest regions in the Province, rainwater harvesting could alleviate the situation to some degree when implemented properly. An economic analysis of a specific water storage system on a specific farm should be conducted to determine the return of investment, and to evaluate if this specific commodity and its operational size have the best chance of beneficial management of our water resources.

Measuring and Reporting. Water licences can also include conditions that require the licence holder to measure and report water use. *The Water Sustainability Act* also includes provisions that would enable government to create a regulation that sets measuring and reporting requirements, although there is as yet no such regulation requiring this as a general rule in BC (2018).

The Ministry of Agriculture, Food and Fisheries worked with the Okanagan Basin Water Board (OBWB) has developed a pilot online tool called the BC Water User Reporting Centre (BCWURC) to allow municipalities to report and track their water use. The tool includes many different ways to measure water use, such as, from the records of a water meter, pumping rate, or operating hours of an irrigation system. The Ministry of Agriculture, Food and Fisheries also collaborated with the Partnership for Water Sustainability in BC (PWSBC) to use the BCWURC as the basis, and develop an online tool called the BC Irrigation Water Use Calculator for farmers to determine their actual annual water use.

Beneficial Use: As a general condition the *Water Sustainability Act* requires that the water licence holders make beneficial use of water that they are authorized to use in a licence.

- BC Agriculture Water Calculator
- BC Irrigation Water Use Calculator

Water Volume Requirement

Farm Requirements. Whether farm water originates from surface water, groundwater 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 rate per animal and annual volume.
  - Factsheet 590.301-1 Livestock Watering Requirements – Quantity and Quality
- For irrigation purposes, volume requirements given as peak flow rate and annual volume.
  ➔ see Irrigation Water Use Checks, **page 9-30** or BC Agriculture Water Calculator
  - BC Agriculture Water Calculator

It is in the best interest of a farm to use only the proper volume of water as needed daily to ensure the water source has sufficient water supply to meet the annual water requirement. Where possible, implement the following practices:

- Use the BC Irrigation Water Use Calculator to determine the actual annual water use for a farm

  BC Irrigation Water Use Calculator
- Install water meters to better monitor and measure the volume of water used for operations that have multiple irrigation systems and cropping, e.g., nurseries, where measuring usage is particularly challenging (note that metering is generally not economically feasible or practical for most farms in BC.)
- Collect, store, and use non-contaminated water wherever feasible.
- Conserve water use, allowing other users access to water.
- Conserve existing water source to reduce the cost of developing new sources:
  - Reduced water use to minimize the requirement for additional water storage or water delivery.
  - Improve water use efficiency by using (or converting old irrigation systems to) more efficient irrigation systems since irrigation typically provides for the greatest opportunities for water conservation on most farms.

  Factsheet 500.310.1 Irrigation Tips to Conserve Water on the Farm
- Schedule irrigation to ensure irrigation water is applied at the proper rate, duration, and frequency based on crop type, soil type and weather condition.

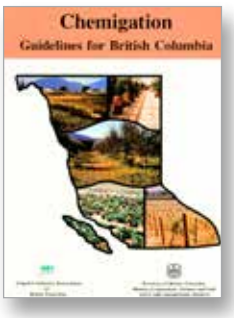
  Farmwest Weather Station Network

  Agricultural Irrigation Scheduling Calculator

Fertigation

Fertigation or chemigation is the introduction of chemicals into an irrigation system that presents a potential hazard to public health. The irrigation system acts as a cross-connection between the chemical solution tank and the water source.

see Chemigation Guidelines for British Columbia



Groundwater Use. Withdrawal of groundwater at rates faster than it can be recharged will lower the water table, and may impact levels and flows in adjacent watercourses that are hydraulically connected to the aquifer. If the withdraw rates are substantially lower than normal during times of the year when water demand is highest, it is an indication that the recharge rate is not fast enough to meet the withdrawal rate resulting in a lowered water table. Water conservation strategies as described above should be explored to manage usage; otherwise, it may be necessary to deepen the well to maintain flows or to acquire additional water sources to meet the annual volume requirement.

To reduce the overuse of groundwater, 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.

Water Supply. When water supply is diminished in the late summer, agriculture still needs water to grow a productive crop and raised a productive herd. Storage can provide the water when natural stream flows can no longer meet the water demand. Storage can also provide benefits to fisheries and improve stream health by increasing baseflow.

Farms often need storage facilities to supply farmstead water or to back up water licences from streams and rivers for irrigation, livestock, crop washing, frost protection, crop cooling, flushing, processing, and other on-farm uses. Storages can be in the form of small dugouts or reservoirs that are impounded behind licensed dams.

Improving rainwater management is a tool that is becoming more widely adopted in regions of Europe and North America. The Water Balance Model (WBM) is fully operational across Canada, and can be used to assess anthropogenic developments to determine if an appropriate amount of rainwater is captured and infiltrated to ground, replenishing baseflows in stream and increasing storage in aquifers.

- Water Balance Model

Water Storage. Design and maintain water storage structures to prevent excessive evaporation and leakage. Minimizing the exposed surface area of water storage is important in dry, warm areas. Follow dam safety protocols for monitoring and maintaining water storage structures and prevent catastrophic water release.

For more information on water conservation and safety for stored water visit:

- Water Storage: Dams
- *Dam Safety Regulation*
- Dam Safety Pocketbook
- Dam Safety Technical Resources
- BC Farm Practices & Climate Change Adaptation – Water Storage
- Dam Safety Management Binder

Linking Drainage and Water Supply. If feasible, link drainage or stormwater capture infrastructure (detention ponds, ditching, roof water collection) to supplement farm water supply needs (supplemental irrigation, stock water), to make beneficial use of precipitation that exceeds the immediate needs of farm operations.

Drought. With climate change, hot, dry summers will continue to become more frequent and more intense across British Columbia. Drought can result in shortage of 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.

- Drought in Agriculture BC
- Dealing with Drought: A Handbook for Water Suppliers in British Columbia
- BC Provincial Drought Portal
- Cowichan Agriculture Extreme Weather Event Preparedness & Mitigation Pilot Project

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 9-37**

Overland Water Flow. Consider how climate change and landscape changes at higher elevations in your watershed may increase the freqency and severity of overland flow. Protect the water supply from overland flow of contaminated water.

➔ see Runoff Flow Management, **page 9-53**

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

➔ see Runoff Flow Management, **page 9-53**

➔ see Leachate, **page 9-57**

Springs. Springs are groundwater that becomes a "stream" (surface water) if the water flows to the surface of the ground without any pumping. They are defined as "streams" under the *Water Sustainability 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 7-17**

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.

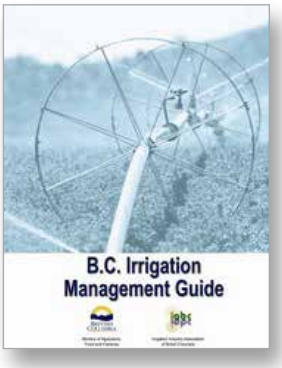
Changes In and About a Stream. When planning any work in or near a "stream", which includes nearly all surface watercourses, contact the FrontCounter BC to ensure that it does not harmfully alter fish habitat or cause a deleterious substance to enter water.

➔ see Changes In and About a Stream, **page 7-17**

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.

- Chemigation Guidelines for British Columbia
- Factsheet 590.301-4 Enhancing Livestock Water Quality
- Factsheet 512.000-2 Treatment of Greenhouse Recirculation Water – Biosand Filtration
- BC Irrigation Management Guide – Chapter 2 Environmental Concerns of Irrigation Water Supply
- Ontario Factsheet 200/560 Improving On-Farm Food Safety Through Good Irrigation Practices



Wells and Groundwater Protection

Groundwater contamination is particularly difficult and very costly to clean up, and therefore should be avoided. Environmental concerns related to wells are associated with contaminants entering groundwater either because of improper well construction or abandoned wells. Annual test should be conducted to ensure groundwater is potable and nitrate levels are acceptable and not increasing above background levels. Possible additional concerns revolve around groundwater withdrawal rates that could decrease flow of connected watercourses.

Well Construction. Licensing is required for all new and existing non-domestic wells under the *Water Sustainability Act.*

- Water Sustainability Act Overview

There are also requirements that wells be constructed by Qualified Well Drillers and pumps installed by Qualified Pump Installers that are registered with the Province.

- Register of Qualified Well Drillers
- Register of Qualified Pump Installers in the Province of BC
- Information regarding groundwater licensing is available through FrontCounter BC
- New Requirements for Groundwater Users
- Information for Water Well Drillers & Well Pump Installers
- Brochure - Information for Well Drillers and Well Pump Installers

Approval is not required to construct a well or to conduct a test for water quality or quantity. However, prior to making regular use of the water, a licence is required.

Wells must be constructed in a manner that meets the standards set out in the *Groundwater Protection Regulation*, and in particular must be located and constructed in a manner to prevent seepage of contaminated runoff and shallow groundwater. Water in all wells should be sampled and the necessary field and laboratory tests conducted to determine whether the groundwater chemical and bacteriological quality of the well is suitable for its intended use.

Once groundwater quantity and quality has been confirmed and a licence has been obtained, locate and construct wells to prevent seepage of both contaminated runoff and shallow groundwater. Water in all wells should be sampled and the necessary field and laboratory tests made to determine the groundwater chemical and bacteriological quality of the well and its suitability for drinking water. The following parameters should be analyzed: total alkalinity, calcium, total hardness, total iron, magnesium, fluoride, nitrate, nitrite, pH, dissolved solids, electrical conductivity, turbidity and total coliforms.

Implement the following practices:

- Construct new wells as required by the *Groundwater 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 m from storage and preparation areas for fertilizer, pesticides, petroleum products, manure, silage, etc (*Health Hazards Regulation*).
- 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.

Groundwater Protection Regulation, Water Sustainability Act

Deactivation of Wells Not in Use. As per the *Groundwater Protection Regulation,* wells that are not in use must be deactivated by taking the well pump out of operation by shutting off the power supply to the well pump, or removing or disconnecting a manual pump handle.

Decommissioned and Abandoned Wells. A well that is not in use for more than 5 years must be decommissioned in accordance with *Groundwater Protection Regulation* requirements. Groundwater 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. A Qualified Well Driller can advise on requirements for decommissioning a well.

Wells Near Watercourses. Of particular concern are wells located near watercourses where water levels are sensitive to water withdrawal rates. A water licence for a well in such circumstances will likely include conditions governing pumping flows and timing of pumping.

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..

- Canadian Drinking Water Guidelines
- Cryptosporidium Infection
- Giardiasis ("Beaver Fever")
- How to Disinfect Drinking Water
- Water-borne Diseases in BC

Livestock Watering

To reduce possible impacts to water quality from livestock or poultry manure, various systems are available that supply livestock water away from sensitive watercourse areas. A watering system is required where direct access to watercourses is not allowed, 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**):

- Use a watering system that reduces livestock impacts on watercourses.
- Meet intake regulations.

➔ see Changes In and About a Stream, **page 7-17**

- Meet water intake fish screen requirements.

➔ see Water Intakes, **page 9-19**

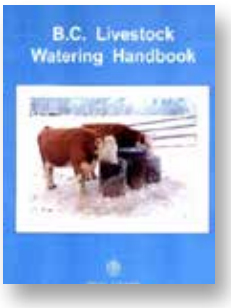
- Locate intakes on gravity-fed systems at as high an elevation as practicable to avoid impacts from low water levels during drought.
- Locate troughs 30 m or more (suggested) from a watercourse.
- Install troughs on a firm base such as concrete, wood, compacted soil or soil and gravel.
- Install water 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.
  - Minimize the exposed surface area of water troughs to slow the rate of evaporative losses.
- 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.
- If natural or constructed ponds are used as part of a stock water system, consider the risks of climate change to water level fluctuations, and evaluate the pond hydrology before modifying the pond shape or depth.

Climate Change Impact Risk Assessment Tool for Ponds Used as Livestock Water Sources

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

Livestock Surface Water Assessment and Options

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.

Factsheet 590.302-1 Watering Livestock Directly from Watercourses

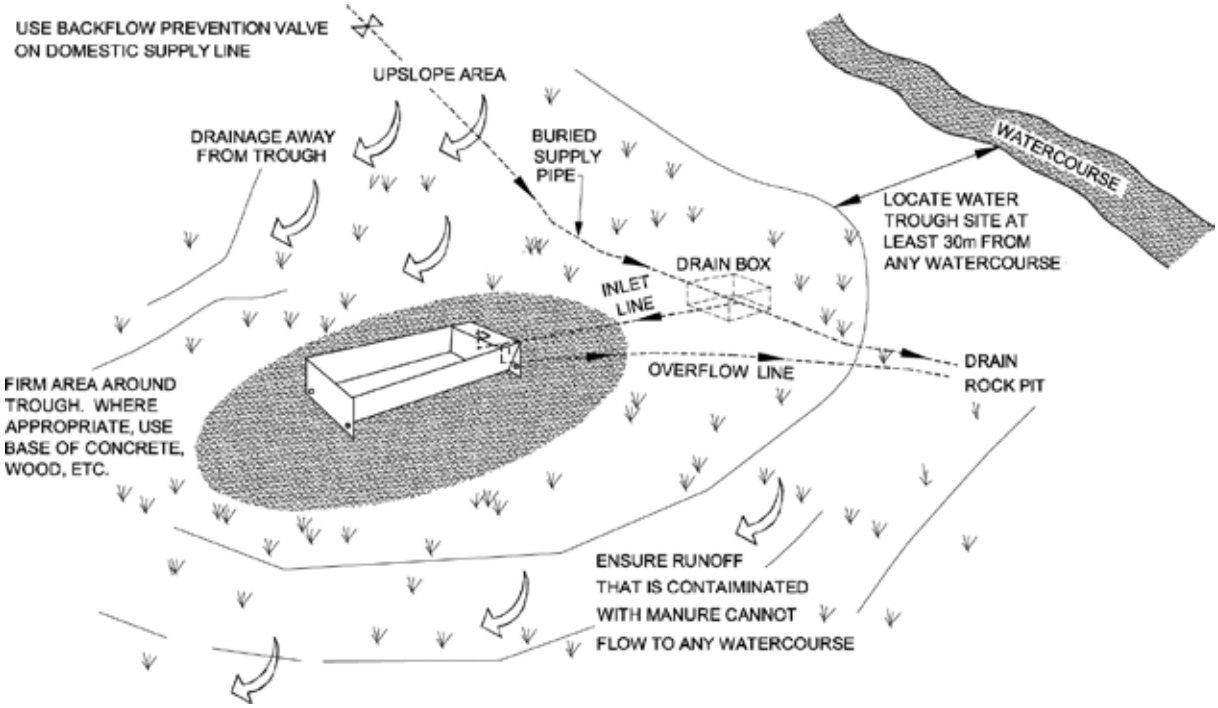


FIGURE 9.1 An Outdoor Livestock Water Trough Installation

Implement the following practices for livestock access to watercourses:

- Do not reduce riparian function.

  ➔ see Riparian Areas, **page 11-15**

- 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 7-17**

- Place salt, minerals or supplemental feeds away from riparian areas to encourage animals to be 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, especially 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** (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.

Ontario Factsheet 400/751 Livestock Access to Watercourses

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** illustrates a managed watercourse access.

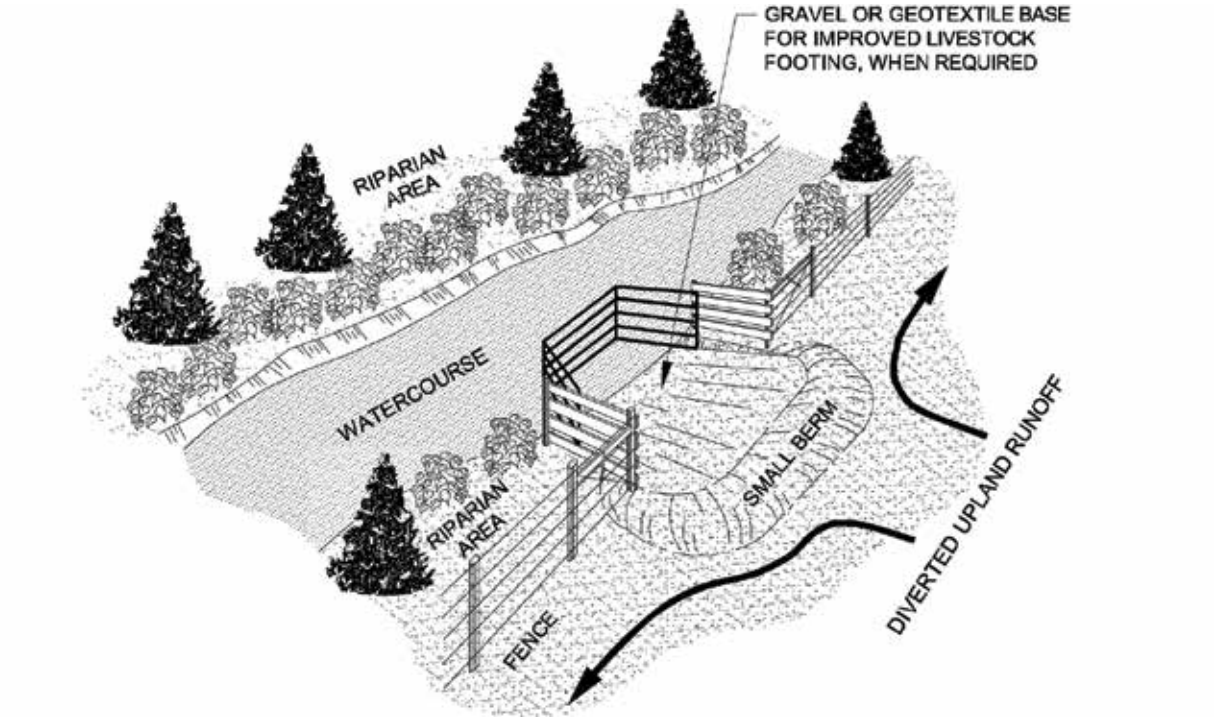


FIGURE 9.2 A Managed Access to a Watercourse for Livestock

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.

- Factsheet 590.302-2 Improved Livestock Access to Water Using Geosynthetics and Gravel
- Factsheet 590.302-3 Offstream Watering to Reduce Livestock Use of Watercourses and Riparian Areas
- Riparian Grazing and Off-Stream Livestock Watering

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 9-20.**
- Use screen mesh sizes with clear openings that do not exceed 2.54 mm (1/10 inch).
- Use screen mesh with open areas that are not less than 50% of the total screen area, **Table 9.1.**
  - 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 7-17**

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 FrontCounter BC (FCBC) or Fisheries and Oceans Canada.

➔ see Changes In and About a Stream, **page 7-17**

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 (1/10 inch)

WORKSHEET #6
Screen Area Check for Fishery Requirements of Water Intakes

Workbook Question 314

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

Information:

Irrigation system flow rate, from Box 9 on Worksheet #7 or #8	963	1	US gpm
Screen mesh size used	8x8	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: Required Screen Surface Area

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

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

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

Method 1: Flat screen

EQUATION: Flat Surface Area Total

No. of flat Screen Surface		Length		Width		Flat Surface Area Total	
4 (5)	x	5 (6) ft	x	2 (7) ft	=	40 (8)	ft²

EQUATION: End Surface Area

Length		Width		End Surface Area	
(9) ft	x	(10) ft	=	0 (11)	ft²

Total Area (8 + 11) = 40 (12) ft²

Method 2: Cylindrical screen

EQUATION: Cylindrical Surface Area

3.14		diameter		length		Cylindrical Surface Area	
3.14	x	(13)	x	(14) ft	=	0 (15)	ft²

EQUATION: Circular End Area

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

$$\frac{3.14 \times (13)^2}{4} = (16)\ \text{ft}^2$$

Total Area (15 + 16) = 0 (17)

Answer:

Step 3

is 35.8 (4) sq. feet

less than 40.0 (12 or 17) sq. feet ?

No **screen area is too small** or YES **screen area is OK**

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

SAMPLE

IRRIGATION

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 groundwater or surface water.
  - Overland flow leading to soil erosion.
- Ability to maintain operations during a drought without impacting critical environmental flows.
- Adapting to climate change.
- Chemigation products or other additives that results in water or soil pollution.

For information on these concerns:

➔ see Soil Quality Factors, **page 8-1**, and refer to Contaminants, and to Salts

➔ see Water Quality and Quantity factors, **page 9-1**, 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.

Environment Management Act

The Code of Practice for Agricultural Environmental Management requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricutural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health.

The Code of Practice of Agricultural Environmental Management under the Act has a requirement for irrigation:

SECTION 26: A person who irrigates on land in a vulnerable aquifer recharge area must ensure that the quantity and timing of irrigation does not exceed crop needs.

Vulnerable aquifer recharge areas are described in Schedule B of the *The Code of Practice of Agricultural Environmental Management*. These areas are also described in the interactive High Risk Areas map.

Map of BC High Risk Areas

Water Sustainability Act

Water Sustainability Act (WSA) is the principal law for managing the diversion and use of water in British Columbia. The WSA establishes that all water in *streams (surface water)* and aquifers (*groundwater)* in British Columbia is owned by the Crown on behalf of the residents of the Province.

Surface water is very broadly defined as water in any above ground natural water body, including springs, glaciers, lakes, ponds, rivers, creeks, and wetlands. Groundwater is defined as any water that is found naturally beneath the surface of the earth.

Under the WSA, no person may divert water from a stream or from aquifer unless the person holds an authorization or the diversion and use of water is allowed by the Act or under a regulation. An authorization can take the form of a "use approval", which allows for short term use of water for up to 24 months, or a water licence which establishes a long term water right. Authorization holders have some responsibilities including the need to pay water fees and rentals and make beneficial use of the water they are authorized to divert, store and use.

Other key aspects of the WSA include:

- Managing water during scarcity, which involves the regulation of diversion of water use to manage periods when there is insufficient water to meet licensed demand or if a fish population is threatened.
- Changes in and about streams: There are two processes that allow a change to be made in and about a stream. A "Change Approval" is a written authorization to make changes in and about a stream and normally involve a more significant or larger change. A "Notification" is for low risk changes that have minimal impact on the environment or third parties.

The following SECTIONS of the WSA may be of interest to agricultural operators in particular:

- SECTION 6: Prohibits diverting water without a licence except in limited circumstances for fire suppression, domestic use and mineral prospecting.
- SECTION 11: Requires approvals for making changes in and about streams.
- SECTIONS 16 & 17: May require mitigation measures on (sensitive) streams where a water diversion or use is authorized.
- SECTION 45: No new dams on protected rivers.
- SECTION 86: Declarations of significant water shortage.
- SECTION 87: Critical environmental flow protection orders.
- SECTION 88: Fish population protection orders.
- SECTION 128: Regulations respecting sensitive streams.

In the case of low or impending low streamflow, temporary protection orders (SECTIONS 86, 87, 88) may be used. These orders are are used for the purposes of protecting environmental flow thesholds or fish populations.

The right to divert and use surface water or groundwater is authorized by a licence or approval. Licences and approvals are granted in accordance with the statutory requirements of the *Water Sustainability Act*.

If you use surface water for any purpose including domestic, or groundwater for any non-domestic purpose, a water licence is required under the *Water Sustainability Act*. The requirement for groundwater licensing came into force on February 29, 2016 which applies to new groundwater users as well as existing groundwater users who began using groundwater prior to February 29, 2016. A water licence may be applied for from FrontCounter BC in person or online. Approval is also required for any work in or about a stream.

Apply for a Water Licence

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

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, including by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *2019 Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:
(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;
(b) The conservation and protection of fish or fish habitat; and
(c) The prevention of pollution.

SECTION 34.4 (1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable.

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

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* (SARA) (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.

On private land, unless an order is made by the government, the SARA prohibitions apply only to:

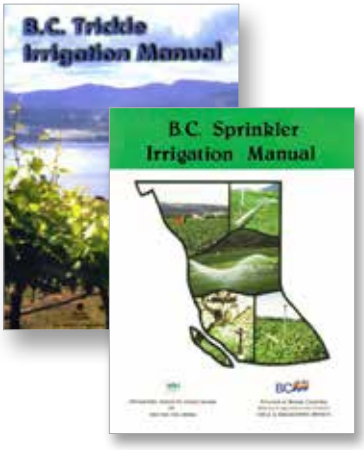
- Aquatic species at risk; and
- Migratory birds listed in the *Migratory Birds Convention Act*, 1994 and also listed as endangered, threatened or extirpated in Schedule 1 of the Act.

IRRIGATION BENEFICIAL MANAGEMENT PRACTICES

Comply with applicable irrigation-related legislation, including the above. Where appropriate, use the following beneficial management practices to protect the environment. It is particularly important to avoid over-irrigation that leaches nutrients down towards vulnerable aquifers, yet realizing it is important in all agricultural areas to irrigate efficiently.

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

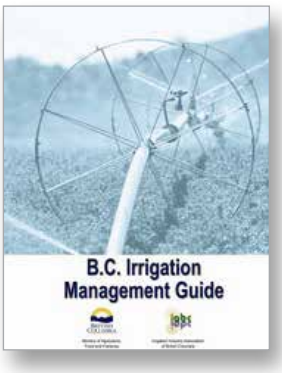


Good irrigation practices combine proper irrigation system design, system operation and maintenance and irrigation scheduling. Soil characteristics determine how an irrigation system should be designed and operated:

- 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 groundwater 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).
  - A sealed soil surface discourages infiltration and promotes ponding and runoff flow causing erosion.
  - Allow soil to dry out between irrigations letting surface cracks to appear which may improve infiltration.
- 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.
  - Irrigation system may need to be designed with a leaching factor to remove salt build up.

Factsheet 619.000-1 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 BC Irrigation Management Guide Chapter 2 - Page 9

➔ see Soil Contamination, **page 8-18**

Table 9.2 below provides threshold values for irrigation water quality tests. For pathogens, E. Coli and fecal coliforms are measured in colony forming units (cfu). If these values are exceeded, the water should be further investigated and treated appropriately; otherwise, the water should not be 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 improve water quality, producers 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 at:

Irrigation Industry Association of British Columbia (IIABC)

B.C. Sprinkler Irrigation Manual, Chapter 11

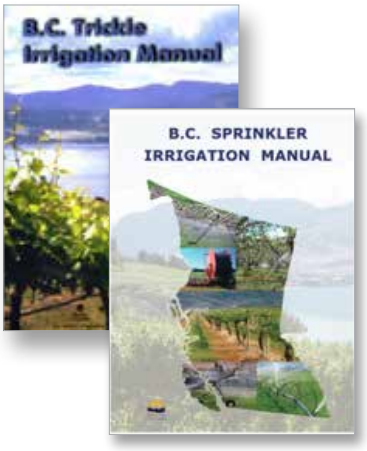
B.C. Trickle Irrigation Manual, Chapter 12

B.C. Irrigation Management Guide, Chapter 2 Environmental Concerns of Irrigation Water Supply

TABLE 9.2	Irrigation Water Quality Guidelines[1]		
Threshold Values to Protect Soil [2]			
Salts	sodium adsorption ratio (SAR) less than 13 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 1,000	less than 1,000

[1] If these values are exceeded, the water should be further investigated and treated appropriately; otherwise, the water should not be used.
[2] from the Water Encyclopedia 2nd ed. Van der Leeden, Fritz et al. 1990, Lewis Publishers. Chelsea Michigan, USA.
[3] from BC ENV
[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 selecting 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 9-27**

- Apply water using scheduling techniques.

➔ see Irrigation Water Scheduling, **page 9-29**

- 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. If managed properly, trickle irrigation systems can be the most water use efficient systems for certain crops with appropriate soil conditions and water quality. In the BC Trickle Irrigation Manual, trickle refers to frequent, low pressure application of water to crops, including tape, drip emitters and spray emitter systems.

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

Gun. 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 Pivot. These systems are automated and travel in a circle or part circle around a field. Those with higher efficiencies use pressure regulated rotator heads on drop tubes that hang just above the crops.

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 water or groundwater.

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. If managed properly, subirrigation systems can irrigate efficiently. If the drainage system is controlled and closed, nutrients that may have leached into the drainage water can be recycled. These systems are not appropriate for crop cooling or chemigation.

- B.C. Agricultural Drainage Manual Chapter 11: Controlled Drainage/Subirrigation
- Drainage and Sub-Irrigation as a Climate Change Adaptation Strategy
- Climate & Agriculture Initiative BC – Irrigation Resources

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 correctly designed will be nearly impossible to manage properly. Manage excess water to avoid the following consequences:

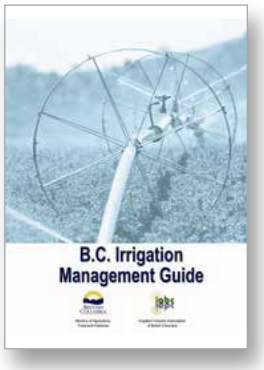
- Erosion – adjust system or rate of application to reduce overland flow.
- Transport of nutrients via leaching out of the root zone and into the groundwater – this is expensive and can cause pollution.
- Transport of nutrients into runoff flow.
- Insufficient water may allow salts to build up in the 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 9-30**

- Have secondary containment for fuel tanks on petroleum powered pumps near watercourses.

- Irrigation Industry Association of British Columbia (IIABC)
- B.C. Sprinkler Irrigation Manual, Chapter 5
- B.C. Trickle Irrigation Manual, Chapter 5 and 7
- Climate & Agriculture Initiative BC – Irrigation Resources

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 gives efficiencies of commonly used systems. When considering irrigation system efficiency, implement the following practices:

- 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, converting an undertree solid set sprinkler system at 75% efficiency to a trickle system at 92% efficiency).

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.
- 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).

 Factsheet 500.310-2 Irrigation Tips to Conserve Water on the Farm

 Climate & Agriculture Initiative BC – Irrigation Resources

TABLE 9.3 Irrigation System Application Efficiency — **Worksheets #9, #10**

Crop Type★	Irrigation System Type		Application Efficiency (%)	
			range	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 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.
- 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 (refer to below).
- Monitor climate information and be aware of the forecast (refer to 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.

Irrigation Industry Association of British Columbia (IIABC)

Agriculture Drip Irrigation Scheduling Calculator Users Guide

Agriculture Sprinkler Irrigation Scheduling Calculator Users Guide

Factsheet 577.100-3 Sprinkler Irrigation Scheduling Using a Water Budget Method

Factsheet 577.100-4 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.

BC Irrigation Management Guide, Chapter 6 and 7 Irrigation System Maintenance

Irrigation Water Use Checks

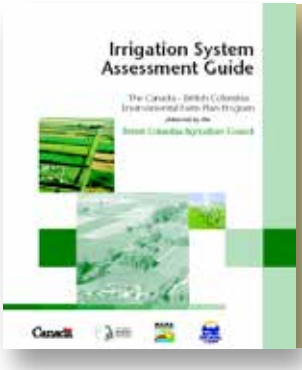
Two water use checks can be done on **existing systems** to determine if the irrigation water use is appropriate. Implement the following practices:

- Do a Peak Flow Rate Check for water withdrawal rate:
  - Explanatory text on **page 9-31,** see **Worksheet #7** for sprinkler systems, **page 9-33.**
  - See **Worksheet #8** for trickle systems, **page 9-34.**
- Do an Annual Water Use Check for total water use:
  - Explanatory text on pages **9-35** to **9-37.**
  - See **Worksheet #9** for sprinkler systems, **page 9-38.**
  - See **Worksheet #10** for trickle systems, **page 9-40.**

  The Ministry of Agriculture, Food and Fisheries collaborated with the Partnership for Water Sustainability in BC (PWSBC) to develop an online tool called the BC Irrigation Water Use Calculator for farmers to determine their actual annual water use by using pump energy consumption, irrigation system operating time, or metered data.

BC Irrigation Water Use Calculator

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**.



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 than 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. Conduct 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

- Conduct 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 the 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 9-33** or **Worksheet #8** (Trickle), **page 9-34**.

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-4**. 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, then divide this volume by the time to determine 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 impeller 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 under the *Water Act* did 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. New water licences under the *Water Sustainability Act* may consider irrigation system type in order to allow a water licence to be approved.
  - An advantage of trickle systems is that they do not need to operate 24 hours a day during peak season as compared with sprinkler systems.

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

STEP 3 Compare the Flow Rates.

The actual peak flow rate cannot exceed the peak flow rate indicated on the water licence. If the licence does not include a peak flow rate, it is recommended that the actual peak flow rate be no greater than the calculated rate.

WORKSHEET #7
System Peak Flow Rate Check - Sprinkler

Workbook Question 321

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

Information:

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 (Table B.2*):	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 = Calculated Peak Flow Rate

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 = Sprinkler System Output Flow Rate

8	7	US gpm	x	105	8	nozzles	=	840	9	US gpm

Answer: Step 3 **Is the calculated peak flow rate or Water Licence peak flow rate greater than the actual sprinkler irrigation system peak flow rate determined in methods 1, 2 or 3**

is	840	maximum of 5, 6 or 9	US gpm
less than	850	2 or 4	

No **flow rate is exceeded** **or** YES **flow rate is ok**

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

SAMPLE

WORKSHEET #8
System Peak Flow Rate Check - Trickle

Workbook Question 321

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

Information:

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 (Table B.2*):	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 = Calculated Peak Flow Rate

6		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 emitters	Number of emitters operating at one time	
	756	8	# of emitters		

EQUATION: Trickle System Output Flow Rate

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

5.7	7	x	756	8	x	0.0167	ft =	72.0	9	US gpm

Answer:

Step 3 **Is the calculated peak flow rate or Water Licence peak flow rate greater than the actual sprinkler irrigation system peak flow rate (methods 1, 2 or 3).**

is	72.0	Maximum of 5, 6 or 9
less than	84	2 or 4

No **Flow rate is exceeded** **or** YES **Flow rate is OK**

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

SAMPLE

Irrigation System Annual Water Use Check

This check compares the annual water use of an existing irrigation system against the licensed amount and against the calculated annual water requirement for the farm location (surface water use, groundwater use or purveyor-supplied water). If the check indicates that the annual water use exceeds the licensed rate or the calculated requirement the system design then the operation of the system needs to be reviewed. Complete the following three steps as given in **Worksheet #9** (Sprinkler), **page 9-38** or **Worksheet #10** (Trickle), **page 9-40.**

If licensed, 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.

Water Licences and Approvals

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

BC Irrigation Management Guide, Chapter 4

STEP 1 Calculated Annual Water Requirement

The calculated annual water requirement is determined by 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 System.** To calculate the sprinkler annual water requirement used, use **Worksheet #9**. This calculation requires the system efficiency to be considered. Typical system efficiencies are given in **Table 9.3, page 9-28**.
- **Trickle System.** 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** 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. 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 horsepower. 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 horsepower used in the calculation is too large.

- **Sprinkler System.** 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 System**. 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.

The Ministry of Agriculture, Food and Fisheries collaborated with the Partnership for Water Sustainability in BC (PWSBC) to develop an online tool called the BC Irrigation Water Use Calculator for farmers to determine their actual annual water use by using pump energy consumption, irrigation system operating time, or metered data.

BC Irrigation Water Use Calculator

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%).

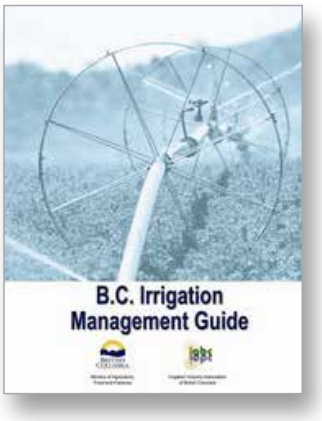
STEP 4 Water Licence Check

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 water allocation in 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

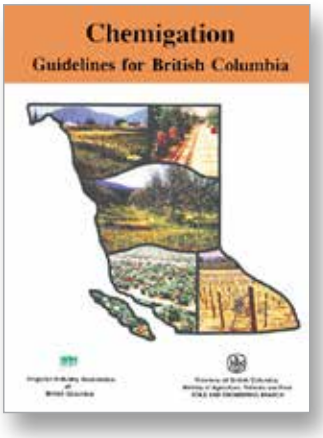
Chemigation is the practice of injecting chemicals into an irrigation system for application to a crop or field. Chemicals that are injected include fertilizers, herbicides, insecticides, fungicides, nematocides and growth regulators. Chemigation may reduce the amount of fertilizers required as nutrients 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, Chapter 9

WORKSHEET #9
Annual Water Use Check -Sprinkler

Workbook Question 321

Question: **Does the system annual water use match the calculated annual irrigation water requirement for the farm, and if surface water is used, does the annual use also match the licensed water quantity for the farm?**

Information:

Irrigated area	170	1	acres
Water withdrawal amount on water license (if applicable)	262	2	ac-ft
Estimated annual crop water requirement (Table B.3*)	12	3	inches
Application efficiency (Table 9.3*)	85	4	%

Calculation:

Step 1 **Determine the calculated annual water requirement.**

EQUATION: Calculated Annual Water Requirement

Estimated Annual Crop Water Requirement / Application Efficiency x 100% = Calculated Annual Water Requirement

(12 [3] / 85 [4]) x 100% = 14 [5] 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: Annual Water Use

Meter Reading at End of Year - Meter Reading at Start of Year / 27027 x Irrigated Area = Annual Water Use

(0 [7] US gal - 0 [6] US gal) / (27027 x 170 [1] acres) = 0 [8] 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: Pump Power

Pump Horsepower x 0.746 KW/hp = Pump Power

125 [9] hp x 0.746 KW/hp = 93.3 [12] KW

EQUATION: Pump Operating Hours

KWh for Entire Year / Pump Power = Pump Power

140.337 [10] KWh / 93.3 [12] KW = 1505.0 [13] hr

SAMPLE

EQUATION: Annual Water Use

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

$$\frac{1505.0\ [13]\ \text{US gpm} \times 825\ [11]\ \text{US gpm} \times 0.0022}{170\ [1]\ \text{acres}} = 16.1\ [14]$$

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

$$\frac{\text{System Flow Rate} \times \text{Irrigation Interval} \times \text{No. of Irrigations} \times 0.053}{\text{Irrigated Area}} = \text{Annual Water Use}$$

$$\frac{840\ [15]\ \text{US gpm} \times 15\ [16]\ \text{days} \times 4\ [17]\ \text{Number} \times 0.053}{170\ [1]} = 16\ [18]\ \text{ac-ft}$$

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

Step 3 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

$$\frac{\text{Actual Annual water use} \times \text{Irrigated Area}}{12} = \text{Annual Water Use acre-feet}$$

$$\frac{16\ [8, 14 \text{ or } 18]\ \text{inches} \times 170\ [1]\ \text{acres}}{12} = 228\ [19]\ \text{ac-ft}$$

is 228 [19] ac-ft
less than 262 [2] ac-ft

YES water license is OK No water use is 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

$$\frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100\% = \text{Percent Difference}$$

$$\frac{16\ [8, 14 \text{ or } 18]\ \text{inches}}{14\ [5]\ \text{inches}} \times 100\% = 114\ [20]\ \%$$

is 114 [20] less than 110%?

No **Reduce water use** or YES **Water use does not exceed requirement by more than 10%**

Refer to Irrigation Assessment Guide' to find ways to reduce water use

WORKSHEET #10
Annual Water Use Check - Trickle

Workbook Question 321

Question: **Does the system annual water use match the calculated annual irrigation water requirement for the farm, and if surface water is used, does the annual use also match the licenced water quantity for the farm?**

Information:

Irrigated area	14	1	acres
Water withdrawal amount on water license (if applicable)		2	ac-ft
Estimated annual crop water requirement (indicate location Table B.3*)	19	3	inches
Crop adjustment factor (indicate crop type Table 9.5*)	1	4	
Application efficiency (indicate system type Table 9.3*)	92	5	%

Calculation:

Step 1 **Determine the calculated annual water requirement.**

EQUATION: Calculated Annual: Water Requirement

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

$$\frac{19\ (3)\ \text{inches} \times 1\ (4)}{92\ (5)} \times 100\% = 21\ (6)\ \text{inches}$$

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

EQUATION: Annual Water Use

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

$$\frac{12{,}116{,}400\ (8)\ \text{US gal} - 100\ (7)\ \text{US gal}}{27027 \times 14\ (1)\ \text{acres}} = 32\ (9)\ \text{inches}$$

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: Pump Power

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

$$0\ (10)\ \text{hp} \times 0.746\ \text{KW/hp} = 0.0\ (13)\ \text{KW}$$

EQUATION: Pump Operating Hours

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

$$\frac{0\ (11)\ \text{KWh}}{0.0\ (13)\ \text{KW}} = 0.0\ (14)\ \text{hr}$$

EQUATION: Annual Water Use

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

$$\frac{\ (14)\ \text{hr} \times\ (12)\ \text{US gpm} \times 0.0022}{14\ (1)\ \text{acres}} = 0.0\ (14)\ \text{inches}$$

SAMPLE

Method 3: Sprinkler system annual water use

Sprinkler system output flow rate from Box 9 of Worksheet 8)	72.0	16	US gpm days
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

$$\frac{\text{Zone Flow Rate} \times \text{No. of Zone} \times \text{Operating Hours} \times \text{No. of Days} \times 0.0022}{\text{Irrigated Area}} = \text{Annual Water Use}$$

$$\frac{\underset{\text{US gpm}}{2.5\ (16)} \times \underset{\text{zones}}{7\ (17)} \times \underset{\text{hr/zone/day}}{2.5\ (18)} \times \underset{\text{day}}{100\ (19)} \times 0.0022}{14\ (1)} = 19.8\ (20)\ \text{inches}$$

Answer: If there is a Water Licence, 3(a), and as a double check, do step 3(b).
If using groundwater 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

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

$$\frac{32\ (9, 15, \text{or } 20)\ \text{inches} \times 14\ (1)\ \text{acres}}{12} = 37\ (19)\ \text{ac-ft}$$

is 37 (19) ac-ft

less than 0 (2) ac-ft

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

$$\frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100\% = \text{Percent Difference}$$

$$\frac{32\ (9, 15, \text{or } 20)}{21\ (6)} \times 100\% = 155\ (21)\ \text{inches}$$

is 155 (21) **% less than 110%**

No Reduce water use or YES Water use does not exceed requirement by more than 10%

Note: 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.
- Drainage of wetlands or peat land that accelerate soil carbon losses contributing to climate change.
- Poorly designed or maintained drainage systems that do not prevent soil saturation resulting in nitrous oxide emissions, a powerful greenhouse gas contributing to climate change.

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 7-7**, and refer to Farm Activities and Impacts

➔ Climate Change Adaptation, **page 12-15**

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 of Practice for Agricultural Environmental Management* requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricutural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health.

The *Code of Practice for Agricultural Environmental Management* has requirements, described in other sections of this Reference Guide, to prevent contaminated runoff from entering watercourses.

Watercourses are are defined to include:

a) An area of land that perennially or intermittently contains surface water, other than:
   - Puddles.
   - Groundwater and dugout ponds for livestock watering; and
   - Furrows, grassed waterways and other temporary ponded areas that are normally farmed, and

b) Drainage ditches that lead to an area described in paragraph (a).

- SECTION 47: Wood residue must not be used:
  - For the construction of berms;
  - As an envelope for tile drains;
  - As fill or to level a site;
  - To create an access way through a watercourse.

Water Sustainability Act

The *Water Sustainability Act* (WSA) is the principal law for managing the diversion and use of water resources. Non-domestic groundwater users are required to apply for a water licence to maintain their right to use groundwater.

- SECTION 6: Prohibits diverting water without a licence except in limited circumstances for fire suppression, domestic use and mineral prospecting.
- SECTION 11: Requires approvals for making changes in and about streams.
- SECTIONS 16 & 17: May require mitigation measures on (sensitive) streams where a water diversion or use is authorized.
- SECTION 45: No new dams on protected rivers.
- SECTION 128: Regulations respecting sensitive streams.

Under the WSA, no person may divert water from surface water or from an aquifer unless the person holds an authorization or the diversion and use of water is allowed by the Act or under a regulation. An authorization can take the form of a "use approval", which allows for short term use of water for up to 24 months, or a water licence which establishes a long term water right. Authorization holders have some responsibilities including the need to pay water fees and rentals and make beneficial use of the water they are authorized to divert, store and use.

In most cases, any person who diverts water for use or storage must apply to the Province for the right to use the water and pay an annual rental fee for that use. The requirement for groundwater licensing for non-domestic (e.g., farm or business use) came into force on February 29, 2016 and applies to new groundwater users as well as those who began using groundwater prior to February 29, 2016.

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.

Apply for a Water Licence

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

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *2019 Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:
(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;
(b) The conservation and protection of fish or fish habitat; and
(c) The prevention of pollution.

SECTION 34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable.

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time:

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

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.

On private land, unless an order is made by the government, the SARA prohibitions apply only to:

- Aquatic species at risk; and
- Migratory birds listed in the *Migratory Birds Convention Act, 1994* and also listed as endangered, threatened or extirpated in Schedule 1 of the Act.

DRAINAGE 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 also serves as an important 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. Proper drainage ensures nitrogen in fertilizer and manure additions is not converted into nitrous oxide, a very powerful greenhouse gas.

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 System

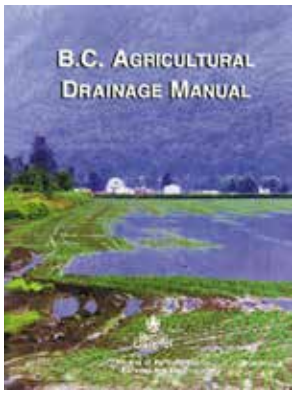
Plants growing in soils with good drainage are more capable to take up nutrients from the soil and water, reducing leaching of nutrients. A drainage system may consist of a combination of land grading improvements, ditches, subsurface drain pipes and pumping systems. A site-specific design produced by 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.

Agricultural drainage criteria were developed under the Agricultural and Rural Development Subsidiary Agreement (ARDSA), and are commonly referred to as ARDSA criteria or the Agricultural Drainage Criteria. These criteria describe the level of drainage required to allow for proper on-farm drainage, and help to improve regional drainage in agricultural lands:

- The runoff from a 10-year, 5-day storm must be removed within 5 days in the dormant period (November 1 to February 28).
- The runoff from a 10-year, 2-day storm must be removed within 2 days in the growing period (March 1 to October 31).
- Between storm events and in periods when drainage is required, the base flow in channels must be maintained at 1.2 m below field elevation.
- The conveyance system must be sized appropriately for both base flow and design storm flow.

Implement the following practices:

- Design subsurface drainage systems for the specific soil conditions and plant rooting requirements.
- Avoid the use of wood residue 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.
- Where feasible, link drainage system to farm water supply infrastructure. See Linking Drainage and Water Supply**, page 9-13.**



- B.C. Agriculture Drainage Manual
- Drainage Management Guide
- Factsheet 535.100-2 Agricultural Drainage Criteria
- BC Agriculture & Food Climate Action Initiative Drainage Resources

Subsurface Drainage System. Maintenance of subsurface drains and outlets is important for the benefits of drainage. A subsurface drainage system is used 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 flow 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 9-49**

- B.C. Agricultural Drainage Manual: Chapter 10 (Subsurface Drainage Design)
- Drainage and Sub-Irrigation as a Climate Change Adaptation Strategy
- Factsheet 532.000-2 Special Care in the Installation of Subsurface Drainage on Sloping Land

Surface Drainage System. 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 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

Below is an overview of the general steps required before working in and around a stream. Please check with the agencies for up-to-date approval process.

- 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.

Factsheet 823.400-1 Agricultural Building Setbacks from Watercourses in Farming Areas

Working Around Water

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,

Factsheet 533.500-1 Agricultural Watercourse Classification

Agency Approval. 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 ENV.

Working Around Water

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 should any occur from maintenance work. These windows are set by the type of watercourse, its condition, and its location in BC.

Working Around Water

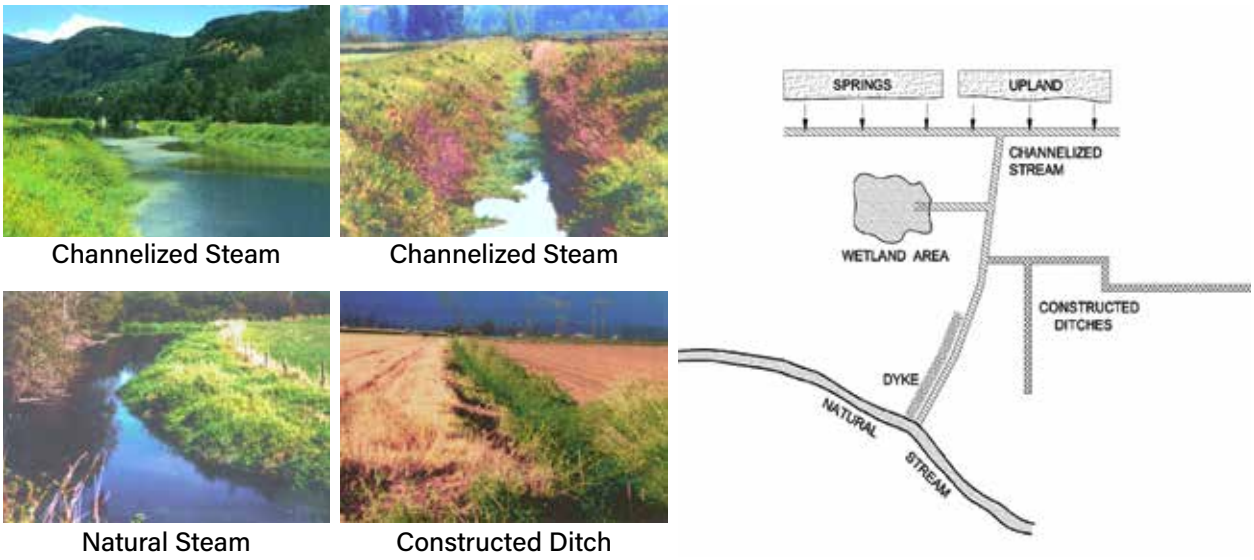


FIGURE 9.3 Watercourse Classification

Drainage Water Quality

There are practices that can reduce the impacts to drainage water in watercourses by surface contaminants reaching the drainage discharge through preferential flow pathways to drain tiles (see Preferential Flow below), or by wood residue leachate used in constructing the drainage system.

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 9-54**

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.

Preferential or macropore flow may increase phosphorus levels in drainage water, even if manure is not discharged through the drains. The risk of phosphorus transport through tile drains decreases if soil phosphorus levels are managed at or below levels required for crop production (see **Chapter 6** for beneficial management practices). The risk also decreases if controlled tile drainage is installed, which may be more practical on some sites than others.

➔ see the Subsurface Drainage Systems, **page 6-28**.

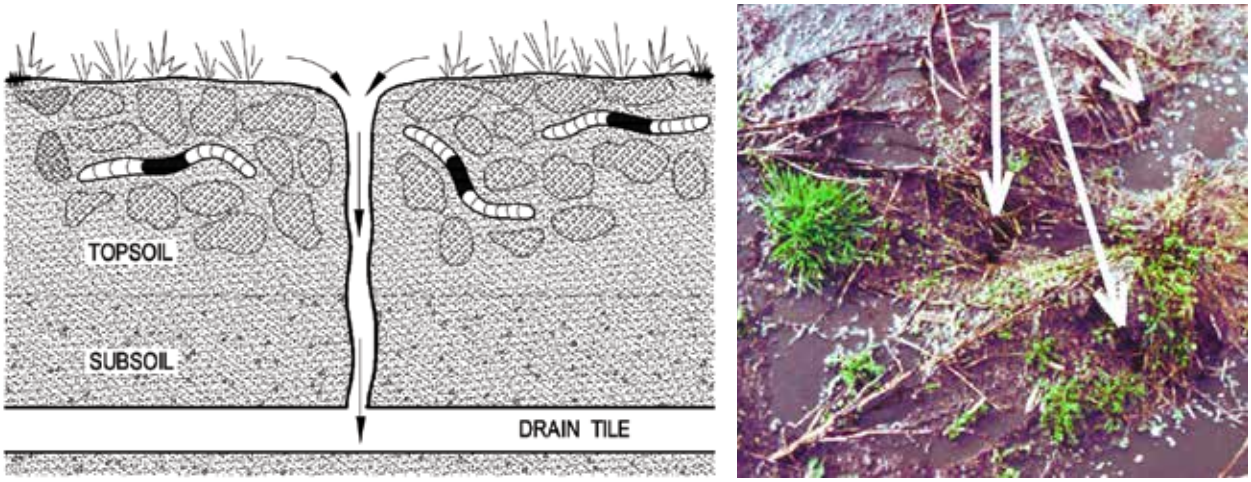


FIGURE 9.4 Preferred Flow or Macropore Flow (Surface Water Flow Directly to Drain Tiles)

Wood Residue. Monitor systems that were constructed in the past using wood residue as backfill during the first few years to determine if wood residue leachate in the drain water poses a pollution risk. Drainage water containing wood residue leachate cannot be released into a watercourse. Wood residue must not be used as fill in new drainage systems.

➔ see Wood Residue, **page 2-37**

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 farm practices are contributing contaminants, such as, nutrients and pathogens to watercourses.

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 7-7**, 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 of Practice for Agricultural Environmental Management* (AEM Code) requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health.

The Code of Practice for Agricultural Environmental Management under the Act defines "runoff" and "contaminated runoff" as follows:

- Runoff is water that flows along the surface of the ground and it may come from equipment, washing, precipitation, and meltwater.
- Contaminated runoff means "runoff that contains suspended or dissolved nutrients, pathogens or other substances after contact with agricultural by-products, leachate or other organic matter or pesticides".

Various SECTIONS of the *The Code of Practice for Agricultural Environmental Management* require that runoff must be diverted from particular storages, structures or processes:

- SECTION 34: storage of agricultural by-products;
- SECTION 38: on-ground under-pen storages;
- SECTIONS 40 AND 71: agricultural composting;
- SECTION 46: storage of wood residues;
- SECTION 63: feedlots;
- SECTION 74: burial pits for slaughter, mortalities and processing waste.
- In addition, the above sections (except Section 63, Feedlots), and the following sections of the AEM code, have requirements for managing contaminated runoff:
- SECTIONS 49 AND 52: nutrient application;
- SECTIONS 62 AND 64: confined livestock or poultry areas, seasonal feeding, grazing and temporary holding areas (Chapter 3);
- SECTIONS 68 AND 74: slaughter, mortalities and processing waste;
- SECTION 77: agricultural products;
- SECTION 77.1: pesticides.

In most cases, the requirements are to prevent contaminated runoff from entering a watercourse, crossing a property boundary or going below the water table. In some cases, there are specific requirements to collect and contain contaminated runoff.

SECTION 78 has requirements for the treatment of contaminated runoff, including notification requirements for existing and modified or new treatment systems. Before modifying or constructing a treatment system, a qualified professional must prepare the designs and plans and approval from ENV is required.

Fisheries Act

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, including by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *2019 Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:

(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;

(b) The conservation and protection of fish or fish habitat; and

(c) The prevention of pollution.

SECTION 34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable.

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time.

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

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. Where feasible, link storm water control systems to farm water supply infrastructure.

➔ See Linking Drainage and Water Supply, **page 9-13**

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 6.9** and **6.10**, 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, wood residue, 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 Runoff Collection, Storage and Use

Water may contain farm contaminants, such as, manure, soil, pesticides, petroleum and fertilizer. Contaminated runoff must be handled as a potential pollutant. To determine the impact of such runoff 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 runoff 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

British Columbia Water Quality – Human Health and Ecosystem Health website

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

- From outdoor areas, use berms or grade the area with a slope of 2 to 4% 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 Runoff. 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 in clayey areas, and impervious materials such as plastic or concrete will be required in coarser soils. Siting considerations are similar to those for manure storages:

- Locate storages with the following setback distances:
  - At least 30 m from drinking water source (the *Code of Practice for Agricultural Environmental Management*).
  - At least 15 m from the high water mark of a watercourse, other than a point of diversion used for a drinking water source (the *Code of Practice for Agricultural Environmental Management*).
  - At least 30 m from wells (*Health Hazards Regulation*).

➔ see Manure Storage – Storage Facilities, **page 3-31**

Sizing Contaminated Runoff 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 the material of contamination.
- The type of ground cover on the drainage area.
- The amount of offsite runoff entering a contaminated area.

To obtain an initial approximation for design of storage of contaminated runoff from outdoor livestock areas (where no offsite surface water enters the area), use **Worksheet #11, page 9-57**:

- 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 Runoff. 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 ENV 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 6-10**.

If the contaminant is **wood residue,** spread the affected water as irrigation onto cropland that readily allows infiltration. It is critical that the water be spread to avoid over-irrigation, so that toxicants in the water are in contact with soil surfaces for natural processes to reduce the load of toxicants. See the Irrigation section starting on **page 9-21** for guidance.

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, following legislative requirements as applicable under SECTION 78 of the *Code of Practice for Agricultural Environmental Management*.

Water Quality Evaluation of Agricultural Runoff in the Lower Fraser Valley

Canadian Drinking Water Guidelines

Centre for Disease Control: Agricultural Water Contamination

WORKSHEET #11
Confined Livestock Area
Determining Volume of Contaminated Runoff from Outside Yard

Workbook Question 331

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

Information:

Area of confined livestock site		300	1	m^2
Type of surface:	hard surface, frozen land or roof	hard		
Select site (Table B.1*):	Abbotsford	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		=	Volume		
1.0	x	300	1	m^2	x	1.54	2	m	=	462	3

Method 2. For soil based yards

EQUATION: Volume

	0.9	x	Area	x	Total Winter Precipitation		=	Volume		
0.9	x	300	1	m^2	x	1.54	2	m	=	462	3	m^3

Method 3. For crop land (not frozen)

EQUATION: Volume

	0.6	x	Area	x	Total Winter Precipitation		=	Volume		
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.

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

SAMPLE

LEACHATE

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

LEACHATE ENVIRONMENTAL CONCERNS

Primary environmental concerns related to leachate are: contamination reaching groundwater 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 of Practice for Agricultural Environmental Management* under the Act defines leachate as follows:

- Concentrated liquid originating from agricultural by-products, wood residue or other organic matter.

Various SECTIONS of the *Code of Practice for Agricultural Environmental Management* require that leachate does not enter a watercourse or go below the water table:

- SECTION 34: storage of agricultural by-products;
- SECTION 38: on-ground under-pen storages;
- SECTIONS 40 AND 71: agricultural composting;
- SECTION 46: storage of wood residues;
- SECTIONS 49, 51 AND 52: nutrient application;

- SECTIONS 62, 63 AND 64: confined livestock or poultry areas, feedlots, and seasonal feeding, grazing and temporary holding areas;
- SECTIONS 68, 69 AND 74: slaughter, mortalities and processing waste;
- SECTION 77: agricultural products.

SECTION 78 has requirements for the treatment of leachate including notification requirements for existing and modified or new treatment systems. Before modifying or constructing a treatment system, a qualified professional must prepare the designs and plans and approval from ENV is required.

Public Health Act

Part 3, Division 1: Preventing Disease and other Health Hazards.

15: A person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard.

Health Hazard Regulation regulates the distance of wells from possible source of contamination

- SECTION 8(1): provides separation distance of wells to be at least 30 m from any probable source of contamination.

Fisheries Act

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, including by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *2019 Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:

(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;

(b) The conservation and protection of fish or fish habitat; and

(c) The prevention of pollution.

SECTION 34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable.

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time.

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

LEACHATE BENEFICIAL MANAGEMENT PRACTICES

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., wood residue, 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 2-19**
- ➔ see Chemical Fertilizer, **page 2-26**
- ➔ see Wood Residue, **page 2-40**
- ➔ see Compost, **page 2-48**
- ➔ see Manure Handling and Storage, **page 3-25**
- ➔ see Mortality Disposal, **page 3-49**
- ➔ see Forage Crop Storage, **page 4-14**
- ➔ see Greenhouse, Container Nursery and Mushrooms, **pages 4-22** and **4-23**
- ➔ see Pesticides, **page 5-15**
- ➔ see Leachate Formation in Soil, **page 8-15**

Leachate Production Factors

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

- Water moving through materials or the soil will produce and move leachate:
  - High precipitation areas are at highest 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, **below**

- 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, 3, and 4**.

➔ see Wood Residue, **page 2-40**

➔ see Compost, **page 2-48**

➔ see Manure, **page 3-25**

see Forage Crop Storage, **page 4-14**

➔ see Mushroom, **page 4-23**

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 groundwater.
- 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 Leaching in Soil, **page 8-14**

- 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 groundwater.
- 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 9-49**

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. Wood residue leachate should be applied to a crop without over-irrigating, so that toxicants in the water are in contact with soil surfaces for natural processes to reduce the load of toxicants. See the Irrigation section starting on **page 9-31** for guidance.

- Buffering. Vegetative Buffers can be used to entrap leachate by being absorbed by root systems limiting the migration into surface water as well as reduces erosion and acts as habitat as seen in FIGURE 9.5.

Vegetative Buffers in BC – resource website

Wetland Ways: Agriculture Buffers to Protect Wetlands in BC

Planning an Installing Vegetative Buffers in BC

Agricultural Vegetative Buffers in BC – Demonstration Sites

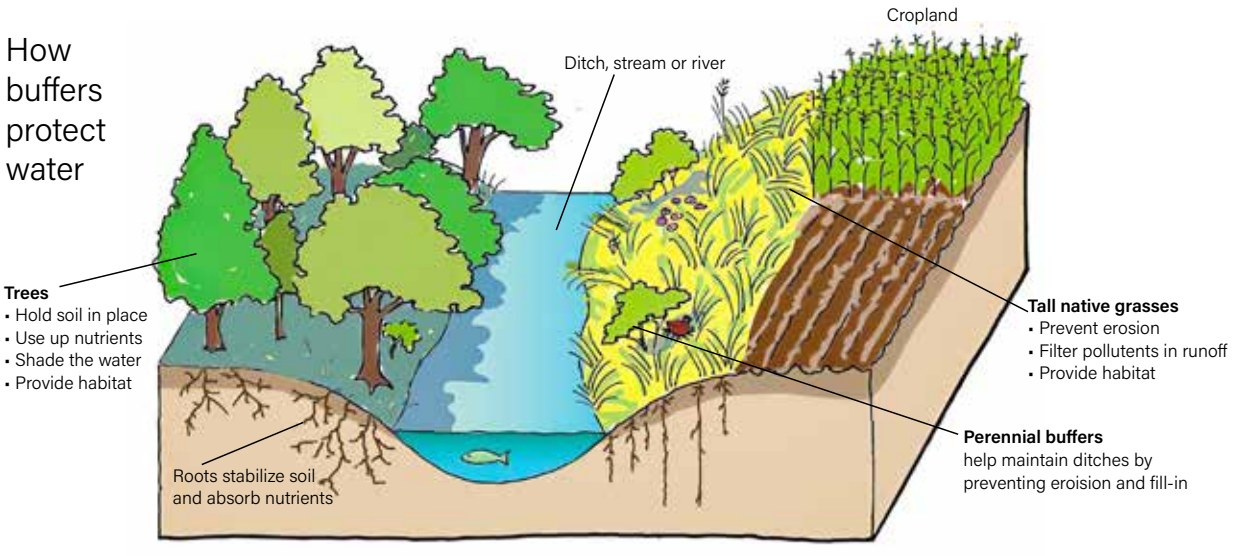


FIGURE 9.5 How Buffers Protect Water

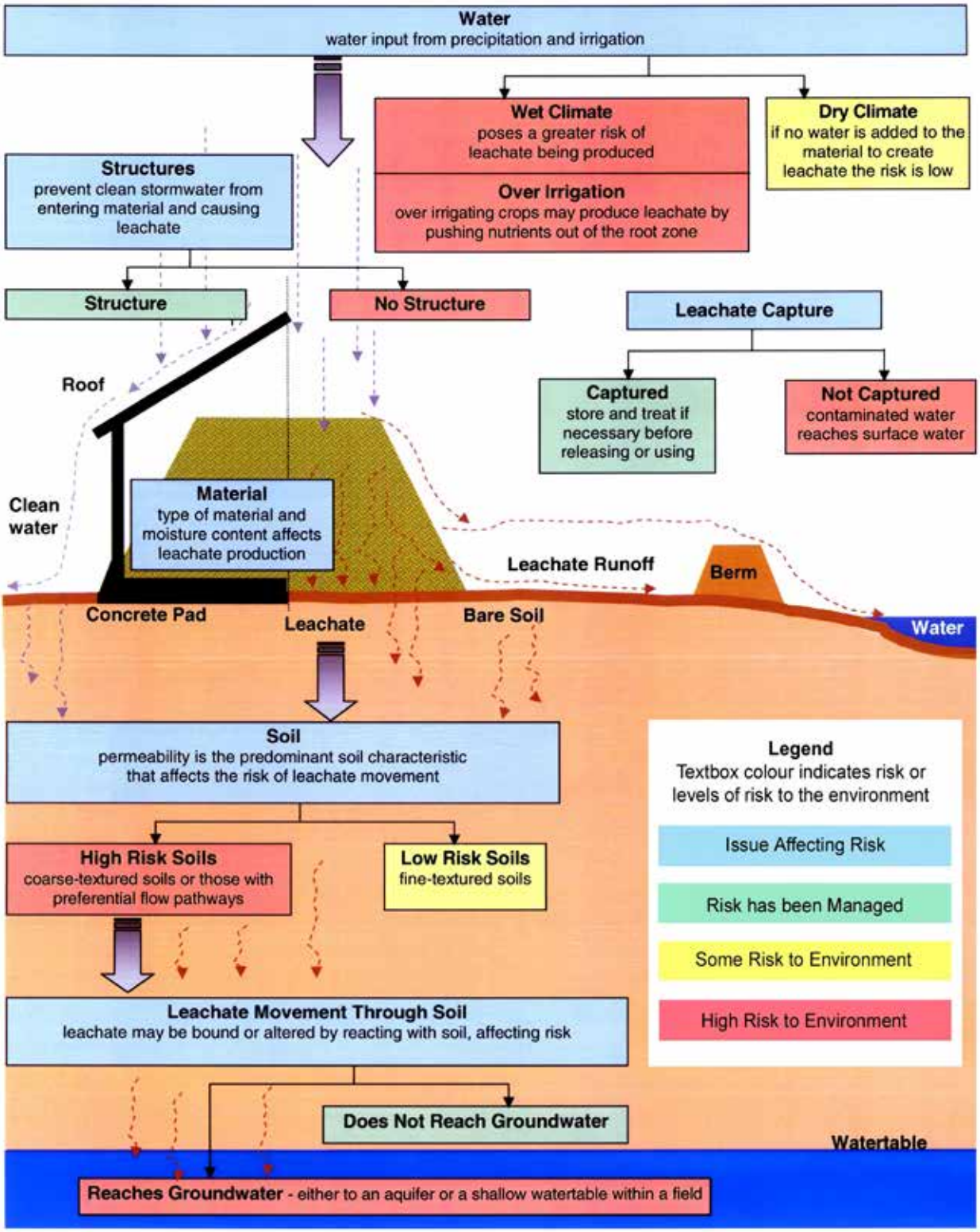


FIGURE 9.6 Leachate Production, Movement and Environmental Risks

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 groundwater.

➔ 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 existence 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 groundwater. 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 9-55**

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 6-1**

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.

ENV requires that for the treatment of leachate, that there be notification for existing and modified or new treatment systems. Before modifying or constructing a treatment system, a qualified professional must prepare the designs and plans, and approval from ENV is required.

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;
  - Groundwater flooding from a rise in water tables.
- Shortage of water that results in:
  - Reduced access to surface or groundwater sources;
  - Drought from seasonal or climate changes.
- Water quality that is unfit for domestic, livestock or irrigation uses.

Water conflicts may become more prominent with projected climate change.

➔ see Climate Mitigation and Adaptation discussions, **Chapter 12**.

WATER CONFLICTS LEGISLATION

Water Sustainability Act

The *Water Sustainability Act* (WSA) is the principal law for managing the diversion and use of water resources.

Under the WSA, no person may divert water from a stream or from an aquifer unless the person holds an authorization or the diversion and use of water is allowed by the Act or under a regulation. An authorization can take the form of a "use approval", which allows for short term use of water for up to 24 months, or a water licence which establishes a long term water right. Authorization holders have some responsibilities including the need to pay water fees and rentals and make beneficial use of the water they are authorized to divert, store and use.

In most cases, any person who diverts water for use or storage must apply to the province for the right to use the water and pay an annual rental fee for that use. The requirement for groundwater licensing for non-domestic (e.g., farm or business use) came into force on February 29, 2016 and applies to new groundwater users as well as those who began using groundwater prior to February 29, 2016.

The requirement to obtain a licence for diversion and use of water from streams or aquifers applies regardless of whether the water source is on private or Crown land. However, the WSA and the regulations allow diversion and use of water without an authorization for certain uses:

- Diversion of groundwater or unrecorded surface water for a domestic purpose;
- Diversion of water to extinguish a fire;
- Diversion of water by a well driller to drill a well;
- Diversion and use of water for small scale placer mining and mineral exploration; and

The following SECTIONS of the WSA may be useful to the diversion of water in particular:

- SECTION 6: Prohibits diverting water without a licence except in limited circumstances for fire suppression, domestic use and mineral prospecting.
- SECTION 11: Requires approvals for making changes in and about streams.
- SECTIONS 16 & 17: May require mitigation measures on (sensitive) streams where a water diversion or use is authorized.
- SECTION 45: No new dams on protected rivers.
- SECTION 88: In the case of low or impending low water, for the purposes of protecting the fish population, the minister may make an order 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 or aquifer connected hydraulically to the stream.
- SECTION 128: Regulations respecting sensitive streams.

The *British Columbia Dam Safety Regulation*, which was updated in 2016, 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.

Riparian Areas Protection Act

The *Riparian Areas Protection Act* creates the authority for government to enact Provincial directives to protect areas that border streams, lakes, and wetlands.

With this Act, and through the *Riparian Areas Regulation* (RAR), local governments in certain regions of the Province are able to protect riparian areas during residential, commercial, and industrial development by ensuring that a Qualified Environmental Professional (QEP) conducts a science-based assessment of proposed activities. This includes residential buildings on land zoned for agricultural purposes. Section 12 provides Provincial directives on streamside protection.

The RAR only applies to the residential portion of the farm and only in the southern half of BC. The RAR does not apply to *farm practices* as defined in the *Farm Practices Protection Act*. In some cases, this can lead to the misunderstanding that the RAR does not apply to lands zoned for agriculture, or in the Agricultural Land Reserve (ALR). The RAR does apply to these lands for activities that are not *farm practices*, for example residential construction. It is important to note that local governments have the ability to establish bylaws that apply to agricultural lands, and some have implemented setbacks for agricultural buildings that complement the setbacks designated under RAR.

WATER CONFLICTS RESOLUTIONS

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-lying farmland.

➔ see Farm Building Siting, **page 2-8**

Factsheet 823.400-1 Agricultural Building Setbacks from Watercourses in Farming Areas

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. Flood protection measures for one farm may become bank erosion problems for another farm. Consult the ENV, 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 and by participating in regional water management planning and protection measures.

➔ see Water Conflict Contingency Plan, **page 9-68**

- Freshet Flooding & Fraser Valley Agriculture: Evaluating Impacts and Options for Resilience
- BC Agriculture & Food Climate Initiative Flood Resources

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 on the requirements and recommended monitoring and maintenance, dam owners should follow the dam safety guidelines:

- *Dam Safety Regulation*
- Dam Safety Pocketbook
- Dam Safety Technical Resources
- BC Dam Safety Program
- Dam Safety Management Binder
- BC Agriculture & Food Climate Initiative Water Storage and Dams Resources

Drought

In many cases, reduced irrigation water can be expected if snowpack levels are low causing reduced flows in streams and reservoirs in subsequent growing season. Good water management in such conditions is more important than ever with a changing climate. Plan your water use in the context of water demand and sustainable supply consideration. Use the following to assist your assessment:

- Drought in Agriculture
- Provincial Drought Information
- BC Irrigation Water Use Calculator
- BC Agriculture Water Calculator
- Irrigation System Assessment Guide
- Farm Water Planning Toolkit

ENV 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.

- BC Drought Information Portal
- BC Agriculture & Food Climate Initiative Water Storage and Dams Resources

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

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 9-21**

BC Irrigation Water Use Calculator

BC Agriculture Water Calculator

Factsheet 500.310-1 Irrigation Tips to Conserve Water on the Farm

Key Drought Management Tips

Cowichan Valley Drought Communications Plan 2017 Report

BC Agriculture & Food Climate Initiative Drought Resources

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 ENV 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 approval from agencies prior to making changes in and about a stream to protect farmland during flooding emergencies. ➔ see Changes In and About a Stream, **page 7-17**

Consider regional water conservation strategies and the potential for climate change impacts in your water conflict planning.

Contingency Plan – Template for On-Farm Planning