WATER SOURCES

When you draw water for irrigation, you must ensure there are no long-term implications for the local environment, and no short-term interference with other uses. More specifically, you need to know:

Be sure you know the recharge rate of your water supply – particularly during periods of greatest need and lowest supplies.

- ▸ an estimate of how much water might be needed
- ▸ how continuous the supply is (or the recharge rate), especially during the time of need when conditions are the driest and supplies usually the lowest
- ▸ that the quality of water matches the needs of the crop to be irrigated
- ▸ how the location of the water supply impacts the design and cost of the system, i.e., horizontal distance and vertical lift
- ▸ the repercussions if adequate water isn't available
  - ▷ a shortage of water with micro-irrigation systems (also known as "drip" or "trickle") can be disastrous
  - ▷ running out of water while protecting a crop from frost can also be disastrous – e.g., small fruit or berry growers should have a water inventory capable of use for several consecutive nights of frost protection
- ▸ whether the amount of water you're taking is environmentally sustainable
  - ▷ effects on fish and fauna – a large suction inlet cuts down on water velocity entering the intake pipe, and allows fish to escape
  - ▷ effects on quality and quantity of water in adjacent bodies of water
  - ▷ effects on the water table.

Here are some calculations with conversions to help you estimate the volumes required:

1 acre inch of water =
3630 cu ft = 27,154 US gal = 22,610 Imp gal = 102,800 L

For example:
10 acres of land to be irrigated with 1½ inches (38 mm) of water

Volume required =
10 x 1.5 x 3630 = 54,450 cu ft of water = 339,150 Imp gal

Equivalent pond storage =
90 ft x 90 ft x 15 ft (27 m x 27 m x 4.6 m)

A 10 Imp gpm* well would take 23.5 days to pump sufficient water to cover this acreage.

To irrigate this field directly from a well in a 10-hour period would require a well with a pumping rating of greater than 565 Imp gpm.

A pump capable of delivering 1,200 US gpm can fill a 900 US gal tank in 45 seconds.

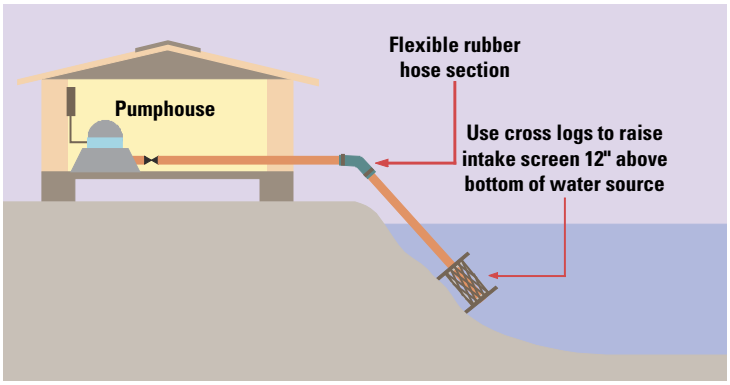
*gpm = gallons per minute

WATER SOURCES

TYPES OF WATER SOURCES

LAKES

- ▸ are an abundant source
- ▸ aren't always accessible and may require extra suction lift if elevation differs substantially from lake level to field
- ▸ can be used to replenish irrigation ponds
- ▸ are important habitats for fish and wildlife – try to keep impact to a minimum, i.e., keep fish out of water intakes
- ▸ offer, generally speaking, good water quality for irrigation
  - ▷ variables include water source feeding the lake, and events such as heavy rainfall and runoff at particular locations (such as the mouths of rivers)
  - ▷ monitor water quality during the irrigation season



An intake apparatus like this one helps reduce damage to aquatic life.

Lakes can be an excellent source of water for irrigation.

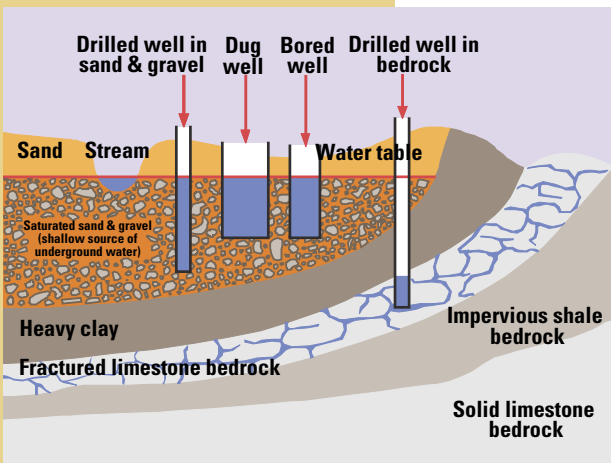
RIVERS AND STREAMS

- ▸ must be deep enough to pump from
- ▸ aren't always accessible and may require extra suction lift if elevation differs substantially from the surface of the water to the field
- ▸ contain sediment and other pollutants that can plug micro-irrigation systems
- ▸ are used by others: water-taking shouldn't interfere with their rights
- ▸ are important habitats for fish and wildlife: to minimize impact, take action such as keeping fish out of water intakes
- ▸ offer a range of water quality
  - ▷ variables include events such as heavy rainfall, as well as neighbouring land uses
  - ▷ even with regular monitoring, take extra caution with more sensitive irrigation applications (e.g., strawberries versus corn)
- ▸ can be used to replenish irrigation ponds but care must be taken to maintain flow

Rivers and streams are moderate to good sources. Low flow usually coincides with periods of crop need. Harvest water during or near times of peak flow.

WATER SOURCES

WATER WELLS



Dug and bored wells typically access shallow ground-water aquifers. Drilled wells access deeper aquifers, such as water-bearing rock formations.

- ▸ use shallow or deep aquifers
- ▸ can be dug, bored, drilled, or sand point
- ▸ will provide water, but not always at the rate or volumes needed
  - ▷ have it tested
  - ▷ pump it for at least 24 hours to determine drawdown and yield
- ▸ can be used to supplement pond storage
- ▸ may provide water that is too cold for irrigation
- ▸ can take enough water to drop water tables
  - ▷ irrigation from wells must not affect neighbouring ones
- ▸ provide water of the most reliable quality, often comparable to municipal water supplies
  - ▷ monitor the water quality during the irrigating season
  - ▷ avoid contamination through proper maintenance and the creation of a well protection zone to keep potential contaminants out of the well

PONDS

- ▸ offer a wide range of water quality, depending in part on water source that fills pond – ponds filled by rainfall or ground water usually provide better quality water
  - ▷ ensure water quality is sufficient for more sensitive irrigation applications (e.g., strawberries versus corn) – test regularly
  - ▷ create buffer zones around pond to prevent entry from runoff and other undesirable contaminants
  - ▷ if harvesting water from a stream or river after rain, avoid taking water during peak flow – peak flows tend to carry more sediments and contaminants

WATER SOURCES

FARM POND WATER CAPACITY

Water Surface Dimension Feet (metres)	Water Depth Feet (metres)	Capacity			
		Litres	US Gallons	Imp Gallons	Acre Inches
100 x 60 (30 x 20)	10 (3)	906,100	239,400	199,300	8.8
100 x 100 (30 x 30)	10 (3)	1,812,200	478,700	398,700	17.6
100 x 100 (30 x 30)	15 (4.5)	2,081,200	549,800	457,900	20.3
100 x 150 (30 x 45)	10 (3)	2,944,900	777,900	647,900	28.7
100 x 150 (30 x 45)	15 (4.5)	3,567,800	942,500	784,900	34.7
100 x 300 (30 x 90)	10 (3)	6,342,800	1,675,500	1,395,400	61.7
100 x 300 (30 x 90)	15 (4.5)	8,027,600	2,120,600	1,766,100	78.1
100 x 500 (30 x 150)	10 (3)	10,873,300	2,872,300	2,392,100	105.8
100 x 500 (30 x 150)	15 (4.5)	13,973,900	3,691,400	3,074,300	136.0

Based on pond measurement at water surface with side slopes of 2 (horizontal): 1 (vertical).

Conversions: **1000 litres = 1 cubic metre** **28.32 litres = 1 cu ft water weighs 62.3 lbs**
3.785 litres = 1 gal (US) **3.785 litres = 1 gal (US) water weighs 8.3 lbs**
4.546 litres = 1 gal (Imp) **4.546 litres = 1 gal (Imp) water weighs 10 lbs**

DUGOUT POND

CONSTRUCTION

- ▸ storage volume determined by how much is excavated
- ▸ side slopes 2:1 (horizontal:vertical) or flatter
- ▸ depth 10 feet (3 m) or more if possible (to help with weed control)
  - ▷ best source is where there's a shallow water table in a pervious soil

MAIN WATER SOURCES

Direct Rainfall

- ▸ not adequate to fill or replenish storage (approx. 39 in/yr [1,000 mm])

Ground Water

- ▸ can be a good source – must be identified by experience within the region, or dig a test hole and observe over one summer season to determine dependability (recharge rate and static water level)

WATER SOURCES

Tile Drainage System
- ► generally not adequate as a total supply unless it's tapped into a spring that continuously supplies water
- ► main supply of water is in the spring
- ► quality of water can be a concern depending on activities on the fields that the system services

Artesian Spring
- ► excellent source of water if quantity is adequate
- ► not very common to most of Ontario

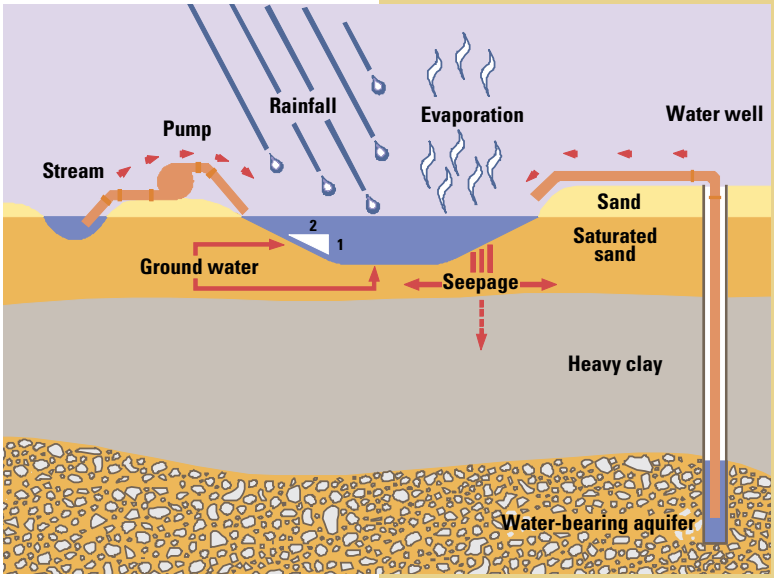
Water Well
- ► can be a total or partial source of water if volumes are available to meet the need
- ► adds considerable cost to system if well has to be installed
- ► if pumped heavily, water level in neighbouring wells may be affected

Rivers, Streams, etc.
- ► excellent source of water if accessible and flows are adequate
- ► pond can be replenished by pumping water from stream into pond at a controlled rate so as not to affect other users and uses of stream, and at time of year that will have least impact (spring) – as a water user, you're required to maintain adequate water flow to maintain the basic functions of the ecosystem, e.g, fish habitat

PERMITS THAT MAY BE REQUIRED
- ► Permit To Take Water for > 50,000 litres (10,000 Imp gal) per day from Ontario Ministry of the Environment
- ► Permit to Construct from Conservation Authority if site is in the designated floodplain
- ► Permit to Construct from Ontario Ministry of Transportation if close to a highway
- ► Permit from Ontario Ministry of Natural Resources to build pond on a stream or river – permit for this use is seldom given
- ► Permit may be required within Niagara Escarpment Commission area

WATER SOURCES

Dugout ponds work best in poorly drained sandy soils when they can be replenished by ground water.



Dugouts can be replenished by many sources. From ground water, ponds can gain water from tile drainage, wells and ground water flow. Water can be pumped from lakes, rivers, streams and ponds. Ponds can also collect rainfall and snowmelt.

BYPASS POND

CONSTRUCTION

- storage volume is determined by how much is excavated
- side slopes are 2:1 (horizontal:vertical) or flatter
- depth is 10 feet (3 m)or more if possible (to help with weed control)
- locate adjacent to stream
- available space is sometimes limited if stream is located in valley

MAIN WATER SOURCES

Rivers, Streams, etc.

- excellent source of water if accessible and flows are adequate
- pond can be replenished by diverting water from stream into pond (through a diversion channel or pipe, at a controlled rate so as not to impact other users and uses of stream [< 10% of flow])
- you can select water with this system not only for quantity but also quality
  - after a storm, when water can be murky with sediment, etc., you can close diversion until water is cleaner
- for intermittent streams, pond needs to be sized bigger to give enough storage between runoff events
- bottom-draw outlets will release only deeper, cooler water, which benefits cool- and cold-water fish like salmon and trout

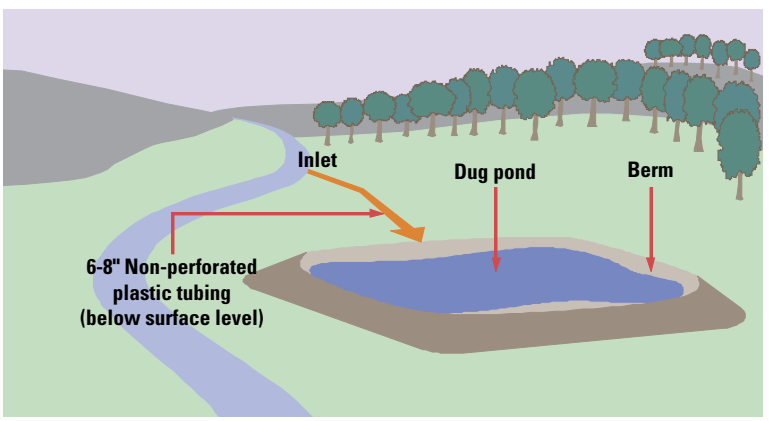
A bypass pond is created close to a stream by flowing water along a small channel. The channel enables a small portion of water (less than 10% of the flow) to flow from the stream or ditch to the pond.

WATER SOURCES

PERMITS THAT MAY BE REQUIRED

- ▸Permit To Take Water for > 50,000 litres (10,000 Imp gal) per day from Ontario Ministry of the Environment (not only for irrigation but also to fill or refill pond)
- ▸Permit To Construct from Conservation Authority if site is in the designated floodplain
- ▸Permit To Construct from Ontario Ministry of Natural Resources
- ▸a permit may be required within Niagara Escarpment Commission area
- ▸a permit for a bypass pond may not be granted

Dammed watercourses are not bypass ponds. Dammed watercourses restrict fish migration.



A properly designed bypass pond can be replenished by diverting water (< 10% of flow) from a stream. Not all bypass ponds have outlets. If an outlet is included, it should be a bottom-draw outlet, as this will release only deeper, cooler water, which benefits cool- and cold-water fish like salmon and trout.

IMPOUNDMENT POND

An impoundment pond is formed by placing a dam across an intermittent stream, a draw or a valley – but not in a continuous-flow stream.

CONSTRUCTION

- ▸a dam is built across an intermittent stream, a draw or a valley (but not in a continuous-flow stream)
  - ▷involves specialized construction: layers of impervious soil are placed between two banks and compacted to form the dam
  - ▷capable of holding back large volumes of water depending on the valley characteristics (slope, elevations, etc.)
- ▸water is held back until it reaches a certain level, and excess water must be passed through an overflow device (spillway)
  - ▷spillways can be made of concrete, steel or plastic, and must be sized according to the predicted flows
- ▸the entire system must be designed according to sound engineering principles and built with equal attention – a failure could cause severe downstream damage
- ▸can be very costly

WATER SOURCES

MAIN WATER SOURCES

Runoff

- ▸ runoff is the main source of water, and is prone to quality problems depending on the land activities in the runoff watershed
- ▸ runoff dams are dependent on surface runoff in the spring to fill; additional runoff in the summer isn't dependable enough for irrigation water
- ▸ the site must be of a soil type (preferably clay) to retain water, since the supply isn't dependable or continuous
- ▸ careful attention to site selection is important in attaining a healthy pond

Rivers, Streams, etc.

- ▸ excellent and dependable sources of water
- ▸ even though a dam usually can't be built across them, they can be used as a source of water by pumping into the pond if runoff is not adequate

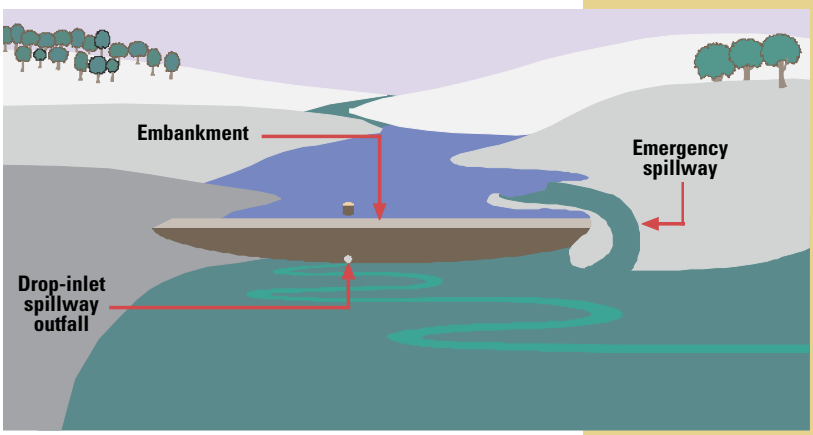
PERMITS THAT MAY BE REQUIRED

- ▸ Permit To Take Water, > 50,000 litres (10,000 Imp gal) per day from Ontario Ministry of the Environment
  - ▷ not only for irrigation but also to fill or refill pond
- ▸ Permit To Construct from Conservation Authority, if site is in the designated floodplain
- ▸ Permit to Construct from Ontario Ministry of Natural Resources
- ▸ Permit to Construct from Ontario Ministry of Transportation, if close to a highway

Note: dams on continuous-flow streams can cause serious problems to fish movement and habitat.

Approval for on-stream dams is rare because of the potential negative impacts.

Dams across ravine areas that don't have a stream in the bottom are the best option.



Impoundment ponds require a dam constructed of impervious layers, and a spillway to outlet excess water.

WATER SOURCES

SEEPAGE CONTROL – ALL POND TYPES

CLAY LINER

- line the pond with clay, 1–2 feet (0.3–0.6 m) thick, and compact; clay content should be greater than 30%
- trucking costs can be very expensive if clay isn't available nearby

BENTONITE

- a special kind of clay that expands 10–20 times its dry size when wetted
- when incorporated with the existing soil, bentonite can act as an excellent seepage reducer
- should not be considered equivalent to an impermeable liner

SYNTHETIC LINERS

- high- and low-density polyethylene, polyvinyl, hypalon and butyl rubber are examples of synthetic liners
- cost rises as durability and longevity increase
- prices of materials range from $0.75–$2.00 per square foot for most products used – costs could mount substantially with increased quality
- generally, the higher the price, the less site preparation required

Dugout ponds in drier medium-textured soils and drier coarse-textured soils may require artificial liners to reduce water loss.

ALGAE CONTROL IN IRRIGATION PONDS

A Permit to Purchase and/or Perform a Water Extermination must be obtained from Ontario Ministry of the Environment before a pesticide for control of aquatic weeds can be legally purchased and/or applied to surface water in Ontario (unless exempt).

An exemption from the permit requirement is made for "Agriculturists" who wish to treat a water body wholly confined within their property and where there is no outflow, at any time, beyond their property limits.

WATER SOURCES

WATER QUALITY CONCERNS

Water quality should always be of concern. The desired level of water quality will depend on crop type and resulting use. If you haven't already, you should:

- ▸ assess the importance of water quality for your operation
- ▸ test your water for *E. coli* or faecal coliforms, i.e., indicators of potential pathogens in the water
- ▸ protect your water source.

DESIRED IRRIGATION WATER QUALITY

CROP TYPE	DESIRED LEVEL OF WATER QUALITY
Not consumed, e.g., tobacco	•
Field crops	•
Consumed after cooking, e.g., sweet corn	••
Consumed raw where water is not applied to the food surface, e.g., tomatoes under drip irrigation	••
Consumed raw where water is applied in overhead irrigation e.g., bell peppers under sprinkler irrigation	•••
Consumed raw where water is applied in overhead irrigation and food surface is textured, allowing for water to remain trapped on the surface until eating (e.g., raspberries under sprinkler irrigation)	••••
Consumed raw, pick-your-own operation	••••

Legend – Quality

•	**Minimal**
••	**Medium**
•••	**High**
••••	**Very high**

WATER SOURCES

If you need high quality water, consider:

- ▸ changing to a water source with a high level of water quality
- ▸ buying an irrigation system where the water does not come in contact with the food product, such as a drip or subsurface drip system
- ▸ treating the water so that it adheres to Canadian Environmental Quality Guidelines for irrigation water, i.e., 100 faecal coliforms/100 ml; 1000 total coliforms/100 ml.

VARIABILITY OF WATER QUALITY FOR IRRIGATION

WATER SOURCE TYPE	VARIABILITY OF WATER QUALITY FROM THE TYPE OF SOURCE
River or stream	••••
Pond filled by stream, ditch or runoff	••••
Lake	•••
Pond filled by groundwater, spring or well	••
Well supplying directly to irrigation system	•
Municipal water supply	No variability

Legend – Variability

•	**Minimal**
••	**Moderate**
•••	**Medium**
••••	**High**