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ACCESSING SURFACE WATER SOURCES
Dugouts, Springs, Creeks, Rivers and Lakes

This Factsheet outlines options to access and develop surface water sources for livestock watering.

Introduction

The following surface water options should be considered with these points in mind:

- water quality will vary and may have to be checked – Factsheet #590.301-2
- direct access of surface water can impact water quality – Factsheet # 590.302-1
- a water licence is required to divert surface water – Factsheet #502.100-4

Dugouts

Collection of surface water in a dug pond can be a cost effective method to provide livestock water. Depending on local conditions and stock requirements, a dugout may provide only the seasonal spring grazing needs. Siting is important to ensure filling from spring snow melt or summer rain storms.

Seasonal "Range" Dugouts. These "scoop outs" are the simplest form of dugouts, often used on grazing areas and **are discussed** in this Factsheet. They may capture ground seepage or surface run-off from snow melt or precipitation.

Full Year "Farm" Dugouts. These "prairie-style" dugouts are usually larger and more sophisticated than "scoop outs" and may supply water for domestic as well as livestock uses. These **are not discussed** in this Factsheet - refer to ***Quality Farm Dugouts***, a publication of Agriculture and Agri-Food Canada.

Dugout Sizing. Size the dugout considering both the volume of water available to capture and livestock volume needs. Table 1, next page, gives capacities of various dugout sizes. Make allowance for evaporation losses of 15 to 50%. Constructing long, narrow dugouts at right angles to the prevailing wind and with a shelterbelt of trees back from the water edge can reduce these losses. Fifty percent porous fences upwind or solid fences downwind can help trap snow to fill dugouts.

Watershed Sizing. Watershed area requirements to fill dugouts are fairly variable and local consultation is required. For example, in the northeast region of B.C. a rule of thumb is for every 100 square feet of dugout surface area, 1/2 acre of watershed is needed. A 200 ft by 100 ft dugout has a surface area of 20,000 sq ft and would require a minimum watershed of 100 acres.

Topography. To reduce evaporation and other water losses, as well as accumulate more snow in winter, dugouts should be located in natural depressions. In Crown grazing areas, consider capturing the flow off forestry road grade ditches, directing water to a dugout set off 15m (50 feet) or so from the road.

Table 1.		Approximate Dugout Capacities * (Million US Gal / Million Litres)													
Length		Width													
ft	m	60ft	18m	70ft	21m	80ft	24m	90ft	27m	100ft	30m	110ft	33	120ft	36m
60	18	0.14	0.51	0.17	0.64	0.20	0.76	0.24	0.89	0.27	1.02	0.30	1.15	0.34	1.28
80	24	0.20	0.76	0.26	0.97	0.31	1.18	0.37	1.39	0.42	1.59	0.48	1.80	0.53	2.01
100	30	0.27	1.02	0.35	1.31	0.42	1.59	0.50	1.88	0.57	2.17	0.65	2.45	0.72	2.74
120	36	0.34	1.28	0.43	1.64	0.53	2.01	0.63	2.37	0.72	2.74	0.82	3.10	0.92	3.47
140	42	0.40	1.53	0.52	1.98	0.64	2.42	0.76	2.87	0.88	3.31	0.99	3.76	1.11	4.20
160	49	0.47	1.78	0.61	2.31	0.75	2.83	0.89	3.36	1.03	3.88	1.17	4.41	1.30	4.94
180	55	0.54	2.04	0.67	2.64	0.86	3.25	1.02	3.85	1.18	4.45	1.34	5.06	1.50	5.67
200	61	0.61	2.50	0.79	2.98	0.97	3.66	1.15	4.35	1.33	5.03	1.51	5.71	1.69	6.40
230	70	0.71	2.68	0.92	3.48	1.13	4.28	1.34	5.08	1.56	5.89	1.77	6.69	1.98	7.49
260	79	0.81	3.06	1.05	3.98	1.23	4.90	1.54	5.83	1.78	6.75	2.03	7.67	2.27	8.59
300	91	0.94	3.57	1.23	4.65	1.51	5.73	1.80	6.81	2.09	7.89	2.37	8.97	2.66	10.1

* assuming a depth of 4.3m (14 feet) with side and end slopes of 2 horizontal : 1 vertical

Livestock Access. Direct use by livestock is the simplest use of dugout water but can degrade water quality. If possible, a fenced dugout with water flow to a trough should be considered. If direct access is used, limit access to one end and consider improving the access with a geotextile / gravel ramp (refer to Factsheet #590.302-2).

Soil Types. When planning large dugouts, soil test holes should be dug in the proposed dugout locations. Once the site is chosen, five test holes, one in each corner and another in the middle, should be dug to warn of impending seepage problems. A soil which is predominantly clay will retain water well. Other soils can be sealed but may only be partially effective and be cost prohibitive.

Seepage Control. Sandy soils are permeable and allow seepage, while a layered soil profile permits water loss along the interface between the two soil types. On most "range" dugouts, extensive seepage control may not be warranted, but the following physical and chemical methods can be used.

- **Gleization.** A 150mm (6 in) layer of organic material, usually straw, followed by another 6 in. layer of clay provides a time-honored method of seepage control, but requires several months to a year to be completed and be effective.

- **Clay Lining.** Up to a twelve inch thick uniform layer of borrowed clay earth is laid down and compacted to ensure seepage control.

- **Bentonite.** Bentonite is highly plastic clay that absorbs water and swells many times its volume. When wetted and mixed with the dugout soil it forms an impermeable seal to water. If it is allowed to dry, bentonite shrinks and cracks which tends to weaken the seal. The seal is reformed when rewetted.

  Two types of bentonite are used; high swell which can increase its volume eight to twelve times when wetted and low swell which can increase five to six times. The swell characteristic and purity of the bentonite should be known when calculating the amount to be used.

Bentonite can be applied dry, either as a pure-blanket covered with 100 to 150mm (4 to 6 in) protective soil cover, or as a mixed-blanket worked into the soil and compacted in a 125 to 150mm (5 to 6 in) layer. Either way, the layer should be moistened and compacted. Dry bentonite should not be applied without either mixing it or covering it.

Bentonite can also be applied to the water surface in the wet method, either as a slurry or as dry material. A gel forms that settles to the bed surface and is either left to form a natural seal or is incorporated several inches into the bed by underwater harrowing. This method is more difficult to do and not as effective as the dry method. High amounts of soluble calcium in the water may reduce the sealing effectiveness of bentonite. However a dry application of 5 to 10 kg per m^2 (1-2 lbs per ft^2) or a wet application of 10 to 20 kg per m^2 (2-4 lbs per ft^2) is usually effective.

- **Soil Cement.** Used primarily in sandy soils, the surface must first be tilled to a depth of 3-6 inches. The soil cement is broadcast onto dry soil at the rate of 4-6 lb/ft^2 and then tilled into the surface. Water should be sprayed on to increase the soil moisture content to 12-15%. A two to four week curing period is required after compaction.
- **Sodium Carbonate.** As a chemical dispensing agent, sodium carbonate reduces the soil permeability by reorienting clay particles in the soil. The degree of effectiveness of sodium carbonate depends on the percentage of exchangeable calcium in the soil which can be determined from a soil test. Application rates may be determined from the test results. The sodium carbonate is applied by a fertilizer spreader onto the surface of the dugout sides. Tillage and subsequent compaction will seal the dugout in a few days.
- **Polyethylene Liner.** Polyethylene membrane liners can be purchased in sheets or formed to a semi-spherical shape. The liner should be covered with a 150 to 300mm (6-12 in) layer of soil to reduce chances of damage from puncture or UV radiation. Use a minimum 6 mil thickness.

Springs

A spring occurs when the water table is at the ground surface, often along a hillside or in a low area. Although water flow may be quite variable during the year and from year-to-year, even a small flow can be worth developing; for instance a seep of one litre/gallon a minute is over 1400 litres/gallons a day. The usable flow rate, at the time of year the water is required, must be determined before starting development.

Artesian Spring. These springs free flow water due to aquifer pressure. They are usually the easiest to develop, requiring no collection just an intake for piping.

Seep Spring. These springs have little or no aquifer pressure, being visible only as a wet area or by a difference of vegetation indicating water is present. They usually require a collection system connected to the distribution pipeline. Refer to Figure 1, next page.

Determining Flow. It is preferable to measure the water flow rate during the season of intended use. Using a temporary dam and pipe, collect the flow and record the time required to fill a container of known volume (refer to Factsheet #501.400-1). If the flow rate will meet the daily requirement and the peak use rate, the development will be straight forward. If the flow over 24 hours is sufficient for the1 livestock, but the peak use flow rate needs are greater, water storage will be required (refer to Factsheet #590.304-1).

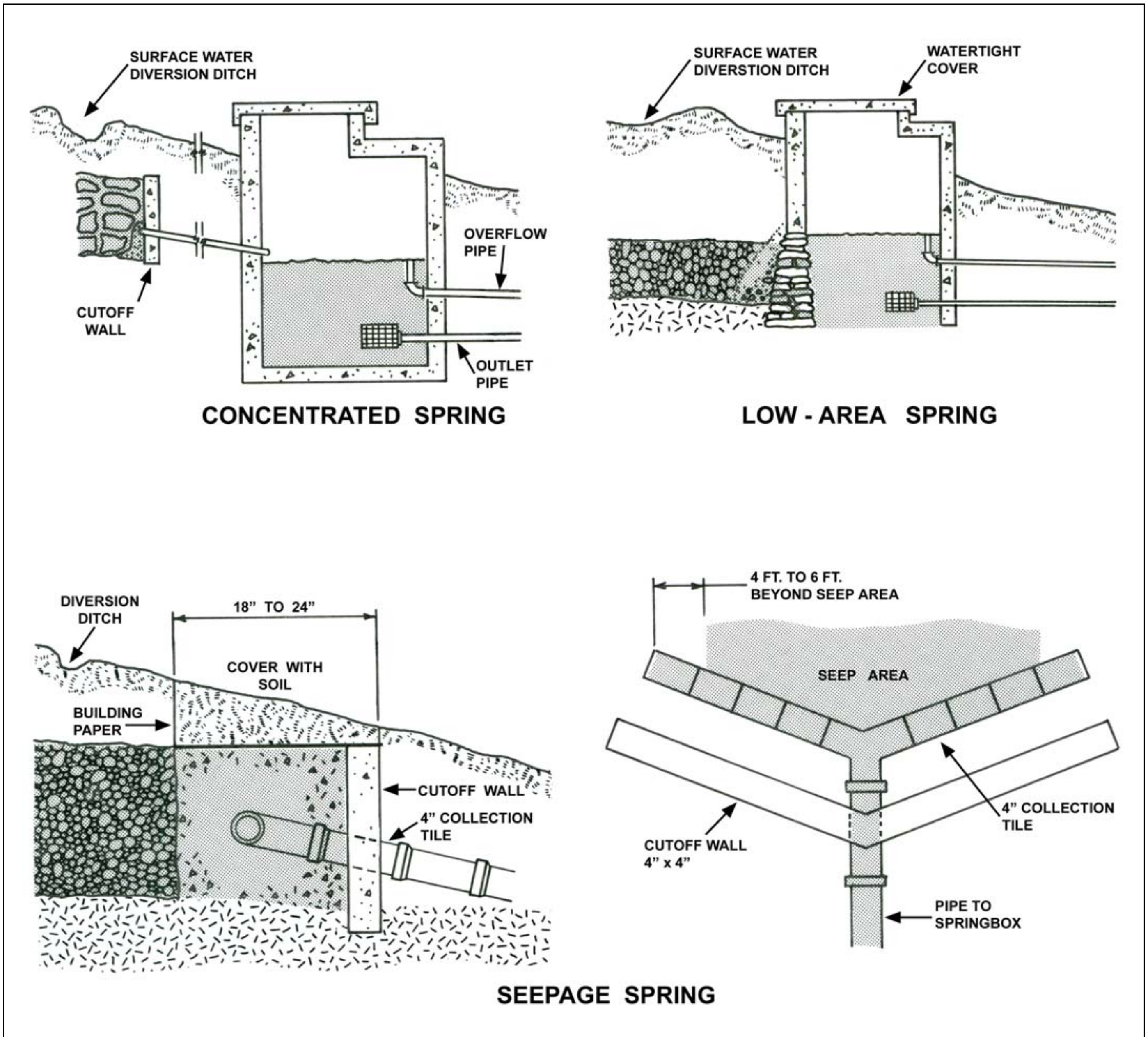


Figure 1 Spring Development

Developing Springs. Works to access a spring may be partially or totally buried in-ground. Basic development may be just to allow livestock direct access to the spring water. For supply to a trough, an intake and distribution system is installed.

The actual surfacing point of the spring may be only a very small section of the potential of the spring. Excavation parallel to the contour of the land, at or slightly below the spring outlet level, may substantially increase the flow of the spring. A series of perforated pipes can be installed in this ditch and backfilled with drain rock or other coarse material. These collector pipes are then joined together at a "spring box" where the water can be gravity fed or pumped to troughs, or to a storage facility. Figure 1 illustrates some good design points for developing springs.

Care must be taken to ensure that the water is not lost in any of the following ways:

- ensure the spring is free flowing and fully captured, as mentioned above
- ensure the water collection is on an impervious layer that will resist seepage
- ensure the water cannot seep around the outlet pipe by using a cutoff collar

There are two final parts to a good spring development. Fence the area off to prevent trampling and contamination by livestock, and ditch the site to protect it from surface runoff. Properly developed springs will have a long, low maintenance life.

Creeks, Rivers and Lakes

Surface water such as in creeks, rivers or lakes is a good source of livestock water. In low intensity grazing areas, such as on rangeland, livestock may access watercourses directly (refer to Factsheet #590.302-1). As livestock concentrations increase, direct watercourse access may not be appropriate and water should be supplied through water troughs to reduce the livestock impact on the water supply. To remove water from a watercourse, works (such as an intake or diversion structure) is required, and they must be licenced by an appropriate water licence.

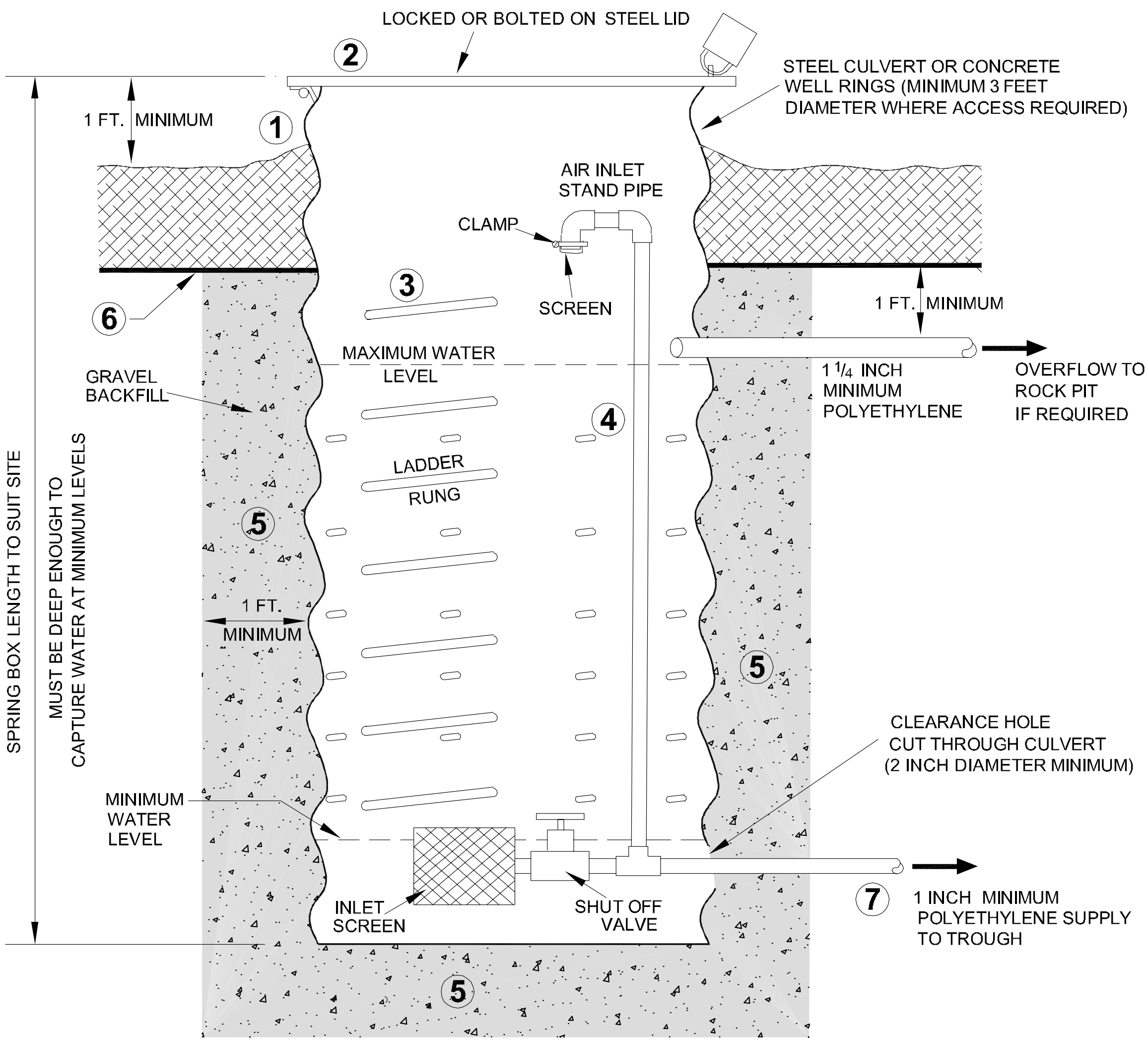
Water Quality. As discussed in dugouts, direct access by livestock may degrade water quality. With lakes, the reverse can also be true - algae 'blooms' can occur that are toxic to livestock (refer to Factsheet #590.301-3).

Intakes. Intakes for gravity feed or pump systems for livestock water are generally very simple structures as the water volumes are not large. Designs can vary greatly depending on the volume of the water source and the volume needs of the intake; debris in the source; high seasonal flows; ice in winter systems; protection of fisheries and compatibility with other water licences on the system.

Gravity Intake. Intakes for gravity pipe systems should not be subjected to high flow velocities but limited to a maximum of 0.3 m/sec (1 ft/sec). Stream flow velocities greater than this will require a diversion structure ahead of the intake. Refer to Figure 2, next page, for a drawing of an in-ground intake and to Factsheet #590.304-5 for details of gravity system piping.

Intakes can be constructed using poured in place concrete, gabions, upright culverts or, for small systems, driven pilings of sheet metal or treated wood, and must:

- allow movement of sufficient water to the distribution system
- regulate the volume of water
- remove floating debris and/or screen the water
- prevent entry of air with submergence of 250 to 300mm (10 to 12 in)
- be compatible with fishery requirements, such as screens



NOTES

1. INSTALL SPRING BOX SO SURFACE WATER CANNOT RUN INTO IT.
2. STEEL LID MUST BE SECURELY ATTACHED TO PREVENT DEBRIS ENTRY.
3. WELD PIPE 1 INCH x 18 INCHES LONG TO INSIDE OF STEEL CULVERT TO ACT AS LADDER RUNGS, ADD A METAL LADDER, OR USE PREFABRICATED LADDER IN CONCRETE RINGS.
4. SLOTS CUT INTO STEEL CULVERT (BELOW WATER LEVEL ONLY) TO ALLOW WATER ENTRY OR USE PERFORATED CONCRETE RINGS
5. GRAVEL BACKFILL ALL AROUND CULVERT (MINIMUM 1 FOOT WIDTH AND 1 FOOT ABOVE HIGH WATER).
6. COVER GRAVEL WITH PLASTIC SHEETING (6 MIL. " VAPOUR BARRIER ") OR GEOSYNTHETIC FABRIC BEFORE SOIL BACKFILL .
7. SIZE OUTLET PIPE FOR THE REQUIRED FLOW (REFER TO FACTSHEET 590.304-2)

Figure 2 In-Ground Gravity Intake

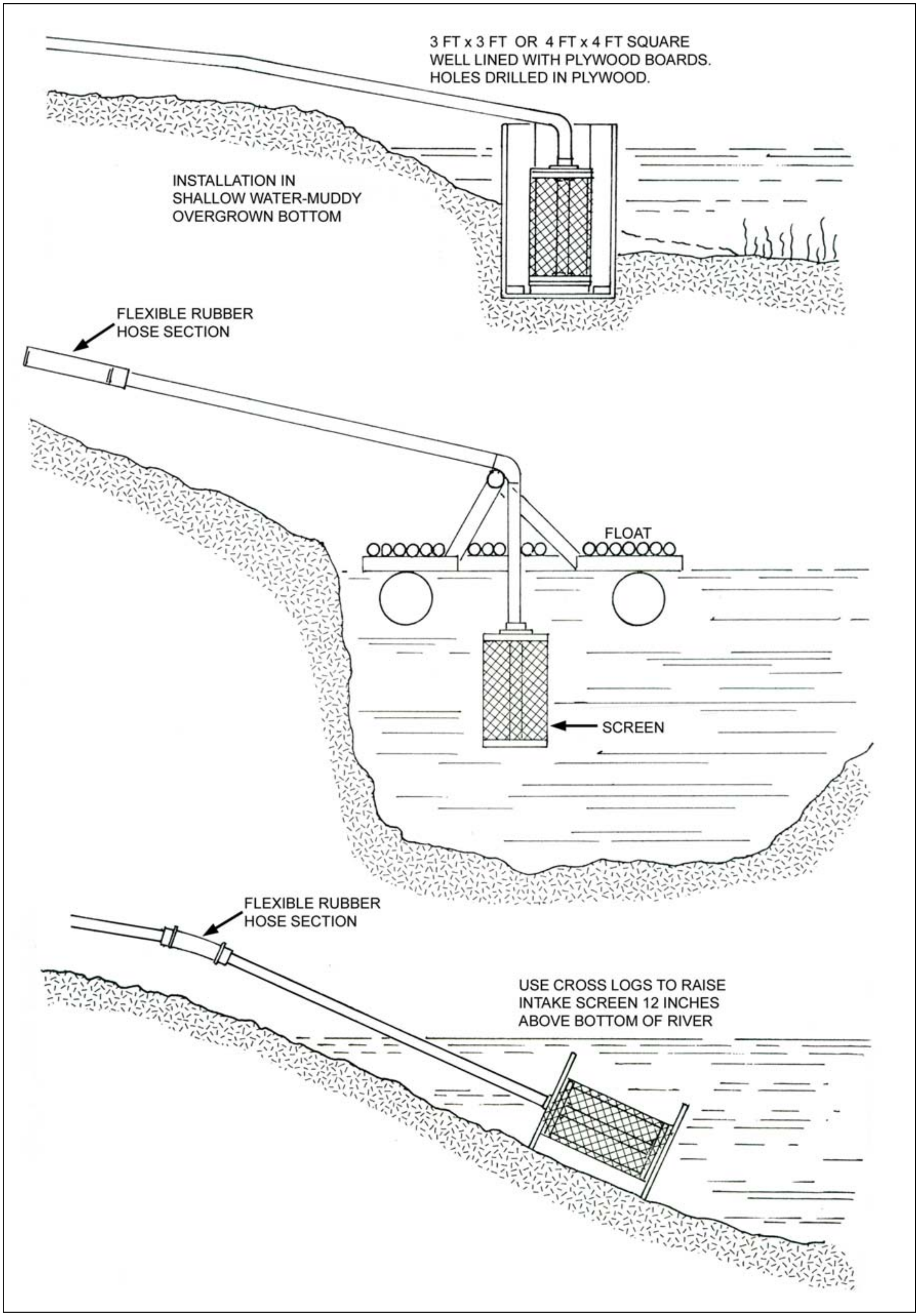


Figure 3 Typical Pumped Intakes

Air Vent. Air must be able to enter a gravity pipeline should the intake become blocked. This prevents damage to the pipeline from a possible vacuum being formed. An air vent can simply be a standpipe open to the atmosphere which extends above the water surface level. It must be positioned after the screen and shut off valve. A 19mm (3/4 in) vent for pipelines 50mm (2 in) or less will be adequate. The vent should be screened. See Figure 2, page 6, for an example of a vented gravity intake.

Pumped Intake. For surface mounted pumps, the intake need only be a screen located in the water source. Three typical installations are shown in Figure 3, page 7. The design used will depend on the water depth as well as the lake or creek bottom profile. A section of flexible rubber hose allows the intake to be easily adjusted. Airtight connections must be maintained to prevent air from entering the suction line.

Trash Racks. A trash rack located at the entrance to the intake or diversion will remove much of the coarse debris in the water source. Used in conjunction with a screen, the stock water supply system will be adequately protected. Trash racks can be vertical or sloped but should not be horizontal. Sloped racks may be easier to clean. A trash rack may be constructed using 6mm (1/4 in) steel bars spaced 19mm (3/4 in) apart.

Intake Screens. A properly sized screen on either gravity or pumped intakes will protect the water system. Screen size is selected for system protection and protection of fish stocks. Fisheries recommendations suggest screen mesh sizes with opening widths under 2.5mm (0.10 in); open screen areas that are not less than 50% of the total screen area and flow velocity through the screen a maximum of 0.03 m/sec (0.1 ft/sec). Refer to “Other Information”, below, for a screen-sizing worksheet.

Siphoning Water. If lake water is available for use but pumping is not a viable option, water can be siphoned out to be used in water troughs. A siphon is defined as a pipe flowing water from a supply source to a lower elevation that goes over an intermediate summit point higher than the supply. Before the flow will start, the entire pipe must be filled with water. This can be done at the summit point in conjunction with a foot valve at the inlet and a shut off valve at the outlet. The flow rate is determined by the difference in the inlet and outlet elevations.

Siphons may be difficult to operate because any air in the pipe will collect at the summit and can lead to air blockage of the water flow. This will occur more readily the higher the summit is above the supply. Because the pipeline pressure is less than atmospheric in this high section, air trapped here cannot be released but must be either drawn out by a suction pump or flushed down through the pipeline. For details on siphons, refer to Factsheet #590.304-5.

Other Information

Refer to the following for more information on accessing surface water:

- ***Quality Farm Dugouts***, a publication of Agriculture and Agri-Food Canada http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/eng4696
- an intake screen-sizing worksheet is available in the ***Environmental Farm Plan Reference Guide*** Chapter 9, Water Supply section, available at http://www.bcac.bc.ca/documents/EFP_Reference_Guide_March_2005_part_9.pdf
- the other Factsheets in this series mentioned in the above text

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