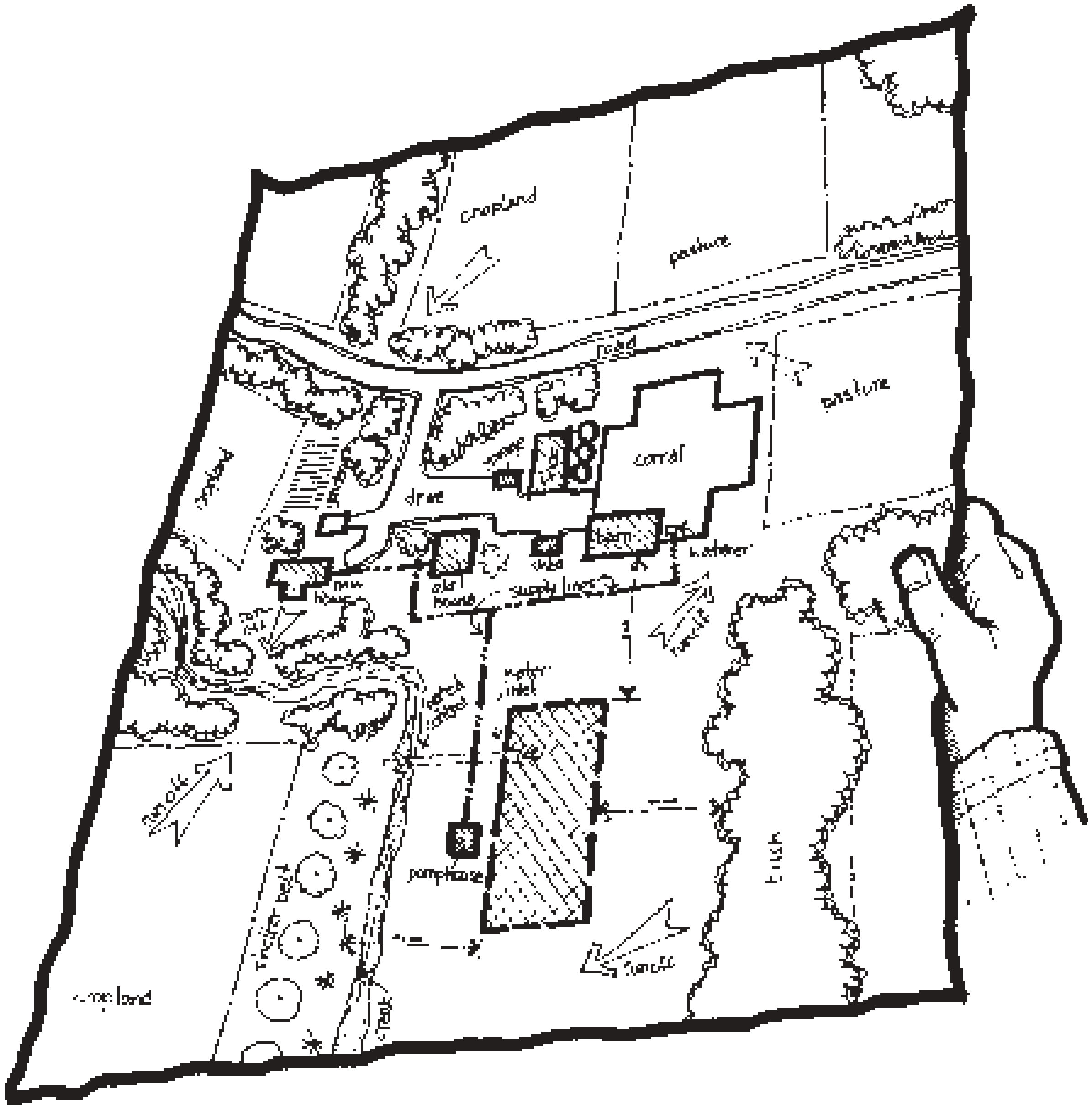
Planning


cropland
pasture
road
pasture
corral
drive
barn
old house
supply lines
water inlet
pumphouse
brush
runoff
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runoff
cropland

Planning Farm Water Supplies

Although a well-planned and designed water system may cost more initially, it will ultimately save money. Costly changes to correct future problems will be avoided.

The initial planning steps include:

- Determination of Water Requirements
  The first step in planning is to determine the amount of water required. Estimating future needs should take into account any anticipated changes such as an expansion or diversification of farm activities.

- Inventory of Water Sources
  The next step is to take an inventory of all water sources. Many farms use more than one water supply. Account for production rates, storage volumes, and any previous problems with water quantity or quality for each source. If the dugout is to be the only source of water, uncertainty of runoff volume should be factored into the sizing calculation. Because of frequent drought on the Prairies, it is recommended that all dugouts be constructed to hold at least a two-year water supply. In situations where the dugout is not critical to operations or alternate supplies are readily available, a smaller dugout may be chosen. Calculations in this manual however, focus on the two-year supply.

- Land Use Planning to Protect Water Supply
  Activities within a watershed have a large impact on water quality and quantity. Evaluating and adapting farm practice where it affects runoff, can do much to increase dugout utility.

Regulatory and Funding Issues

Before constructing a new dugout, it is important to be aware of legal restrictions that may apply. Ownership of surface and groundwater is vested in the provinces. Dugouts for household and livestock consumption do not usually require provincial approval. However, approval is required for the following uses:

- Aquaculture

- Commercial uses

- Municipal uses
- Tank-loading
- Irrigation.

In most jurisdictions, municipal and provincial, there are also requirements for minimum setback distances from public roadways. Stocking of dugouts with fish is controlled to minimize the risks of discharges that could introduce disease and non-native species of fish into natural waterways.

Before constructing a dugout, it is important that appropriate authorities are consulted to ensure compliance with existing regulations. Obtaining approvals well in advance will avoid delays in construction.

The federal government, through the PFRA, and the provincial governments offer technical assistance for the construction or improvement of dugout water supplies. Financial assistance may be available for some projects. Regulations and funding vary significantly between provinces. Provincial regulation summaries are provided in **Appendix 1.**

Watershed Runoff Potential and Water Quality

Both the quantity and quality of water are affected by the characteristics of the drainage area and the activities that take place within it. The most important characteristic in determining potential runoff into a dugout is the size of the drainage area or watershed. In addition, soil type, land use, topography, and vegetative cover all influence the total quantity of water that will flow into a dugout.

Watershed Runoff Potential and Dugout Sizing

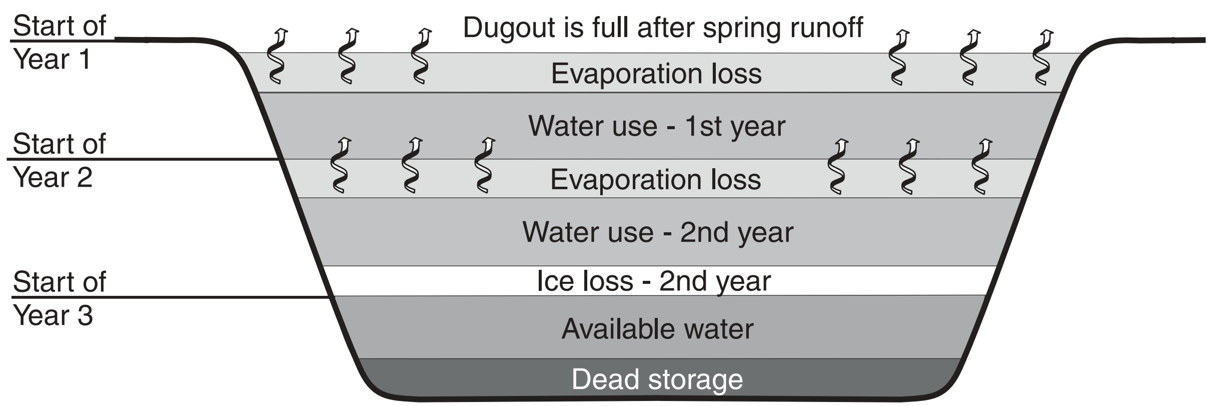
This section discusses factors that should be considered when selecting a site for your dugout. It is essential that a dugout be located to capture the quantity of water required. There are many considerations when choosing a site. Inevitably, some trade-off between conflicting factors will be required. However, it is worth the time and trouble to find the best location for a dugout that will be in use for many years.

Dugout Sizing

Dugouts fill with runoff from the surrounding land. The most important factors to consider in sizing are the potential amount of runoff that will be captured, evaporation loss, and the shape and dimensions of the dugout.

Figure 10 illustrates the necessity of sizing dugouts properly so they provide a dependable source of water. In this example, the dugout has received no runoff water in two years. The cross-sectional view shows how the supply of available water is reduced by farm use, lack of runoff, evaporation, and ice formation in winter. In addition to uses and losses, the water at the bottom of the dugout will be of such poor quality, that it is rated as dead storage and unavailable for use.

Figure 10 Dugout Size vs. Available Water



Runoff volume is determined by the amount and timing of snowmelt or precipitation, plus vegetation, soil type, soil moisture, and topography. The smaller the quantity of runoff expected in an area, the larger the contributing area must be to fill a dugout. In some dry regions of southeastern Alberta and southwestern Saskatchewan, more than 2000 acres of land are required to produce enough runoff to fill a dugout with a capacity of one million imperial gallons. In wetter areas of southeastern Manitoba, less than 25 acres would be required to supply the same volume.

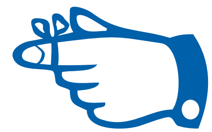


Figure 11 shows the approximate area of land required to provide runoff water volume equal to or greater than one million imperial gallons. Runoff varies a great deal from year to year. The map is based on long term runoff data. In eight out of every ten years, the specified amount or more runoff occurred. In two out of ten years, there was less runoff. The uncertainty of runoff should be kept in mind when planning dugout size. If a particular watershed is too small to provide enough runoff, you have two choices:

- Find a larger watershed.
- Find an additional watershed and build a second dugout.

When faced with these choices it is a good idea to consult a water specialist. Evaporation rate is an important factor in dugout sizing that varies widely between regions. Figure 12 is a map of evaporation loss zones on the Prairies. The greater the evaporative losses, the greater the storage volume must be to guarantee continuous supply.

The shape of a dugout has important implications for both the quantity and quality of the stored water. Historically, most dugouts have been about 12 feet deep. However, new larger structures are being excavated to depths of 15, 18, and 21 feet and even deeper.

A deeper dugout is more efficient because it has less surface area for the same capacity, and thus loses less water to evaporation. This can have a significant effect on the required volume. For example, in Evaporation Zone 4, a 21 foot-deep dugout can be constructed with approximately two thirds the volume of a 15 foot deep dugout and provide the same amount of available water. Deeper dugouts tend to have better water quality, particularly in winter. Three main concerns with deeper dugouts are high water tables, seepage losses, and increased safety hazard.

During winter, dugouts freeze and some of the stored water becomes unavailable for use. Ice can reach up to 2 to 3 feet in thickness, which may represent up to 20-40% of total volume. Figure 10 shows the amount of stored water that becomes unavailable for use during winter.

Figure 11 Runoff Map

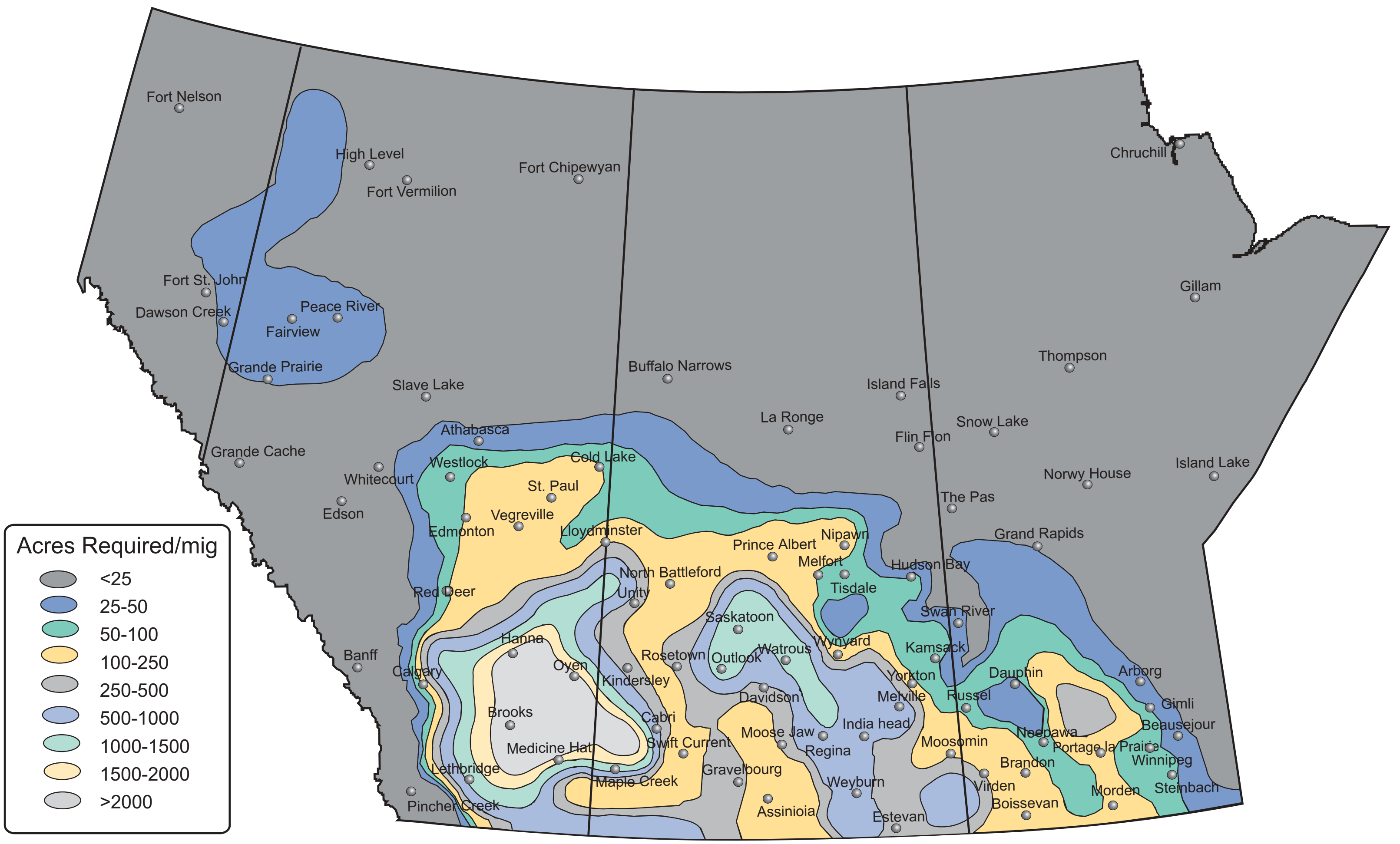
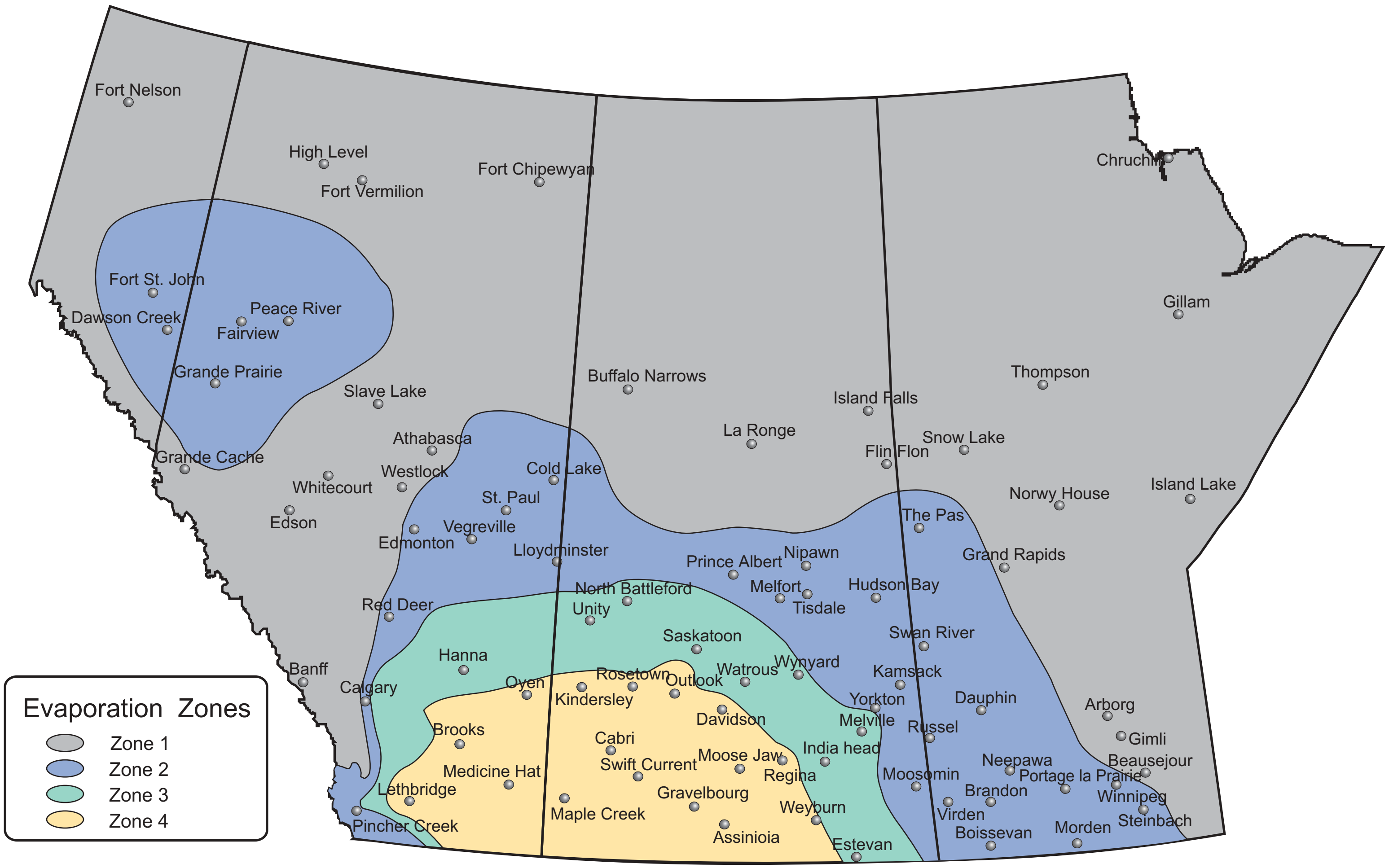
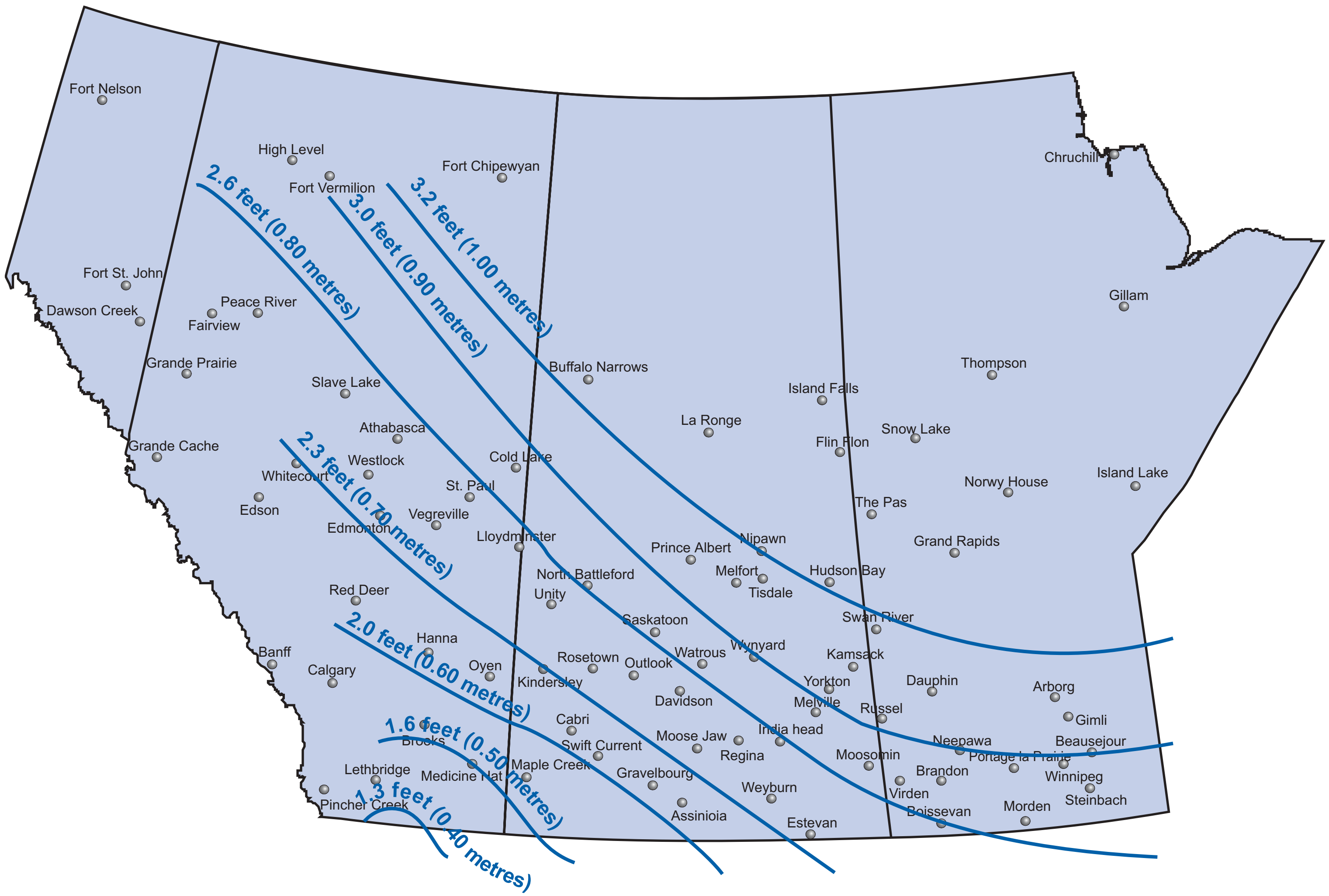


Figure 12 Evaporation Zones



In general, the colder the climate the thicker the ice, and the greater the loss of available water. However, this can be offset by differences in snowfall. Snow cover on the ice insulates the water from further freezing. Figure 13 shows average expected ice thickness on small water bodies in different parts of the Prairies.

Figure 13 Ice Thickness Map



The climate and runoff information given above is used to plan the size of a dugout for any location on the Prairies.

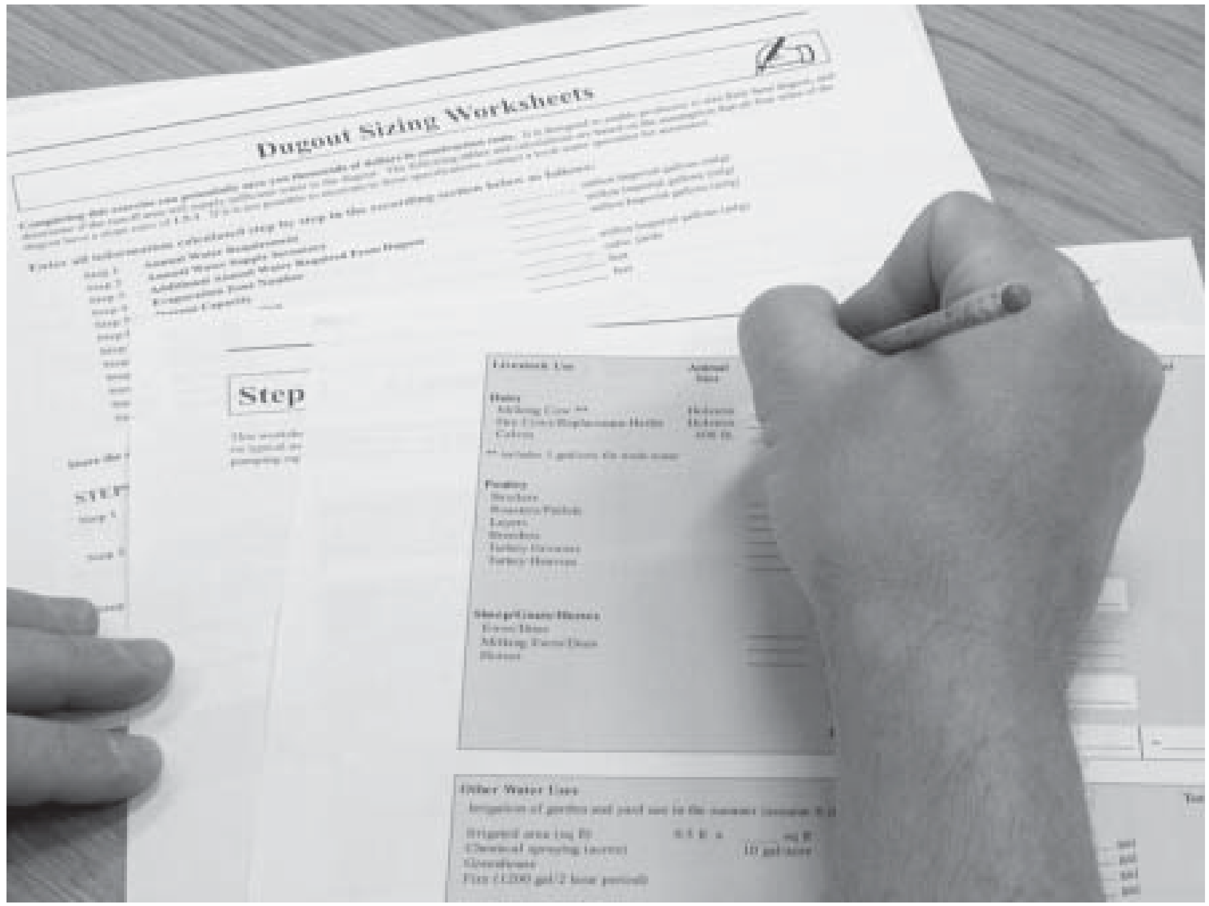
Figure 14 illustrates an example of the dugout sizing process for the Joe Agricola Family Farm at Kindersley, Saskatchewan. Remove the completed example from the pocket inside the front cover of the manual and work through it. **Completing this exercise can potentially save you thousands of dollars in construction costs.** Carefully follow the steps and calculations to understand the process. Blank forms for accurately sizing your farm dugout are located in the pocket inside the back cover of the manual.

Water Quality and Watershed Management

Good watershed management is the first line of defense for ensuring good quality, dugout water. Using what are termed Best Management Practices or **BMPs** within the catchment or runoff area can minimize the possibility of dugout water contamination. Contamination occurs through a number of processes.

- Plant nutrients from natural sources, fertilizers, and manure entering a dugout in field runoff stimulate the growth of plants and algae.
- Pesticides can contaminate water when stored improperly, mixed carelessly, or spilled. They can also be present in runoff water from recently sprayed fields. Airborne drift clouds are able to travel long distances and may be deposited in streams, lakes, and dugouts.
- Runoff from livestock confinement areas is typically rich in nutrients and likely contaminated with bacteria, viruses, and parasites.
- Poorly sited waste disposal sites or inadequate storage facilities, can contribute fuels, paints, solvents, and other hazardous chemicals to dugout in-flow water.
- Water erosion loads runoff water with soil, nutrients, and pesticides that may end up in dugouts. Long, steep slopes in the landscape, that are not under perennial cover, are very susceptible to water erosion events. Even relatively level fields can be subject to severe water erosion during spring runoff and heavy rainfall events. Silty soils are particularly susceptible to water erosion. Suspended solids in runoff water cause turbidity in dugouts, causing problems in water distribution systems and increasing the difficulty and cost of treatment.
- Wind erosion may lead to contamination of dugouts when soil is blown into the water from adjacent fields or livestock areas. Sandy soils and heavy clay soils are most susceptible to wind erosion.

Figure 14 Dugout Sizing Example

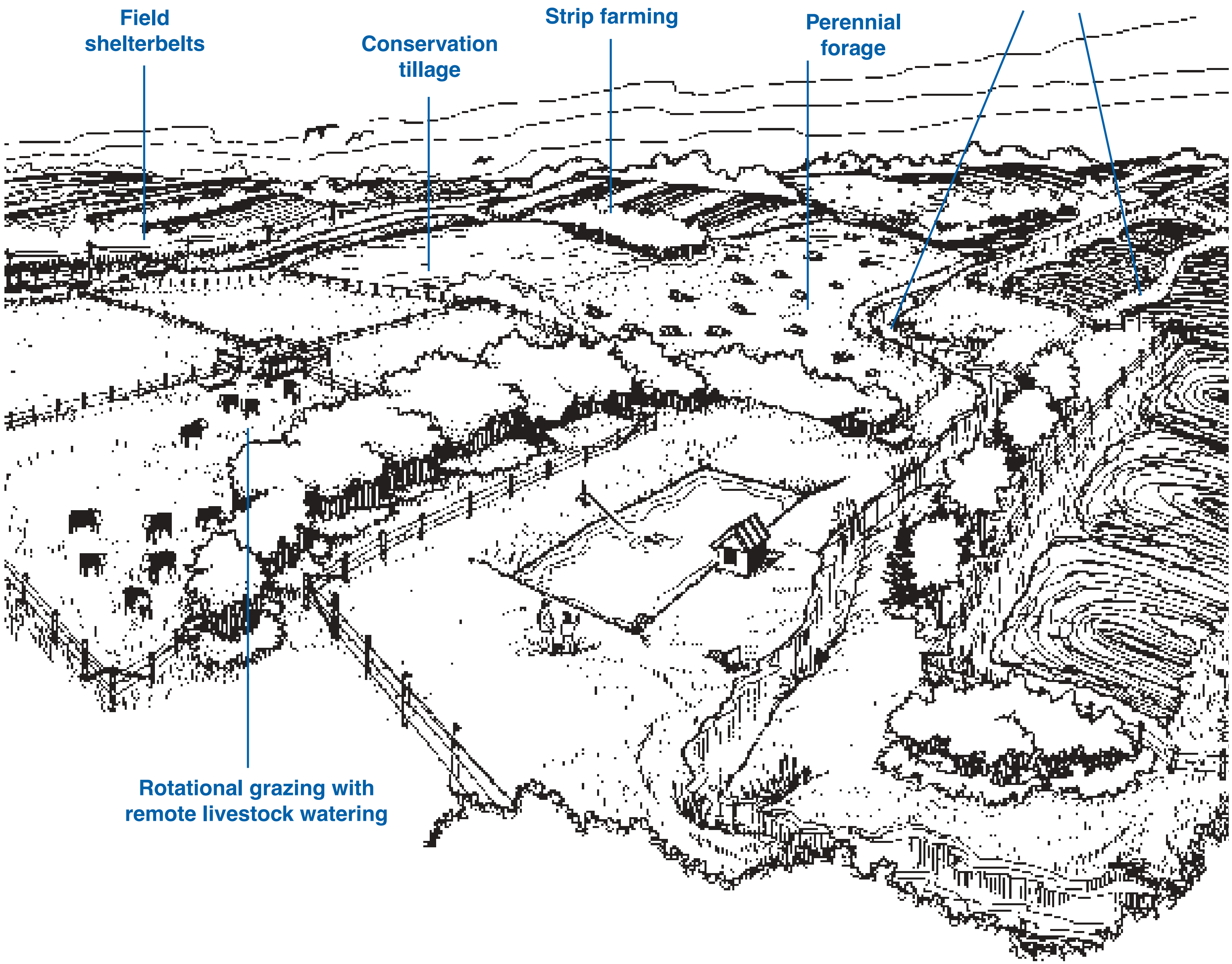


Best Management Practices in a Watershed

The following BMPs can reduce erosion and contamination of inflow water:

- Agricultural fields in annual cultivation are prone to wind and water erosion, particularly when residue cover is poor in winter and early spring. Soil surface protection practices are highly effective ways of preventing erosion:
  - Seeding erodible land to perennial forages
  - Using conservation tillage
  - Maintaining crop residues in the fall
  - Using winter cover crops
  - Using crop rotations that follow low-residue crops with those with higher straw-yield.
- Practices that slow water runoff velocity and reduce water erosion:
  - Grassing waterways
  - Contour planting placing rows perpendicular to the slope of a field.
- Practices that slow wind velocity and reduce wind erosion:
  - Strip farming consisting of alternating bands of annual and perennial crops.
  - Planting and maintaining shelterbelts.
- The amount of fertilizers applied in a watershed can be minimized by proper nutrient management planning. Nutrient management is based on application of only enough fertilizer to make up the difference between the amount available in the soil and the crop requirement.
- Total amounts of pesticides applied to a watershed can be minimized through the principles of Integrated Pest Management or "IPM". IPM is a pest management system using the application of a variety of management practices and control measures.
- Remote watering systems prevent livestock from having direct access to a dugout, or to other areas in the watershed that directly contribute runoff to a dugout.
- Good manure management protects water from contamination. As with chemical fertilizers, manure should not be applied in quantities that provide plant nutrients in amounts that exceed crop requirements.
- Good livestock management prevents over-grazing, which can leave soils susceptible to erosion. This can be prevented by using a rotational grazing system.

Figure 15 Watershed with Best Management Practices



Dugout Siting

Locating a dugout to collect enough water is of primary importance, but there are other factors to consider when planning the location:

Proximity to Water Use:

By locating a dugout close to places where the water will be used, construction and maintenance costs of water lines and power pumping costs can be minimized.

Proximity to Electrical Power

Most water delivery systems have the pump near the dugout. Nearby electrical power reduces costs for extending power lines. Ready access to power also allows for easy installation of an electric aeration system.

Trees

Properly placed trees can act as snow traps and increase the amount of runoff collected each spring. However, trees close to the dugout tend to block the wind and reduce the positive effects of wind on the mixing of dugout water. Trees also reduce the effectiveness of any windmill-driven mixing devices. Leaves and twigs that are dropped by trees and deposited into dugout water add organic matter and plant nutrients that encourage weed and algae growth and reduce water quality. Large trees planted close to a dugout can use much of the stored water if their roots can reach the reservoir. It is recommended that deciduous trees be planted no closer than 160 feet (50 meters) and coniferous trees and shrubs no closer than 65 feet (20 meters).

Proximity to Other Water Sources

If possible, locating a dugout near another water source is advisable. Dugout water quality can sometimes be improved by pumping water into a dugout from another source such as a creek or slough.

Contamination

Sites that could be affected by contaminated runoff or leaching should be avoided:

- Manure storage areas
- Animal confinement areas
- Waste disposal sites
- Pesticide and fertilizer storage areas
- Septic fields
- Commercial and industrial sites.