

B.C. SPRINKLER IRRIGATION MANUAL

Chapter 1

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LIMITATION OF LIABILITY AND USER'S RESPONSIBILITY

The primary purpose of this manual is to provide irrigation professionals and consultants with a methodology to properly design an agricultural irrigation system. This manual is also used as the reference material for the Irrigation Industry Association's agriculture sprinkler irrigation certification program.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to complete more advanced design for some systems. Advice of appropriate professionals and experts may assist in completing designs that are not adequately covered in this manual.

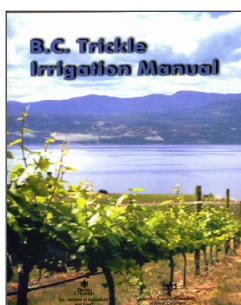
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HOW TO USE THIS MANUAL

This manual provides design information for agricultural sprinkler irrigation systems in British Columbia. Wheel lines, solid set sprinkler, guns and travelling guns and center pivot systems are all covered. The manual provides the designer with data on soils, crops, and evapotranspiration rates; how to calculate irrigation system water requirements, application rates, set times and irrigation intervals; and design information on piping, pumps, screens and water diversions. Some of the design information has been compiled from the various publications listed in the references.



Copies of this manual can be obtained from the Irrigation Industry Association of British Columbia (IIABC). See the web link below. A separate manual on trickle irrigation (B.C. Trickle Irrigation Manual) is also available through the IIABC.

 **B.C. Trickle Irrigation Manual**

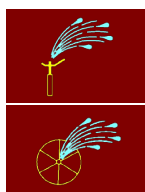
 **www.irrigationbc.com**

1.1 Contents of this Manual

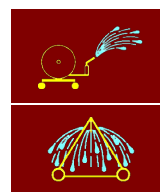
This manual has 11 chapters and six appendices that provide a step by step process for the design of a sprinkler irrigation system. Figure 1.1 provides an outline of the step by step process along with a reference to the chapter where the information can be found. Not all of the steps must be followed in the chronological order shown however this approach offers the best chance for a novice designer to accomplish an efficient and effective design.

Sprinkler Irrigation Design Procedure

To assist in this process there are four example designs that are carried through the entire Manual to demonstrate how formulae and concepts are applied. The four designs chosen are solid set sprinkler, wheelline, travelling gun and centre pivot systems. The examples and/or worksheets will indicate which type of system is being evaluated by using the following symbols:



Solid Set Sprinkler



Travelling Gun



Wheelline Sprinkler



Centre Pivot

Chapters in this Manual

A summary of each of the chapters is as follows:

Chapter 1. How to Use this Manual and Get Started

This chapter provides a chart that explains a step by step design process, conventions and nomenclature used in the manual as well as a brief summary of the content of each chapter.

Chapter 2. Legislation and Governance

This chapter discusses regulations pertaining to the withdrawal and use of water for irrigation purposes, approval requirements for works in and about a stream, regulations regarding chemigation and reclaimed water use as well as backflow prevention requirements for various water sources.

Chapter 3. Irrigation System Selection

Correct selection of sprinkler system type is the first step in designing an efficient irrigation system that is right for a specific crop. This chapter provides information on the various system types such as operation characteristics, efficiencies and design considerations.

Chapter 4. Crop, Soil and Climate

Soil, crop and climate limitations determine the irrigation design parameters that must be met by the irrigation system. Maximum soil water deficit, maximum application rate and irrigation interval are all determined by the climate, soil and crop type and all affect the design of an irrigation system.

Chapter 5. Sprinkler System Design

Correct selection of sprinkler spacing, nozzles and operating pressures is required to design an efficient irrigation system. This chapter includes tables developed by the B.C. Ministry of Agriculture which offer a rapid technique for selecting sprinkler nozzle sizes, spacings and aluminium lateral pipe sizes based on application efficiency, operating pressures and application rates for wheel line and hand line systems.

The design process for solid set sprinkler and micro-sprinkler systems is also provided.

Chapter 6. Gun System Design

Design information is provided to help select nozzle size, operating pressures, gun spacing and set times. Formulas for calculating the instantaneous application rate of stationary and travelling gun systems are provided. Gun equipment tables are available that assist in determining gun flow rates and operating wetted diameters.

Travelling gun systems have specific design requirements that are different than stationary sprinklers. Design considerations for a travelling gun system

including instantaneous application rates for part circle guns, hose friction loss and machine hook up pressure information are provided. Tables are included which provide depth of water applied for various flow rates, lane spacings and travel speeds.

The operation of irrigation systems near electrical transmission lines has been of concern to hydro authorities. This chapter provides a method, developed by B.C. Hydro and B.C. Ministry of Agriculture, for designing stationary and travelling gun systems to ensure that minimum clearance standards from hydro transmission lines are met.

Chapter 7. Centre Pivot Design

Centre pivot systems are available with fixed pattern sprinklers, variable spaced sprinklers and spray nozzle configurations. Information on the operation and design of centre pivot irrigation systems is provided.

Chapter 8. Pipe Selection, Design and Installation

Nozzle size, flow rate and operating pressure contribute to lateral design in solid set and micro-sprinkler systems. This chapter provides information on how to design laterals to ensure irrigation system uniformity is maintained.

Irrigation mainline pipe selection is based on pressure ratings, pipe size, friction loss, water hammer and installation. This chapter should be used in conjunction with Appendix A and B to design irrigation system mainlines. Appendix A provides information on pipe properties. Appendix B provides friction loss for the various types of pipe used in the irrigation industry.

Chapter 9. Motors, Engines and Power

Information on pumps and motors are provided to assist a designer in selecting the best available pumping unit that will be most optimal for the irrigation system. This chapter includes information on cavitation of centrifugal pumps, well sizes for turbines and phase converters for irrigation pumps.

Chapter 10. Diversions and Intakes

Various types of intakes and diversions are discussed and provide general guidelines in diverting water from creeks and rivers. Information on screen sizing is important to ensure that the irrigation system intake meets fishery regulations.

Chapter 11. Irrigation Water Quality

Water quality can affect the performance of sprinkler irrigation systems, infiltration rate and crop growth. Information from the Canadian Water Quality Guidelines for use with irrigation are provided.

Appendices

There are six appendices in this Manual:

- Appendix A. Properties of Irrigation Pipe
- Appendix B. Friction Loss Tables
- Appendix C. Sprinkler Irrigation Design Plans
- Appendix D. Publications and Website
- Appendix E. Unit Conversions
- Appendix F. Glossary

1.2 Conventions Used in this Manual

Units

This guide uses an assortment of units for irrigation system design. Conventional units that are common to the irrigation industry are used. Metric units are also provided as much as possible. A unit conversion chart is provided in Appendix D.

Colour Codes

This Manual uses a variety of colours for users to easily identify tables, equations, assessments, design examples, calculations and helpful tips.

Tables

Sorted data or information is tabulated.

Equations

On the right of the equation bar, reference is made to the worksheet number where the Equation will be used.

Irrigation Design Examples



The design examples that are carried through the manual will be designated in boxes with this colour scheme and the symbol noted in the top right hand corner. The examples and/or worksheets will indicate which type of system is being used for the calculation by using the following symbols:



Sprinkler System



Wheel line System



Travelling Gun System



Centre Pivot System

Helpful Tips / Warnings or Clarification

Helpful tips are provided in some instances to assist the designer through the design process and to ensure that the correct values are chosen. In some cases this box may also be used for warnings with respect to system safety or clarification of calculations used.

Acronyms

Commonly used acronyms in this Manual are:

AWSC = Available Water Storage Capacity

CID = Certified Irrigation Designer

DU = Distribution Uniformity

ET = Evapotranspiration

IIABC = Irrigation Industry Association of British Columbia

MSWD = Maximum Soil Water Deficit

Reference Information

Reference information is included within the text in each chapter. The following symbols indicate that reference information is available:

in other publications,

 **B.C. Trickle Irrigation Manual**

in the world wide web, or

 **www.irrigationbc.com**

within this Manual.

 **Sprinkler System Design, Chapter 4**

1.3 Site Information

To complete an irrigation design the following site information should be collected:

- Field dimensions, shape and topography;
- Location of water source;
- Hydro power location if electric supply is to be used;
- Elevation from water source to the highest point of the field;
- Soil texture and depth of each soil layer;
- Crop type;
- Climatic data for the farm location; specifically peak Evapotranspiration rates, annual Evapotranspiration and Climatic Moisture Deficits.

Example site plans and design plans are provided throughout the chapters in the manual that show the details indicated above. Appendix C provides complete plans and design information for the examples used in the manual.

1.4 Design Procedure

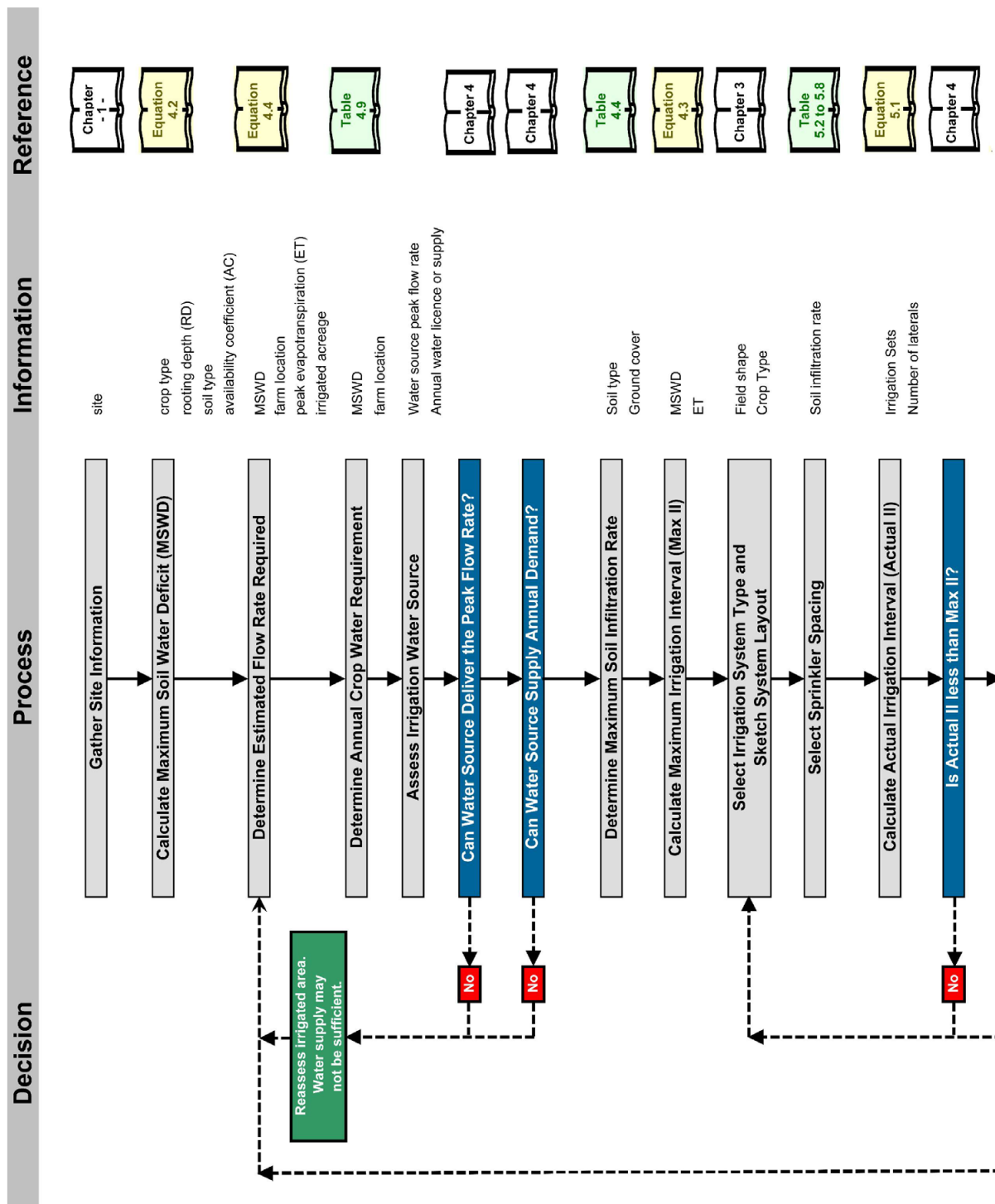
The design of an irrigation system can be made easier if the design steps are followed in a sequence as outlined in Figure 1.1.

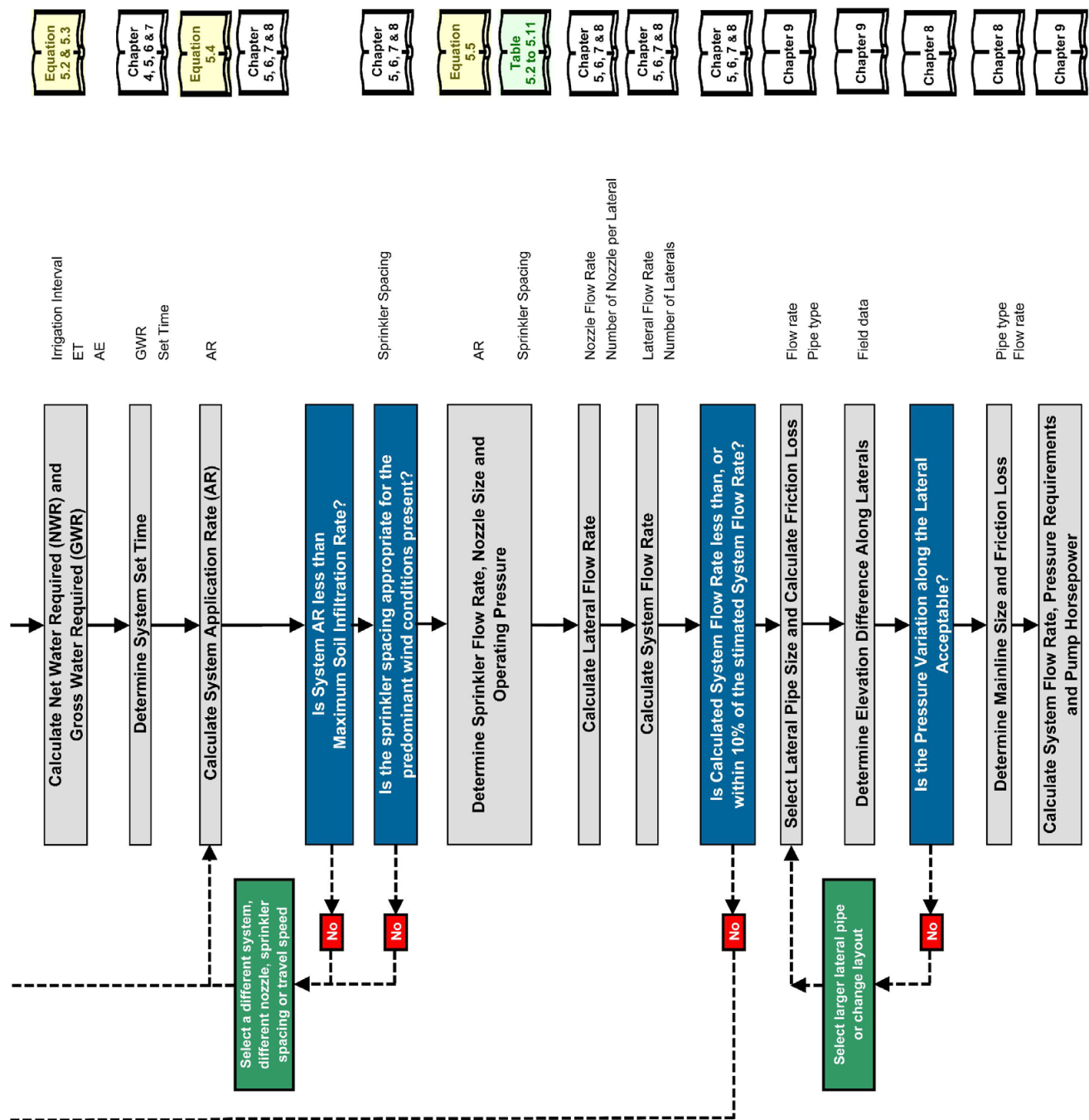
The sequence outlined is for a sprinkler irrigation system such as wheelline, handline or solid set system. If doing a travelling gun design the same sequence can be followed but the equations that are referenced in Figure 1.1 in this section may change. For example the calculation of the application rate or the Gross Water Applied would be equation 6.4. The process in chapter 6 should be followed.

For center pivot design, the process for determining the estimated system flow rate and crop water requirements can be used but Chapter 7 should be used to determine the particulars of the pivot system. Many of the center pivot design and operating characteristics are established by the manufacturer based on the crop water requirement and area irrigated.

Completed plans and design parameters used for the examples in this manual can be found in appendix C.

Figure 1.1 Sprinkler Irrigation System Design Flow Chart





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