652.1005 State Supplement

(a)(1) Irrigation Water Management (IWM) Plans and Documentation

Appendix A establishes minimum requirements in Idaho for an IWM Plan and minimum requirements to document implementation of an IWM Plan with cost-share assistance. Enhancements to the minimums are identified and are encouraged to be used. Appendix B is an example IWM plan and in Appendix C the record keeping documentation for one irrigation season is shown.

The IWM plan shall be reviewed with and a hard copy given to the cooperator. A copy of the complete plan shall be kept in the cooperator's file.

Note that improvements in delivery efficiency, application efficiency or other irrigation water management improvements do not always result in "water saved" at the water source.

(b)(1) Appendix A - Minimum IWM Plan Documentation Requirements

Minimum IWM Plan Requirements for all NRCS Assistance is located in Montana Irrigation Manual, Amend. MT5, Feb. 2002.

Irrigation Water Management (IWM) Plans

Irrigation Water Management (IWM) Planning is required for ALL irrigation water management practices, components and system evaluations. (For example: flow measurement /flow meter assistance, irrigation scheduling assistance, surge valves, pipelines, reuse systems, land leveling, etc.). These minimum requirements apply to all NRCS cost shared and non-cost share assistance.

The IWM plan shall be reviewed with the cooperator, and a hard copy given to the cooperator. A copy of the complete plan shall be kept in the cooperator's file.

Note that improvements in delivery efficiency, application efficiency or other irrigation water management improvements do not always result in "water saved" at the water source.

Minimum Requirements. Recorded in the IWM plan or contained in the conservation plan.

1. Statement of Purpose or Goal and controlling factors of the irrigation method being used.
2. Conservation Plan Map
   a. Irrigation Distribution System (water supply and quality, controls and system losses)
   b. Irrigation Application System (controls, problems, efficiency considerations)
3. Soils
   a. Soils Map – Non-Technical Soil Description (with additional detailed information as needed)
   b. Available Water Holding Capacity (AWHC) of the irrigated area (for each field being planned)
4. Crop Data
   a. Effective irrigation rooting depths used for management decisions.
   b. Description of Consumptive Use (peak use and/or seasonal growth curves)
   c. Seasonal Crop Water Use (for type of crop).
5. Gross Application Determination
   a. System capacity to meet maximum gross application requirements for all crops to be grown.

b. Gross irrigation application determination for scheduled applications for each crop to be irrigated by the system.

6. Description of Scheduling
   a. Time of operation
   b. Day to day effects of wind, heat and humidity on system performance
   c. Soil moisture estimation method

7. Operation and Maintenance (O&M)
   a. Frequency required for each maintenance item
   b. System specific details.

Documentation of Irrigation Water Management (IWM) Plan

As a first step in setting up an Irrigation Water Management Plan (IWM), one should gather the on-file conservation plan for the farm or relevant information downloaded from computer data files. The IWM plan for a specific contracted item or component practice should be coordinated with other aspects of the total farm plan.

a. A goal to be accomplished for the current activity or practice should be described. The goal should relate to other irrigation activities on the farm, and those items that control or effect the successful outcome of the irrigation practice(s) being evaluated.

b. From the conservation plan map, soils photo, ortho-quad or other image, the water source, control devices, field and application system should be described along with conditions that might affect the operation.

c. A brief description of the soil characteristics should be made. Intake family characteristics or rates, Available Water Holding Capacity (AWHC), Management Allowed Depletion (MAD), and possible erosion or salinity problems should be outlined for the major soil areas. Any other soil details that could affect the operation should be highlighted.

d. All crops grown or being considered by the operator should be characterized for rooting depths used in irrigation, peak and seasonal consumptive use rates, and impacts on production of water shortages during important growth periods.

e. The peak period of crop consumptive use for all crops likely to be grown must be determined to calculate the minimum water delivery. The peak period may be any of the following:

   1) A one- or two-week period of maximum consumption for sets where an effective root zone is filled to the total water holding capacity,

   2) The total seasonal use expected to be needed by the crop, considering effective carryover moisture and effective rainfall or,

   3) The maximum crop water use for an individual day to be provided as a net depth by the application system (for example, by a center pivot).

f. With the peak period consumptive use determined, a net application required to meet the crop demand is made. A gross application volume is determined by dividing the required net depth by the system application efficiency, adjusted for effects of wind, field elevation variations, distribution uniformity, or other site-specific conditions.

g. A suggested schedule for repeated applications should be made that describes how the system operation can meet the seasonal water needs of the crop. This schedule must be flexible to meet varying crop growth rate demands and changes or interruptions in water delivery.

h. A method to estimate soil moisture available before (carryover) or during the irrigation season should be included to help make adjustments to the scheduled applications.

i. A measurement method for determining the amount of water applied shall be included. Tools such as flow meters, flumes, measurement weirs, tables for nozzle performance, or other appropriate methods for the type of systems could be used.

j. The quantity of water conserved, or the improved uniformity of water application, either per application or throughout the entire irrigation season should be estimated.

k. An Operation and Maintenance (O&M) Plan to keep the performance of the systems near its original operating condition should be outlined for the owner/operator's benefit.

Optional Information. The following are examples of optional information which may included in the IWM plans. Some will not apply at some sites, and some will apply only to certain system types. There may be other information not listed that may be included in these plans.

8. System
   a. Discussion of application method
   b. System capacity
   c. Expected efficiencies
   d. Pumping plant information
   e. Economics
   f. Manufacturer's information (pipeline installation, sprinklers, valves, etc.)

9. Additional Soils Information
   a. Detailed soil AWHC by soil families
   b. Estimating Soil Moisture by Feel and Appearance
   c. Infiltration information
   d. Leaching requirements and methods (required for some situations)
   e. Erosion information and computations
   f. Maximum non-erosive flow “Qmax”
   g. PAM information
   h. Organic matter information
   i. Soil test analysis

10. Additional Crop Information
    a. Irrigation Water Requirements (IWR) Output
    b. Root depth limitations
    c. Maximum percentage by crop and/or crop stage
    d. Actual and predicted Evapo-Transpiration (ET) information
    e. Agri-Met sites that may be nearby and helpful
    f. Nutrient management, chemigation, pesticide management, etc.
    g. Crop rotation and yield information

11. Additional Scheduling Information:
    a. Consulting agronomists (MSU, seed companies, private consultants)
    b. Description of soil moisture equipment
    c. Surge valve operation recommendations
    d. General definition, QT = DA

12. Evaluation and Recommendations
    a. Engineering forms plus design data
    b. Computer model documentation (i.e., FIRI– Farm Irrigation Rating, SRFR– Surface Irrigation, CPED– Center Pivots, etc.)
    c. Evaluation results (catch can tests, cylinder intake information, etc.)
    d. Listing of System Planning Alternative

e. RUSLE (soil loss), WEQ WIN-PST (pesticides) documentation

f. Supporting information.

References

1. Montana Irrigation Guide and Manual
2. NRCS, National Irrigation Guide, Part 652, in particular:
   a. Chapters 2, 3, and 4
   b. Chapters 9 and 10, which contain example Irrigation Water Management Plans
   c. Chapter 15, which contains numerous blank forms and worksheets.
3. NRCS, National Engineering Handbook, Part 623, Irrigation
4. NRCS, National Agronomy Manual
5. Local County Extension Agents
6. U.S. Bureau of Reclamation's AGRIMET system; available on the Web
7. Manufacturer's Information

(b)(1) Appendix B - Example Irrigation Water Management Plans

(MT-ENG-250A or 250B IWM Plan Cover sheet are available on the Montana NRCS web site)

U.S. Department of Agriculture
Natural Resources Conservation Service

MT-ENG-250B
January 2002

NRCS MONTANA - IWM - SPRINKLER IRRIGATION

What is Irrigation Water Management (IWM)?

Irrigation Water Management (IWM) is managing the rate, amount, and timing of water application according to the seasonal crop needs, giving consideration to the soil intake and water holding capabilities. The application frequency and water quantity used are managed to obtain optimum yields, using the appropriate amount of water based on soil moisture and crop water use.

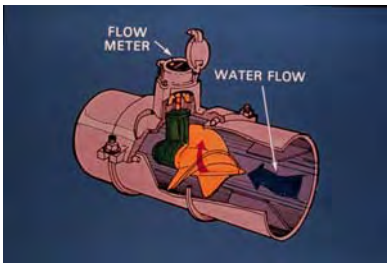
Soil and Water Resources

In most cases, IWM reduces water loss due to deep percolation, runoff, evaporation, system leaks, or seepage. It takes advantage of any effective rainfall.

Sprinkler applications that exceed the soil intake, can cause runoff, erosion, and deposition of sediment along with attached nutrient transport.

Requirements of Irrigation Water Management

The adage "You can't manage what you can't measure" is very true in irrigation. It is the starting place for every irrigation set. There are many types of flow measurement meters that can be used to determine the amount of water delivered to a sprinkler system.



Propeller-Type Flow Meter

Many are a type of propeller that is placed into the pipeline flow, which displays a reading in gallons per minute. The flow rate is shown on a dial gauge having a needle pointing to the GPM, or with digital readout. Most measurement devices have less than 5% error when properly installed and used. Knowing the flow rate available, the next step is to determine the existing soil moisture at the time of irrigation. determine the approximate soil moisture in a given soil layer by using feel and appearance.

Soil Moisture Measurement Methods and Tools

With practice, many irrigators can develop the skill to When re-filling a selected depth of root zone during a set, such as done with wheel roll laterals, a rough estimate of moisture in several soil layers may be adequate. A photographic brochure called "**Estimating Soil Moisture by Feel and Appearance**" is available from local Conservation Districts and NRCS Field Offices.

With the development in pivot sprinkler technology of precise low-pressure application methods, such as LESA, MESA, and LEPA, (see explanations under Pivot Sprinkler) more precise tools need to be used to determine the required soil water available to manage. An easy to use, inexpensive tool to keep track of existing soil moisture in sandier soils is the tensiometer.

Tensiometers can be "nested" together in a field at two or more depths, to check the full root zone.

Moisture lost or gained in the soil is transposed to a tube through a ceramic tip on the end of the tube. Vacuum pressure within the tube is measured by a pressure gauge as water from the soil fills or leaves the tube. Gauge readings are calibrated to soil moisture levels.

The resistance block is another easy to use tool. Electric wire contacts are imbedded in a ceramic or similar material block. The blocks are buried into the soil at two or more depths and "nested" at one or more locations in the field. The wire leads extend to the ground surface, for connection to a portable resistance meter. The meter measures a current passed through the block reflecting the resistance variations of moisture held in the block.

Other sophisticated sensors using capacitance, heat dissipation and other techniques are available as well.

Soils Information

Without restrictive layers, root development and water extraction take place as shown in Fig. 1. About 40% of the crops water extraction occurs in the upper quarter of the root zone, 70% in the upper half of the root zone.

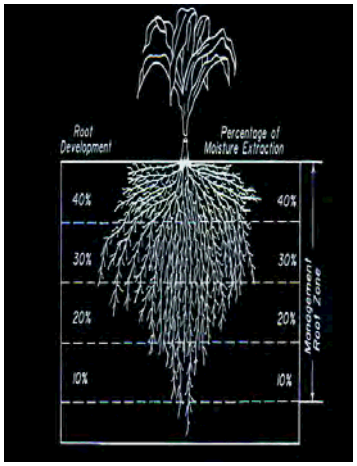


FIGURE 1

A restrictive soil layer such as a plow pan, heavy clay, or coarse gravel may reduce root zone development.

At times of limited water availability, adjusting your irrigation set times to infiltrate only one-half to three-quarters of the developed root depth, will reduce loss to deep percolation beyond the root zone. BUT, remember if you irrigate to a lesser depth, you will need to irrigate one or two additional times during the year.

Table 1. Approximate available water capacity for various soil types.

SOIL TYPE	Available water in upper 3 feet of soil profile (inches)
Silty clay and clay	4.9
Silty clay loam or clay loam	6.9
Silt loam over Silty clay, or Clay	5.2
Silt loam	7.1
Loamy sand	3.8
Fine sand	2.8

Typical IWM rooting depths for crops grown in Montana vary from 30 to 60 inches. NRCS recommends the use of a Management Allowed Depletion, (MAD) of 50% of the soil available water holding capacity before an irrigation set begins (except for potatoes and dry beans). This 50% MAD works well for sets using Wheel Roll and Big Gun sprinklers. For example, using Table 1 above for a grain crop (3 foot rooting depth) in a clay soil, irrigation should begin before the crop consumes 2.5 inches. (50% of the 4.9 inch available water).

Pivot Sprinklers

There are many types of pivot and linear sprinklers available. In addition to those using impact sprinklers, there are various low-pressure units using rotating stream or spray heads at various levels of the crops.

Sprinkler head levels are: above the crop canopy, Mid Elevation Spray Application (MESA), Low Elevation Spray Application (LESA), and Low Pressure In Canopy (LPIC) systems. LEPA, Low Energy Precision Application systems, which place water on the ground through drag socks or "bubblers" at 18 inches or lower, are rare in Montana.

Each of these pivot sprinkler types requires very accurate soil moisture monitoring. Since most of these systems are designed to apply an inch or less in a 24-hour period, if seasonal irrigation begins with less than a nearly full potential root zone, the irrigator may not be able to keep up with the crop's peak consumptive use. Once behind, the system may not be able to keep up and supply the daily crop needs, particularly on windy and hot days when application efficiency is reduced.

Drought and Limited Water Sources

IWM is particularly important during dry years, or where water is in limited supply. Knowledge of critical crop growth stages and water availability to meet plant needs can maximize production. Measurement of flow is a "must" under these conditions. Water application at the same rate throughout the irrigation season may not provide adequate water for best plant production. Consideration of water available, the root system development (Fig.1), and critical crop growth stages for water application, will use less water throughout the season.

Late season runoff, particularly during low water years may be high in salinity content. This will require water management changes to reduce salt build up in the soil that may lead to decreased production.

CROP ROOTING DEPTHS
GRAIN_____ ALFALFA_____ _____
CORN_____ POTATOES_____ _____
SPRINKLER SYSTEM FLOWRATE (GPM)_____
GROSS WATER APPLICATION / SET TIMES_____

AERIAL PHOTO OR PLAN MAP

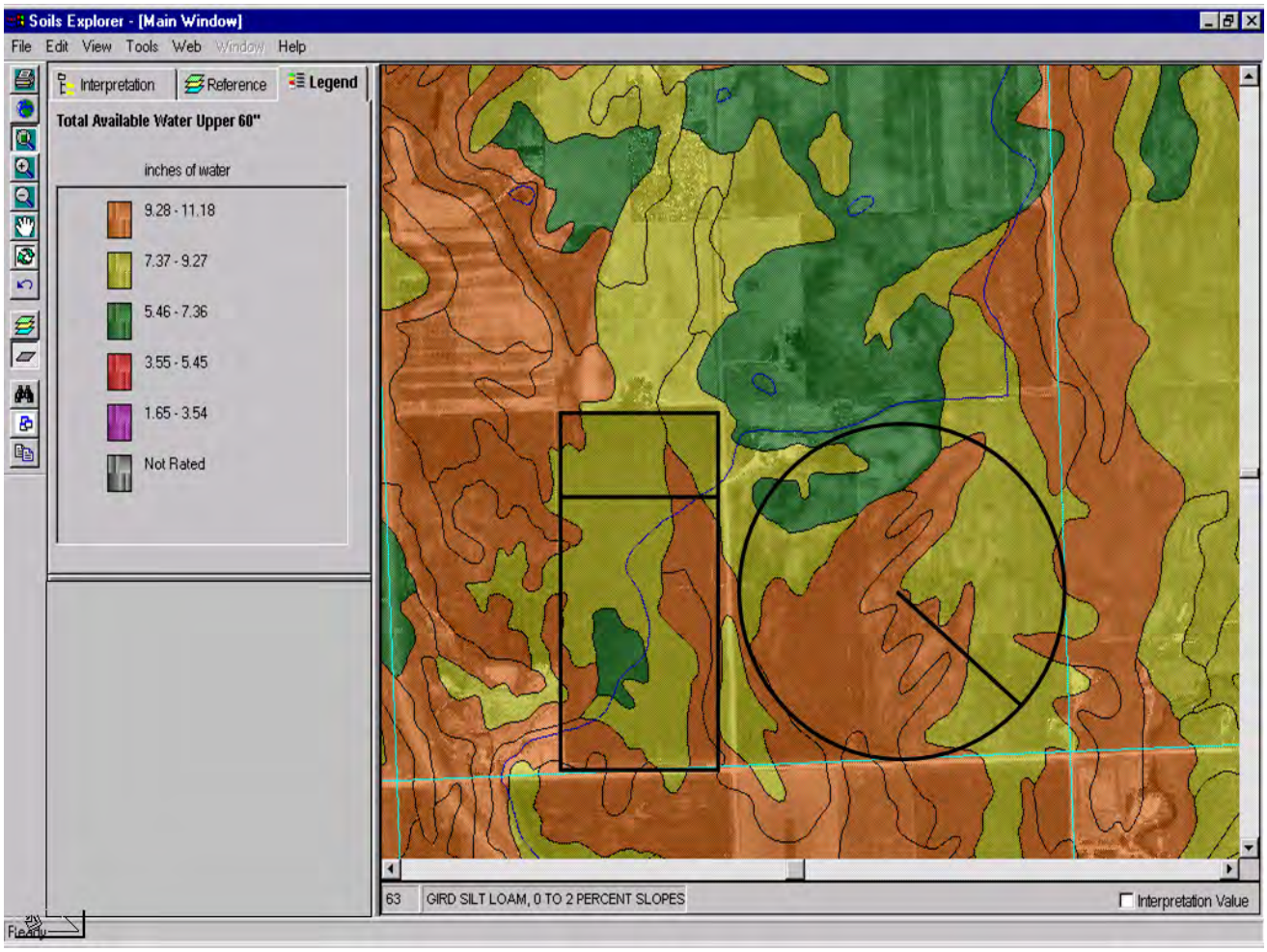
Irrigation Water Management Plan

for

Mr. Joe Irrigator
Pleasant County, Montana

1. Method of Irrigation

About 80 acres will be irrigated by a wheel roll irrigation system. The area was irrigated in the past by flood irrigation from the Reload Canal. The new system will consist of a gravity line from the Reload Canal. There will be a pump system located in the draw to the northeast of the field that will be connected to the gravity system which will able to capture waste water when the flow in the Reload Canal runs low in the summer. The system will consist of 6-inch and 4-inch PVC pipe.



2. Soils

There are two principle soils in the area to be irrigated. These soils are Bigarm and Round Butte. Design characteristics of these soils are:

	Bigarm	Round Butte
Infiltration Rate Inches per Hour	1.4”/hour	.34”/hour
Water holding Capacity by Foot	1’/2.0”	1’/2.0”
	2’/2.9”	2’/4.1”
	3’/3.9”	3’/6.1”
	4’/4.5”	4’/8.2”
	5’/5.1”	5’/10.2”

3. Crops

The fields will be used for pasture and hay production. Peak consumptive use for the crops in the rotation are:

Alfalfa	Grain
.27”/day	.23”/day

4. Water Supply

The Reload Canal and also wastewater from the pump will supply the water for the system. The landowner has the water rights for this use.

5. Peak Use System Design

Crops to be grown	**Alfalfa Grass**
Net Water to be replaced	2.0”
Design Efficiency	65
Gross water application	3.1”
Hours per set	11.5 hours
Water use by crop	.27”pre day
Sprinkler spacing	60 by 40’
Gallons per minute per head*	6.7 GPM

*Due to the variation in pressures flow, control nozzles should be used.

6. System Operation

The system should be operated according to the IWM plan and manufacturers guidelines. Although the area is limited in the amount of water delivered to the cooperator by the Ditch Company, 12” per acre is generally available in a good year. With this in mind irrigation should be done according to the following information and also the enclosed Figure 3.1 Critical Growth Periods.

Irrigation Water Requirements
IWR Crop Data Summary

Job: Joe Irrigator
Location: BZN
By: MNN
Weather Station: BELGRADE AIRPORT
Latitude: 4547 Longitude: 11109

Crop: Alfalfa Hay
County: Gallatin, MT
Date: 03/01/05
Sta. No: MT0622
Elevation: 4000 feet

Computation Method Blaney Criddle (TR21)
Net irrigation application: inches
Crop Curve: Blaney-Criddle Perennial Crop

Estimated carryover moisture used at season:

Begin Growth: 5/10 End Growth: 9/22
Begin: 0.5 inches End: 0.5inches

	Dry Year			Normal Year			
Month	Total Monthly ET (3) inches	80% Chance (1) Effective Precip. inches	Net Irrig. Requirements inches (2)	50% Chance (1) Effective Precip. inches	Net Irrig. Requirements inches (2)	Average Daily ETc inches	Peak Daily ETPk inches
January	0.00	0.00	0.00	0.00	0.00	0.00	
February	0.00	0.00	0.00	0.00	0.00	0.00	
March	0.00	0.00	0.00	0.00	0.00	0.00	
April	0.00	0.00	0.00	0.00	0.00	0.00	
May	2.04	0.82	0.72	1.07	0.47	0.10	
June	5.67	1.39	4.28	1.83	3.84	0.19	0.20
July	7.57	0.75	6.82	0.99	6.58	0.24	0.27
August	6.29	0.79	5.50	1.04	5.25	0.20	0.22
September	2.51	0.57	1.44	0.75	1.27	0.11	
October	0.00	0.00	0.00	0.00	0.00	0.00	
November	0.00	0.00	0.00	0.00	0.00	0.00	
December	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	24.08	4.32	18.76	5.67	17.40		

(1) For 80 percent occurrence, growing season effective precipitation will be equaled or exceeded 8 out of 10 years. For 50 percent chance occurrence, effective precipitation will be equaled or exceeded 1 out of 2 years.

(2) Net irrigation requirements is adjusted for carryover moisture used at the beginning of the season and carryover moisture used at the end of the growing season.

(3) ET Evapo-transpiration) is adjusted upwards 10% per 1000 meters above sea level.

Date: March 30, 2005

7. Method to Determine Soil Moisture

Begin irrigation in the spring when 50% of the soil moisture is depleted. Soil moisture in the spring should be determined by the "feel and appearance method" (see attached information) prior to irrigation and adjust the amounts of irrigation water applied to the field. One method of scheduling is the evaporation pan and checkbook method. See enclosed information bulletin for setting up an irrigation schedule with the use of evaporation pan. Also attached is information on soil tensiometers.

Appearance of clay, clay loam, and silty clay loam soils at various soil moisture conditions.

Available Water Capacity* 1.6-2.4 *inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water needed to refill a foot of soil to field capacity.

0-25 percent available 2.4-1.2 in/ft. depleted
Dry, soil aggregations separate easily, clods are hard to crumble with applied pressure.
(Not pictured)

25-50 percent available 1.8-0.8 in/ft. depleted
Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure.