



# Agriculture Pivot Irrigation Scheduling Calculator Users Guide

The screenshot shows the homepage of the Agricultural Irrigation Scheduling Calculator. The background is a photograph of a pivot irrigation system in a field. The title 'Agricultural Irrigation SCHEDULING CALCULATOR' is displayed in the top left. A login box for 'Returning Users' is on the left, with fields for 'Username' and 'Password', a 'Login!' button, and links for 'Forgotten Username/Password?' and 'Help'. In the center, there is a section titled 'Is this your first visit to the Calculator?' with explanatory text and a 'Register New Account' button. On the right, there is a section titled 'Also Available:' featuring a 'Landscape Irrigation Scheduling Calculator' app icon and a 'Click to Switch!' button. A navigation bar at the bottom contains the following items: 'User Guide', '1. Users Guide', '2. Practical Workshops', '3. Background Science', '4. Case Studies', and '5. Questions and Answers'.

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**[www.irrigationbc.com](http://www.irrigationbc.com)**

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# Agricultural Pivot Irrigation Scheduling Calculator User's Guide

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Information from the B.C. Irrigation Management Guide produced by the **Irrigation Industry Association of British Columbia** has been used as a guide in the preparation of this document. The Irrigation Scheduling Calculator was developed solely by the Ministry of Agriculture and Lands and the Irrigation Industry Association of British Columbia with funding from the Canada British Columbia Water Supply Expansion Program.

## INTRODUCTION

The Irrigation Scheduling Calculator found at [www.irrigationbc.com](http://www.irrigationbc.com) has been developed specifically for use in British Columbia although other regions can use the calculator by entering their own Reference Evapotranspiration (ET<sub>o</sub>) data. This guide provides background information on the parameters and calculations used for sprinkler systems in the Agricultural Irrigation Scheduling Calculator. While there is on line help available on the calculator often not enough detail is provided to make a good determination on which value to use.

Irrigation systems should be designed and operated to supply the crop water requirement while minimizing runoff and leaching. To ensure peak irrigation system performance the system design should take into account evapotranspiration, crop coefficients, soil type and irrigation system efficiencies. High frequency irrigation leads to increased surface evaporation and usually a higher rate of transpiration by the crop. The Agricultural Irrigation Scheduling Calculator minimizes the frequency of irrigation but maximizes duration of application that is allowed by the soil and crop. It is better to have an irrigation schedule where irrigation occurs less frequently but fully utilizes water stored in the crops' root zone.

The Agricultural Irrigation Scheduling Calculator assumes that the irrigation system has been properly designed to match the location, soil type and crop water requirements and maintained in good operating condition. It is recommended that a Certified Irrigation Designer be used to design an irrigation system.

The calculator takes the following information into account in the development of an irrigation schedule:

- How much water the crop requires.
- How much water can be stored in the soil that is readily available to the plant?
- The amount of effective rainfall that is useable by the plant.
- How much water the irrigation system needs to apply to make up the moisture deficit that has occurred.

This User's Guide provides direction on the calculations that are made by the calculator and how to select the information that populates the entry boxes in the calculator. There are four sections in the calculator that must be completed in order for a schedule to be developed. These are:

- Crop Type
- Soil Cross-section
- Irrigation System Design
- Irrigation Scheduling

To navigate from step to step click the next button on the lower right side of the screen.

To begin using the irrigation calculator, open the website [www.irrigationbc.com](http://www.irrigationbc.com) Scroll down to the irrigation calculators. Click on the Agricultural Calculator icon.



Figure 1- Irrigation Calculators

The sign-in page will appear. Follow the instructions on the page if creating a new account. See Figure 2.

Enter your username and password, then click **Login!**



Figure 2 - Login

The opening page will appear. See Figure 3. You will need to select a field you have already entered or create a new one by clicking on **New Field**.

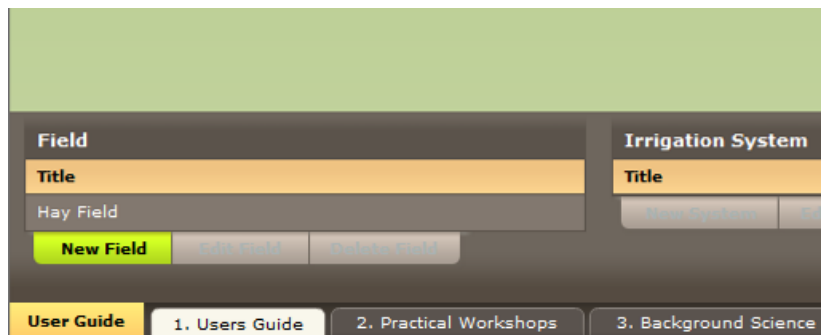


Figure 3 - New Field

Now select the irrigation system you entered earlier. See Figure 4. Then click complete worksheets. You can create another system by clicking on **New System**

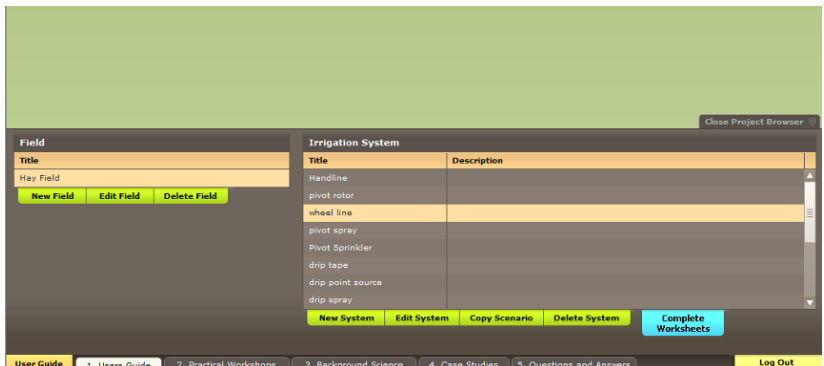


Figure 4 - New System

## 1.1 CROP TYPE

The crop tab allows the type of crop that is to be grown to be selected. Once this is done a number of default values will be displayed

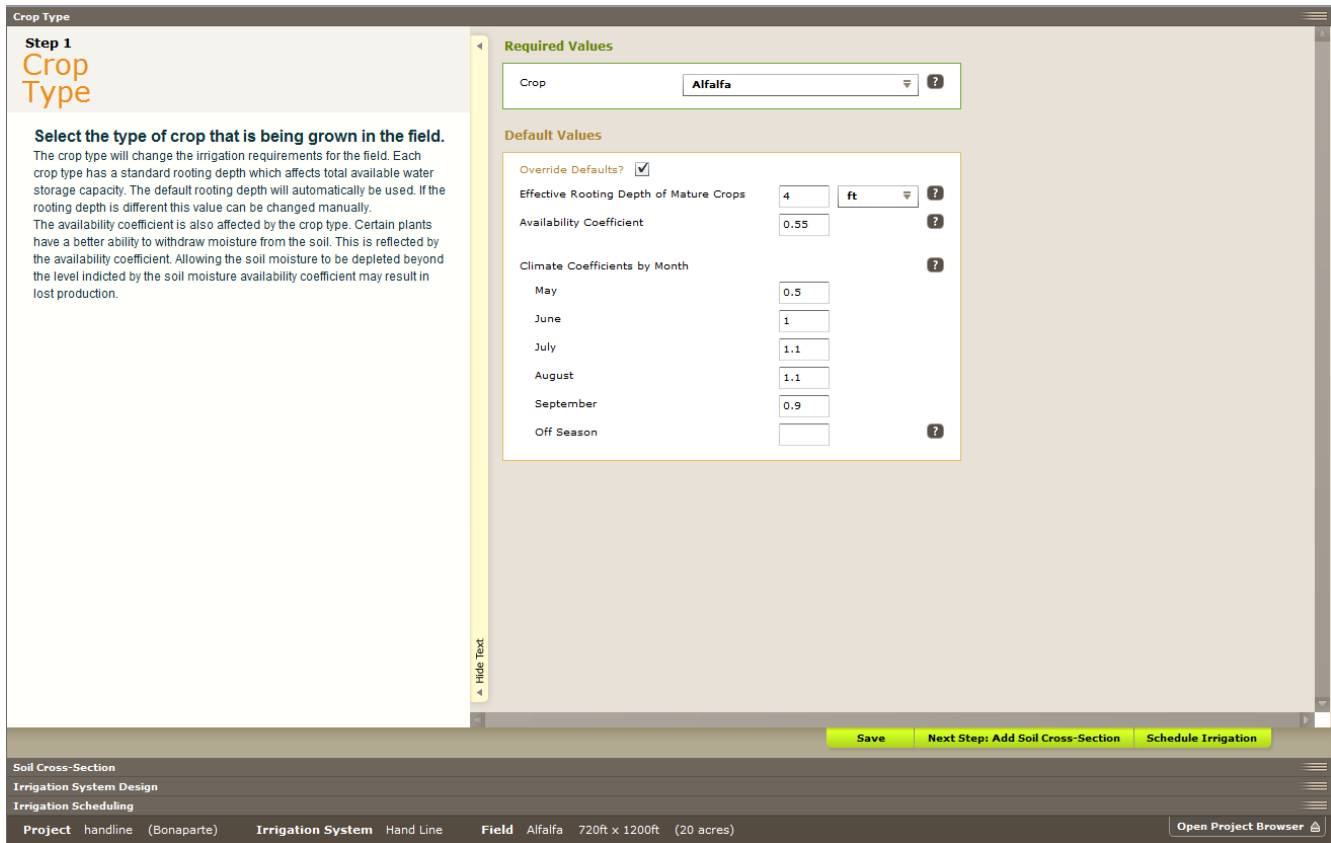


Figure 5 - Crop Type Tab

## Effective Rooting Depth of Mature Crops

The crop's active **rooting depth (RD)** is the soil depth from which the crop extracts most of its water needs. It is determined by digging a soil pit to observe the actual rooting depth or using plant rooting depth information from other sources. A deeper rooting depth creates a larger reservoir of water for the plant to draw upon between irrigation. The calculator provides an estimate of the crop rooting depth automatically. The depth selected by the calculator can be altered if the plant is not mature or if there is a soil depth restriction that limits the crop rooting depth by clicking on the override defaults tab.

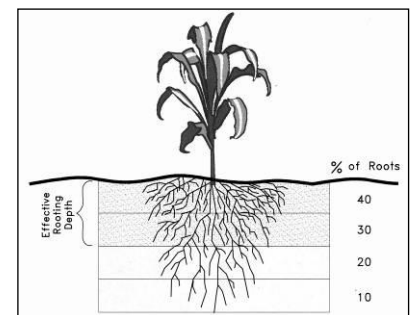


Figure 6 - Rooting Depth



## Availability Coefficient (AC)

Plants can only extract a portion of the soil water storage without being stressed. An **availability coefficient (AC)** is used to determine the portion of water stored in the soil that is readily available to the plant. The availability coefficient is expressed as a percentage and is used to calculate the Maximum Soil Water Deficit (MSWD) in the soil cross – section tab. The MSWD is the maximum amount of water that may be removed from the soil before irrigation is again required.

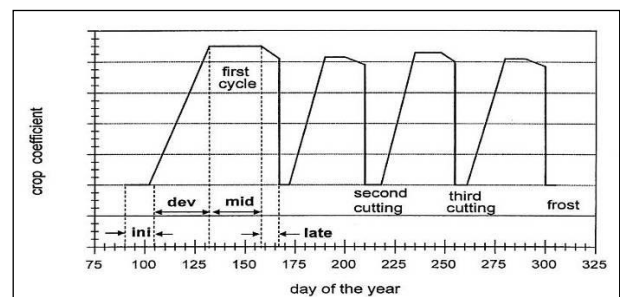
Rooting Depth (RD) and Availability Coefficient (AC)							
Crop	RD		AC	Crop	RD		AC
	[ft]	[m]			[ft]	[m]	
Alfalfa	4	1.2	0.55	Hops	4	1.2	0.50
Almonds	4	1.2	0.40	Kiwifruit	3	0.9	0.35
Asparagus	4	1.2	0.45	Lettuce	1 1/2	0.45	0.30
Beans, green	2	0.6	0.45	Loganberries	4	1.2	0.50
Beets	2	0.6	0.50	Onions, green	1 1/2	0.45	0.30
Blackberries	4	1.2	0.50	Pasture species	1 1/2	0.45	0.50
Blueberries	2	0.6	0.50	Peas	2	0.6	0.35
Broccoli	2	0.6	0.45	Peppers, sweet	3	0.9	0.30
Brussel Sprouts	3	0.9	0.45	Potato	2	0.6	0.35
Cabbage	1 1/2	0.45	0.45	Pumpkin	4	1.2	0.35
Cantaloupe	4	1.2	0.45	Radishes	1 1/2	0.45	0.30
Carrots	2	0.6	0.35	Raspberries	4	1.2	0.50
Cauliflower	1 1/2	0.45	0.45	Spinach	2	0.6	0.20
Celery	2	0.6	0.20	Squash	3	0.9	0.50
Cereals	3	0.9	0.50	Strawberries	2	0.6	0.20
Clover (ladino)	1 1/2	0.45	0.50	Sugar Beets	4	1.2	0.55
Clover (red)	3	0.9	0.50	Tomato	2	0.6	0.40
Corn, field	4	1.2	0.50	Tree fruits (12 ft x 18 ft)	4	1.2	0.40
Corn, sweet	3	0.9	0.50	Tree fruits (3 ft x 10 ft)	2	0.6	0.40
Cucumber	1 1/2	0.45	0.50	Tree fruits (6 ft x 12 ft)	3	0.9	0.40
Eggplant	3	0.9	0.45	Turf	1/2	0.15	0.50
Garlic	1 1/2	0.45	0.30	Turnip	1 1/2	0.45	0.50
Grapes	4	1.2	0.40				

Table 1 - Rooting Depth and Availability Coefficient

## Climate Coefficients by Month

Each type of crop selected has a different consumptive rate for water. The crop coefficient adjusts the evapotranspiration rate for the crop type and crop growth stage. The calculator provides a default crop coefficient for each month. With crops that have multiple cuts the crop coefficient will cycle through the growing season. For use with the calculator these numbers have been averaged for the growing season. A user can override the coefficients provided by the calculator if better information is available.

Figure 7  
Growth Cycle for Multiple Cuttings





## 1.2 SOIL CROSS SECTION

Knowledge about the soil is important to ensure that water is applied when required by the crop. Also the application rate and irrigation interval are affected by the soil. The basic soil information required and calculated in the calculator is described below. The Soil Texture by Depth tab is where the soil type and depth is entered. The calculator selects the parameters described below.

### Soil Texture and Structure

**Soil texture** is a term used to describe the size of individual soil particles such as sand, silt, or clay. Soil texture class is a name given to a soil to describe the relative amounts of sand, silt, or clay in that particular soil. The class name may be sandy loam, loamy clay, silty clay loam, etc. See figure 2. Soil texture has a major influence on the amount of water that can be stored in the soil against the pull of gravity. It also has a major influence on soil infiltration rate and the permeability of a soil; these terms are described in more detail later in this section.

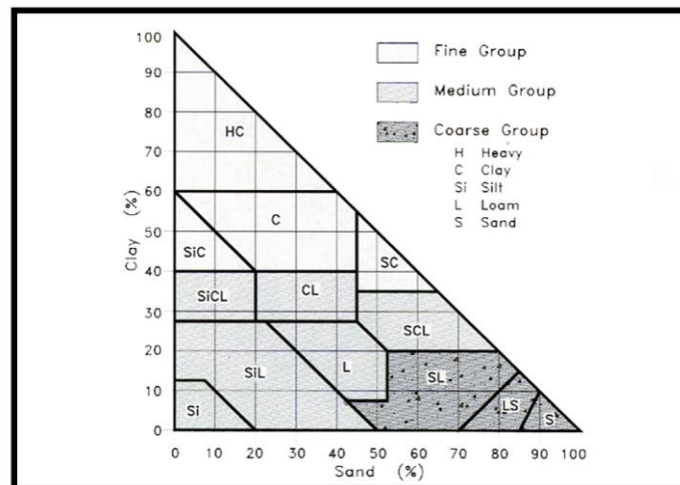


Figure 8 - Soil textural Triangle

**Soil structure** is the arrangement of soil particles and soil aggregates into recognizable particles or lumps. Aggregates occur in almost all soils, but their strength, size and shape varies between soil types. Soil structure can be described in many ways such as; granular, blocky, crumb, platy, massive or granular. The structure also influences the amount soil water holding capacity and the infiltration rate. Soil with poor structure at the surface will not allow water to infiltrate easily.

# Soil Layers

**Step 2 Soil Cross-Section**

Enter the soil textural class by depth.

Each soil textural class has a different water holding capacity. When irrigation occurs it replenishes the amount of water that can be stored in the soil. Accurately knowing the textural class of the soil allows proper irrigation to be done without wasting water. Most fields have more than one type of soil by depth. Enter each soil layer and the total available water storage capacity will be calculated for the profile.

**Required Values**

Soil Texture By Depth: in

Layer Depth	Soil Type	AWSC
24 in	Sandy Clay Loam	2.0 in/ft
24 in	Sandy Loam	1.5 in/ft

**Default Values**

Override Defaults?

Total AWSC: 7 in

Maximum Application Rate: 0.35 in/hr

Maximum Soil Water Deficit: 3.85 in

Sod Cover:

Buttons: Save, Next Step: Add Irrigation System Design, Schedule Irrigation

Figure 9 - Soil Cross - Section Tab

The soil cross section tab in the calculator allows a user to add a soil layer by using the drop down table or the soil texture triangle. Once a soil type is selected a soil layer depth must be added in inches. The total depth of the soil must be greater than the rooting depth that was selected in the previous tab. The first soil depth can be less than the rooting depth if a second rooting depth is added. The total depth of the two or more soil types should be greater than the plant rooting depth.

**Add a new Soil Layer**

1. Select a Soil Type from either the List or the Triangle

- Heavy Clay
- Silty Clay
- Clay
- Sandy Clay
- Silty Clay Loam
- Clay Loam
- Sandy Clay Loam
- Silty Loam
- Loam
- Silt
- Sandy Loam
- Loamy Sand
- Sand

2. Enter the Depth of this Soil Layer

Depth:  in

**Default Values**

Override Defaults?

AWSC:  in/ft

Buttons: Add Layer, Cancel

Figure 10 - Soil Triangle Tool

When the soil layer has been added the calculator will select and calculate a number of soil parameters using the information shown in Table 2. The terms shown in the calculator are shown below. Although all the values are shown as defaults only the Available Water Storage Capacity should be adjusted by the user if better information is available.

SOIL PROPERTIES					
SOIL TEXTURE CLASS	AWSC (in. water/ in. soil)	AWSC (in. water/ ft. soil)	AWSC (mm water/ m soil)	INFILTRATION RATE	
				(in/hr)	(mm/hr)
Clay	0.20	2.4	200	0.25	6.3
Silt loam	0.21	2.5	208	0.35	8.9
Clay loam	0.20	2.4	200	0.30	7.6
Loam	0.18	2.1	175	0.35	8.9
Fine sandy loam	0.14	1.7	142	0.40	10.1
Sandy loam	0.12	1.5	125	0.45	11.4
Loamy sand	0.10	1.2	100	0.65	16.5
Sand	0.08	1.0	83	0.75	19

Table 2 - Soil Properties

## Total Available Water Storage Capacity (AWSC)

The soil's **Available Water Storage Capacity (AWSC)** is the amount of moisture the soil can store between field capacity and the permanent wilting point. The AWSC is related to the soil texture and the soil structure. Table 2 contains AWSC values for various soil types.

**The Total AWSC** as shown in the calculator is determined from the Available Water Storage Capacity (AWSC) and the plant's active rooting depth (RD). Knowing the soil water storage allows the calculator to determine how much water to apply at one time and how long to wait between irrigations. For example, the amount of water applied at one time on a sandy soil, which has a low soil AWSC, would be less than for a loam soil, which has a higher AWSC. This is assuming the plant's rooting depth is the same for both soils. Applying more water to the soil than can be stored results in a loss of water to deep percolation and leaching of nutrients beyond the root zone.

## Maximum Application Rate

The infiltration rate is a measure of how quickly water enters the soil. The irrigation system application rate cannot exceed the soil's infiltration rate or ponding or runoff will occur. The calculator has built in values that determine an estimated maximum run time based on soil texture. **The Maximum Application Rate** which is equal to the infiltration rate is shown in the default values. Compacted soils and slopes will reduce the infiltration rate of the soil. With the irrigation system running it is useful to physically observe and determine if runoff occurs. These observations can be used to override the calculator values.

## Maximum Soil Water Deficit (MSWD)

**Maximum soil water deficit (MSWD)** is the amount of water that can be stored in the soil that is readily available to the plant. It is the maximum amount of water that should be removed from the soil before irrigation is again required. The MSWD is also the maximum amount of water that can be applied at one time before the risk of deep percolation occurs. It is calculated by multiplying the Total AWSC by the Availability Coefficient.

To encourage deep root growth for plants, a sprinkler irrigation system should be operated as infrequently as possible, irrigating just long enough to fill the soil water storage to full capacity. The maximum amount that can be applied will be equal to the MSWD, providing that the soil moisture level had dropped this amount prior to irrigation.

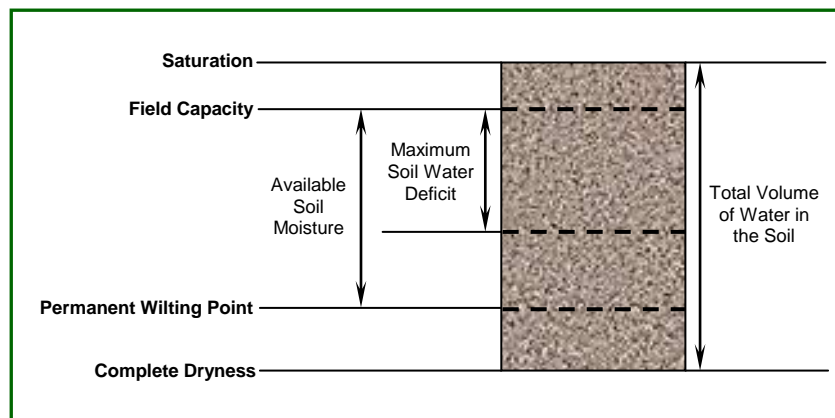


Figure 11 - Soil Water Moisture Terminology

## Initial Soil Water Moisture

Pivot systems apply less water per irrigation than other field irrigation systems. They operate based on multiple passes that slowly build up the soil moisture. It is typical practice for pivot systems to begin irrigation while there is still some water storage in the soil. The **Initial Soil Water Moisture** is an estimate on the amount of the Maximum Soil Water Deficit available in the soil before irrigation begins. The calculator uses 25 percent as a default estimate. The default over ride can be selected to change this percentage. To accurately estimate soil moisture it is recommended to use Tensiometers or electrical resistance blocks. These devices are explained in greater detail in the Ministry of Agriculture and Lands fact sheet available at:

[www.al.gov.bc.ca/resmgmt/publist/500series/577100-1.pdf](http://www.al.gov.bc.ca/resmgmt/publist/500series/577100-1.pdf)

[www.al.gov.bc.ca/resmgmt/publist/500series/577100-2.pdf](http://www.al.gov.bc.ca/resmgmt/publist/500series/577100-2.pdf)

## 1.3 IRRIGATION SYSTEM DESIGN

The Irrigation System Design tab allows for the entry of irrigation design and operation parameters. The basic information that must be entered is the length of the pivot, the arc of the pivot and the flow rate supplied.

**Step 3**  
**Irrigation System Design**

**Pivot System Design Parameters.**

To determine the amount of water applied by a pivot system certain parameters are required. The length of boom is the irrigated length of the pivot including the end gun. The maximum sprinkler wetted diameter is for the largest sprinkler at the end of the pivot but not the end gun. The pivot arc is the degrees of a circle that the pivot covers. The flow rate is generally supplied by the manufacture of the pivot. The revolution duration is the number of hours that the pivot take to do one irrigation pass.

**Required Values**

Effective Wetted Radius of Pivot	2300	ft	?
Maximum Sprinkler Wetted Radius	40	ft	?
Pivot Arc	180	deg	?
Flow Rate	1100	gpm	?
Revolution Duration	24	hrs/rev	?

**Default Values**

Override Defaults?

Application Efficiency: 0.8 %

**Calculated Values**

Application Rate	1.46	in/hr	?
Gross Water Applied	0.31	in/revolution	?
Net Water Applied	0.25	in/revolution	?

Save    Next Step: Schedule Irrigation    Previous Step: Add Soil Cross-Section

Project: pivot rotor (Abbotsford Airport)    Irrigation System: Centre Pivot - Drop Rotor    Field: Alfalfa 4600ft x 2300ft (243 acres)    Open Project Browser

User Guide    1. Users Guide    2. Practical Workshops    3. Background Science    4. Case Studies    5. Questions and Answers    Log Out

Figure 12 - Irrigation System Design Tab

It is very important that accurate data is entered in to the calculator. The entered data will be used to calculate the amount of water that enters the soil. The calculator also offers the option of using metric numbers. By clicking the drop down menu beside the data input boxes meters or feet can be selected

### Effective Wetted Radius of Pivot (L)

The **Effective Wetted Radius of Pivot** is the physical length of the pivot plus the effective coverage of the last sprinkler or end gun. The physical length of the pivot can be measured or taken from the manufacturer's identification plate.

## Maximum Sprinkler Wetted Radius (r)

**Maximum Sprinkler Wetted Radius** is the distance the last sprinkler other than the end gun throws. The area of the field irrigated by the end tower is much larger than the irrigated area of the first pivot tower. The amount of water applied at the end tower is therefore also much greater than near the pivot point and it must be applied in a relatively short period of time. The application rate at the end tower is therefore quite high. The application rate of the pivot is calculated using the sprinklers on the last tower. The wetted radius of the end sprinkler must be known to do the calculation.

## Pivot Arc

The **Pivot Arc** is the degrees of a circle through which the pivot travels. If it is a full circle pivot it would be 360 degrees. If it is a half circle pivot it would be 180 degrees.

## Flow Rate (Q)

The **Flow Rate** is the amount of water that is delivered to the pivot. The flow rate is usually shown on the manufacturer's identification plate. It is usually supplied in (US) gallons per minute.

## Revolution Duration

The **Revolution Duration** is the time in hours it takes the pivot to complete a single application of water to the entire area to be irrigated.

## Application Efficiency (AE)

Not all the water that leaves the sprinkler nozzle enters the soil profile. Evaporation, wind and runoff account for a proportion of this water. When taken into account they determine the **Application Efficiency (AE)** of the irrigation system. The default application efficiency for the irrigation system type will be automatically entered. This number should only be changed by a knowledgeable designer.

## Application Rate (AR)

**Application rate (AR)** also known as precipitation rate, is a measure of the rate at which water is applied to an area by the irrigation system per unit of time. It is a critical factor in design because a pivot system can easily apply water at rates greater than the soil's ability to absorb water (infiltration rate), which leads to runoff. Pivot systems work on the design concept that dry soils can absorb up to 2.5 times more water in the first 15 to 30 minutes than soil that is being irrigated by a sprinkler system for 12 hours. The maximum acceptable application rates for pivots are therefore approximately 2.5 times higher than the soil infiltration rate values given in Table 2. Table 3 provides guidance on the maximum application rates for center pivot systems for different soil types.

The application rate is used to determine how long the pivot system should run to replace soil moisture.

Pivot Short Duration Application Rates ( in/hr)				
Textural Class	15 Minutes		30 Minutes	
	Sod	Cultivated	Sod	Cultivated
Sand	1.88	1.00	1.50	0.80
Loamy Sand	1.63	0.88	1.30	0.70
Sandy Loam	1.13	0.63	0.90	0.50
Fine Sandy Loam	1.00	0.63	0.80	0.50
Loam	0.88	0.50	0.70	0.40
Silt	0.88	0.50	0.70	0.40
Silt Loam	0.88	0.50	0.70	0.40
Silty Clay	0.88	0.50	0.70	0.40
Clay Loam	0.75	0.38	0.60	0.30
Silty Clay Loam	0.75	0.38	0.60	0.30
Clay	0.63	0.25	0.50	0.20
Heavy Clay	0.63	0.25	0.50	0.20
Organic Soils (muck)	1.25	1.25	1.00	1.00

Table 3 - Pivot Short Duration Application Rates

The irrigation calculator raises a red flag when the soil infiltration rate has been exceeded. This flag has been turned off for the pivot scenarios due to the short application duration of pivots as explained above.

## Gross Water Applied (GWA)

The **Gross Water Applied (GWA)** per irrigation is calculated from the pivot application rate and the set time that the system operates on that location. The gross water applied per irrigation would be the number that is divided into the annual irrigation duty to determine the allowable number of irrigations per year.

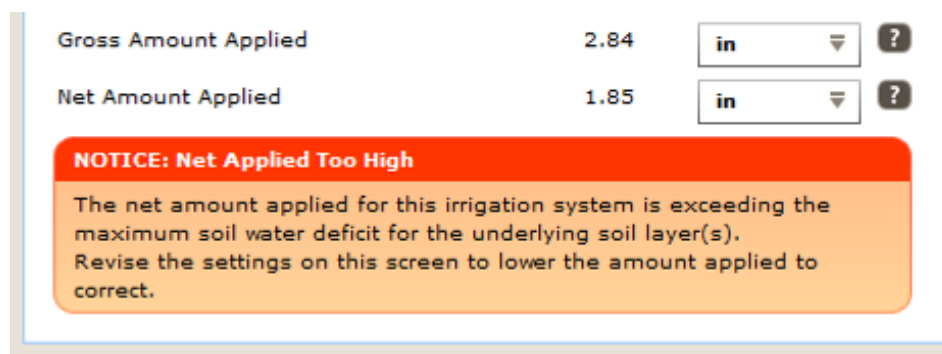


## Net Water Applied (NWA)

The **Net Water Applied (NWA)** per irrigation is calculated from the gross water applied and the application efficiency of the system. The net water applied per irrigation is the amount of water that enters the soil.

If the amount of water applied exceeds the soils capacity to store the water a red flag will appear notifying the user. You can still proceed to determine the irrigation schedule but modifications to system operation should be made to improve performance. One option for a pivot would be to increase the travel speed.

Since pivots apply relatively low amounts of water on each pass it is unlikely that this flag will be triggered.



The screenshot shows a user interface for an irrigation calculator. It features two rows of data: 'Gross Amount Applied' with a value of 2.84 and 'Net Amount Applied' with a value of 1.85. Both values are followed by a unit selector dropdown menu set to 'in' and a help icon (question mark). Below this, a prominent red banner with white text reads 'NOTICE: Net Applied Too High'. Underneath the banner, a yellow box contains the following text: 'The net amount applied for this irrigation system is exceeding the maximum soil water deficit for the underlying soil layer(s). Revise the settings on this screen to lower the amount applied to correct.'

Figure 13 - Red Flag - Net Applied

*Note: The calculator provides the net amount applied over a 24 hour period. If the pivot rotation time is 24 hours then the calculator will provide an accurate value for the amount of water applied over the entire field.*

*However if the pivot rotation time is less than 24 hours then a portion of the field will have started a second application. The calculator will then show an average amount applied to the entire field.*

*Conversely if the pivot rotation time is more than 24 hours some parts of the field will not yet have been irrigated. Again the calculator will show an average amount applied over the entire field.*

***It is suggested that a pivot be allowed to make several applications prior to using the calculator to determine if the pivot can be shut down or when the next irrigation should start.***

## 1.4 IRRIGATION SCHEDULING

When the crop, soil and irrigation system information has been entered into the calculator, an irrigation schedule can now be determined. The calculator will retrieve Evapotranspiration data from a weather station of your choice. The calculator operates in real time so the climate date generated by the calculator will be the current date with an estimated forecast of the next five days. Climate data for the calculator is obtained from [www.Farmwest.com](http://www.Farmwest.com)

**Evapotranspiration (ET)** is the term used to describe plant water use and is a measurement of the total amount of water evaporated from the soil and plant surfaces plus the amount of water transpired by the plant. Factors such as temperature, wind, solar radiation and latitude all determine the ET rate. ET can be obtained from various sources. The data is collected daily but can be summarized for any time period.

**Note:** If accessing the calculator in the morning the climate data for the current date may not have been posted to the Farmwest web site yet. Climate data gets posted in the early afternoon of each day. For best results the calculator should be used in the evening to determine a schedule for the next few days.

To obtain irrigation scheduling information: select the **Closest Weather Station** to be used, and select the **Field Irrigation Started On** date from the calendar.

The calculator can also go back in time if desired to previous weeks, months or years if desired. By entering a date in the **Explore Historical Weather Data** calendar the calculator will determine an irrigation schedule from the past.



Figure 14 - Irrigation System Scheduling Tab

## Closest Weather Station

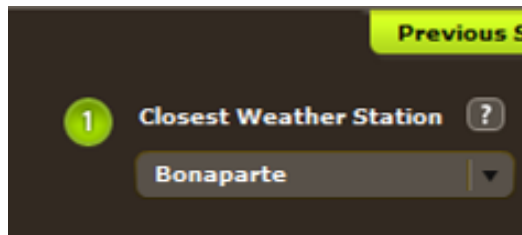


Figure 15 - Closest Weather Station

The **Closest Weather Station** will default to the station selected when the field was entered in the calculator. This can be changed if the station data is missing or another station better represents the climatic conditions at the field.

If you have your own data that is not connected through Farmwest.com then **Custom Values** can be entered. This is explained in greater detail at the end of the user's guide.

## Field Irrigation Started On

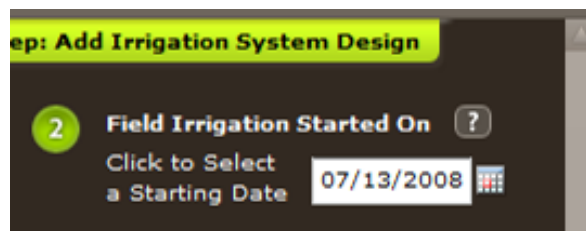


Figure 16 - Field Irrigation Started On

The **Field Irrigation Started On** date refers to the start date for this irrigation cycle not the beginning of the season. When the irrigation system was designed and installed it should have had an irrigation schedule supplied. This supplied schedule would have been based on a Peak ET rate for the hottest time of the year. This calculator determines an irrigation schedule for times of the year when ET conditions are not at peak conditions. For best results the calculator should be used to determine a schedule the night before the supplied schedule would have started.

## Field Irrigation Stopped On

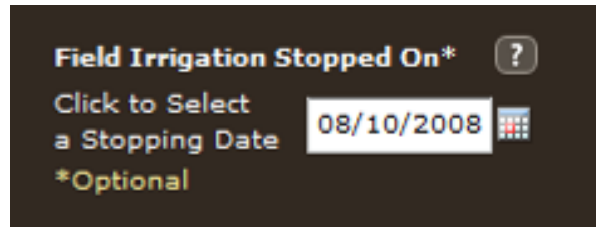


Figure 17 - Field Irrigation Stopped On

The **Field Irrigation Stopped On** date refers to the end date for the current irrigation cycle.

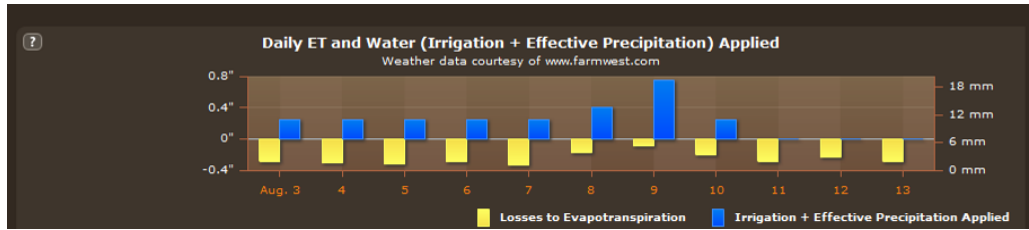
## Explore Historical Weather Data



Figure 18 - Explore Historical Weather Data

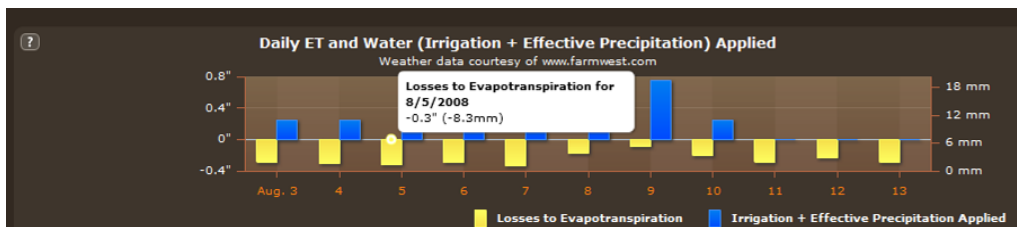
The **Explore Historical Weather Data** calendar allows the user to look at past climatic records and compare to the irrigation practice that was done. When explore historical data is selected the field irrigation started on date needs to be earlier.

## Effective Precipitation & Daily ET



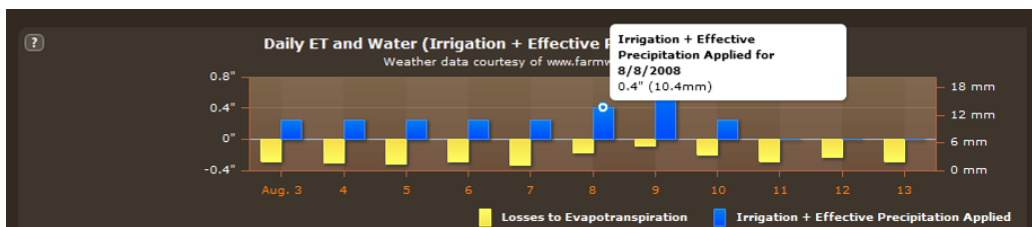
**Figure 19 - Effective Precipitation & Daily ET**

The Effective Precipitation & Daily ET box has the downloaded data from Farmwest.com. By putting the computer mouse on top of a graph bar for the ET or Effective Precipitation the amount for that date will be shown.



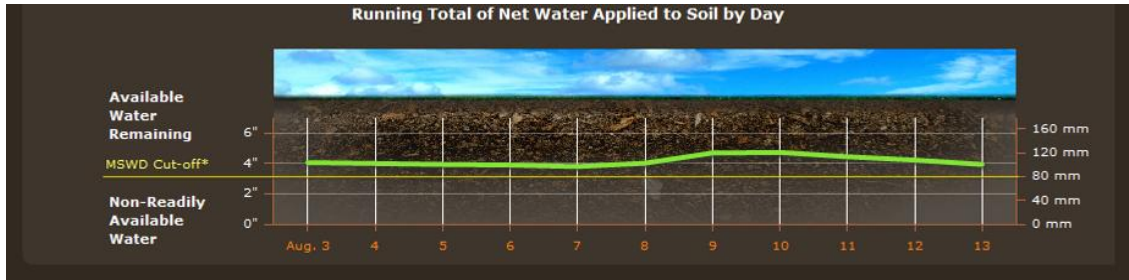
**Figure 20 - Evapotranspiration by Date**

Effective precipitation is the amount of rainfall that occurs above 5 mm. It is then multiplied by 75 percent to cover application efficiency losses. If the rainfall event is less than 5 mm then no rainfall amount is entered since very little or none of the rainfall will enter the soil reservoir.



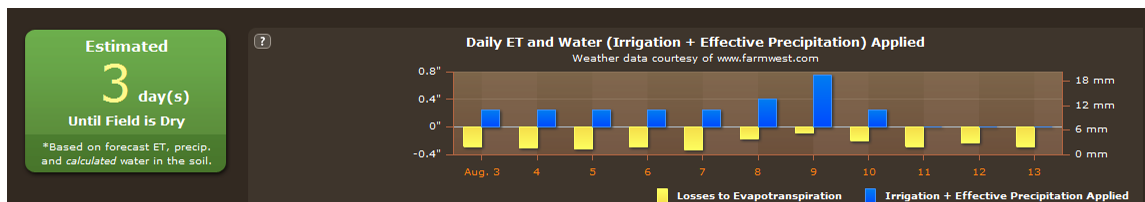
**Figure 21 - Irrigation and Effective Precipitation by Date**

## Running Total of Net Water Applied to Soil by Date



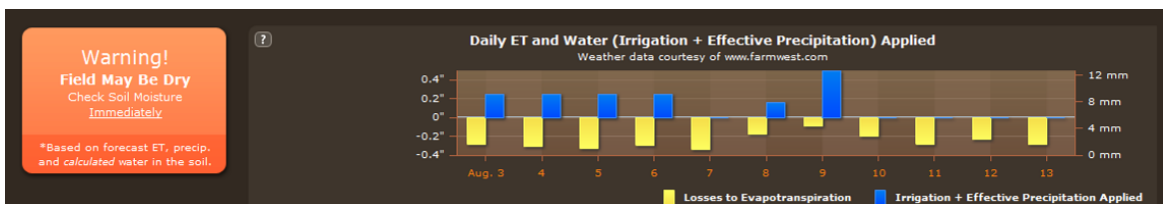
**Figure 22 - Water in Soil**

The water remaining in the soil is indicated by the green line on the graph. The first date on the graph is the irrigation start date and the last date is today or the selected historical date. If an effective precipitation occurred it is added to the water storage on the day it occurred. The Evapotranspiration received from Farmwest.com which has been adjusted by crop coefficients is removed daily. As the graph shows the available water remaining on each day chronologically reduces.



**Figure 23 - Green Box**

The box on the left will provide information on an estimated time until the next irrigation. If there is adequate water in the soil the calculator will recommend a length of time before irrigation needs to occur again. If the box indicates a 5+ days value the calculator should be run again in 4 or 5 days to determine an irrigation date.



**Figure 24 - Orange Box**

When the remaining water reaches the MSWD Cut-off (maximum soil water deficit) the indicator box turns orange warning that the field is dry.

## Custom Evapotranspiration Values

The **Custom Values** option is at the bottom of the weather station drop down menu. When this is selected the Enter Custom ET Values button appears. By clicking this button the process for entering custom ET begins.



Figure 25 - Custom Values...

The **Enter Custom Evapotranspiration Data** pane appears first. The Start date and then the end date are requested. After they are entered the daily ET and Effective Precipitation data can be entered. Each box requires data for the schedule to be determined. The **Fill ET** and **Fill Precip** box will populate all the boxes with the same data then edits can be done. After entering the data click the **Use Entered Data** button.

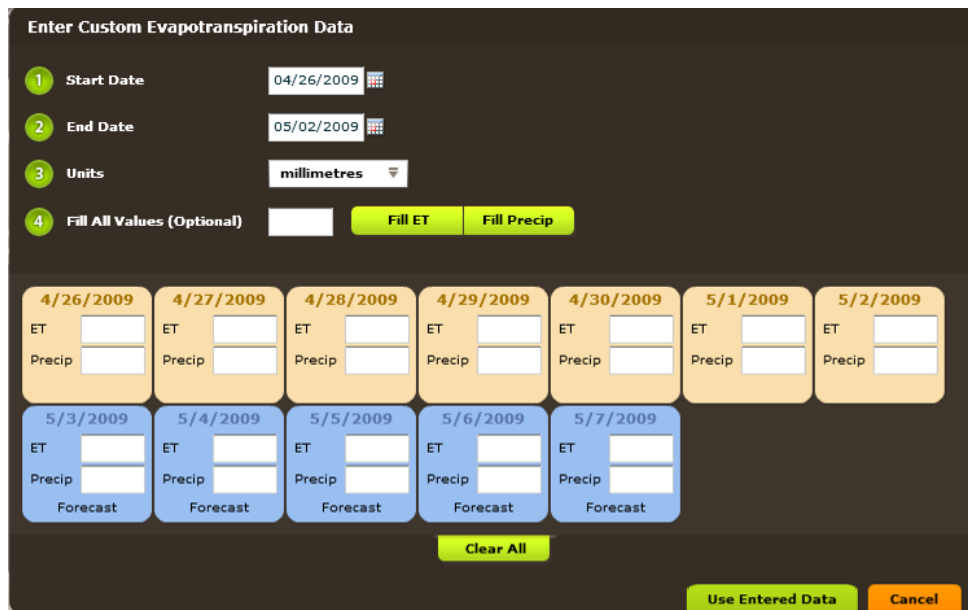
A screenshot of a form titled 'Enter Custom Evapotranspiration Data'. It has a dark background. At the top, there are four numbered steps: 1. 'Start Date' with a date field containing '04/26/2009' and a calendar icon. 2. 'End Date' with a date field containing '05/02/2009' and a calendar icon. 3. 'Units' with a dropdown menu showing 'millimetres'. 4. 'Fill All Values (Optional)' with a white input field and two yellow buttons: 'Fill ET' and 'Fill Precip'. Below these are two rows of date boxes. The first row has dates from 4/26/2009 to 5/2/2009. The second row has dates from 5/3/2009 to 5/7/2009. Each date box contains 'ET' and 'Precip' labels with input fields. The boxes for 5/3/2009 to 5/7/2009 also have a 'Forecast' label. At the bottom, there are three buttons: 'Clear All' (yellow), 'Use Entered Data' (green), and 'Cancel' (orange).


Figure 26 - Enter Custom Evapotranspiration Data



## View and Print Irrigation Report

At the bottom right hand corner of the irrigation scheduling tab is an icon for printing a report on the irrigation system. Click the **View and Print Irrigation Report** to do this.

### Agricultural Irrigation SCHEDULING CALCULATOR



Report for  
**pivot rotor in Hay Field**  
Alfalfa. Field Size: 3400 x 1700 ft. Irrigation Method: Centre Pivot - Drop Rotor. Climate Station: Douglas Lake

**Crop** Alfalfa

Soil Properties (includes sod)		
Soil Type	Soil Depth	Soil AWSC
Clay Loam	24 in	2.3 in/ft
Sandy Loam	24 in	1.5 in/ft
Plant Rooting Depth		4 ft
Availability Coefficient		0.55
Max Soil Water Deficit		4.18 in
Max Application Rate		0.3 in/hr
Initial Soil Water Moisture		25 %

Centre Pivot - Drop Rotor System Design	
Effective Wetted Radius of Pivot	1700 ft
Maximum Sprinkler Wetted Radius	40 ft
Pivot Arc	360
Flow Rate	900 gpm
Revolution Duration	3 ft
Application Efficiency	80
Application Rate	1.6200000000000003 in/hr
Gross Applied	0.03 in
Net Applied	0.02 in

Monthly Climate Modifier	
May	0.5
June	1
July	1.1
August	1.1
September	0.9
Off Season	.5

Simulation Results for the selected period of **Fri May 1 2009 to Fri May 8 2009**  
**The field contains adequate levels of water.**

File #300-302

**Figure 27 – View and Print Irrigation Report**

## 1.5 EQUATIONS

The following formulas are used in the calculator to generate a schedule.

### EQUATION 1 - TOTAL AVAILABLE WATER STORAGE CAPACITY

$$\text{Total AWSC} = (\text{AWSC}_1 \times \text{RD}_1) + (\text{AWSC}_2 \times \text{RD}_2) + \dots$$

Where:

Total AWSC = Total available water storage capacity, in or mm  
AWSC<sub>1,2,...</sub> = Available water storage capacity of that soil layer  
RD<sub>1,2,...</sub> = Rooting depth of that soil layer

### EQUATION 2 - MAXIMUM SOIL WATER DEFICIT

$$\text{MSWD} = \text{Total AWSC} \times \text{AC}$$

Where:

MSWD = Maximum soil water deficit, inch or mm  
Total AWSC = Total available water storage capacity, in or mm  
AC = Availability coefficient of the soil, %

### EQUATION 3 - SETS PER DAY

$$\text{Sets per day} = \text{round} ( 24 / \text{runtime} )$$

Where:

Sets per day = Number of irrigation sets per day  
24 = Number of hours per day  
Runtime = Length of time the system operates in one location

#### EQUATION 4 - APPLICATION RATE

$$AR = \frac{122.5 \times Q}{R \times r}$$

Where:

- AR = Application rate, in/hr
- Q = Pivot flow rate, USgpm
- R = Effective wetted radius of the pivot, ft
- r = Maximum radius of largest sprinkler other than end gun, ft
- 122.5 = factor used to convert gpm and spacing in ft to application in in/hr

#### EQUATION 5 - GROSS WATER APPLIED

$$GWA = AR \times \text{Set time}$$

Where:

- GWA = Gross water applied, in or mm
- AR = Application rate, in/hr or mm/hr
- Set time = Length of time lateral operated, hrs

#### EQUATION 6 - NET WATER APPLIED

$$NWA = GWA \times AE$$

Where:

- NWA = Net water applied, in or mm
- GWA = Gross water applied, in or mm
- AE = Application efficiency, %

## EQUATION 7 - CROP EVAPOTRANSPIRATION

The crop **water use** ( $ET_C$ ) can be calculated for a specific plant by using a reference evapotranspiration rate ( $ET_O$ ), and applying a **crop coefficient** ( $K_C$ ) to convert the reported  $ET_O$  to  $ET_C$ .

$$ET_C = K_C \times ET_O$$

Where:

$ET_C$  = Evapotranspiration Crop, inch or mm

$K_C$  = Crop coefficient

$ET_O$  = Reference evapotranspiration for a grass reference crop, mm

## EQUATION 8 - WATER REMAINING IN SOIL BY SET AND DATE IRRIGATED

The remaining water each day is determined by removing the daily ET and adding the effective precipitation.

$$MSWDR = \text{Previous day MSWDR} - \text{daily } (ET_C + PPT_e)$$

Where:

$MSWDR$  = Remaining available water for plant growth, in or mm

Previous day MSWD = Previous days maximum soul water deficit, in or mm

$ET_C$  = daily Evapotranspiration, in or mm

$PPT_e$  = daily effective precipitation, in or mm

$PPT_e$  =  $(PPT - 5) \times 0.75$