B.C. IRRIGATION MANAGEMENT GUIDE

Appendix C – Blank Worksheets

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LIMITATION OF LIABILITY AND USER'S RESPONSIBILITY

The primary purpose of this B.C. Irrigation Management Guide is to provide irrigation professionals and consultants with a methodology to assess the irrigation system performance and manage the system effectively.

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

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C BLANK WORKSHEETS

The table below lists which worksheets are used for sprinkler systems and which ones are for trickle systems. The blank versions of these worksheets are provided in this appendix.

Worksheet	Sprinkler	Trickle	Example
1(a) Information from Farm Plan – **Sprinkler**	✓		Page 34
1(b) Information from Farm Plan – **Trickle**		✓	Page 37
2(a) Irrigation System Audit – **Sprinkler**	✓		Page 40
2(b) Irrigation System Audit – **Trickle**		✓	Page 40
3(a) Total Irrigated Area Using System Information	✓		Page 44
3(b) Total Irrigated Area Using Field Dimension	✓	✓	Page 45
4(a) Irrigation System Peak Flow Rate Check – **Sprinkler**	✓		Page 49
4(b) Irrigation System Peak Flow Rate Check – **Trickle**		✓	Page 50
5(a) Annual Water Use Check – **Sprinkler**	✓		Page 57
5(b) Annual Water Use Check – **Trickle**		✓	Page 59
6 Water Diversion and Conveyance Loss Checks	✓	✓	Page 65
7 Intake Screen Area Check	✓	✓	Page 70
8 Irrigation Water Quality Check	✓	✓	Page 74
9 Irrigation System Uniformity Check	✓	✓	Page 78
10 Soil-Crop Report	✓	✓	Page 97 – 98
11 Lateral Pressure Distribution Check – **Sprinkler**	✓		Page 112
12 Wheelmove or Handmove Lateral Line Assessment	✓		Page 115
13 PVC Lateral Line Assessment	✓		Page 119

14	Wheelmove or Handmove Sprinkler Spacing Check	✓		Page 122
15	Assessment of Sprinkler System Performance	✓		Page 128
16	Assessment of Travelling Gun Performance	✓		Page 141
17	Centre Pivot System Performance Check	✓		Page 151
18	Equipment and Layout Check – **Trickle**		✓	Page 163
19	System Operating Time – **Trickle**		✓	Page 170
20	Determining Evaporation Using an Evaporation Pan	✓	✓	Page 188
21	Crop Water Use	✓	✓	Page 194
22	Sprinkler Irrigation Scheduling Using Water Budget Method	✓		Page 197 – 198
23	Trickle Irrigation Scheduling Using Plant Water Requirement Method		✓	Page 200
24	Trickle Irrigation Scheduling Using Water Budget Method		✓	Page 202
25	Mainline Friction Loss	✓		Page 213
26	Pump Assessment	✓	✓	Page 217
27	Irrigation Operating Cost	✓	✓	Page 223
28	Chemigation Information	✓	✓	Page 228, 230

Worksheet 1(a) Information from Farm Plan – *SPRINKLER*

INFORMATION	Value and Box No.	Unit	Source
Worksheet 3(a) Total Irrigated Area Using System Information			
Irrigation interval per pass	1	days/pass	Farm info
Irrigation sets per day	2	sets	Farm info
Sprinkler spacing	3	ft	Farm info
Number of sprinklers	4	sprinklers	Farm info
Distance moved per set	5	ft	Farm info
Worksheet 3(b) Total Irrigated Area Using Field Dimension			
Field width	1	ft	Farm info
Field length	2	ft	Farm info
Worksheet 4(a) Irrigation System Peak Flow Rate Check			
Calculated Irrigation System Peak Flow Rate			
Peak flow rate on water licence or provided by irrigation district or water purveyor	2	US gpm	Water licence or purveyor
Peak evapotranspiration (ET) in [ ]	–	in/d	Table 3.1
Estimated peak flow rate requirement per acre	3	US gpm/acre	Table 3.2 or 3.3
Actual Irrigation System Flow Rate			
Flow rate metered or provided by district	5	US gpm	Meter or district
Pump Specifications:			
Model number	–		Field check
Impellor size	–	in Dia.	Pump name plate
Revolution per minute (rpm)	–	rpm	
Flow rate	6	US gpm	Pump curve
Nozzle Specifications:			
Size	–	in x in	Field check
Operating pressure	–	psi	Field check
Flow rate	7	US gpm	Farm plan
Number of nozzles	8	nozzles	Farm plan
Worksheet 5(a) Annual Water Use Check			
Calculated Annual Water Use Requirement			
Annual water withdrawal stated on water licence	2	ac-ft	Water licence
Estimated annual crop water requirement	3	in	Table 3.4
Application efficiency of irrigation system	4	%	Table 6.1
Meter Information			
Meter reading at start of year	6	US gal	Water purveyor
Meter reading at end of year	7	US gal	

Pump Specifications

Pump horsepower	9	hp	Pump name plate
Energy consumption for entire year	10	KWh	Hydro bill

Refer to Worksheet 4(a) for the rest of the information regarding pump

Irrigation Specifications

Irrigation interval	16	days	Farm plan
Number of irrigations per year	17		Farm plan

Worksheet 6 Water Diversion and Conveyance Loss Checks

Conveyance channel flow rate at/near diversion	1	US gpm	Site
Overflow in channel	2	US gpm	Site
Number of operating days per season	3	days	Site
Amount of water licensed	4	ac-ft	Water licence
Conveyance channel flow rate at/near intake	5	US gpm	Site

Worksheet 7 Intake Screen Area Check

Screen mesh size	2	mesh	Site
Percent open area of mesh size	3	%	Table 4.3

For flat screen,

Number of screened surfaces	5	ft	Site
Length of screen	6	ft	Site
Width of screen	7	ft	Site

For cylindrical screen,

Diameter of screen	9	ft	Site
Length of screen	10	ft	Site

Worksheet 8 Irrigation Water Quality Check

Sodium adsorption ratio (SAR)	1		Laboratory
Electrical conductivity (EC) of water	3	dS/m	Table 4.4
E. coli count	5	cfu/100 ml	Laboratory
Fecal coliform count	6	cfu/100 ml	Laboratory

Worksheet 1(b) Information from Farm Plan – *TRICKLE*

INFORMATION	Value and Box No.	Unit	Source
Worksheet 3(b) Total Irrigated Area			
Field width	1	ft	Farm info.
Field length	2	ft	Farm info.
Worksheet 4(b) Irrigation System Peak Flow Rate Check			
Calculated Irrigation System Peak Flow Rate			
Peak flow rate on water licence or provided by irrigation district or water purveyor	2	US gpm	Water licence or purveyor
Peak evapotranspiration (ET) in [ ]	–	in/d	Table 3.1
Estimated peak flow rate requirement per acre	3	US gpm/acre	Table 3.2 or 3.3
Actual Irrigation System Flow Rate			
Flow rate metered or provided by district	5	US gpm	Meter or district
Pump Specifications:			
Model number	–		Field check
Impellor size	–		Pump name plate
Revolution per minute (rpm)	–	rpm	
Flow rate	6	US gpm	Pump curve
Emitter Specifications:			
Size	–	in I.D.	Field check
Operating pressure	–	psi	Field check
Flow rate (zone 4)	7	gph	Farm plan
Number of emitters (zone 4)	8	emitters	Farm plan
Worksheet 5(b) Annual Water Use Check			
Calculated Annual Water Use Requirement			
Water withdrawal amount on water licence	2	ac-ft	Water licence
Estimated annual crop water requirement	3	in	Table 3.4
Crop adjustment factor	4		Table 4.2
Application efficiency of irrigation system	5	%	Table 6.1
Meter Information			
Meter reading at start of year	6	US gal	Water purveyor
Meter reading at end of year	7	US gal	
Pump Specifications			
Pump horsepower	10	hp	Pump name plate
Energy consumption for entire year	11	KWh	Hydro bill
Refer to Worksheet 4(b) for the rest of the information regarding pump			

Irrigation Specifications (based on emitter specifications)

Number of zones	17	zones	Farm plan
Operating hours per zone per day	18	hr/zone/d	Farm plan
Number of operating days per year	19	days	Farm plan

Worksheet 6 Water Diversion and Conveyance Loss Checks

Conveyance channel flow rate at/near diversion	1	US gpm	Site
Overflow in channel	2	US gpm	Site
Number of operating days per season	3	days	Site
Amount of water licensed	4	ac-ft	Water licence
Conveyance channel flow rate at/near intake	5	US gpm	Site

Worksheet 7 Intake Screen Area Check

Screen mesh size	2	mesh	Site
Percent open area of mesh size	3	%	Table 4.3

For flat screen,

Number of screened surfaces	5	ft	Site
Length of screen	6	ft	Site
Width of screen	7	ft	Site

For cylindrical screen,

Diameter of screen	9	ft	Site
Length of screen	10	ft	Site

Worksheet 8 Irrigation Water Quality Check

Adjusted sodium adsorption ratio (SAR_{adj})	2		Laboratory
Electrical conductivity (EC) of water	3	dS/m	Table 4.4
E. coli count	5	cfu/100 ml	Laboratory
Fecal coliform count	6	cfu/100 ml	Laboratory

Worksheet 2(a) Irrigation System Audit – *SPRINKLER*

Checklist:

	Yes	No
1. Are all sprinklers of the same model?	☐	☐
2. Are all nozzles of the same size?	☐	☐
3. Are all sprinkler and lateral spacing uniform (50 – 60% wetted diameter)?	☐	☐
4. Is the operating pressure in the best range?	☐	☐
5. Is pressure differential minimal?	☐	☐

Answer:

Do the system conditions meet all the minimum standards?

☐ **Yes** - OK

☐ **No** - See action items.

Worksheet 2(b) Irrigation System Audit – *TRICKLE*

Checklist:

	Yes	No
For each zone,		
1. Are all emitters of the same model throughout the zone?	☐	☐
2. Are all emitters of the same size throughout the zone?	☐	☐
3. Are all emitter spacing uniform throughout the zone?	☐	☐
4. Is pressure differential minimal?	☐	☐
5. Is the same crop or same plant size grown in the zone?	☐	☐
6. Is the soil type uniform throughout the zone?	☐	☐

Answer:

Do the system conditions meet all the minimum standards?

☐ **Yes** - OK

☐ **No** - See action items.

Worksheet 3(a) Total Irrigated Area Using System Information

Information:

Irrigation interval per pass	1	days/pass
Irrigation sets per day	2	sets
Sprinkler spacing	3	ft
Number of sprinklers	4	sprinklers
Distance moved per set	5	ft

Calculation:

Step 1. Calculate the number of sets per pass

No. of Sets per Pass = Irrigation Interval per pass x Irrigation Sets per Day

= 1 days x 2

= 6 sets

Step 2. Calculate the field width

Field Width = Sprinkler Spacing x No. of Sprinklers

= 3 ft x 6

= 7 ft

Step 3. Calculate the field length

Field Length = Distance Moved per Set x No. of Sets

= 5 ft x 6

= 8 ft

Step 4. Determine the field area

Equation 4.1(a)

$$\text{Total Irrigated Area} = \frac{\text{Field Width} \times \text{Field Length}}{43{,}560}$$

$$= \frac{7 \text{ ft} \times 8 \text{ ft}}{43{,}560}$$

= 9 acres

Repeat the same step for irregular shaped field.

Answer:

Total Irrigated Area = Sum of All Field Areas

= (9 + 9 + 9) acres

= 10 acres

Worksheet 3(b) Total Irrigated Area Using Field Dimension

(can be used for both sprinkler and trickle systems)

Information:

Field width [1] ft
Field length [2] ft

Calculation:

Determine the field area

Equation 4.1(a)

$$\text{Total Irrigated Area} = \frac{\text{Field Width x Field Length}}{43{,}560}$$

$$= \frac{[\ 1\ ]\ \text{ft} \times [\ 2\ ]\ \text{ft}}{43{,}560}$$

$$= [\ 3\ ]\ \text{acres}$$

Repeat the same step for irregular shaped field

Answer:

Total Irrigated Area = Sum of All Field Areas

= ([3] + [3] + [3]) acres

= [4] acres

Worksheet 4(a) System Peak Flow Rate Check - *SPRINKLER*

Information:

Irrigated area (Box 10 of Worksheet 3(a))	1	acres
EITHER peak flow rate on water licence (if stated)	2	US gpm
OR peak flow rate requirement per acre (Table 3.3)	3	US gpm/acre

Calculation:

Step 1. Determine calculated peak flow rate.

Equation 4.2

Calculated Peak Flow Rate = **Estimated Peak Flow Rate Requirement per Acre** x **Irrigated Area**

= 3 US gpm/acre x 1 acres

= 4 US gpm

Step 2. Determine actual irrigation system flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district 5 US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow from pump curve 6 US gpm

Method 3. Determine flow rate using sprinkler nozzles

Nozzle flow rate from supplier's tables 7 US gpm

No. of nozzles 8 nozzles

Equation 4.3

Sprinkler System Output Flow Rate = **Nozzle Flow Rate** x **No. of Nozzles**

= 7 US gpm x 8 nozzles

= 9 US gpm

Answer:

Step 3. Calculate percent difference of peak flow rate.

Equation 4.5

$$\textbf{Percent Difference} = \frac{\textbf{Irrigation System Flow Rate}}{\textbf{Calculated Peak Flow Rate}} \times 100\%$$

$$= \frac{\text{Maximum of 5, 6 or 9 US gpm}}{\text{2 or 4 US gpm}} \times 100\%$$

= 10 %

Is 10 % less than or equal to 100%

Yes Flow rate is not exceeded

No Refer to action items

Worksheet 4(b) System Peak Flow Rate Check - *TRICKLE*

Information:

Irrigated area (Box 10 of Worksheet 3(b))	1	acres
EITHER peak flow rate on water licence (if stated)	2	US gpm
OR peak flow rate requirement per acre (Table 3.3)	3	US gpm/acre

Calculation:

Step 1. Determine calculated peak flow rate.

Equation 4.2

Calculated Peak Flow Rate = **Estimated Peak Flow Rate Requirement per Acre** x **Irrigated Area**

= [3] US gpm/acre x [1] acres

= [4] US gpm

Step 2. Determine actual irrigation system flow rate using one or more of the following methods:

Method 1. Water purveyor restriction or measured flow rate using a meter

Flow rate measured using a meter or provided by district [5] US gpm

Method 2. Pump peak flow rate

Irrigation pump peak flow from pump curve [6] US gpm

Method 3. Determine flow rate using trickle emitters

Emitter flow rate from supplier's tables [7] gph

Number of emitters operating at one time [8] emitters

Equation 4.4

Trickle System Output Flow Rate = **Emitter Flow Rate** x **No. of Emitters** x **0.0167**

= [7] gph x [8] emitters x 0.0167

= [9] US gpm

Answer:

Step 3. Calculate percent difference of peak flow rate.

Equation 4.5

$$\text{Percent Difference} = \frac{\text{Irrigation System Flow Rate}}{\text{Calculated Peak Flow Rate}} \times 100\%$$

$$= \frac{\text{[Maximum of 5, 6 or 9]} \text{ US gpm}}{\text{[2 or 4]} \text{ US gpm}} \times 100\%$$

= [10] %

Is [10] % less than or equal to 100%

[Yes] Flow rate is not exceeded

[No] Refer to action items

Worksheet 5(a) Annual Water Use Check - *SPRINKLER*

Information:

Irrigated area (Box 10 of Worksheet 3(a))	1	acres
Water withdrawal amount on water licence (if applicable)	2	ac-ft
Estimated annual crop water requirement from Table 3.4	3	in
Application efficiency from Table 6.1	4	%

Calculation:

Step 1. Determine calculated annual water requirement.

Equation 4.6

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement}}{\text{Application Efficiency}} \times 100\%$$

$$= \frac{3 \text{ in}}{4 \%} \times 100\%$$

$$= 5 \text{ in}$$

Step 2. Determine actual annual water use using one or more of the following methods:

Method 1. Metered water use

Meter reading at start of year	6	US gal
Meter reading at end of year	7	US gal

Equation 4.8

$$\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year – Meter Reading at Start of Year}}{\text{27027 x Irrigated Area}}$$

$$= \frac{7 \text{ US gal} - 6 \text{ US gal}}{27027 \times 1 \text{ acres}}$$

$$= 8 \text{ in}$$

Method 2. Pump water use

Pump horsepower from supplier's table	9	hp
Energy consumption for entire year from hydro bill	10	KWh
Pump flow rate from pump curve	11	US gpm

Equation 4.9(a)

$$\text{Pump Power} = \text{Pump Horsepower x 0.746 KW/hp}$$

$$= 9 \text{ hp} \times 0.746 \text{ KW/hp}$$

$$= 12 \text{ KW}$$

Equation 4.9(b)

$$\text{Pump Operating Hours} = \frac{\text{KWh for Entire Year}}{\text{Pump Power}}$$

$$= \frac{10 \text{ KWh}}{12 \text{ KW}}$$

$$= 13 \text{ hr}$$

Equation 4.9(c)

Annual Water Use = **Pump Operating Hours x Pump Flow Rate x 0.0022 / Irrigated Area**

= (13 hr x 11 US gpm x 0.0022) / 1 acres

= 14 in

Method 3. Sprinkler system annual water use

Sprinkler system output flow rate from Box 5, 6 or 9 of Worksheet 4(a): 15 US gpm

Irrigation interval: 16 days

Number of irrigations per year: 17

Equation 4.10

Annual Water Use = **System Flow Rate x Irrigation Interval x No. of Irrigations x 0.053 / Irrigated Area**

= (15 US gpm x 16 days x 17 x 0.053) / 1 acres

= 18 in

Answer:

If there is a water licence, go to Step 3(a), and do Step 3(b) to double-check.
If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 3(b) only.

Step 3(a). Calculate the annual water use and compare it with the water licence withdrawal.

Equation 4.12

Annual Water Use [ac-ft] = **Annual Water Use [in] x Irrigated Area [acres] / 12 [in/ft]**

= (8, 14 or 18 in x 1 acres) / 12 in/ft

= 19 ac-ft

Is 19 ac-ft less than 2 ac-ft?

Yes — Water withdrawal not exceeded

No — Refer to Section 3.5

Step 3(b). Calculate percent difference of annual water use. Use the metered water use if available because it is the most accurate method.

Equation 4.5

Percent Difference = **Actual Annual Water Use / Calculated Annual Water Requirement** **x 100%**

= (8,14 or 18 in / 5 in) x 100%

= 10 %

Is 10 % less than 110%? Yes — annual water use not exceeded by more than 10%

No — Refer to action items

Worksheet 5(b) Annual Water Use Check - *TRICKLE*

Information:

Irrigated area (Box 10 of Worksheet 3(b))	1	acres
Water withdrawal amount on water licence (if applicable)	2	ac-ft
Estimated annual crop water requirement from Table 3.4	3	in
Crop adjustment factor from Table 4.2	4	
Application efficiency from Table 6.1	5	%

Calculation:

Step 1. Determine calculated annual water requirement.

Equation 4.7

$$\text{Calculated Annual Water Requirement} = \frac{\text{Estimated Annual Crop Water Requirement} \times \text{Crop Adjustment Factor}}{\text{Application Efficiency}} \times 100\%$$

$$= \frac{\text{[3] in} \times \text{[4]}}{\text{[5] \%}} \times 100\%$$

$$= \text{[6] in}$$

Step 2. Determine actual annual water use using one or more of the following methods:

Method 1. Metered water use

Meter reading at start of year	7	US gal
Meter reading at end of year	8	US gal

Equation 4.8

$$\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year} - \text{Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}}$$

$$= \frac{\text{[8] US gal} - \text{[7] US gal}}{27027 \times \text{[1] acres}}$$

$$= \text{[9] in}$$

Method 2. Pump water use

Pump horsepower from supplier's table	10	hp
Energy consumption for entire year from hydro bill	11	KWh
Pump flow rate from pump curve	12	US gpm

Equation 4.9(a)

$$\text{Pump Power} = \text{Pump Horsepower} \times 0.746 \text{ KW/hp}$$

$$= \text{[10] hp} \times 0.746 \text{ KW/hp}$$

$$= \text{[13] KW}$$

Equation 4.9(b)

$$\text{Pump Operating Hours} = \frac{\text{KWh for Entire Year}}{\text{Pump Power}}$$

$$= \frac{\text{[11] KWh}}{\text{[13] KW}}$$

$$= \text{[14] hr}$$

Equation 4.9(c)

Annual Water Use = **Pump Operating Hours x Pump Flow Rate x 0.0022 / Irrigated Area**

= [14] hr x [12] US gpm x 0.0022 / [1] acres

= [15] in

Method 3. Sprinkler system annual water use

Trickle system output flow rate from Box 5, 6 or 9 of Worksheet 4(b)	[16]	US gpm
Number of zones	[17]	zones
Operating hours per zone per day	[18]	hr/zone/d
Number of operating days per year	[19]	d

Equation 4.11(a)

Annual Water Use

= **Zone Flow Rate x No. of Zones x Operating Hours x No. of Days x 0.0022 / Irrigated Area**

= [16] US gpm x [17] zones x [18] hr/zone/d x [19] d x 0.0022 / [1] acres

= [20] in

Answer:

If there is a water licence, go to Step 3(a), and do Step 3(b) to double-check.
If groundwater is used or water is supplied by a purveyor (no water licence), follow Step 3(b) only.

Step 3(a). Calculate the annual water use and compare it with the water licence withdrawal.

Equation 4.12

Annual Water Use [ac-ft] = **Annual Water Use [in] x Irrigated Area [acres] / 12 [in/ft]**

= [9, 15 or 20] in x [1] acres / 12 in/ft

= [19] ac-ft

Is [19] ac-ft less than [2] ac-ft?

[Yes] Water withdrawal not exceeded

[No] Refer to Section 4.5

Step 3(b). Calculate percent difference of annual water use. Use the metered water use if available because it is the most accurate method.

Equation 4.5

$$\text{Percent Difference} = \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100\%$$

$$= \frac{9,\ 15 \text{ or } 20 \text{ in}}{6 \text{ in}} \times 100\%$$

$$= 21\ \%$$

Is 21 % less than 110% **Yes** annual water use not exceeded by more than 10%

No Refer to action items

Worksheet 6 Water Diversion and Conveyance Loss Check

(can be used for both sprinkler and trickle systems)

Information:

Conveyance channel flow rate at point of stream diversion	1	US gpm
Overflow in channel	2	US gpm
Number of operating days per season	3	days
Amount of water licensed	4	ac-ft
Conveyance channel flow rate near intake	5	US gpm

Water Diversion Check

Calculation:

Step 1. Determine Annual Water Diverted.

Equation 4.12

$$\text{Annual Water Diverted} = \frac{\text{(Channel Flow Rate – Overflow) x No. of Operating Days}}{226.3}$$

$$= \frac{(\ [1]\ -\ [2]\ )\ \text{US gpm x}\ [3]\ \text{days}}{226.3}$$

$$= [6]\ \text{ac-ft}$$

Answer:

Step 2. Water Diversion Check

Is [6] ac-ft less than [1] ac-ft?

[Yes] - OK

[No] - The licensed amount of water is exceeded.
- Reduce conveyance losses

Conveyance Loss Check

Calculation:

Step 3. Calculate conveyance losses

Equation 4.14(a)

$$\text{Reduction in Channel Flow Rate} = \text{Flow Rate at Diversion} - \text{Flow Rate at Irrigation}$$

$$= [1]\ \text{US gpm} - [5]\ \text{US gpm}$$

$$= [7]\ \text{US gpm}$$

Equation 4.14(b)

$$\text{Conveyance Losses} = \frac{\text{Reduction in Channel Flow Rate x No. of Operating Days}}{226.3}$$

$$= \frac{[7]\ \text{US gpm x}\ [3]\ \text{days}}{226.3}$$

$$= [8]\ \text{ac-ft}$$

Answer:

Step 4. Assess Conveyance Losses

Recommended Maximum Conveyance Losses = **Water Licensed Amount x 25%**

= 1 ac-ft x 25%

= 9 ac-ft

Is 8 ac-ft equal to or less than 9 ac-ft?

Yes - OK

No - see action items.

Worksheet 7 Intake Screen Area Check

(can be used for both sprinkler and trickle systems)

Information:

Irrigation system flow rate from Worksheet 4(a) or 4(b)	1	US gpm
Screen mesh size used	2	mesh
Percent screen open area of mesh size from Table 4.3	3	%
Number of screened surface (for flat screens only)	4	
Screen length (for both flat and cylindrical screens)	5	ft
Screen width (for flat screens only)	6	ft
Screen breadth (for flat screens only if end area is screened)	7	ft
Screen diameter (for cylindrical screens only)	8	ft

Calculation:

Step 1. Calculate required screen surface area.

Equation 4.15

$$\text{Suggested Screen Surface Area} = \frac{\text{Flow Rate}}{0.448 \times \%\ \text{Open Area}}$$

$$= \frac{[\ 1\ ]\ \text{US gpm}}{0.448 \times [\ 3\ ]\ \%}$$

$$= [\ 9\ ]\ \text{ft}^2$$

Step 2. Calculate actual screen area.

Equation 4.16(a) Flat Screen

$$\text{Total Flat Surface Area} = \text{No. of Flat Screened Surface} \times \text{Length} \times \text{Width (+ end area if screened)}$$

$$= [\ 4\ ] \times [\ 5\ ]\ \text{ft} \times [\ 6\ ]\ \text{ft}$$

$$(+ [\ 6\ ]\ \text{ft} \times [\ 7\ ]\ \text{ft})$$

$$= [\ 10\ ]\ \text{ft}^2$$

Equation 4.16(b) Cylindrical Screen

$$\text{Total Cylindrical Surface Area} = 3.14 \times \text{Diameter} \times \text{Length} \left(+ \text{end area if screened}\right)$$

$$= 3.14 \times \text{Diameter} \times \text{Length} + \left[\frac{3.14 \times (\text{Diameter})^2}{4}\right]$$

$$= 3.14 \times [\ 8\ ]\ \text{ft} \times [\ 5\ ]\ \text{ft} + \left[\frac{3.14 \times (\ [\ 8\ ]\ \text{ft})^2}{4}\right]$$

$$= [\ 11\ ]\ \text{ft}^2$$

Answer:

Step 3. Is [9] ft^2 less than [10 or 11] ft^2?

[Yes] - OK

[No] - Screen area is too small. Refer to action items.

Worksheet 8 Irrigation Water Quality Check

(can be used for both sprinkler and trickle systems)

Calculation:

Step 1. SAR or SAR_{adj} Check

SAR for sprinkler systems	1	
SAR_{adj} for trickle systems	2	
Electrical conductivity (EC) (Table 4.4)	3	dS/m
Restriction on water use from Table 4.4 or 4.5	4	

If the answer in Box 4 is slight to moderate or severe, water use from this source may need to be restricted.

Step 2. Pathogen Check

E.Coli	5	cfu/100 ml
Fecal coliform	6	cfu/100 ml

Answer: Use Table 4.6 to determine if the values are within acceptable parameters.

Worksheet 9 Irrigation System Uniformity Check

(can be used for both sprinkler and trickle systems)

Information/ Calculation:

Total number of catch cans [1]

Number of cans in the lowest 25% = [1] x 25%

= [2]

Water Depth [mm]	Ranking	Lowest Quartile [mm]
Total [3]		[4]

LQ = [4] mm / [2]

= [5] mm

Average Catch Overall = [3] mm / [1]

= [6] mm

Equation 4.17

$$DU = \frac{LQ \times 100}{\text{Average Catch Overall}}$$

= [5] mm x 100 / [6] mm

= [7] %

Answer:

Is [7] % more than or equal to 80% (for sprinkler systems) or 90% (for trickle systems)

[Yes] Ok.

[No] See action items.

Worksheet 10 Soil-Crop Report

Information:

Pit	A	B	C
Crop			
Rooting Depth (RD) [m]			
Availability Coefficient (AC) [decimal], Table 5.2	1	1	1
Maximum Application Rate (AR) [mm/hr], Table 5.4			

Soil Depth [m]	RD* [m]	Texture	AWSC [mm/m]	SWS [mm]	Texture	AWSC [mm/m]	SWS [mm]	Texture	AWSC [mm/m]	SWS [mm]
	2		3	4		3	4		3	4
	2		3	4		3	4		3	4
	2		3	4		3	4		3	4
	2		3	4		3	4		3	4
Total SWS [mm]				5			5			5
MSWD [mm]				6			6			6
Sum of MSWD [mm]				7						

* RD = soil depth is only calculated for the soil in the root zone.

Sample Calculations – Pit A:

Step 1. Calculate soil water storage (SWS)

(a) Calculate SWS for each soil depth interval that has roots. Use the first interval as an example.

Equation 5.1

SWS = RD x AWSC

= [2] m x [3]

= [4] mm

(b) Total SWS within the zone

Total SWS = $SWS_{(\ -\ m)}$ + $SWS_{(\ -\ m)}$ + $SWS_{(\ -\ m)}$ + $SWS_{(\ -\ m)}$

= ([4] + [4] + [4] + [4]) mm

= [5] mm

Step 2. Calculate MSWD

(a) **Equation 5.2**

MSWD = SWS x AC

= [5] mm x [1]

= [6] mm

(b) Calculate average MSWD for all soil pits

$$\text{Average MSWD} = \frac{\text{Sum of MSWD}}{\text{Number of Readings}}$$

= [7] mm / [ ]

= [8] mm

Note: *If the soil types and values vary a lot between soil pits, e.g., sandy loam in one area and clay loam in another area, the area within the soil boundaries should be managed separately. Do not average these values. Rather, keep a separate record of each soil area.*

Worksheet 11 Lateral Pressure Distribution Check – *SPRINKLER*

Information:

Location of Reading	Reading		
First sprinkler		1	psi
Sprinkler at ¼ distance		2	psi
Sprinkler at ½ distance		3	psi
Sprinkler at ¾ distance		4	psi
Last sprinkler		5	psi
Highest value		6	psi
Lowest value		7	psi
Number of readings		8	psi
Operating pressure range guide (Table 6.3)		9	psi

Assessment:

Check if all pressure readings are within the recommended operating pressure range (Table 6.3)

Are **all** pressure readings within [9] psi?

[Yes] Ok.

[No] Check action items.

Calculation:

Step 1. Calculate the average pressure

$$\text{Average Pressure} = \frac{\text{Sum of Readings}}{\text{Number of Readings}}$$

$$= \frac{(\,[\,1\,] + [\,2\,] + [\,3\,] + [\,4\,] + [\,5\,]\,)\ \text{psi}}{[\,8\,]}$$

$$= [\,10\,]\ \text{psi}$$

Step 2. Calculate the percent pressure difference

Equation 6.1

$$\text{Percent Pressure Difference} = \frac{\text{Highest Value} - \text{Lowest Value}}{\text{Average Value}} \times 100\%$$

$$= \frac{[\,1\,]\ \text{psi} - [\,2\,]\ \text{psi}}{[\,5\,]\ \text{psi}} \times 100\%$$

$$= [\,6\,]\ \%$$

Answer:

Is [6] % less than 20%? [Yes] Ok.

[No] Check action items.

Worksheet 12 Wheelmove or Handmove Lateral Line Assessment

Note: Worksheet 11 should be completed to ensure all sprinklers are operating in the proper pressure range. All measurements are in imperial units to facilitate using the tables in the B.C. Sprinkler Irrigation Manual. Appendix B provides conversions from imperial to metric units.

Information: The data shown in the boxes below was determined from the site. The data is evaluated with the information provided in the sprinkler selection sheets (Table 3.3 to 3.9 of the B.C. Sprinkler Irrigation Manual)

System type and location		
Sprinkler spacing	1	ft x ft
Nozzle flow rate	2	gpm
Average operating pressure	3	psi
Pressure at the start of the lateral	4	psi
Pipe size(s) along lateral (diameters and % split)	5	
Number of nozzles operating at one time on the lateral	6	

Assessment: *Check that the nozzle size and pressure in use match those on the chart.*

Step 1. Assess the sprinkler operating pressure at the start of the lateral

Recommended pressure at the start of the lateral [8] psi

Is [4] psi less than or equal to [8] psi?

[Yes] Ok.

[No] Check action items.

Step 2. Assess the number of sprinklers operating at one time on the lateral

Recommended number of sprinklers [9]

Is [6] less than or equal to [9] ?

[Yes] Ok.

[No] See action items.

Worksheet 13 PVC Lateral Line Assessment

Information:

Sprinkler operating pressure [1] psi
Elevation change (10 ft x 0.433 psi) [2] psi

Maximum friction loss = Pressure at the Start of the Lateral x 20%
= [1] psi x 20%
= [3] psi

Nozzle Number	Total Flow Rate [US gpm]	Pipe Diameter [in]	Pipe Length [ft]		Friction Loss [psi/100 ft]		Friction Loss per Length [psi]
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	
				÷ 100 ft x		=	

Total friction loss (sum of the right most column) = [4] psi
Miscellaneous loss = [4] psi x 10% = [5] psi

Total friction loss (including miscellaneous loss)
= [4] psi + [5] psi = [6] psi

Total lateral line friction loss (elevation loss + total friction loss)
= [2] psi + [6] psi = [7] psi

Answer:

Is [7] psi less than [3] psi?

[Yes] Total friction loss is fine.
[No] Check action items.

Worksheet 14 Wheelmove or Handmove Sprinkler Spacing Check

Information:

Nozzle type		
Nozzle size (diameter)	1	in
Lateral spacing	2	ft
Operating pressure	3	psi
Maximum wind speed	4	km/hr

Calculation:

Diameter of throw (Table 6.5)	5	ft
Spacing as a percentage of wetted diameter (Table 6.4)	6	%

Equation 6.2

Recommended Spacing	=	Sprinkler Wetter Diameter	x	Spacing as a Percentage of Wetter Diameter

= 5 ft x 6 %

= 7 ft

For a **rectangular** spacing, the maximum spacing should not exceed the recommended value by 15%.

Maximum Spacing = 7 ft x 115%

= 8 ft

Answer:

Is 2 ft less than or equal to 8 ft?

Yes Spacing is fine.

No Check action items.

Worksheet 15 Assessment of Sprinkler System Performance

Information:

System type and location			
Nozzle flow rate (Box 7, Worksheet 4(a))	1		US gpm
Sprinkler spacing (S_1 = 40ft)	2		m
Lateral spacing or distance the line is moved (S_2 = 60ft)	3		m
Stationary guns only, wetted radius (r)	4		m
Maximum application rate (Table 5.4)	5		mm/hr
Maximum soil water deficit (MSWD) (Box 8, Worksheet 10(a))	6		mm
Application efficiency (AE)	7		%
Irrigation set time currently used on farm	8		hr
Peak ET rate (Table 3.1)	9		mm/d
Number of sets currently used to irrigate the field	10		sets

Calculation:

❹ Application Rate Check

(a) For ***sprinkler systems***, calculate the application rate (AR)

Equation 6.3

$$AR = \frac{227 \times Q}{S_1 \times S_2}$$

$$= \frac{227 \times \text{[1] US gpm}}{\text{[2] m} \times \text{[3] m}}$$

$$= \text{[11] mm/hr}$$

For ***stationary guns only***, calculate the instantaneous application rate (IAR)

Equation 6.10

$$IAR = \frac{227 \times Q}{3.14 \times r^2}$$

$$= \frac{227 \times \text{[1] US gpm}}{3.14 \times (\text{[4] m})^2}$$

$$= \text{[12] mm/hr}$$

(b) Is [11 or 12] mm/hr less than or equal to [5] mm/hr

[Yes] Ok.

[No] See action items.

❺ Maximum Set Time Check

(a) Calculate maximum set time

Equation 6.4

$$\text{Maximum Set Time} = \frac{\text{MSWD} \times 100\ \%}{\text{AR} \times \text{AE}}$$

$$= \frac{\text{[6] mm} \times 100\%}{\text{[11 or 12] mm/hr} \times \text{[7] \%}}$$

$$= \text{[13] hr}$$

(b) Is [8] hr less than [13] hr?

[Yes] Ok.

[No] See action items.

Note: A set time that is convenient to match farm operations is often chosen. The actual operating time for a 12-hour set may be 11.5 hrs to allow time for moving the system, but 12 hours should be used in this calculation to determine the number of sets.

❻ Irrigation Interval Check

(a) Calculate the net amount of irrigation water applied during this set time

Equation 6.5

$$IRR = \frac{AR \times AE \times \text{Set Time}}{100\%}$$

$$= \frac{\text{11 or 12 mm/hr} \times \text{7 \%} \times \text{8 hr}}{100\%}$$

$$= \text{14 mm}$$

(b) Calculate irrigation interval for the new set time

Equation 6.6

$$\text{Irrigation Interval} = \frac{IRR}{\text{Peak ET Rate}}$$

$$= \frac{\text{14 mm}}{\text{9 mm/d}}$$

$$= \text{15 d}$$

(c) Calculate the available number of sets that can be applied over the irrigation interval

Equation 6.8

$$\text{Available Sets} = \frac{\text{24 hr} \times \text{Irrigation Interval}}{\text{Set Time}}$$

$$= \frac{\text{24 hr} \times \text{15 d}}{\text{8 hr}}$$

$$= \text{16 sets}$$

(d) Compare the available sets with the actual number of sets to irrigate the field

Is 10 sets

- less than — The system does not need to be run continuously during peak times – see Scenario 1.
- close to — The system is able to meet water requirements during peak times – see Scenario 2.
- more than — The system may not have the capacity to irrigate the entire field during peak conditions – see Scenario 3.

16 sets?

Basic Farm Irrigation Schedule

The basic irrigation schedule for this system during peak water use periods is:

Set Time 8 hr

Irrigation Interval 16 d

This will be used as a starting point for irrigation scheduling during peak times of the year. For other times of the year, the irrigation interval may be longer or the set time is reduced.

Worksheet 16 Assessment of Travelling Gun Performance

Information:

System type and location			
Nozzle flow rate		1	US gpm
Lane spacing (S = 200 ft)		2	m
Wetted radius (r = 165 ft)		3	m
Longest travelled distance (L = 1,300 ft)		4	m
Time to irrigate the longest travel lane		5	hr
Percent of full circle covered (c)		6	
Maximum application rate		7	mm/hr
Maximum soil water deficit (MSWD)		8	mm
Application efficiency (AE) (Table 6.1)		9	%
Peak ET rate (Table 3.1)		10	mm/d
Actual Irrigation interval		11	d

Calculation:

❹ Application Rate Check

(a) Calculate instantaneous application rate (IAR).

Equation 6.10

$$IAR = \frac{227 \times Q}{3.14 \times r^2 \times c}$$

$$= \frac{227 \times [\ 1\ ] \text{ US gpm}}{3.14 \times (\ [\ 3\ ] \text{ m})^2 \times [\ 6\ ]}$$

$$= [\ 12\ ] \text{ mm/hr}$$

(b) Is [12] mm/hr less than [7] mm/hr

[Yes] Ok.

[No] See action items.

❺ Travel Speed Check

(a) Calculate the time required to irrigate the longest lane applying the MSWD

Equation 6.11

$$T = \frac{L \times S \times MSWD}{2.27 \times Q \times AE}$$

$$= \frac{[\ 4\ ] \text{ m} \times [\ 2\ ] \text{ m} \times [\ 8\ ] \text{ mm}}{2.27 \times [\ 1\ ] \text{ US gpm} \times [\ 9\ ] \%}$$

$$= [\ 13\ ] \text{ hr}$$

(b) Calculate actual and minimum travel speeds

Equation 6.12

$$Speed = \frac{L}{T}$$

$$\text{Actual Speed} = \frac{[\ 4\ ] \text{ m}}{[\ 5\ ] \text{ hr}} = [\ 14\ ] \text{ m/hr}$$

$$\text{Minimum Speed} = \frac{[\ 4\ ] \text{ m}}{[\ 13\ ] \text{ hr}} = [\ 15\ ] \text{ m/hr}$$

(c) Compare the actual and the minimum travel speeds

Is [14] m/hr

- [less than] The system is applying more water than soil can store - causing over-irrigation – see Scenario 1.
- [close to] (within 10%) The amount applied matches the soil water storage capacity – see Scenario 2.
- [more than] The system is applying less water than what the soil can store – see Scenario 3.

[15] m/hr?

❻ Irrigation Interval Check

(a) Calculate the net amount applied

Equation 6.13

$$IRR = \frac{2.27 \times Q \times AE}{S \times Speed}$$

$$= \frac{2.27 \times [1]\ \text{US gpm} \times [9]\ \%}{[2]\ \text{m} \times [14]\ \text{m/hr}}$$

$$= [16]\ \text{mm}$$

Is [16] mm less than or equal to [8] mm?

- [Yes] Ok.
- [No] See action items.

(b) Calculate irrigation interval during the peak season

Equation 6.14

$$\text{Irrigation Interval} = \frac{IRR}{\text{Peak ET Rate}}$$

$$= \frac{[16]\ \text{mm}}{[10]\ \text{mm/d}}$$

$$= [17]\ \text{d}$$

(c) Is [11] d

- [less than] The system does not need to be run continuously during peak times – see Scenario 1.
- [close to] The system is able to meet water requirements during peak times – see Scenario 2.
- [more than] The system may not have the capacity to irrigate the entire field during peak conditions – see Scenario 3.

[17] d?

Worksheet 17 Centre Pivot System Performance Check

Information:

System type and location			
Soil type			
Pivot flow rate (Q)		1	US gpm
Pivot length (R = 1,300 ft)		2	m
Wetted radius (r = 40 ft)		3	m
Percentage of full circle irrigated (P)		4	%
Rotation speed (N)		5	hr/rev
Application efficiency (AE) (Table 6.1)		6	%
Maximum soil water deficit (MSWD)		7	mm
Peak ET rate (Table 3.1)		8	mm/d
Irrigation interval (24 hr)		9	d

Calculation:

❸ Rotation Time Check

(a) Calculate the pivot maximum application rate

Equation 6.14

$$PAR = \frac{289 \times Q}{R \times r}$$

$$= \frac{289 \times \boxed{1}\ \text{US gpm}}{\boxed{2}\ \text{m} \times \boxed{3}\ \text{m}}$$

$$= \boxed{10}\ \text{mm/hr}$$

(b) Calculate the minimum travel speed

Using the calculated PAR from (a) above the (T_m) can be determined from Figure 6.9

Maximum duration of application (T_m) (Figure 6.9) [11] min

Equation 6.15

$$S = \frac{2\ r}{T_m}$$

$$= \frac{2 \times \boxed{3}\ \text{m}}{\boxed{11}\ \text{min}}$$

$$= \boxed{12}\ \text{m/min}$$

(c) Calculate the maximum rotation time and compare it with the actual rotation time

Equation 6.16

$$N = \frac{3.14 \times R}{30 \times S}$$

$$= \frac{3.14 \times \boxed{2}\ \text{m}}{30 \times \boxed{12}\ \text{m/min}}$$

$$= \boxed{13}\ \text{hr/rev}$$

Is the actual rotation time [5] hr/rev

less than or equal to [13] hr/rev?

[Yes] Ok.

[No] See action items.

❹ Irrigation Interval Check

(a) Calculate the area irrigated by the pivot

Equation 6.18

$$A = \frac{3.14 \times R^2 \times P}{10{,}000}$$

$$= \frac{3.14 \times (\ [2]\ \text{m})^2 \times [4]}{10{,}000}$$

$$= [14]\ \text{ha}$$

(b) Calculate the net amount applied, and compare it with the MSWD

Equation 6.17

$$IRR = \frac{Q \times N_a \times AE}{A \times 4382}$$

$$= \frac{[1]\ \text{US gpm} \times [13]\ \text{hr/rev} \times [6]\ \%}{[14]\ \text{ha} \times 4382}$$

$$= [15]\ \text{mm}$$

Is [15] mm less than or equal to [7] mm?

- [Yes] Ok.
- [No] See action items.

(c) Calculate the irrigation interval, and compare it with the actual value

Equation 6.6

$$\text{Irrigation Interval} = \frac{IRR}{\text{Peak ET Rate}}$$

$$= \frac{[15]\ \text{mm}}{[8]\ \text{mm/d}}$$

$$= [16]\ \text{d}$$

Is [9] d less than or equal to [16] d?

- [Yes] Ok.
- [No] See action items.

Worksheet 19 System Operating Time

Information:

System type and location			
Application efficiency (AE) (Table 6.1)	1	%	
Peak ET rate (Table 3.1)	2	mm/d	
Effective soil water storage capacity (S) (Table 6.11)	3		
Plant area (A) (Worksheet 18, Box 15)	4		
Crop coefficient factor (K) (Worksheet 18, Box 11)	5		
Zone operating time	6	hr	

For **drip line** systems,

Emitter flow rate per 100 m	7	L/hr
Number of plants per 100 m	8	

For **emitter** systems,

Emitter flow rate (Worksheet 18, Box 3)	9	L/hr
Number of emitters per plant (Worksheet 18, Box 16)	10	

Calculation: Calculations for zone 1 are shown here.

❹ **System Operating Time Check**

(a) Calculate irrigation output

For **drip line** systems,

Equation 6.22(a)

$$\text{Irrigation Output} = \frac{\text{Emitter Flow Rate per 100 m x AE}}{\text{Number of Plants per 100 m x 100\%}}$$

$$= \frac{\text{– 7 L/hr x – 1 \%}}{\text{– 8 plants x 100\%}}$$

$$= \text{– 11 L/p/hr}$$

For **emitter** systems,

Equation 6.22(b)

$$\text{Irrigation Output} = \frac{\text{Emitter Flow Rate x Number of Emitters per Plant x AE}}{\text{100\%}}$$

$$= \frac{\text{9 L/hr x 10 emitters/p x 1 \%}}{\text{100\%}}$$

$$= \text{12 L/p/hr}$$

(b) Calculate plant water requirement

Equation 6.23

L/P/D = ET x S x A x K

= 2 mm/d x 3 x 4 m^2 x 5

= 13 L/p/d

(c) Calculate the operating time per day for each zone

Equation 6.24

$$\text{Operating Time} = \frac{\text{L/P/D}}{\text{Irrigation Output}}$$

$$= \frac{13 \text{ L/p/d}}{11 \text{ or } 12 \text{ L/p/hr}}$$

$$= 14 \text{ hr/d}$$

This is the number of hours per day the irrigation system should be running in peak periods to provide the crop with sufficient water without over-irrigation. The irrigation time per zone can be shorter during non-peak periods, but it should never be longer.

Answer:

(a) For each zone, calculate the time required to irrigate the plants during the peak time of the year, and input the answers under "Time to Irrigate Zone" below. Then, sum up all the times together to perform a check.

Zone Number	Required Operating Time [hr]	Actual Operating Time [hr]
	14	6
	14	6
Total =	15	16

(b) For each zone,

Is 6 hr less than 14 hr?

Yes Ok.

No See action items.

(c) For the entire system,

Is 16 hr equal to or less than 20 hr?

Yes Ok.

No See action items.

Worksheet 20 Determining Evaporation Using an Evaporation Pan

Recording information from an evaporation pan in the following table.

Date	Water Depth [mm]	Evaporation [mm]	Moisture Deficit per Day [mm/d]

Sample Calculations:

Number of days between _____ and _____ 1 d

Evaporation between _____ and _____

= Water Depth on _____ – Water Depth on _____

= 2 mm – 3 mm

= 4 mm

$$\text{Evaporation per Day} = \frac{\text{Evaporation}}{\text{No. of Days}}$$

$$= \frac{4 \text{ mm}}{1 \text{ d}}$$

= 5 mm/d

Worksheet 21 Crop Water Use

Information:

Evaporation [1] mm

Factor to convert ET_p (pan) to ET_o (grass) from Table 7.5 [2]

Method 1. For crops listed in Table 7.7 or 7.8

Crop coefficient (K_c) from Table 7.7 or 7.8 [3]

Method 2. For other vegetable crops

Width of planting canopy (W_p) [4] mm

Bed spacing (W_b) [5] mm

Calculations:

Step 1 Calculate grass reference evapotranspiration (ET_o)

ET_o	=	ET_p		x	Factor
	=	[1] mm		x	[2]
	=	[6] mm			

Step 2 Method 2 is used to check the K_c value from Table 7.7.

Equation 7.2

$$K_c = \frac{W_p}{W_b}$$

$$= \frac{[\ 4\ ]\ \text{mm}}{[\ 5\ ]\ \text{mm}}$$

$$= [\ 7\ ]$$

Answer:

Step 3 Calculate crop evapotranspiration (ET_c)

Equation 7.1

ET_c	=	ET_o	x	K_c
	=	[6] mm	x	[3 or 7]
	=	[8] mm		

Worksheet 22 Sprinkler Irrigation Scheduling Using Water Budget Method

Information:

Maximum soil water storage (SWS) capacity		mm
Maximum soil water deficit (MSWD)		mm
Crop coefficient (K_c)		

Analysis:

Nomenclature:

PSWS	=	Previous Soil Water Storage
EP	=	Effective Precipitation
IRR	=	Net Depth of Irrigation Water Applied
ET_o	=	Reference Evapotranspiration
K_c	=	Crop Coefficient
CSWS	=	Current Soil Water Storage

All units are in millimetres (mm) except for Date and K_c.

Date	PSWS	+	EP	+	IRR	–	ET_o	x	K_c	=	CSWS
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	

Worksheet 23 Trickle Irrigation Scheduling Using *Plant Water Requirement Method*

Information:

Maximum zone operating time		1	hr/day
Peak ET		2	mm

Analysis:

Date	Daily ET_o [mm]	x	K_c	=	ET_c [mm]		Operating Time [hr/day]	
		x		=		3		4
		x		=		3		4
		x		=		3		4
		x		=		3		4
		x		=		3		4
		x		=		3		4
		x		=		3		4
Weekly Total								
Average								

Sample Calculations:

Equation 7.5

$$\text{Zone Operating Time} = \text{Maximum Zone Operating Time} \times \frac{ET_c}{\text{Peak ET}}$$

$$= \text{[ ] 1 hr/day} \times \frac{\text{[ ] 3 mm}}{\text{[ ] 2 mm}}$$

$$= \text{[ ] 4 hr/day}$$

Worksheet 24 Trickle Irrigation Scheduling Using *Water Budget Method*

Information:

Emitter spacing (S_1)	1	m
Row spacing (S_2)	2	m
Maximum soil water storage (SWS) capacity	3	mm
Emitter Flow Rate (Q)	4	L/hr
Application efficiency (AE)	5	%

Calculation:

(a) The maximum soil water deficit (MSWD) for trickle systems is 25% of the SWS; therefore,

MSWD = 3 mm x 25%

= 6 mm

= **Net Depth of Irrigation Water Applied (IRR)**

(b) Irrigation should start when the balance reaches:

= 3 mm – 6 mm

= 7 mm

(c) Determine operating time

Equation 7.6

$$T = \frac{S_1 \times S_2 \times IRR \times 100\%}{Q \times AE}$$

$$= \frac{1\ \text{m} \times 2\ \text{m} \times 4\ \text{mm} \times 100\%}{4\ \text{L/hr} \times 5\ \%}$$

= 8 hr

(d)

Nomenclature:

PSWS	=	Previous Soil Water Storage
EP	=	Effective Precipitation
IRR	=	Net Depth of Irrigation Water Applied
ET_o	=	Reference Evapotranspiration
K_c	=	Crop Coefficient
CSWS	=	Current Soil Water Storage

All units are in millimetres (mm) except for Date and K_c.

Date	PSWS	+	EP	+	IRR	–	ET_o	x	K_c	=	CSWS
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	
		+		+		–		x		=	

Worksheet 25 Mainline Friction Losses

Assessment:

(a) Record all the information in the table below:

Location	Type	ID [in]	Flow Rate [US gpm]	Length [ft]	x	Friction Loss Factor per 100 ft			Head Loss [psi]	Flow Speed [m/s]
$X_0 - X_1$		1	2		x		÷ 100 ft	=	3	4
$X_1 - X_2$		1	2		x		÷ 100 ft	=	3	4
$X_2 - X_3$		1	2		x		÷ 100 ft	=	3	4
$X_3 - X_4$		1	2		x		÷ 100 ft	=	3	4
$X_5 - X_6$		1	2		x		÷ 100 ft	=	3	4

Total friction loss along mainline [psi] = 5

(b) Friction loss check

Check the head loss for all of the pipe sections (boxes labelled 3)

E.g., $X_5 - X_6$ Is 3 psi less than or equal to 10 psi?

Yes Ok.

No See action items

(c) Flow speed check

Check the flow speed for all of the pipe sections (boxes labelled 4)

Equation 8.2

$$\text{Flow Speed} = \frac{Q \times 0.125}{d^2}$$

$$= \frac{1 \text{ US gpm} \times 0.125}{(1 \text{ in})^2}$$

$$= 6 \text{ m/s}$$

E.g., $X_5 - X_6$ Is 4 or 6 m/s less than or equal to 1.5

Yes Ok.

No See action items

Worksheet 26 Pump Assessment

Information for Total Dynamic Head:

Static suction head	1	ft
Elevation head	2	ft
Sprinkler pressure (H_p)	3	ft
Friction head (H_f) (Worksheet 25, Box 5))	4	ft

Calculate Total Dynamic Head:

Equation 8.1

$H = H_s + H_e + H_p + H_f$

= (1 + 2 + 3 + 4) ft

= 5 ft

Information for Pump Assessment:

Pump Best Efficiency Point (BEP) from Figure 8.2	6	%
Pump operating efficiency from Figure 8.2	7	%
NPSHR from Figure 8.2	8	ft
Irrigation system flow rate	9	US gpm

Calculate Pump Horsepower:

Equation 8.3

$$HP = \frac{Q \times H}{39.6 \times E}$$

$$= \frac{9 \text{ US gpm} \times 5 \text{ ft}}{39.6 \times 7 \%}$$

= 10 hp

Pump Assessment:

Is the pump operating within 80% of the best efficiency point?

80% of the pump BEP = 6 x 80%

= 11 %

Is 7 % within 11 %?

Yes Ok.

No See action items.

Pump NPSHR Check:

Is the pump operating close enough to the water level to function properly?

Is 1 ft 5 ft less than 8 ft?

Yes Ok.

No See action items.

Worksheet 27 Irrigation Operating Cost

Information:

Farm location			
Water Purveyor			
Water source (stream or lake)			
Irrigated area	1		acres
System Efficiency	2		%
Number of days system is operated	3		days

Annual Water Licence Fee

Water use ≤ 40 ac-ft (Table 8.1) $	4		
Each additional 2 ac-ft of water use (Table 8.1) $	5		
Crop water requirement (Table 3.4)	6		in

Annual Water Storage Licence Fee

Water stored ≤ 2,000 ac-ft (Table 8.1) $	7		
Each additional 1,000 ac-ft of water use (Table 8.1) $	8		
Crop water requirement (Table 3.4)	9		in
Amount of water stored	10		in

Electric Cost

Electric rate in irrigation season (Table 8.2)	11		$/Kw-hr
Operating hours per season (days x 24 hours /day)	12		hrs
Pump horsepower	13		hp

Fuel Cost

Fuel unit cost $	14		/gal
Fuel consumption	15		gal

Water Purveyor

Total charges per acre of irrigation (Table 8.3)	16		$/acre
Amount of water allowed (Table 8.3)	17		US gpm/acre

Calculation:

1. Annual Water Licence Rental

Equation 8.4

$$\text{Amount of Water Use} = \frac{\text{Irrigated Area x Crop Water Requirement x 100\%}}{\text{12 x AE}}$$

$$= \frac{[1]\ \text{acre} \times [6]\ \text{in} \times 100\%}{12 \times [2]\ \%}$$

$$= [18]\ \text{ac-ft}$$

$$\text{Annual Water Licence Fee} = \$[4] + \$[5] \times \frac{([18] - 40)\ \text{ac-ft}}{2}$$

$$= \$[19]$$

$$\text{Annual Storage Licence Fee} = \$[7] + \$[8] \times \frac{([10] - 2{,}000)\ \text{ac-ft}}{2}$$

$$= \$[20]$$

2. Annual Water Pumping Fee (choose either a or b)

(a) Electric

Equation 8.5(a)

Annual Electric Cost = Electric Charge x Number of Operating Hours x Pump Power x 0.746

= $ [11] /KWh x [12] hr x [13] hp x 0.746

= $ [21]

(b) Fuel

Equation 8.5(b)

Annual Fuel Cost = Fuel Unit Cost x Fuel Consumption x Number of Operating Hours

= $ [14] /gal x [15] gal x [12] hr

= $ [22]

3. Water Purveyor Cost

Water Purveyor Cost = $ [16] /acre x [17] acres

= $ [23]

Worksheet 28 Chemigation Information

Information:

INFORMATION	Value	Unit	Source
System Information			
	Field 1		
Crop			Worksheet 10(a)
Field area		ha	Worksheet 3(a), Box 10
Number of irrigation sets		sets	Worksheet 15, Box 16
Area covered per set		ha	Worksheet 1, Box 16
Sprinkler Spacing		ft x ft	Worksheet 12, Box 1
Nozzle size		in x in	Worksheet 4(a)
Operating pressure		psi	Worksheet 4(a)
Sprinkler flow rate		US gpm	Worksheet 4(a), Box 7
Application rate		in/hr	Worksheet 15, Box 11 or 12
Irrigation set time		hr	Worksheet 15, Box 13
Chemical Applied (obtain all information from system operation)			
Number of applications per year			
Date of application			
Area to be treated per application		ha	
Chemical			
Amount of nutrient to be applied per application		kg/ha	
Total amount of chemical to be applied		kg/ha	
Amount of chemical required for area		kg	
Injection rate		L/min	
Injection start time after irrigation begins [hr]		hr	
Length of injection time per set [hr]		hr	