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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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 Info Irrigation interval per pass Irrigation sets per day Sprinkler spacing Number of sprinklers Distance moved per set	1 2 3 4	days/pass sets ft sprinklers ft	Farm info Farm info Farm info Farm info Farm info
Worksheet 3(b) Total Irrigated Area Using Field Dimen Field width Field length	. 1	ft ft	Farm info Farm info
Worksheet 4(a) Irrigation System Peak Flow Rate Chec <u>Calculated Irrigation System Peak Flow Rate</u> Peak flow rate on water licence or provided by	ck		Water
irrigation district or water purveyor		US gpm in/d US gpm/acre	licence or purveyor Table 3.1 Table 3.2 or 3.3
Actual Irrigation System Flow Rate Flow rate metered or provided by district		US gpm	Meter or district
Model number Impellor size Revolution per minute (rpm) Flow rate		in Dia. rpm US gpm	Pump name plate Pump curve
Nozzle Specifications: Size Operating pressure Flow rate Number of nozzles	7	in x in psi US gpm nozzles	Field check Field check Farm plan Farm plan
Worksheet 5(a) Annual Water Use Check			
Calculated Annual Water Use Requirement Annual water withdrawal stated on water licence Estimated annual crop water requirement	3	ac-ft in %	Water licence Table 3.4 Table 6.1
Meter Information Meter reading at start of year Meter reading at end of year		US gal US gal	Water purveyor

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
W 1 1 1 4 2 W 1 2 Di vita di la Constanti di		
Worksheet 6 Water Diversion and Conveyance Loss Checks	110	0:4-
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
	,	00
For cylindrical screen,		
Diameter of screen	9 ft	Site
Length of screen	10 ft	Site
25194151551551	10	
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

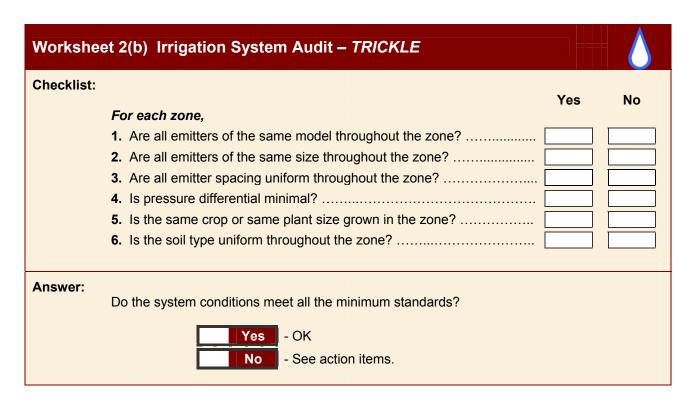
Worksheet 1(b) Information from Farm Plan – TRICKLE



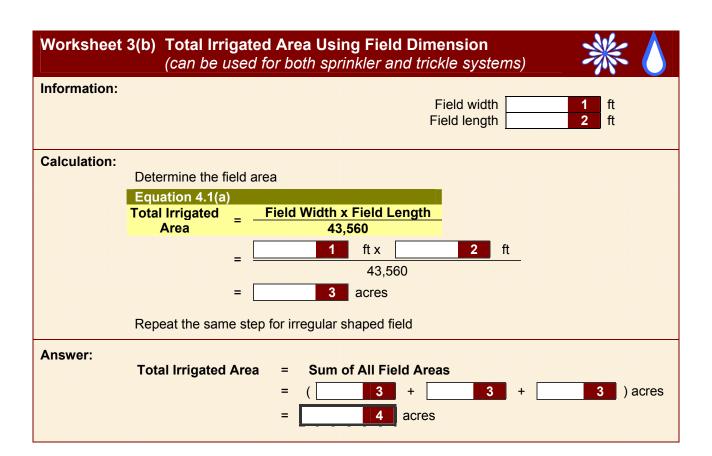
INFORMATION	Value and Box No.	Unit	Source
Worksheet 3(b) Total Irrigated Area			
Field width		ft	Farm info.
Field length	1 2	ft	Farm info.
Worksheet 4(b) Irrigation System Peak Flow Rate Chec	k		
Calculated Irrigation System Peak Flow Rate			
Peak flow rate on water licence or provided by			Water
irrigation district or water purveyor	2	US gpm	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:			uistrict
Model number	_		Field check
Impellor size			Pump
Revolution per minute (rpm)		rpm	name plate
Flow rate	6	US gpm	Pump curve
Emitter Specifications:			
Size	_	in I.D.	Field check
Operating pressure	_	psi	Field check
Flow rate (zone 4)		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	0/	Table 4.2
Application efficiency of irrigation system	5	%	Table 6.1
Meter Information			
Meter reading at start of year	6	US gal	Water
Meter reading at end of year	7	US gal	purveyor
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	zones	Farm plan
Operating hours per zone per day	hr/zone/d	Farm plan
Number of operating days per year	days	Farm plan
The state of the s		
Worksheet 6 Water Diversion and Conveyance Loss Checks		
Conveyance channel flow rate at/near diversion	US gpm	Site
Overflow in channel 2	US gpm	Site
Number of operating days per season	days	Site
Amount of water licensed	ac-ft	Water
		licence
Conveyance channel flow rate at/near intake 5	US gpm	Site
Worksheet 7 Intake Screen Area Check Screen mesh size	mesh %	Site Table 4.3
For flat screen,		
Number of screened surfaces	ft	Site
Length of screen	ft	Site
Width of screen	ft	Site
For cylindrical screen,		
Diameter of screen9	ft	Site
Length of screen10	ft	Site
Wartshoot 9 Junioration Water Quality Charles		
Worksheet 8 Irrigation Water Quality Check Adjusted sodium adsorption ratio (SAR _{adi})		Laboratory
	dS/m	Table 4.4
Electrical conductivity (EC) of water	cfu/100 ml	
E. coli count		Laboratory
Fecal coliform count	cfu/100 ml	Laboratory

Worksheet 2(a) Irrigation System Audit – SPRINKLER			
Checklist:	Yes	s 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.		



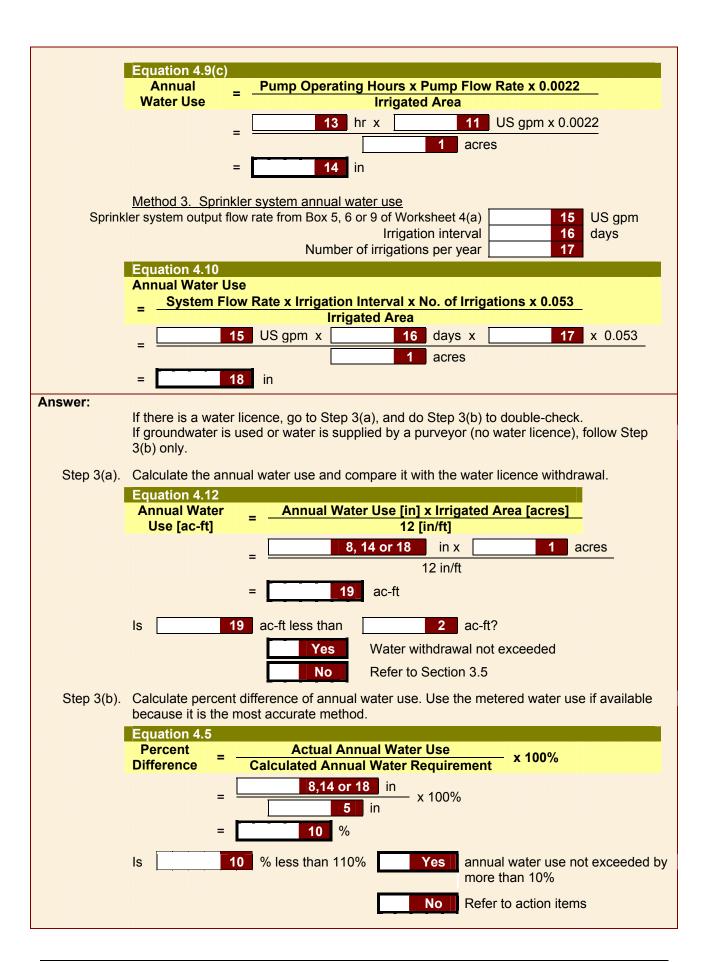
Workshee	et 3(a) Total Irrigated Area Using System Information
Information	Irrigation interval per pass Irrigation sets per day Sprinkler spacing Number of sprinklers Distance moved per set Irrigation interval per pass Sets tt sprinklers ft
Calculation: Step 1.	
Ctop 1.	No. of Sets per Pass = Irrigation Interval per pass x Irrigation Sets per Day
	=1 days x2
	= 6 sets
Step 2.	
	Field Width = Sprinkler Spacing x No. of Sprinklers
	= 3 ft x 6
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)
	Total Irrigated = Field Width x Field Length Area 43,560
	7 ft x 8 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



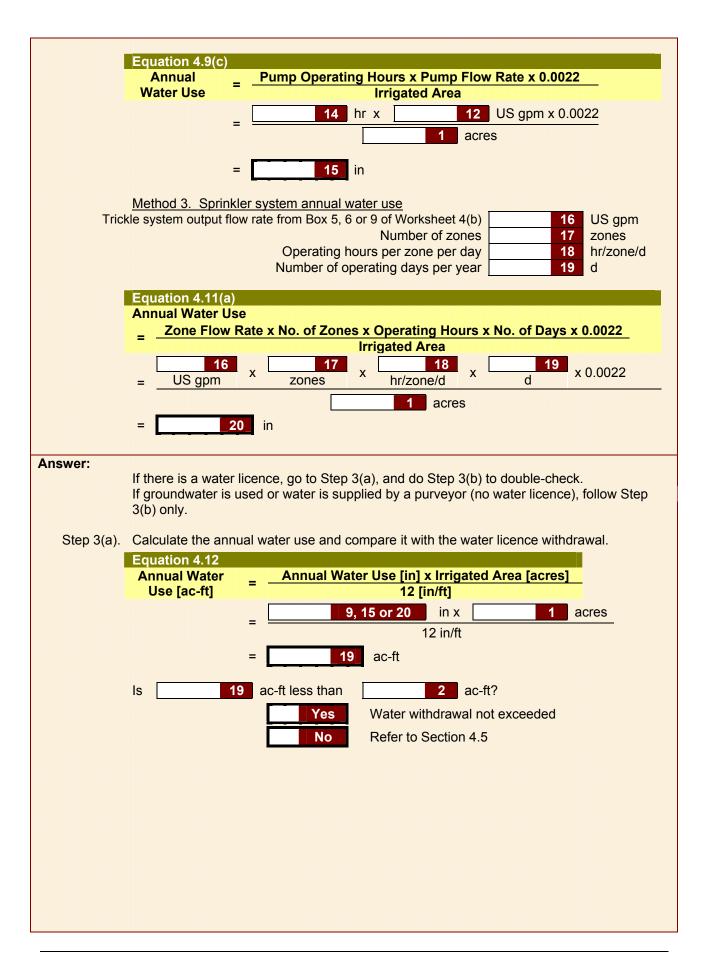
Worksheet 4	4(a) System Peak Flow Rate Check - SPRINKLER						
Information:	Irrigated area (Box 10 of Worksheet 3(a)) EITHER peak flow rate on water licence (if stated) OR peak flow rate requirement per acre (Table 3.3) 1 acres US gpm US gpm/acre						
Calculation: Step 1.	Determine calculated peak flow rate. Equation 4.2 Calculated Peak _ Estimated Peak Flow Rate Irrigated						
	Flow Rate = Requirement per Acre						
Step 2.	= US gpm Determine actual irrigation system flow rate using one or more of the following methods:						
Ctop 2.	Method 1. Water purveyor restriction or measured flow rate using a meter						
	Flow rate measured using a meter or provided by district5 US gpm						
	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 No. of nozzles US gpm nozzles						
	Sprinkler System Output Flow Rate = Nozzle Flow Rate x No. of Nozzles						
	=						
Answer: Step 3.	Calculate percent difference of peak flow rate.						
	Percent = Irrigation System Flow Rate						
	= Maximum of 5, 6 or 9 US gpm x 100% = 2 or 4 US gpm = 10 %						
	Is % 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)) EITHER peak flow rate on water licence (if stated) OR peak flow rate requirement per acre (Table 3.3) 1 acres 2 US gpm US gpm/acre
Calculation:	Determine calculated a calculate
Step 1.	Determine calculated peak flow rate. Equation 4.2
	Calculated Peak Estimated Peak Flow Rate Irrigated Flow Rate Requirement per Acre 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 US gpm
	Method 2. Pump peak flow rate
	Irrigation pump peak flow from pump curve US gpm
	Method 3. Determine flow rate using trickle emitters
	Emitter flow rate from supplier's tables Number of emitters operating at one time 7 gph emitters
	Equation 4.4 Trickle System Emitter No. of
	Output Flow Rate = Flow Rate x Emitters x 0.0167
	= 7 gph x 8 emitters x 0.0167
	= US gpm
Answer:	
Step 3.	Calculate percent difference of peak flow rate.
	Equation 4.5 Percent Irrigation System Flow Rate
	Difference = Calculated Peak Flow Rate x 100%
	= Maximum of 5, 6 or 9 US gpm x 100%
	2 or 4 US gpm
	= 10 %
	Is % less than or equal to 100%
	Yes Flow rate is not exceeded
	No Refer to action items

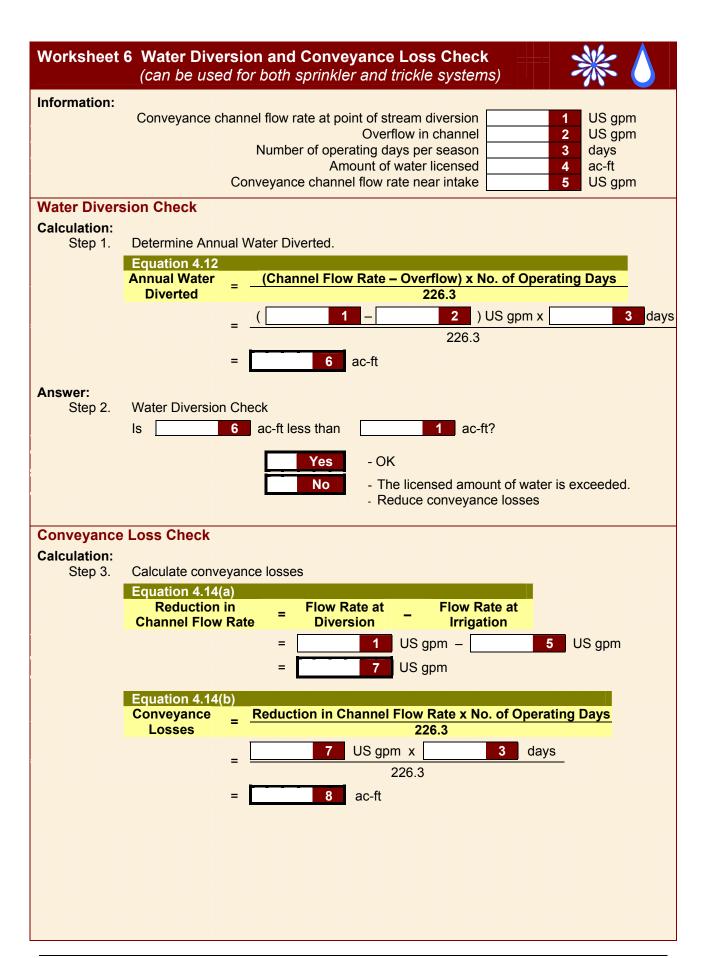
Worksheet 5(a) Annual Water Use Check - SPRINKLER Information: Irrigated area (Box 10 of Worksheet 3(a)) acres Water withdrawal amount on water licence (if applicable) 2 ac-ft 3 Estimated annual crop water requirement from Table 3.4 in Application efficiency from Table 6.1 % Calculation: Determine calculated annual water requirement. Step 1. Equation 4.6 **Estimated Annual Crop Water Requirement Calculated Annual Application Efficiency** Water Requirement x 100% 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 US gal Meter reading at end of year US gal Equation 4.8 Meter Reading at End of Year - Meter Reading at Start of Year Annual Water Use 27027 x Irrigated Area US gal -US gal 27027 x acres in Method 2. Pump water use Pump horsepower from supplier's table hp KWh Energy consumption for entire year from hydro bill 10 Pump flow rate from pump curve US gpm Equation 4.9(a) **Pump Power** Pump Horsepower x 0.746 KW/hp 9 hp x 0.746 KW/hp 12 KW Equation 4.9(b) **Pump Operating KWh for Entire Year** Hours **Pump Power** 10 KWh 12 KW 13 hr

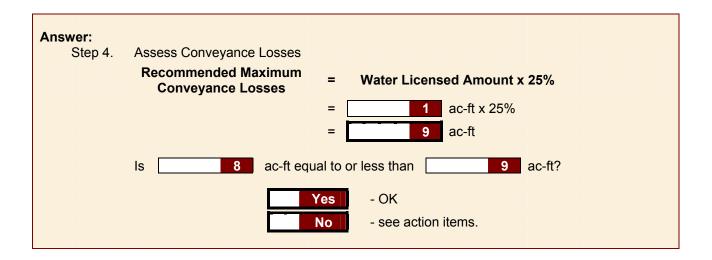


Worksheet 5(b) Annual Water Use Check - TRICKLE Information: Irrigated area (Box 10 of Worksheet 3(b)) acres Water withdrawal amount on water licence (if applicable) 2 ac-ft 3 Estimated annual crop water requirement from Table 3.4 in Crop adjustment factor from Table 4.2 4 Application efficiency from Table 6.1 % 5 Calculation: Determine calculated annual water requirement. Step 1. Equation 4.7 Crop **Estimated Annual Crop Calculated Annual Adjustment** Water Requirement x 100% **Factor Water Requirement Application Efficiency** 3 in x x 100% % 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 US gal Meter reading at end of year US gal Equation 4.8 Annual Meter Reading at End of Year - Meter Reading at Start of Year Water Use 27027 x Irrigated Area US gal US gal -27027 x acres in Method 2. Pump water use Pump horsepower from supplier's table hρ Energy consumption for entire year from hydro bill 11 KWh Pump flow rate from pump curve US gpm Equation 4.9(a) **Pump Power** Pump Horsepower x 0.746 KW/hp 10 hp x 0.746 KW/hp 13 Equation 4.9(b) **Pump Operating KWh for Entire Year Hours Pump Power 11** KWh 13 KW 14 hr



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 **Actual Annual Water Use** x 100% **Difference Calculated Annual Water Requirement** 9, 15 or 20 x 100% in 21 % % less than 110% annual water use not exceeded by ls 21 Yes more than 10% No Refer to 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) US gpm 2 Screen mesh size used mesh 3 Percent screen open area of mesh size from Table 4.3 % Number of screened surface (for flat screens only) 4 5 Screen length (for both flat and cylindrical screens) 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 **Suggested Screen** Flow Rate **Surface Area** 0.448 x % Open Area US gpm 0.448 x ft² Step 2. Calculate actual screen area. Equation 4.16(a) Flat Screen **Total Flat** No. of Flat Screened Surface x Length x Width **Surface Area** (+ end area if screened) ft x 6 (+ ft x ft) ft² 10 **Equation 4.16(b) Cylindrical Screen Total Cylindrical** 3.14 x Diameter x Length + end area if screened Surface Area 3.14 x (Diameter)2 3.14 x Diameter x Length + ft x 3.14 x Answer: Step 3. ft² less than 10 or 11 ft²? - OK Yes - 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 2 SAR_{adi} for trickle systems 3 Electrical conductivity (EC) (Table 4.4) dS/m Restriction on water use from Table 4.4 or 4.5 If the answer in Box 4 is slight to moderate or severe, water use from this source may need to be restricted. Pathogen Check Step 2. E.Coli cfu/100 ml Fecal coliform cfu/100 ml

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

Answer:

Worksheet 9 Irrigation System Uniformity Check (can be used for both sprinkler and trickle systems) **Information/ Calculation:** Total number of catch cans Number of cans in the lowest 25% 1 x 25% Water Depth Lowest Ranking Quartile [mm] [mm] Total 3 mm LQ **Average Catch Overall** mm mm Equation 4.17 LQ x 100 DU **Average Catch Overall** 5 mm x 100 mm

90% (for trickle systems)

Yes
Ok.
No
See action items.

% more than or equal to

Answer:

ls

80% (for sprinkler systems) or

Worksheet 10 Soil-Crop Report Information: Pit Crop Rooting Depth (RD) [m] **Availability** Coefficient (AC) [decimal], Table 5.2 **Maximum Application** Rate (AR) [mm/hr], Table 5.4 Soil Depth **AWSC AWSC AWSC** RD* [m] SWS [mm] Texture **Texture** SWS [mm] **Texture** SWS [mm] [mm/m] [mm/m] [mm/m] [m] 4 2 3 4 3 4 3 4 2 3 4 3 4 3 4 2 3 3 4 4 4 3 Total SWS [mm] 5 5 5 MSWD [mm] 6 6 6 Sum of MSWD [mm] * RD = soil depth is only calculated for the soil in the root zone. Sample Calculations - Pit A: Step 1. Calculate soil water storage (SWS) Calculate SWS for each soil depth interval that has roots. Use the first interval as an example. Equation 5.1 **SWS AWSC** 3 2 m x = 4 mm Total SWS within the zone (b) = SWS_(_ m) + SWS_(_ m) + SWS_(_ m) + SWS₍ **Total SWS** 4) mm mm Step 2. Calculate MSWD Equation 5.2 (a) **MSWD** SWS x AC 5 mm x mm (b) Calculate average MSWD for all soil pits **Note:** If the soil types and values vary a Average **Sum of MSWD MSWD** Number of Readings lot between soil pits, e.g., sandy loam in one area and clay loam in another area, mm the area within the soil boundaries should be managed separately. Do not average these values. Rather, keep a separate 8 mm

record of each soil area.

Worksheet 11 Lateral Pressure Distribution Check – SPRINKLER Information: **Location of Reading** Reading First sprinkler psi 2 Sprinkler at 1/4 distance psi 3 Sprinkler at ½ distance psi Sprinkler at ¾ distance psi 5 Last sprinkler psi Highest value 6 psi Lowest value psi 8 Number of readings psi Operating pressure range guide (Table 6.3) psi **Assessment:** Check if all pressure readings are within the recommended operating pressure range (Table 6.3) Are **all** pressure readings within psi? Ok. Yes Check action items. No Calculation: Step 1. Calculate the average pressure Average **Sum of Readings Pressure Number of Readings** 5) psi 10 psi Step 2. Calculate the percent pressure difference Equation 6.1 Highest Value - Lowest Value x 100% **Percent Pressure Difference Average Value** psi – psi x 100% psi 6

% less than 20%?

Yes

No

Ok.

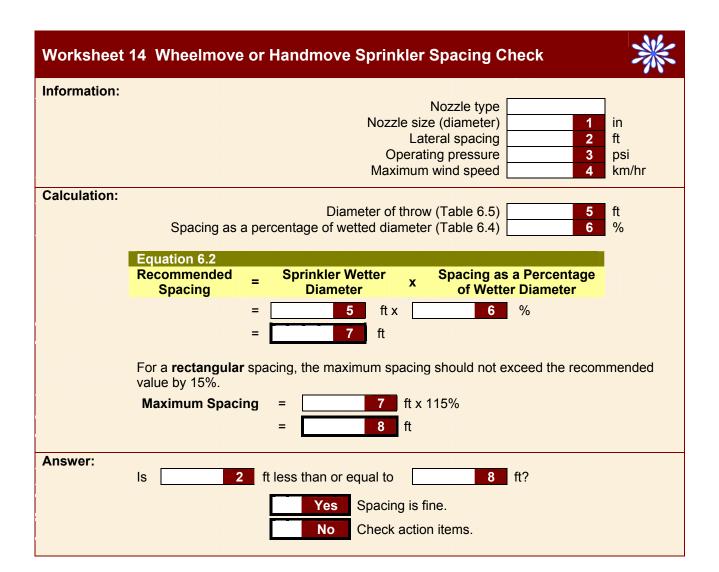
Answer:

ls

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 Nozzle flow rate Nozzle flow rate Average operating pressure Pressure at the start of the lateral Pipe size(s) along lateral (diameters and % split) Number of nozzles operating at one time on the lateral Sprinkler spacing 1 ft x ft gpm psi psi psi Number of nozzles operating at one time on the lateral 6
Assessment: Step 1.	Check that the nozzle size and pressure in use match those on the chart. Assess the sprinkler operating pressure at the start of the lateral
Otep 1.	Recommended pressure at the start of the lateral Recommended pressure at the start of the lateral S psi S psi S Psi 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.

Workshe	et 13 PVC	Lateral Line	Assessn	nent		==	}	※
Information		n friction loss		ation change ssure at the	operating press (10 ft x 0.433 Start of the Losi x 20%	psi)	20%	psi psi
Nozzle Number	Total Flow Rate [US gpm]	Pipe Diameter [in]	Pipe Length [ft]	÷ 100 ft x ÷ 100 ft x	Friction Loss [psi/100 ft]		ction Loss er Length [psi]	
	Total frictio	Total friction Miscellaneous In loss (includ	ing miscell	4	nost column) psi x 10%)	= = =	6	psi psi psi
	Total latera	l line friction l		on loss + to	tal friction lo	ss) =	7	psi
Answer:	Is	7 psi	less than			riction loss action iter		



Worksheet 15 Assessment of Sprinkler System Performance



Information:

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

Calculation:

4 Application Rate Check

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

Equation 6.3

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

$$= \frac{227 \times 1}{2 \times 1} = \frac{227 \times 1}{3 \times 1} = \frac{3 \times 1}{1} =$$

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

Equation 6.10

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

= $\frac{227 \times 1}{3.14 \times (10^{-3} \text{ J})^2}$

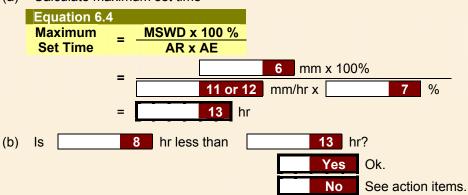
= $\frac{12 \text{ mm/hr}}{12}$

(b) Is _____ mm/hr less than or equal to _____ 5 mm/hr

Yes Ok.
No See action items.

6 Maximum Set Time Check

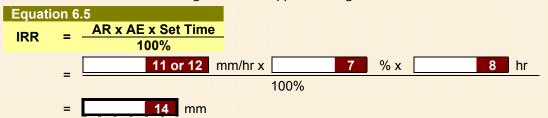
(a) Calculate maximum set time



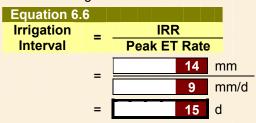
Note: A set time that is convenient to match farm operations is often chosen. The actual operating time for a 12-hour set may be 11.5 hrs to allow time for moving the system, but 12 hours should be used in this calculation to determine the number of sets.

6 Irrigation Interval Check

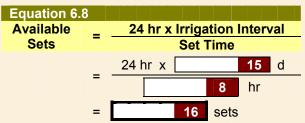
(a) Calculate the net amount of irrigation water applied during this set time



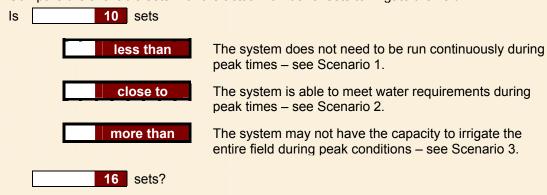
(b) Calculate irrigation interval for the new set time



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



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



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:

Application Rate Check

(a) Calculate instantaneous application rate (IAR).

Equation 6.10

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

= $\frac{227 \times 1}{3.14 \times (10^{-2} \times 10^{-2} \times 10$

(b) Is ______ 7 mm/hr less than _____ 7 mm/hr

Yes Ok.

No See action items.

6 Travel Speed Check

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

Equation 6.11
$$T = \frac{L \times S \times MSWD}{2.27 \times Q \times AE}$$

$$= \frac{4 \times S \times MSWD}{2.27 \times Q \times AE}$$

$$= \frac{4 \times S \times MSWD}{4 \times S \times S \times S}$$

$$= \frac{4 \times S \times MSWD}{4 \times S \times S}$$

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$$= \frac{4 \times S \times MSWD}{4 \times S \times S}$$

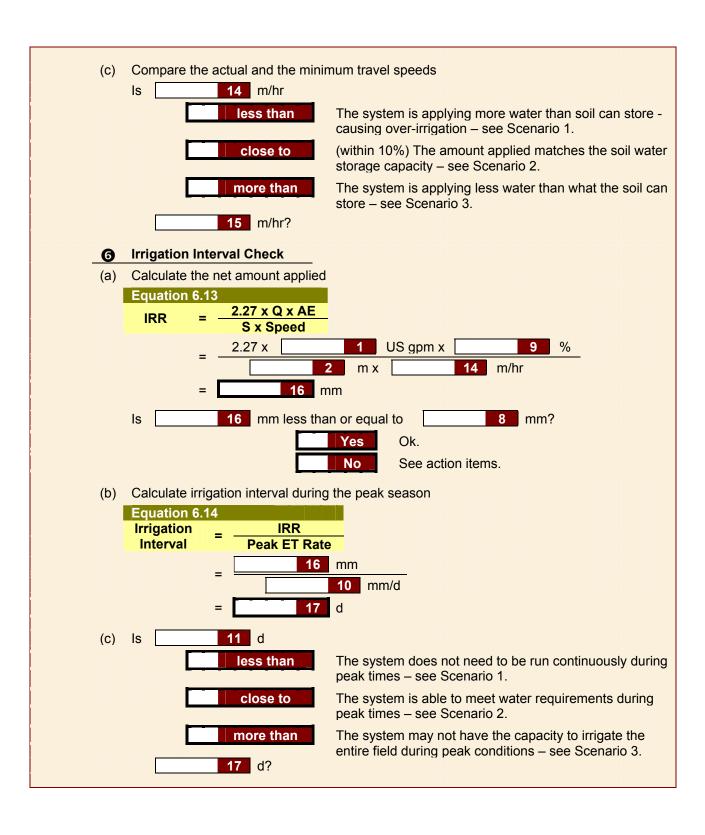
$$= \frac{4 \times S \times MSWD}{4 \times S \times S}$$

$$= \frac{4 \times S \times MSWD}{4 \times S}$$

$$= \frac{4 \times MSWD}{4 \times S}$$

(b) Calculate actual and minimum travel speeds





Worksheet 17 Centre Pivot System Performance Check



Information:

1	US gpm
2	m
3	m
4	%
5	hr/rev
6	%
7	mm
8	mm/d
9	d
	2 3 4 5 6 7 8

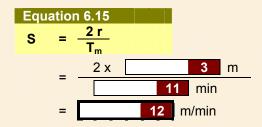
Calculation:

Rotation Time Check

(a) Calculate the pivot maximum application rate

(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)



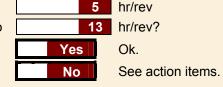
(c) Calculate the maximum rotation time and compare it with the actual rotation time

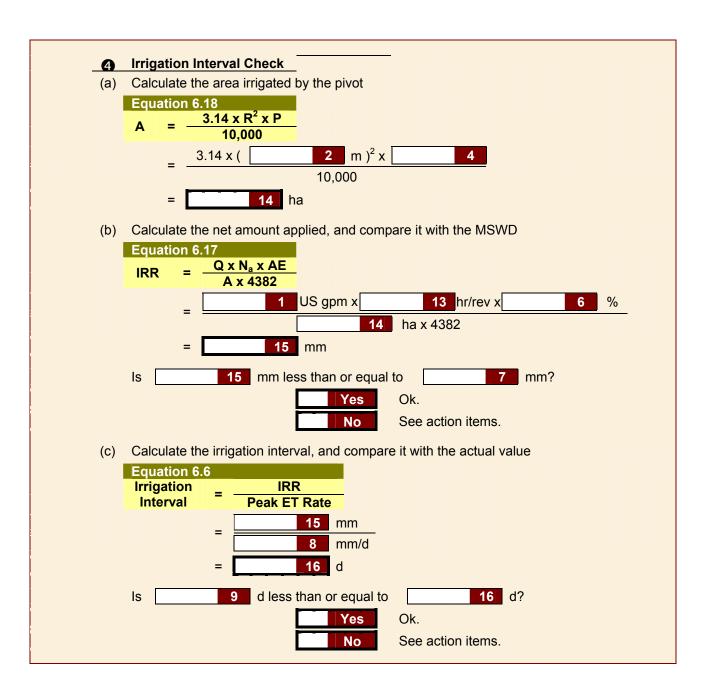
Equation 6.16
$$N = \frac{3.14 \times R}{30 \times S}$$

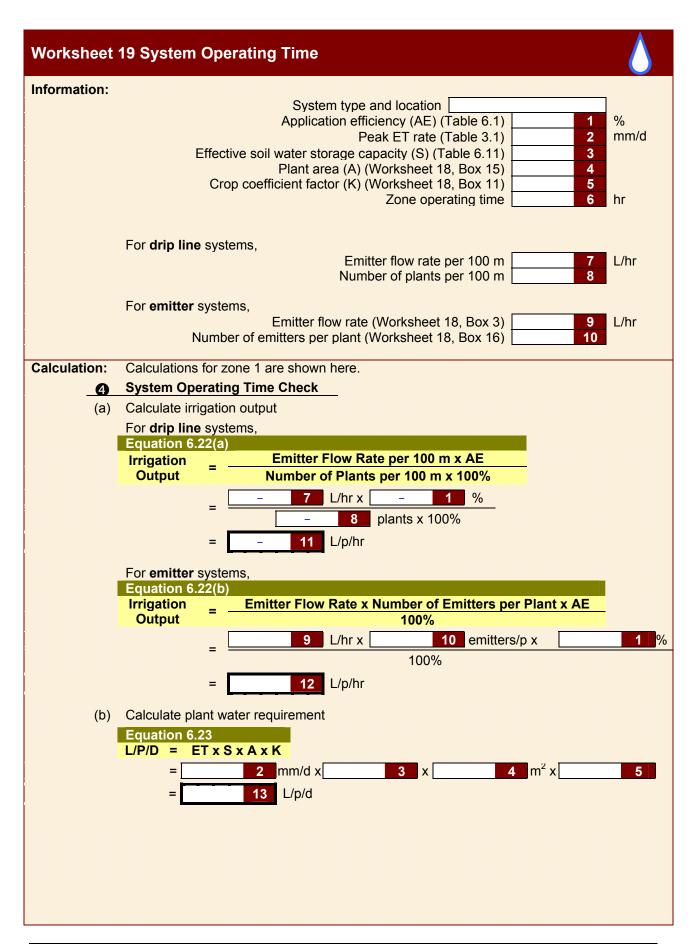
$$= \frac{3.14 \times 2 \quad m}{30 \times 12 \quad m/min}$$

$$= \frac{3.14 \times 12 \quad m/min}{13 \quad hr/rev}$$

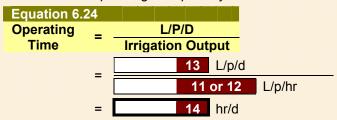
Is the actual rotation time less than or equal to







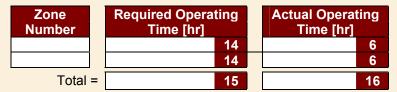
(c) Calculate the operating time per day for each zone



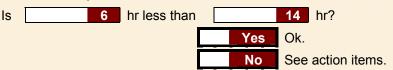
This is the number of hours per day the irrigation system should be running in peak periods to provide the crop with sufficient water without over-irrigation. The irrigation time per zone can be shorter during non-peak periods, but it should never be longer.

Answer:

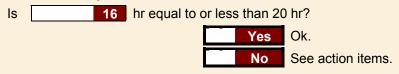
(a) For each zone, calculate the time required to irrigate the plants during the peak time of the year, and input the answers under "Time to Irrigate Zone" below. Then, sum up all the times together to perform a check.



(b) For each zone,



(c) For the entire system,



Worksheet 20 Determining Evaporation Using an Evaporation Pan





Recording information from an evaporation pan in the following table.

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

Samp	ole	Cal	cul	lati	ons:
-	,,,	-			00.

Number of days between and d								
Evaporation between		and						
	=	Water Depth on – Water Depth on						
	=	2 mm – 3 mm						
	=	4 mm						
Evaporation per Day	=	Evaporation No. of Days						
	=	4 mm 1 d						
	=	5 mm/d						

Worksheet 21 Crop Water Use





Information:

Evaporation	1	mm
Factor to convert ET _a (pan) to ET _a (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

Method 2. For other vegetable crops

<u> </u>		
Width of planting canopy (W _p)	4	mm
Bed spacing (W _b)	5	mm

Calculations:

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 _o)	

Analysis:

Previous Soil Water Storage

Nomenclature:

PSWS =

EP =

IRR = Effective Precipitation
Net Depth of Irrigation Water Applied Reference Evapotranspiration Crop Coefficient ET_{o}

CSWS Current Soil Water Storage

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

Date	PSWS	+	EP	+	IRR	_	ET _o	X	Kc	=	CSWS
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		ı		X		H	
		+		+		-		X		=	
		+		+		ı		X		H	

Worksheet 23 Trickle Irrigation Scheduling Using Plant Water Requirement **Method** Information: Maximum zone operating time hr/day Peak ET 2 mm Analysis: Operating Date Daily ET_o Kc ET_c X = Time [hr/day] [mm] [mm] X = 3 3 3 X = 4 X 4 = 3 3 3 4 X 4 X = X 4 = 3 X 4 Weekly Total **Average** Sample Calculations: Equation 7.5 **Zone Operating Maximum Zone** ET_c = Time **Operating Time** Peak ET mm hr/day x mm 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	%

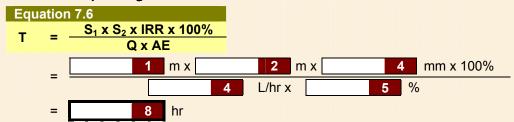
Calculation:

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

= Net Depth of Irrigation Water Applied (IRR)

(b) Irrigation should start when the balance reaches:

(c) Determine operating time



(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	Kc	=	CSWS
		+		+		-		X		=	
		+		+		I		X		=	
		+		+		I		X		=	
		+		+		I		X		=	
		+		+		I		X		=	
		+		+		I		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		-		X		=	
		+		+		I		X		=	
		+		+		I		X		=	
		+		+		I		X		=	

Worksheet 25 Mainline Friction Losses



Assessment:

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

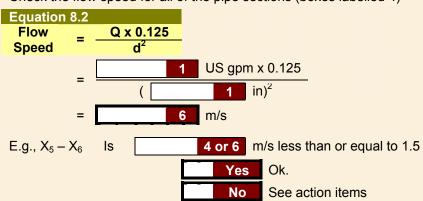
Location	Type	ID [in]	Flow Rate [US gpm]	Length [ft]	x	Friction Loss Factor per 100 ft			Head Loss [psi]	Flow Speed [m/s]
$X_0 - X_1$		1	2		х		÷ 100 ft	=	3	4
$X_1 - X_2$		1	2		х		÷ 100 ft	=	3	4
$X_2 - X_3$		1	2		х		÷ 100 ft	=	3	4
$X_3 - X_4$		1	2		х		÷ 100 ft	=	3	4
$X_5 - X_6$		1	2		х		÷ 100 ft	=	3	4
	Total friction loss along mainline [psi] =								5	

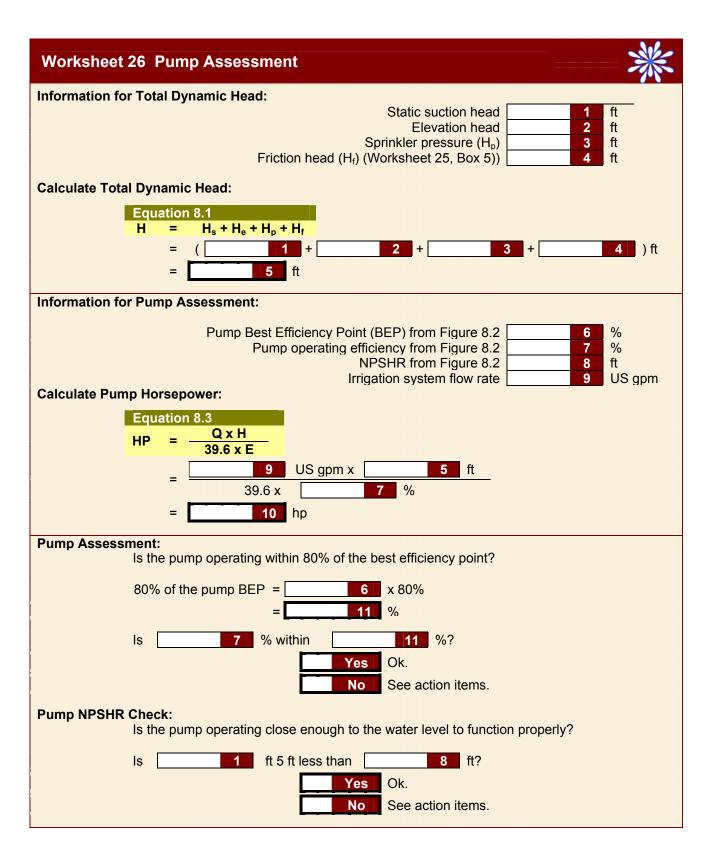
(b) Friction loss check

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



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





Worksheet 27 Irrigation Operating Cost Information: Farm location Water Purveyor Water source (stream or lake) Irrigated area acres System Efficiency 2 % Number of days system is operated days **Annual Water Licence Fee** Water use ≤ 40 ac-ft (Table 8.1) \$ Each additional 2 ac-ft of water use (Table 8.1) \$ 5 Crop water requirement (Table 3.4) **Annual Water Storage Licence Fee** Water stored ≤ 2,000 ac-ft (Table 8.1) \$ 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 **Electric Cost** Electric rate in irrigation season (Table 8.2) \$/Kw-hr Operating hours per season (days x 24 hours /day) 12 hrs Pump horsepower 13 hp **Fuel Cost** Fuel unit cost \$ /gal Fuel consumption gal **Water Purveyor** Total charges per acre of irrigation (Table 8.3) \$/acre Amount of water allowed (Table 8.3) 17 US gpm/acre Calculation: **Annual Water Licence Rental** Equation 8.4 Amount of Irrigated Area x Crop Water Requirement x 100% **Water Use** 12 x AE in x 100% acre x 12 x 18 ac-ft **Annual Water** 18 – 40) ac-ft Licence Fee 19 - 2,000) ac-ft **Annual Storage** + \$ Licence Fee 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									
/l=\	Final									
(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 op-	eration)		
Chemical Applica (obtain all linormation licin by com op-	oracion,		
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	