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.

<table>
<thead>
<tr>
<th>Worksheet</th>
<th>Sprinkler</th>
<th>Trickle</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a) Information from Farm Plan – <strong>Sprinkler</strong></td>
<td>✓</td>
<td></td>
<td>Page 16</td>
</tr>
<tr>
<td>1(b) Information from Farm Plan – <strong>Trickle</strong></td>
<td></td>
<td>✓</td>
<td>Page 19</td>
</tr>
<tr>
<td>2(a) Irrigation System Audit – <strong>Sprinkler</strong></td>
<td>✓</td>
<td></td>
<td>Page 22</td>
</tr>
<tr>
<td>2(b) Irrigation System Audit – <strong>Trickle</strong></td>
<td></td>
<td>✓</td>
<td>Page 22</td>
</tr>
<tr>
<td>3(a) Total Irrigated Area Using System Information</td>
<td>✓</td>
<td></td>
<td>Page 26</td>
</tr>
<tr>
<td>3(b) Total Irrigated Area Using Field Dimension</td>
<td>✓</td>
<td>✓</td>
<td>Page 27</td>
</tr>
<tr>
<td>4(a) Irrigation System Peak Flow Rate Check – <strong>Sprinkler</strong></td>
<td>✓</td>
<td></td>
<td>Page 31</td>
</tr>
<tr>
<td>4(b) Irrigation System Peak Flow Rate Check – <strong>Trickle</strong></td>
<td></td>
<td>✓</td>
<td>Page 32</td>
</tr>
<tr>
<td>5(a) Annual Water Use Check – <strong>Sprinkler</strong></td>
<td>✓</td>
<td></td>
<td>Page 39</td>
</tr>
<tr>
<td>5(b) Annual Water Use Check – <strong>Trickle</strong></td>
<td></td>
<td>✓</td>
<td>Page 41</td>
</tr>
<tr>
<td>6 Water Diversion and Conveyance Loss Checks</td>
<td>✓</td>
<td>✓</td>
<td>Page 47</td>
</tr>
<tr>
<td>7 Intake Screen Area Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 52</td>
</tr>
<tr>
<td>8 Irrigation Water Quality Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 56</td>
</tr>
<tr>
<td>9 Irrigation System Uniformity Check</td>
<td>✓</td>
<td>✓</td>
<td>Page 60</td>
</tr>
<tr>
<td>10 Sprinkler Irrigation Scheduling Using Water Budget Method</td>
<td>✓</td>
<td></td>
<td>Page 73</td>
</tr>
<tr>
<td>11 Trickle Irrigation Scheduling Using Plant Water Requirement Method</td>
<td>✓</td>
<td></td>
<td>Page 75</td>
</tr>
<tr>
<td>12 Trickle Irrigation Scheduling Using Water Budget Method</td>
<td>✓</td>
<td></td>
<td>Page 76</td>
</tr>
</tbody>
</table>
**Worksheet 1(a) Information from Farm Plan – SPRINKLER**

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation interval per pass</td>
<td>1</td>
<td>days/pass</td>
<td>Farm info</td>
</tr>
<tr>
<td>Irrigation sets per day</td>
<td>2</td>
<td>sets</td>
<td>Farm info</td>
</tr>
<tr>
<td>Sprinkler spacing</td>
<td>3</td>
<td>ft</td>
<td>Farm info</td>
</tr>
<tr>
<td>Number of sprinklers</td>
<td>4</td>
<td>sprinklers</td>
<td>Farm info</td>
</tr>
<tr>
<td>Distance moved per set</td>
<td>5</td>
<td>ft</td>
<td>Farm info</td>
</tr>
</tbody>
</table>

**Worksheet 3(a) Total Irrigated Area Using System Information**

- Irrigation interval per pass: 1 day/pass (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**

- 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: [missing value] in/d (Table 2.1)
- Estimated peak flow rate requirement per acre: 3 US gpm/acre (Table 2.2 or 2.3)

**Actual Irrigation System Flow Rate**

- Flow rate metered or provided by district: 5 US gpm (Meter or district)

**Pump Specifications**

- Model number: [missing value]
- Impeller size: [missing value] in Dia.
- Revolution per minute (rpm): [missing value] rpm
- Flow rate: 6 US gpm (Pump name plate)

**Nozzle Specifications**

- Size: [missing value] in x in (Field check)
- Operating pressure: [missing value] psi (Field check)
- Flow rate: 7 US gpm (Farm plan)
- Number of nozzles: 8 nozzles (Farm plan)

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

- Annual water withdrawal stated on water licence: 2 ac-ft (Water licence)
- Estimated annual crop water requirement: 3 in (Table 2.4)
- Application efficiency of irrigation system: 4 % (Table 3.2)

**Meter Information**

- Meter reading at start of year: 6 US gal (Water purveyor)
- Meter reading at end of year: 7 US gal (Water purveyor)
### Pump Specifications

- Pump horsepower: 9 hp
- Energy consumption for entire year: 10 KWh

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

### Irrigation Specifications

- Irrigation interval: 16 days
- Number of irrigations per year: 17

### Worksheet 6 Water Diversion and Conveyance Loss Checks

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at/near diversion</td>
<td>1</td>
<td>US gpm</td>
<td>Site</td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2</td>
<td>US gpm</td>
<td>Site</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3</td>
<td>days</td>
<td>Site</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4</td>
<td>ac-ft</td>
<td>Water licence</td>
</tr>
<tr>
<td>Conveyance channel flow rate at/near intake</td>
<td>5</td>
<td>US gpm</td>
<td>Site</td>
</tr>
</tbody>
</table>

### Worksheet 7 Intake Screen Area Check

For flat screen:
- Number of screened surfaces: 5 ft
- Length of screen: 6 ft
- Width of screen: 7 ft

For cylindrical screen:
- Diameter of screen: 9 ft
- Length of screen: 10 ft

### Worksheet 8 Irrigation Water Quality Check

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium adsorption ratio (SAR)</td>
<td>1</td>
<td>dS/m</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Electrical conductivity (EC) of water</td>
<td>3</td>
<td>dS/m</td>
<td>Table 3.5</td>
</tr>
<tr>
<td>E. coli count</td>
<td>5</td>
<td>cfu/100 ml</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Fecal coliform count</td>
<td>6</td>
<td>cfu/100 ml</td>
<td>Laboratory</td>
</tr>
</tbody>
</table>
**Worksheet 1(b) Information from Farm Plan – TRICKLE**

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>Value and Box No.</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Worksheet 3(b) Total Irrigated Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field length</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **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 2.1 |
| Estimated peak flow rate requirement per acre | | 3 US gpm/acre | Table 2.2 or 2.3 |
| 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) | | – | Pump 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) | | 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 2.4 |
| Crop adjustment factor | | 4 | Table 3.3 |
| Application efficiency of irrigation system | | 5 % | Table 3.2 |
| Meter Information | | | |
| Meter reading at start of year | | 6 US gal | Water purveyor |
| Meter reading at end of year | | 7 US gal | Water 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.
### Appendix C: Blank Worksheets

#### Irrigation Specifications (based on emitter specifications)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of zones</td>
<td>17 zones</td>
</tr>
<tr>
<td>Operating hours per zone per day</td>
<td>18 hr/zone/day</td>
</tr>
<tr>
<td>Number of operating days per year</td>
<td>19 days</td>
</tr>
</tbody>
</table>

#### Worksheet 6: Water Diversion and Conveyance Loss Checks

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at/near diversion</td>
<td>1 US gpm</td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2 US gpm</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3 days</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4 ac-ft</td>
</tr>
<tr>
<td>Conveyance channel flow rate at/near intake</td>
<td>5 US gpm</td>
</tr>
</tbody>
</table>

#### Worksheet 7: Intake Screen Area Check

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen mesh size</td>
<td>2 mesh</td>
</tr>
<tr>
<td>Percent open area of mesh size</td>
<td>3%</td>
</tr>
</tbody>
</table>

**For flat screen,**

- Number of screened surfaces | 5 ft |
- Length of screen | 6 ft |
- Width of screen | 7 ft |

**For cylindrical screen,**

- Diameter of screen | 9 ft |
- Length of screen | 10 ft |

#### Worksheet 8: Irrigation Water Quality Check

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted sodium adsorption ratio (SARadj)</td>
<td>2 dS/m</td>
</tr>
<tr>
<td>Electrical conductivity (EC) of water</td>
<td>3 dS/m</td>
</tr>
<tr>
<td>E. coli count</td>
<td>5 cfu/100 ml</td>
</tr>
<tr>
<td>Fecal coliform count</td>
<td>6 cfu/100 ml</td>
</tr>
</tbody>
</table>
### Worksheet 2(a) Irrigation System Audit – SPRINKLER

**Checklist:**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are all sprinklers of the same model?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are all nozzles of the same size?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are all sprinkler and lateral spacing uniform (50 – 60% wetted diameter)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is the operating pressure in the best range?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Is pressure differential minimal?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Answer:**

Do the system conditions meet all the minimum standards?

- Yes - OK
- No - See action items.

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

**Checklist:**

For each zone,

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are all emitters of the same model throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are all emitters of the same size throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are all emitter spacing uniform throughout the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is pressure differential minimal?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Is the same crop or same plant size grown in the zone?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Is the soil type uniform throughout the zone?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>Information</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation interval per pass</td>
<td>1</td>
</tr>
<tr>
<td>Irrigation sets per day</td>
<td>2</td>
</tr>
<tr>
<td>Sprinkler spacing</td>
<td>3</td>
</tr>
<tr>
<td>Number of sprinklers</td>
<td>4</td>
</tr>
<tr>
<td>Distance moved per set</td>
<td>5</td>
</tr>
</tbody>
</table>

Calculation:

Step 1. Calculate the number of sets per pass

\[
\text{No. of Sets per Pass} = \text{Irrigation Interval per pass} \times \text{Irrigation Sets per Day}
\]

\[
= 1 \text{ days/pass} \times 2 \text{ sets}
\]

\[
= 2 \text{ sets}
\]

Step 2. Calculate the field width

\[
\text{Field Width} = \text{Sprinkler Spacing} \times \text{No. of Sprinklers}
\]

\[
= 3 \text{ ft} \times 6 \text{ sprinklers}
\]

\[
= 18 \text{ ft}
\]

Step 3. Calculate the field length

\[
\text{Field Length} = \text{Distance Moved per Set} \times \text{No. of Sets}
\]

\[
= 5 \text{ ft} \times 6 \text{ sets}
\]

\[
= 30 \text{ ft}
\]

Step 4. Determine the field area

\[
\text{Total Irrigated Area} = \text{Field Width} \times \text{Field Length}
\]

\[
= 18 \text{ ft} \times 30 \text{ ft}
\]

\[
= 540 \text{ sq ft}
\]

\[
= 9 \text{ acres}
\]

Repeat the same step for irregular shaped field.

Answer:

\[
\text{Total Irrigated Area} = \text{Sum of All Field Areas}
\]

\[
= (9 + 9 + 9) \text{ acres}
\]

\[
= 27 \text{ acres}
\]
Worksheet 3(b)  Total Irrigated Area Using Field Dimension
(can be used for both sprinkler and trickle systems)

Information:

<table>
<thead>
<tr>
<th>Field width</th>
<th>1 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field length</td>
<td>2 ft</td>
</tr>
</tbody>
</table>

Calculation:

Determine the field area

\[ \text{Field Width} \times \text{Field Length} = 43,560 \text{ ft}^2 \]

\[ \frac{43,560}{1 \text{ ft} \times 2 \text{ ft}} = 3 \text{ acres} \]

Repeat the same step for irregular shaped field

Answer:

\[ \text{Total Irrigated Area} = \text{Sum of All Field Areas} \]

\[ = (3 \text{ acres} + 3 \text{ acres} + 3 \text{ acres}) \]

\[ = 4 \text{ acres} \]
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 2.3) 3 US gpm/acre

Calculation:
Step 1. Determine calculated peak flow rate.

Equation 3.2
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 3.3
Sprinkler System Output Flow Rate = Nozzle Flow Rate x No. of Nozzles

= 7 US gpm x 8 nozzles
= 9 US gpm

Note: Either one of the two values (850 US gpm pump flow rate or 856 US gpm sprinkler flow rate) can be used. In this case, the higher one is used.

Answer:
Step 3. Calculate percent difference of peak flow rate.

Equation 3.5
Percent Difference = Irrigation System Flow Rate x 100%
Calculated Peak Flow Rate

= Maximum of 5, 6 or 9 US gpm x 100%
= 2 or 4 US gpm
= 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 2.3) 3 US gpm/acre

Calculation:
Step 1. Determine calculated peak flow rate.

Equation 3.2
\[
\text{Calculated Peak Flow Rate} = \text{Estimated Peak Flow Rate Requirement per Acre} \times \text{Irrigated Area}
\]
\[
= 3 \text{ US gpm/acre} \times 1 \text{ acres} = 4 \text{ US gpm}
\]

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

Equation 3.4
\[
\text{Trickle System Output Flow Rate} = \text{Emitter Flow Rate} \times \text{No. of Emitters} \times 0.0167
\]
\[
= 7 \text{ gph} \times 8 \text{ emitters} \times 0.0167 = 9 \text{ US gpm}
\]

Answer:
Step 3. Calculate percent difference of peak flow rate.

Equation 3.5
\[
\text{Percent Difference} = \frac{\text{Irrigation System Flow Rate} - \text{Calculated Peak Flow Rate}}{\text{Calculated Peak Flow Rate}} \times 100\%
\]
\[
= \frac{\text{Maximum of 5, 6 or 9 US gpm} - 4 \text{ US gpm}}{4 \text{ US gpm}} \times 100\%
\]
\[
= \frac{10 \text{ %}}{10 \text{ %}} = 10\%
\]

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): \(1\) acres
- Water withdrawal amount on water licence (if applicable): \(2\) ac-ft
- Estimated annual crop water requirement from Table 2.4: \(3\) in
- Application efficiency from Table 3.2: \(4\)%

#### Calculation:

**Step 1.** Determine calculated annual water requirement.

**Equation 3.6**

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

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

**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 3.8**

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

\[
= \frac{7 \text{ US gal} - 6 \text{ US gal}}{27027 \times 1 \text{ acres}} = 8 \text{ in}
\]

**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 3.9(a)**

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

\[
= 9 \text{ hp} \times 0.746 \text{ KW/hp} = 12 \text{ KW}
\]

**Equation 3.9(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 3.9(c)

**Annual Water Use** = \( \frac{\text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022}{\text{Irrigated Area}} \)

\[
\begin{align*}
\text{Annual Water Use} &= \frac{13 \text{ hr} \times 11 \text{ US gpm} \times 0.0022}{1 \text{ acres}} \\
&= 14 \text{ in} \\

\text{Method 3. Sprinkler system annual water use} \\
\text{Sprinkler system output flow rate from Box 5, 6 or 9 of Worksheet 4(a)} &= 15 \text{ US gpm} \\
\text{Irrigation interval} &= 16 \text{ days} \\
\text{Number of irrigations per year} &= 17 \\

\text{Equation 3.10}

\text{Annual Water Use} = \text{System Flow Rate} \times \text{Irrigation Interval} \times \text{No. of Irrigations} \times 0.053

\[
\begin{align*}
\text{Annual Water Use} &= 15 \text{ US gpm} \times 16 \text{ days} \times 17 \times 0.053 \\
&= 18 \text{ in} \\

\text{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 3.12**

\[
\text{Annual Water Use [ac-ft]} = \frac{\text{Annual Water Use [in]} \times \text{Irrigated Area [acres]}}{12 \text{ [in/ft]}}
\]

\[
\begin{align*}
\text{Annual Water Use [ac-ft]} &= \frac{8, 14 \text{ or 18 in} \times 1 \text{ acres}}{12 \text{ in/ft}} \\
&= 19 \text{ ac-ft} \\
\end{align*}
\]

Is 19 ac-ft less than 2 ac-ft? Yes Water withdrawal not exceeded

**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 3.5**

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

\[
\begin{align*}
\text{Percent Difference} &= \frac{8, 14 \text{ or 18 in}}{5 \text{ in}} \times 100\% \\
&= 10\% \\
\end{align*}
\]

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 2.4: 3 in
- Crop adjustment factor from Table 3.3: 4
- Application efficiency from Table 3.2: 5 %

Calculation:

Step 1. Determine calculated annual water requirement.

**Equation 3.7**

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

\[
\begin{align*}
\text{Calculated Annual Water Requirement} &= \frac{3 \text{ in} \times 4 \times 100\%}{5 \%} \\
&= 6 \text{ in}
\end{align*}
\]

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 3.8**

\[
\text{Annual Water Use} = \frac{\text{Meter Reading at End of Year} - \text{Meter Reading at Start of Year}}{27027 \times \text{Irrigated Area}} \times 100\%
\]

\[
\begin{align*}
\text{Annual Water Use} &= \frac{8 \text{ US gal} - 7 \text{ US gal}}{27027 \times 1 \text{ acres}} \\
&= 9 \text{ in}
\end{align*}
\]

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 3.9(a)**

\[
\text{Pump Power} = \frac{\text{Pump Horsepower} \times 0.746 \text{ KW/hp}}{\text{Pump Horsepower} \times 0.746 \text{ KW/hp}}
\]

\[
\begin{align*}
\text{Pump Power} &= 10 \text{ hp} \times 0.746 \text{ KW/hp} \\
&= 13 \text{ KW}
\end{align*}
\]

**Equation 3.9(b)**

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

\[
\begin{align*}
\text{Pump Operating Hours} &= \frac{11 \text{ KWh}}{13 \text{ KW}} \\
&= 14 \text{ hr}
\end{align*}
\]
Equation 3.9(c)

\[
\text{Annual Water Use} = \frac{\text{Pump Operating Hours} \times \text{Pump Flow Rate} \times 0.0022}{\text{Irrigated Area}}
\]

\[
= \frac{14 \text{ hr} \times 12 \text{ US gpm} \times 0.0022}{1 \text{ acres}}
\]

\[= 15 \text{ in}\]

Method 3. Sprinkler system annual water use

Trickle system output flow rate from Box 5, 6 or 9 of Worksheet 4(b)

Equation 3.11(a)

\[
\text{Annual Water Use} = \frac{\text{Zone Flow Rate} \times \text{No. of Zones} \times \text{Operating Hours} \times \text{No. of Days} \times 0.0022}{\text{Irrigated Area}}
\]

\[
= \frac{16 \text{ US gpm} \times 17 \text{ zones} \times 18 \text{ hr/zone/d} \times 19 \text{ d} \times 0.0022}{1 \text{ acres}}
\]

\[= 20 \text{ in}\]

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 3.12

\[
\text{Annual Water Use [ac-ft]} = \frac{\text{Annual Water Use [in]} \times \text{Irrigated Area [acres]}}{12 \text{ [in/ft]}}
\]

\[
= \frac{9, 15 \text{ or } 20 \text{ in} \times 1 \text{ acres}}{12 \text{ in/ft}}
\]

\[= 19 \text{ ac-ft}\]

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.

<table>
<thead>
<tr>
<th>Equation 3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Difference = ( \frac{\text{Actual Annual Water Use}}{\text{Calculated Annual Water Requirement}} \times 100% )</td>
</tr>
<tr>
<td>= ( \frac{9, 15 \text{ or } 20 \text{ in}}{6 \text{ in}} \times 100% )</td>
</tr>
<tr>
<td>= 21%</td>
</tr>
</tbody>
</table>

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)*

**Question:** A farmer in Williams Lake has a water licence which allows a water withdrawal of 300 acre-feet from a stream. A diversion channel of 2 km delivers water from the creek to the irrigation system intake. The channel flow rate at the diversion is 1,000 US gpm, and near the intake is 820 US gpm. The overflow channel flow rate is 50 US gpm. The irrigation system operates for 80 days per season. Is the amount of water diverted within the licensed water amount? Are the conveyance losses acceptable?

**Information:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance channel flow rate at point of stream diversion</td>
<td>1 US gpm</td>
</tr>
<tr>
<td>Overflow in channel</td>
<td>2 US gpm</td>
</tr>
<tr>
<td>Number of operating days per season</td>
<td>3 days</td>
</tr>
<tr>
<td>Amount of water licensed</td>
<td>4 ac-ft</td>
</tr>
<tr>
<td>Conveyance channel flow rate near intake</td>
<td>5 US gpm</td>
</tr>
</tbody>
</table>

### Water Diversion Check

**Calculation:**

**Step 1.** Determine Annual Water Diverted.

**Equation 3.12**

\[
\text{Annual Water Diverted} = \frac{(\text{Channel Flow Rate} - \text{Overflow}) \times \text{No. of Operating Days}}{226.3}
\]

\[
= \left( \frac{1 - 2}{3} \right) \text{US gpm} \times 3 \text{ days}
\]

\[
= \frac{6}{226.3} \text{ ac-ft}
\]

**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 3.14(a)**

\[
\text{Reduction in Channel Flow Rate} = \frac{\text{Flow Rate at Diversion} - \text{Flow Rate at Irrigation}}{1 \text{ US gpm} - 5 \text{ US gpm}}
\]

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

**Equation 3.14(b)**

\[
\text{Conveyance Losses} = \frac{\text{Reduction in Channel Flow Rate} \times \text{No. of Operating Days}}{226.3}
\]

\[
= \frac{7 \times 3 \text{ days}}{226.3}
\]

\[
= \frac{8 \text{ ac-ft}}{}
\]
Answer:
Step 4. Assess Conveyance Losses

<table>
<thead>
<tr>
<th>Recommended Maximum Conveyance Losses</th>
<th>Water Licensed Amount x 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 ac-ft x 25%</td>
</tr>
<tr>
<td></td>
<td>9 ac-ft</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation system flow rate from Worksheet 4(a) or 4(b)</td>
<td>1 US gpm</td>
</tr>
<tr>
<td>Screen mesh size used</td>
<td>2 mesh</td>
</tr>
<tr>
<td>Percent screen open area of mesh size from Table 3.4</td>
<td>3 %</td>
</tr>
<tr>
<td>Number of screened surface (for flat screens only)</td>
<td>4</td>
</tr>
<tr>
<td>Screen length (for both flat and cylindrical screens)</td>
<td>5 ft</td>
</tr>
<tr>
<td>Screen width (for flat screens only)</td>
<td>6 ft</td>
</tr>
<tr>
<td>Screen breadth (for flat screens only if end area is screened)</td>
<td>7 ft</td>
</tr>
<tr>
<td>Screen diameter (for cylindrical screens only)</td>
<td>8 ft</td>
</tr>
</tbody>
</table>

### Calculation:

**Step 1.** Calculate required screen surface area.

**Equation 3.15**

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

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>US gpm</th>
<th>% Open Area</th>
<th>Suggested Screen Surface Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 US gpm</td>
<td>3 %</td>
<td>9 ft²</td>
</tr>
</tbody>
</table>

**Step 2.** Calculate actual screen area.

**Equation 3.16(a)  Flat Screen**

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

<table>
<thead>
<tr>
<th>Flat Screened Surface</th>
<th>Length</th>
<th>Width</th>
<th>Total Flat Surface Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5 ft</td>
<td>6 ft</td>
<td>10 ft²</td>
</tr>
</tbody>
</table>

**Note:** End area is not screened.

**Equation 3.16(b)  Cylindrical Screen**

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

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length</th>
<th>Total Cylindrical Surface Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ft</td>
<td>5 ft</td>
<td>11 ft²</td>
</tr>
</tbody>
</table>

### Answer:

**Step 3.** Is 9 ft² less than 10 or 11 ft²?

- 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:

<table>
<thead>
<tr>
<th>Step 1.</th>
<th>SAR or SAR\textsubscript{adj} Check</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAR for sprinkler systems</td>
</tr>
<tr>
<td></td>
<td>SAR\textsubscript{adj} for trickle systems</td>
</tr>
<tr>
<td></td>
<td>Electrical conductivity (EC) (Table 3.5)</td>
</tr>
<tr>
<td></td>
<td>Restriction on water use from Table 3.5 or 3.6</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>E.Coli</th>
<th>5</th>
<th>cfu/100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal coliform</td>
<td>6</td>
<td>cfu/100 ml</td>
</tr>
</tbody>
</table>

Answer: Use Table 3.5 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%

<table>
<thead>
<tr>
<th>Water Depth [mm]</th>
<th>Ranking</th>
<th>Lowest Quartile [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

LQ  =  4 mm

Average Catch Overall  =  3 mm

Equation 3.17

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

DU  =  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.
### Information:

<table>
<thead>
<tr>
<th></th>
<th>mm</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum soil water storage (SWS) capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum soil water deficit (MSWD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop coefficient ($K_r$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Analysis:

**Nomenclature:**

- PSWS = Previous Soil Water Storage
- EP = Effective Precipitation
- IRR = Net Depth of Irrigation Water Applied
- $E_{To}$ = Reference Evapotranspiration
- $K_r$ = Crop Coefficient
- CSWS = Current Soil Water Storage

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

<table>
<thead>
<tr>
<th>Date</th>
<th>PSWS</th>
<th>$+$</th>
<th>EP</th>
<th>$+$</th>
<th>IRR</th>
<th>$-$</th>
<th>$E_{To}$</th>
<th>$x$</th>
<th>$K_r$</th>
<th>$=$</th>
<th>CSWS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Even though the total water storage would be 113 mm, the maximum soil water storage can only be 110 mm. The rest of the water is therefore assumed to be lost due to deep percolation and/or runoff.

2. The maximum depletion of 55 mm is reached, so irrigation should start.
Worksheet 11 Trickle Irrigation Scheduling Using *Plant Water Requirement Method*

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily ET&lt;sub&gt;c&lt;/sub&gt; [mm]</th>
<th>K&lt;sub&gt;c&lt;/sub&gt;</th>
<th>ET&lt;sub&gt;c&lt;/sub&gt; [mm]</th>
<th>Operating Time [hr/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Weekly Total Average

Sample Calculations (July 20):

Equation 4.4

\[
\text{Zone Operating Time} = \frac{\text{Maximum Zone Operating Time} \times \text{ET}_c}{\text{Peak ET}}
\]

\[
= \frac{1 \text{ hr/day} \times 3 \text{ mm}}{2 \text{ mm}} = 4 \text{ hr/day}
\]

Answer:
Worksheet 12  Trickle Irrigation Scheduling Using *Water Budget Method*

Information:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emitter spacing ((S_1))</td>
<td>1 m</td>
</tr>
<tr>
<td>Row spacing ((S_2))</td>
<td>2 m</td>
</tr>
<tr>
<td>Maximum soil water storage ((SWS)) capacity</td>
<td>3 mm</td>
</tr>
<tr>
<td>Emitter Flow Rate ((Q))</td>
<td>4 L/hr</td>
</tr>
<tr>
<td>Application efficiency ((AE))</td>
<td>5 %</td>
</tr>
</tbody>
</table>

Calculation:

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

\[
\text{MSWD} = 3 \text{ mm} \times 25% = 6 \text{ mm}
\]

Net Depth of Irrigation Water Applied \((IRR)\)

(b) Irrigation should start when the balance reaches:

\[
3 \text{ mm} - 6 \text{ mm} = 7 \text{ mm}
\]

(c) Determine operating time

Equation 4.5

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

\[
= \frac{1 \text{ m} \times 2 \text{ m} \times 4 \text{ mm} \times 100%}{4 \text{ L/hr} \times 5 \text{ %}} = 8 \text{ hr}
\]

(d) Nomenclature:

| PSWS       | Previous Soil Water Storage |
| EP         | Effective Precipitation     |
| IRR        | Net Depth of Irrigation Water Applied |
| \(E_{To}\) | Reference Evapotranspiration |
| \(K_c\)   | Crop Coefficient            |
| CSWS       | Current Soil Water Storage  |

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