



## Determining Whether Nutrients are Leaching from Your Fields

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Leaching is the downward movement of water-soluble plant nutrients from the root zone due to rain and irrigation events.

Leaching may occur when the amount of water applied to a crop exceeds the amount of water used by the crop (evapotranspiration) and when nutrients are present in the soil.

### Three Steps to Determine if You're Leaching

1. Determine crop evapotranspiration (ET) since the last irrigation (see CDQAP WDR Binder Document 11.6 - Determining Crop Evapotranspiration for details on how to do this).
2. Determine how much water (fresh and manure) you applied (see below).

There are two choices of formulas for this. To choose which formula to use, determine whether your flow rate is measured in gallons per minute (gpm, use formula #1) or cubic feet per second (cfs, use formula #2).

3. If 2 (applied water) is greater than 1 (ET), and nutrients are present in the soil, then nutrients are probably leaching.

### Management Options, if You're Leaching

1. Determine if the irrigation interval can be increased to more closely match the crop ET (from Step 1) and the irrigation application (from Step 2).
2. Reduce the amount of water applied, especially during irrigations following nutrient applications.
3. Change the nutrient applications so that they more closely match the crop nutrient uptake at the time of application. This reduces nitrate that may be stored in the root zone and susceptible to leaching.

## Step 1. Determine crop ET since the last irrigation

See CDQAP WDR Binder Document 11.6 - Determining Crop Evapotranspiration for details on how to do this.

## Step 2. Choose the correct formula and determine the amount of water applied in a single irrigation event .

**Formula #1** (flow rate in gpm)

$$d = \frac{(Q \div 449) \times T}{A}$$

Where: Q = Flow rate in **gallons per minute (gpm)**  
T = Irrigation time in hrs.  
A = Irrigated area in acres  
d = Depth of irrigation in inches

Example 1: Flow rate = 1000 gal/min  
Irrigation time = 9 hours  
Irrigated area = 3 acres  
What is the depth of applied water?

$$d = \frac{(Q \div 449) \times T}{A}$$

$$(1000 \div 449) \times 9 = 20 \div 3 =$$

$$d = 6.7 \text{ inches}$$

**Formula #2** (flow rate in cfs)

$$d = \frac{Q \times T}{A}$$

Where: Q = Flow rate in **cubic feet per second (cfs)**  
T = Irrigation time in hrs.  
A = Irrigated area in acres  
d = Depth of irrigation in inches

Example 2: Flow rate = 15 cfs  
Irrigation time = 1 hours  
Irrigated area = 3 acres  
What is the depth of applied water?

$$d = \frac{Q \times T}{A}$$

$$15 \times 1 = 15 \div 3 =$$

$$d = 5 \text{ inches}$$

### Step 3. Determine whether nutrients are leaching from your field.

This requires the answers to Steps 1 and 2, and one last simple calculation.

**First**, use the daily ET you found in Step 1 to calculate the total ET during the time since the last irrigation event.

For example, if you planted corn around March 1 in the Parlier area, irrigated last on May 16 and today is May 31:

Daily Crop ET (Table CWU-5, Column "Parlier", Row "May 16-31"): 0.28

Days since last irrigation event: 14

Total crop ET since last irrigation event:

$$0.28 \times 14 = 3.92 \text{ inches}$$

**Second**, from step 2 above, you know you applied 6.7 inches of water (you used Formula #1 because you measure flow in gallons per minute).

**Third**, compare the crop ET since the last irrigation (3.92 inches) with the amount of water you applied (6.7 inches). Oops, you applied too much water.

$$6.7 - 3.2 = 3.5 \text{ inches too much}$$

Because too much water was applied, drainage or deep percolation certainly occurred. If nutrients were present in the soil prior to this irrigation, it is likely that leaching occurred.

*Information in this document was compiled by UCCE and CDQAP to assist dairy producers in understanding and complying with the General Order Waste Discharge Requirements for Existing Milk Cow Dairies (Central Valley Regional Water Board Order R5-2007-0035). Effort has been made to ensure accuracy, but these summaries are not official regulatory guidance and are not legal advice. Producers are advised that these summaries are not intended to be a substitute for producers reading the complete order and consulting their own legal counsel to ensure compliance with the waste discharge requirements. Should any information here conflict with the General Order and/or official information provided by the Regional Board, Board-provided information takes precedence.*

## Conversion Formulas:

### I. Determining the Volume of Applied Water:

If you know the flowrate in gallons per minute (gpm) and the hours of irrigation:

$$\underline{\text{flowrate}} \text{ gpm} \times \underline{\text{Irrig. time}} \text{ hrs.} \times 8.02 = \underline{\text{Volume applied}} \text{ cubic feet}$$

$$\underline{\text{flowrate}} \text{ gpm} \times \underline{\text{Irrig. time}} \text{ hrs.} \times 0.0022 = \underline{\text{Volume applied}} \text{ acre-in}$$

$$\underline{\text{flowrate}} \text{ gpm} \times \underline{\text{Irrig. time}} \text{ hrs.} \times 0.000184 = \underline{\text{Volume applied}} \text{ acre-ft}$$

If you know the flowrate in cubic ft. per second (cfs) and the hours of irrigation:

$$\underline{\text{flowrate}} \text{ cfs} \times \underline{\text{Irrig. time}} \text{ hrs.} \times 3600 = \underline{\text{Volume applied}} \text{ cubic feet}$$

$$\underline{\text{flowrate}} \text{ cfs} \times \underline{\text{Irrig. time}} \text{ hrs.} = \underline{\text{Volume applied}} \text{ acre-in.}$$

$$\underline{\text{flowrate}} \text{ cfs} \times \underline{\text{Irrig. time}} \text{ hrs.} \times 0.0826 = \underline{\text{Volume applied}} \text{ acre-ft}$$

### II. Determining the Depth of Applied Water:

If you know the volume of water applied (cubic feet, acre-in, or acre-ft) and the area (square feet or acres) the water is applied to:

$$\underline{\text{Volume applied}} \text{ cu. ft} \div \underline{\text{Irrig. area}} \text{ sq. ft.} = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ cu. ft} \div \underline{\text{Irrig. area}} \text{ sq. ft.} \times 12 = \underline{\hspace{2cm}} \text{ in. of applied water}$$

$$\underline{\text{Volume applied}} \text{ cu. ft} \div \underline{\text{Irrig. area}} \text{ acres} \times 0.000023 = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ cu. ft} \div \underline{\text{Irrig. area}} \text{ acres} \times 0.000275 = \underline{\hspace{2cm}} \text{ in. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-in.} \div \underline{\text{Irrig. area}} \text{ sq. ft.} \times 3630 = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-in.} \div \underline{\text{Irrig. area}} \text{ sq. ft.} \times 43,560 = \underline{\hspace{2cm}} \text{ in. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-in} \div \underline{\text{Irrig. area}} \text{ ac.} \div 12 = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-in} \div \underline{\text{Irrig. area}} \text{ ac.} = \underline{\hspace{2cm}} \text{ in. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-ft.} \div \underline{\text{Irrig. area}} \text{ sq. ft.} \times 43,560 = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-ft.} \div \underline{\text{Irrig. area}} \text{ sq. ft.} \times 522,720 = \underline{\hspace{2cm}} \text{ in. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-ft} \div \underline{\text{Irrig. area}} \text{ acres} = \underline{\hspace{2cm}} \text{ ft. of applied water}$$

$$\underline{\text{Volume applied}} \text{ ac-ft} \div \underline{\text{Irrig. area}} \text{ acres} \times 12 = \underline{\hspace{2cm}} \text{ in. of applied water}$$

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1 acre = 43,560 square feet

1 gallon = 3.785 liters

1 acre-ft. of water = 325,828 gallons

1 cubic foot of water = 7.48 gallons

1 acre-in of water = 27,152 gallons

1 gallon = 8.33 lbs.

## Determination of Applied Water (flow measured in gpm)

Volume (acre-inches) of water applied with different irrigation flows and set times

<b>Irrigation Set Time (hours - T)</b>						
<b>Flow (gpm - Q)</b>	<b>2</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>10</b>	<b>12</b>
<b>200</b>	0.89	1.78	2.67	3.56	4.45	5.35
<b>400</b>	1.78	3.56	5.35	7.13	8.91	10.69
<b>600</b>	2.67	5.35	8.02	10.69	13.36	16.04
<b>800</b>	3.56	7.13	10.69	14.25	17.82	21.38
<b>1000</b>	4.45	8.91	13.36	17.82	22.27	26.73
<b>1200</b>	5.35	10.69	16.04	21.38	26.73	32.07
<b>1400</b>	6.24	12.47	18.71	24.94	31.18	37.42
<b>1600</b>	7.13	14.25	21.38	28.51	35.63	42.76
<b>1800</b>	8.02	16.04	24.05	32.07	40.09	48.11
<b>2000</b>	8.91	17.82	26.73	35.63	44.54	53.45

Inches (D) of water applied with various volumes of water and irrigation set sizes

<b>Acres in Irrigation Set (A)</b>						
<b>Volume (QxT) (acre-inches)</b>	<b>0.5</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>2</b>	4.0	2.0				
<b>5</b>	10.0	5.0	2.5			
<b>10</b>		10.0	5.0	3.3		
<b>15</b>		15.0	7.5	5.0	3.8	
<b>20</b>			10.0	6.7	5.0	4.0
<b>25</b>			12.5	8.3	6.3	5.0
<b>30</b>			15.0	10.0	7.5	6.0
<b>35</b>				11.7	8.8	7.0
<b>40</b>				13.3	10.0	8.0
<b>50</b>				16.7	12.5	10.0
<b>60</b>				20.0	15.0	12.0

**Determination of Applied Water (flow measured in cfs)**

**Volume (acre-inches) of water applied with different irrigation flows and set times**

**Irrigation Set Time (hours - T)**

<b>Flow (cfs - Q)</b>	<b>0.5</b>	<b>0.75</b>	<b>1</b>	<b>1.25</b>	<b>1.5</b>	<b>1.75</b>
<b>5</b>	2.50	3.75	5.00	6.25	7.50	8.75
<b>6</b>	3.00	4.50	6.00	7.50	9.00	10.50
<b>7</b>	3.50	5.25	7.00	8.75	10.50	12.25
<b>8</b>	4.00	6.00	8.00	10.00	12.00	14.00
<b>9</b>	4.50	6.75	9.00	11.25	13.50	15.75
<b>10</b>	5.00	7.50	10.00	12.50	15.00	17.50
<b>11</b>	5.50	8.25	11.00	13.75	16.50	19.25
<b>12</b>	6.00	9.00	12.00	15.00	18.00	21.00
<b>13</b>	6.50	9.75	13.00	16.25	19.50	22.75
<b>14</b>	7.00	10.50	14.00	17.50	21.00	24.50
<b>15</b>	7.50	11.25	15.00	18.75	22.50	26.25

**Inches (D) of water applied with various volumes of water and irrigation set sizes**

**Acres in Irrigation Set (A)**

<b>Volume (QxT) (acre- inches)</b>	<b>0.5</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>2</b>	4.0	2.0				
<b>5</b>	10.0	5.0	2.5			
<b>10</b>		10.0	5.0	3.3		
<b>15</b>		15.0	7.5	5.0	3.8	
<b>20</b>			10.0	6.7	5.0	4.0
<b>25</b>			12.5	8.3	6.3	5.0
<b>30</b>			15.0	10.0	7.5	6.0
<b>35</b>				11.7	8.8	7.0
<b>40</b>				13.3	10.0	8.0
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