College of Agricultural, Consumer and Environmental Sciences

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Irrigation: Water Quality & Testing

Robert Flynn, Ph.D
Extension Plant Sciences

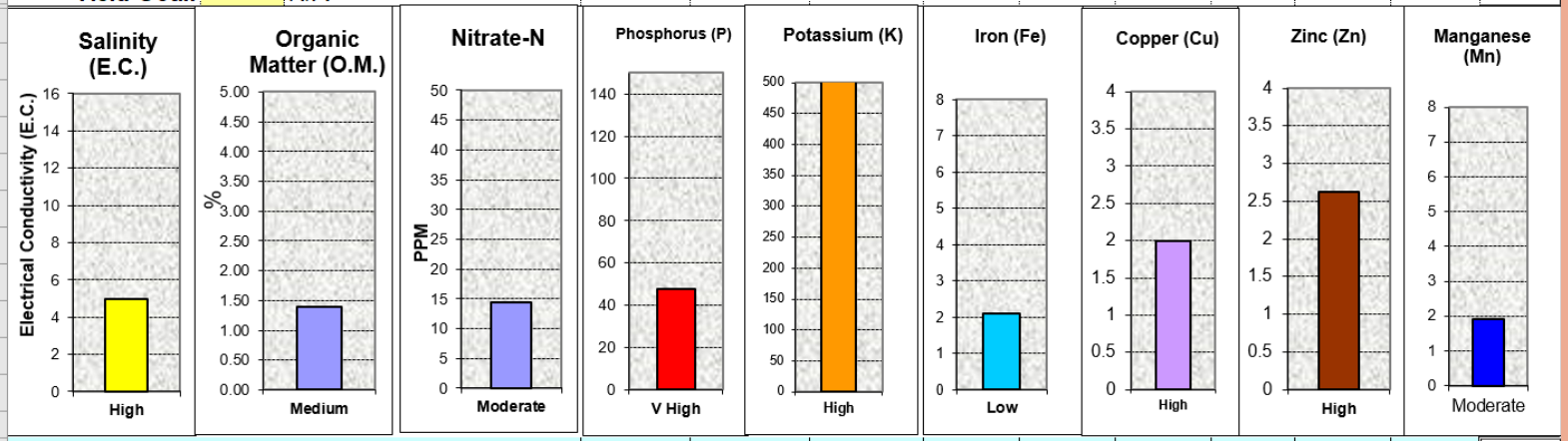
About the College: The College of Agricultural, Consumer and Environmental Sciences is an engine for economic and community development in New Mexico, improving the lives of New Mexicans through academic, research, and extension programs.

NMSU's Soil Workbook

N.M.S.U.-Soil Test Interpretation Report vs 5.1 - (590 Nutrient Management Jobsheet)

C to County Agent:	DONA ANA	Save To Farm Sum	Field ID:			Crop Rotation:								
Client Name:			Record #:	1	Square feet:	or Acres:	1.000	Irr. Water (acin/ac):	48					
Address:			Planner Name:		Form Notes:	Lab used: Ward Laboratories, Inc. 308-234-2418								
	88003	Date: 6/4/2017	Depth increment (in):	12	Sodium Adsorb. Ratio:	8.4	ESP:	10.04						
Phone:		Note: E.C.-Electrical Conductivity or Saltiness, O.M.-Organic Matter, and ESP-Exchangeable Sodium %.												

Samp. ID	pH	E.C.	Soil Texture	O. M.	NO_3-N	P (Olsen)	K(NH4OAc)	Mg	Ca	Na	Cu	Zn	Mn	Fe
(#)	(#)	(mmhos/cm)	(class)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
W142958	8.1	4.95	Sandy Loam	1.4	14.4	47.6	575.0	74.0	396.0	698.0	2.0	2.6	1.9	2.1
Crop to grow:	Vegetables, General				lbs/ac	P_2O_5 (lbs/ac)	K_2O (lbs/ac)	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac	lbs/ac
Yield Goal:	40	N/A			102	454	2885	130	696	1227	8	11	8	9



Nutrient Recommendation:	N lbs/ac	P_2O_5 lbs/ac	K_2O lbs/ac	Mg lbs/ac	Ca lbs/ac	Fe lbs/ac	Cu lbs/ac	Zn lbs/ac	Mn lbs/ac
Recommended Nutrient Rate:	90	0	40	0	0.0	5.0	0.0	0.0	0.0
Organic Nutrient Source (Liquid or Solid Manure):	0	0	0						

Organic Nut Source | Report | Farm Sum | P Uptake | Records | Fert Cost | Crop | Tables | Fert Cost Data Reference | Data Entry | Sheet1

NM STATE

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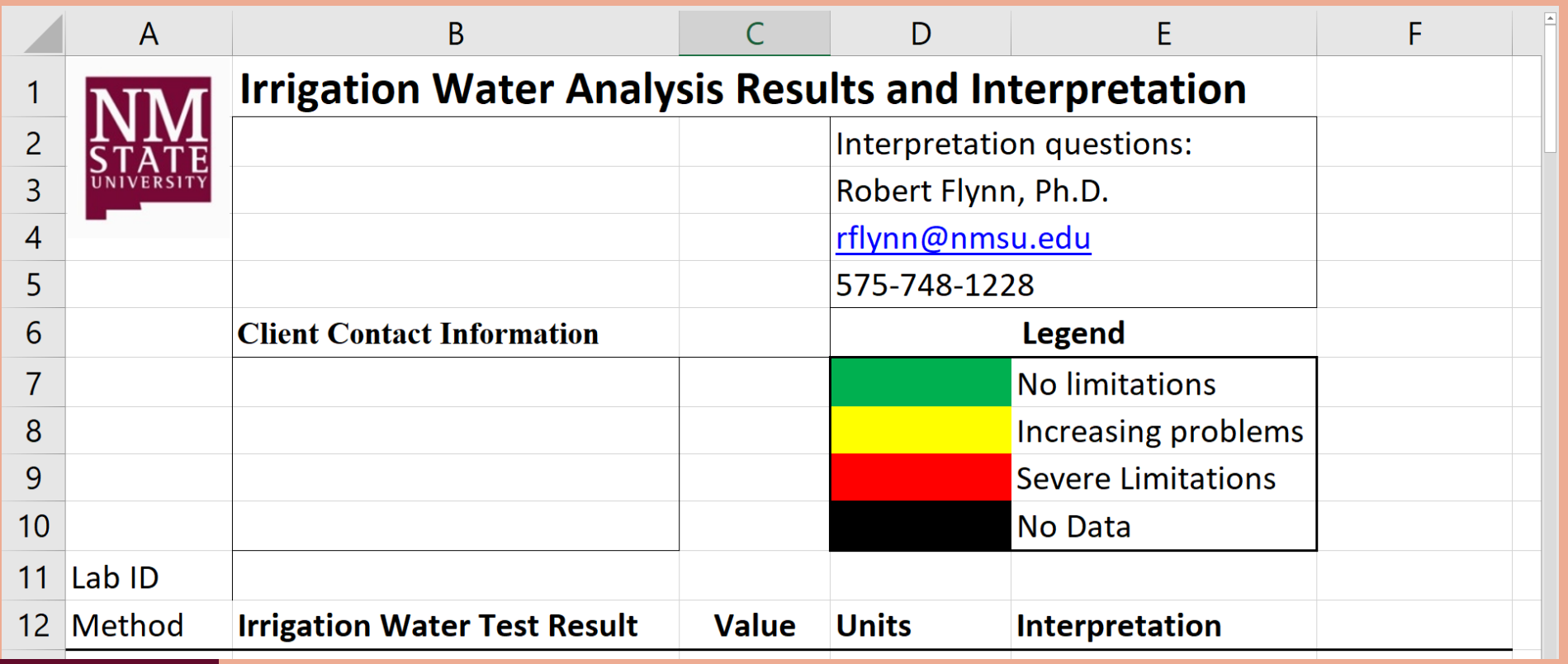
NMSU Irrigation H_2O Quality Workbook



	A	B	C	D	E	F
1		**Irrigation Water Analysis Results and Interpretation**				
2				Interpretation questions:		
3				Robert Flynn, Ph.D.		
4				rflynn@nmsu.edu		
5				575-748-1228		
6		**Client Contact Information**		**Legend**		
7					No limitations	
8					Increasing problems	
9					Severe Limitations	
10					No Data	
11	Lab ID					
12	Method	**Irrigation Water Test Result**	**Value**	**Units**	**Interpretation**	

What about water?

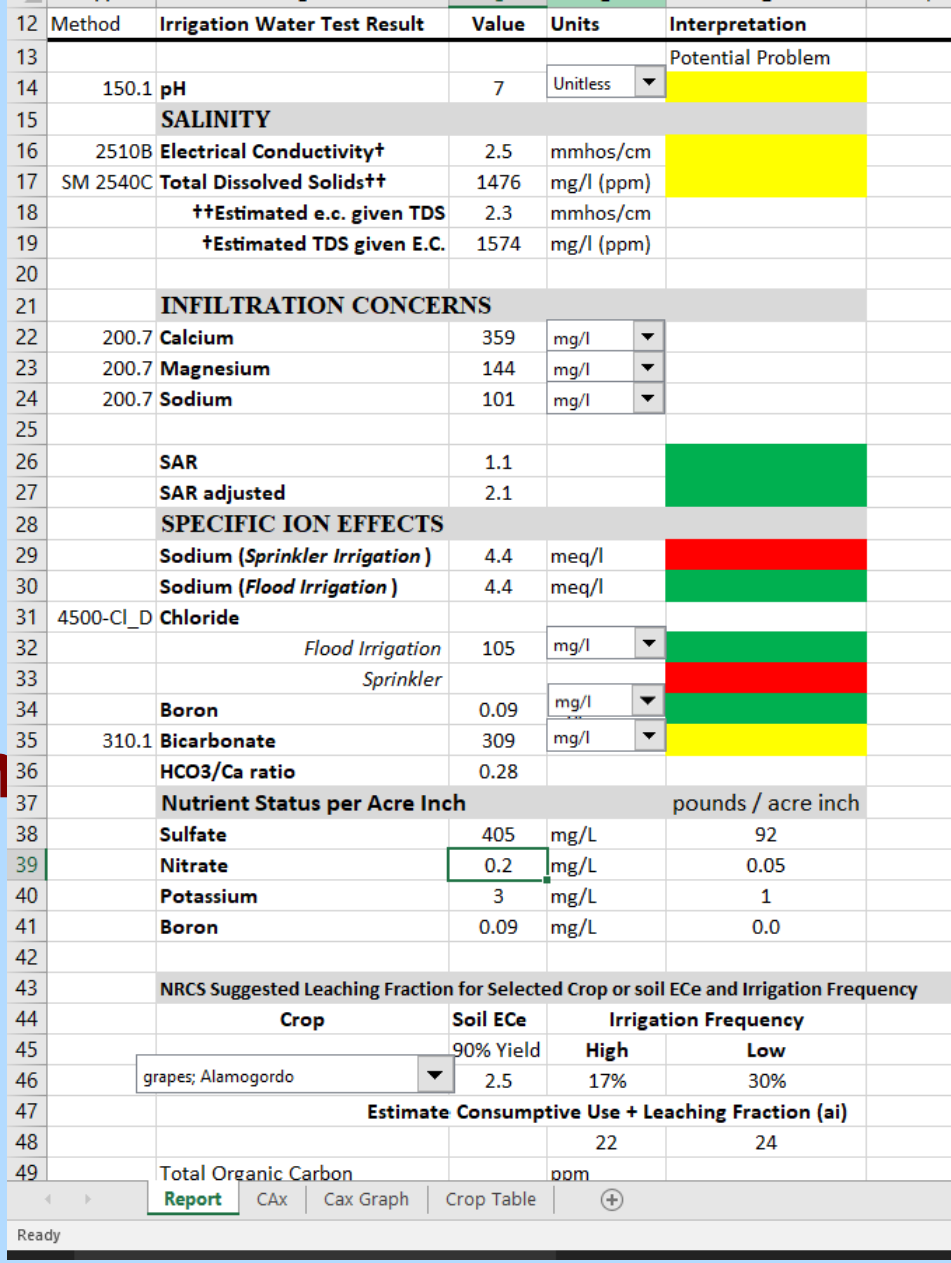
Sample your water for limitations and management

Irrigation Water Tests

- pH
- Nitrate-N
- Electrical Conductivity
  - TDS (total dissolved solids)
- Ca, Mg, Na
- Chloride
- Boron
- Potassium
- Sulfate
- Bicarbonate

NMSU H_2O Workbook

- Salinity Rating
- Infiltration Concerns
- Specific Ion Effects
- Nutrient Contribution
- Leaching fraction
  - By crop



	Method	Irrigation Water Test Result	Value	Units	Interpretation
12					
13					Potential Problem
14	150.1	pH	7	Unitless	
15		SALINITY			
16	2510B	Electrical Conductivity†	2.5	mmhos/cm	
17	SM 2540C	Total Dissolved Solids††	1476	mg/l (ppm)	
18		††Estimated e.c. given TDS	2.3	mmhos/cm	
19		†Estimated TDS given E.C.	1574	mg/l (ppm)	
20					
21		INFILTRATION CONCERNS			
22	200.7	Calcium	359	mg/l	
23	200.7	Magnesium	144	mg/l	
24	200.7	Sodium	101	mg/l	
25					
26		SAR	1.1		
27		SAR adjusted	2.1		
28		SPECIFIC ION EFFECTS			
29		Sodium (*Sprinkler Irrigation*)	4.4	meq/l	
30		Sodium (*Flood Irrigation*)	4.4	meq/l	
31	4500-Cl_D	Chloride			
32		*Flood Irrigation*	105	mg/l	
33		*Sprinkler*			
34		Boron	0.09	mg/l	
35	310.1	Bicarbonate	309	mg/l	
36		HCO3/Ca ratio	0.28		
37		Nutrient Status per Acre Inch			pounds / acre inch
38		Sulfate	405	mg/L	92
39		Nitrate	0.2	mg/L	0.05
40		Potassium	3	mg/L	1
41		Boron	0.09	mg/L	0.0
42					
43		NRCS Suggested Leaching Fraction for Selected Crop or soil ECe and Irrigation Frequency			
44		Crop	Soil ECe	Irrigation Frequency	
45			90% Yield	High	Low
46		grapes; Alamogordo	2.5	17%	30%
47			Estimate Consumptive Use + Leaching Fraction (ai)		
48				22	24
49		Total Organic Carbon		ppm	

Report | CAx | Cax Graph | Crop Table

Ready

NRCS Suggested Leaching Fractions can be determined

grapes; Alamogordo

for Selected Crop or soil ECe and Irrigation Frequency

Crop	Soil ECe	Irrigation Frequency	
	90% Yield	High	Low
	2.5	17%	30%
Crop	Soil ECe	Irrigation Frequency	
	90% Yield	High	Low

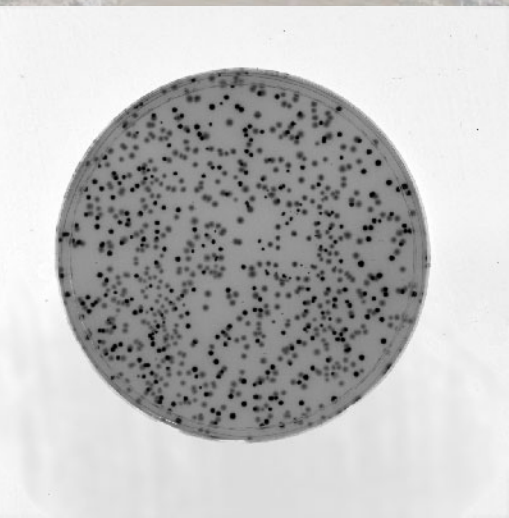
Why Wait for Problems to Show?

Sampling

- Use a clean, triple rinsed plastic bottle of at least ½ gallon (2 liters) for all tests
- Collect after well or system has run for at least 15 minutes
- Surface water (ditch water) should be collected below water surface
- Store below 40°F if sample can not be analyzed within 3 hours.
- Check with lab for appropriate forms

Biological Testing

- **Requires Sterile Bottles available from the water testing laboratories.**
- **Important for Drip Irrigation Systems**



What are we looking for?

- pH
- Salinity
- Specific Ion Effects
  - Sodium
  - Bicarbonate
  - Chloride
  - Boron
- Other

Water ρH

- ρH = $-\log(H^+)$
  - Acidic, Basic, or Neutral
- Normal Range
  - 6.5 to 8.4
  - New Mexico (>7 pH <8.4)
- Best to measure immediately

Water Salinity

- **Presence of dissolved salts**
  - **Cations (Ca^{++}, Mg^{++}, K^{+}, Na^{+})**
  - **Anions (HCO_3^{-}, $CO_3^{=}$, Cl^{-}, $SO_4^{=}$)**
- **Measured as**
  - **Electrical Conductivity (e.c.)**
  - **TDS (mg/l or ppm)**

Examples of ec_w

RO Reject

Tap water/ Irrigation water

R.O. water

0 = distilled water

Interpreting ec_w

Degree of restriction on use

None	Slight - Moderate	Severe
<0.7	0.7 – 3.0	> 3.0

UNITS: mmhos/cm

Interpreting TDS

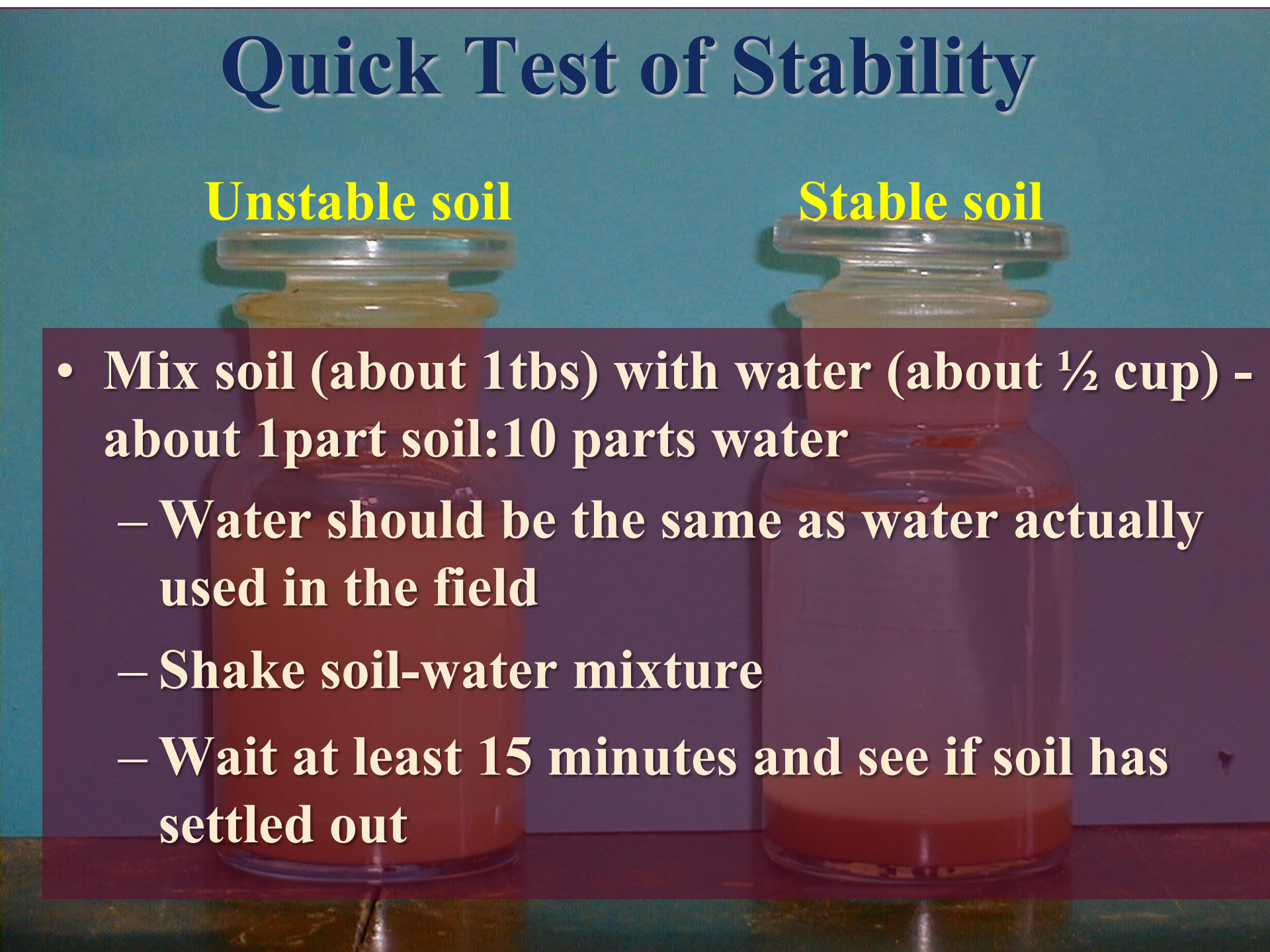
Degree of restriction on use

None	Slight - Moderate	Severe
<450	450 - 2000	> 2000

UNITS: ppm or mg/l

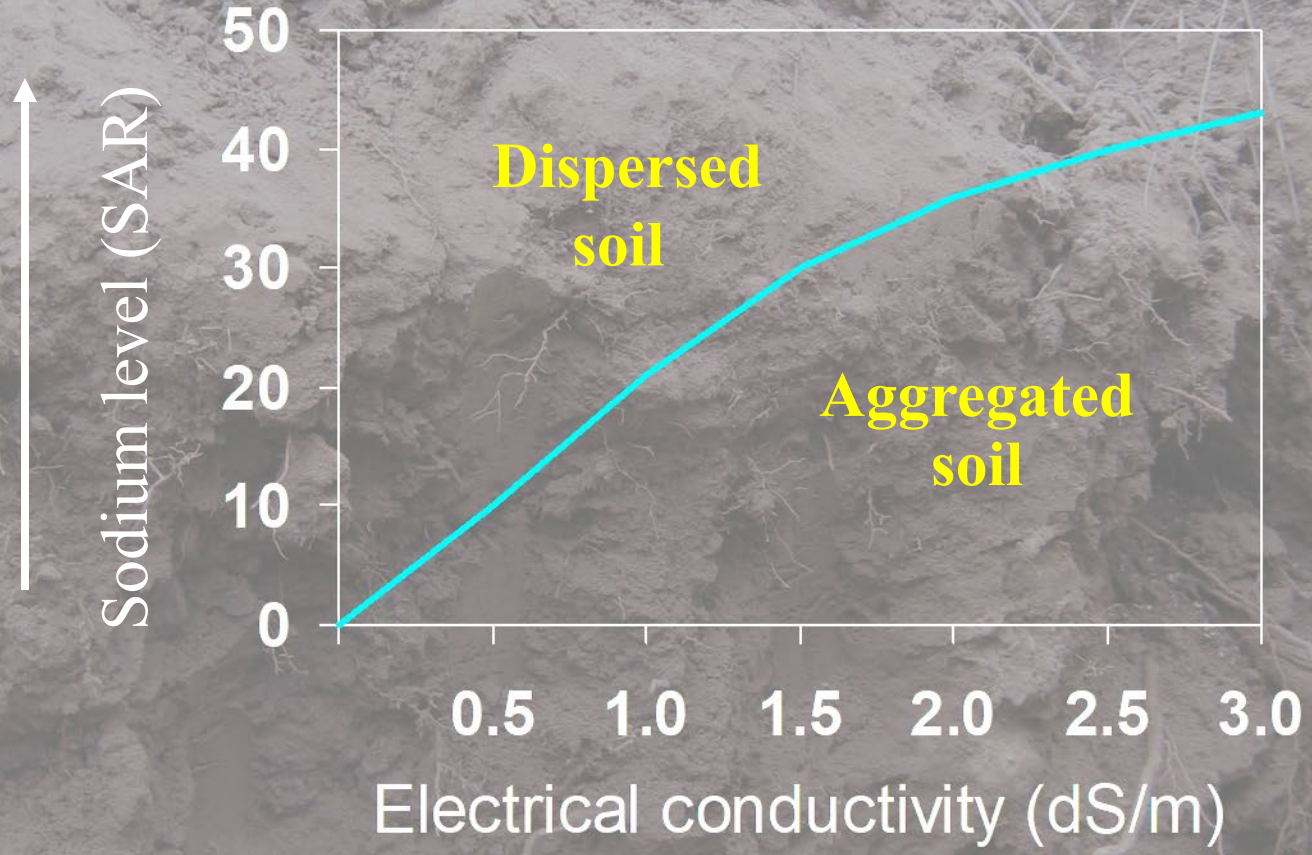
e.c. X 640 ≈ TDS

Quick Test of Stability



- Mix soil (about 1tbs) with water (about ½ cup) - about 1part soil:10 parts water
  - Water should be the same as water actually used in the field
  - Shake soil-water mixture
  - Wait at least 15 minutes and see if soil has settled out

Both the amount of salts and the kind of salts affect soil structure



Interpreting SAR & EC_w

	Degree of restriction on use		
	None	Slight - Moderate	Severe
SAR = 0–3 & EC_w =	>0.7	0.7-0.2	<0.2
SAR = 3-6 & EC_w =	>1.2	1.2–0.3	<0.3
SAR = 6-12 & EC_w =	>1.9	1.9–0.5	<0.5
SAR = 12-20 & EC_w =	>2.9	2.9–1.3	<1.3
SAR = 20-40 & EC_w =	>5.0	5.0–2.9	<2.9

Specific Ion Effects - SAR

Degree of restriction on use

None	Slight - Moderate	Severe

Surface Irrigation

<3	3 - 9	>9

Specific Ion Effects – Cl^-

Degree of restriction on use

None	Slight - Moderate	Severe

Surface Irrigation (meq/l)

<4	4 - 10	>10

meq Cl^-/l = ppm/35.5

Irrigation & Na^+, Cl^-

- **Surface Irrigation**
  - Most woody species are sensitive to sodium and chloride
  - Most annual species are not sensitive
- **Overhead irrigation + low humidity**
  - Na^+ and Cl^- may be absorbed through the leaves of sensitive plants.

Crop Tolerance to Na^+ & Cl^-

5 – 10 meq/l	10 – 20 meq/l	>20 meq/l
Grape	Alfalfa	Cauliflower
Pepper	Barley	Cotton
Potato	Corn	Sugarbeet
Tomato	Cucumber	Sunflower
	Safflower	
	Sesame	
	Sorghum	

Grape Tolerance to Cl^- (meq/l)

Grape RS or CV	Root Zone	Irrigation water
Salt Creek, 1613-3	40	27
Dog Ridge	30	20
Thomson seedls	20	13.3
Perlette	20	13.3
Cardinal	10	6.7
Black Rose	10	6.7

Specific Ion Effects – Boron

Degree of restriction on use

None	Slight - Moderate	Severe
ppm		
<0.7	0.7 – 3.0	>3.0

Crop Tolerance to Boron (ppm)

- Very Sensitive (<0.5)
  - Blackberry
- Sensitive (0.5 – 0.75)
  - Grape
  - Pecan
  - Onion
- Less Sensitive (0.75 – 1)
  - Wheat
  - Peanut
- Moderately Sensitive (1-2)
  - Pepper, red
  - Potato
- Moderately Tolerant (2 – 4)
  - Corn
  - Squash
- Tolerant (4 – 6)
  - Sorghum
  - Tomato
  - Alfalfa
- Very Tolerant (>6)
  - Cotton
  - Asparagus

Specific Ion Effects – Bicarbonate (HCO_3^-)

Degree of restriction on use

None	Slight - Moderate	Severe
meq/l		
<1.5	1.5 – 8.5	>8.5

meq HCO_3^- /l = ppm/61

Drip Irrigation Concerns

Clogging Hazards

- Clogging caused by:
  - Chemical
  - Physical
  - Biological
- Waters in New Mexico are hard
  - Meaning they have a high mineral content (especially calcium)
  - Some wells produce sand
  - Some have biological concerns

Chemical Precipitation Hazards

- ρH
  - Low
    - <7.0
  - Moderate
    - 7.0 – 8.0
  - High
    - >8.0

Chemical Precipitation Hazards

- **Iron (Fe)**
  - **Low**
    - <0.2 ppm (mg/l)
  - **Moderate**
    - 0.2 – 1.5 ppm (mg/l)
  - **High**
    - >1.5 ppm (mg/l)

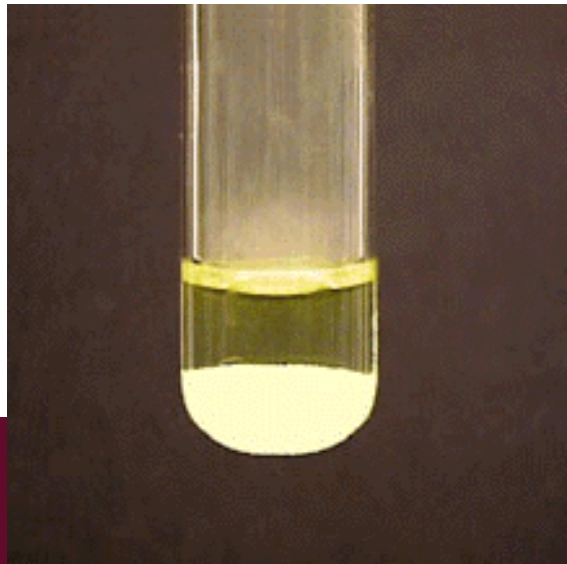
Chemical Precipitation Hazards

- **Manganese (Mn)**
  - **Low**
    - <0.1 ppm (mg/l)
  - **Moderate**
    - 0.1 – 1.5 ppm (mg/l)
  - **High**
    - >1.5 ppm (mg/l)

Chemical Precipitation Hazards

In presence of sulfides can form a black, sand-like insoluble precipitate.

- **Hydrogen sulfide (H_2S)**
  - **Low**
    - <0.1 ppm (mg/l)
  - **Moderate**
    - 0.1 – 2.0 ppm (mg/l)
  - **High**
    - >2.0 ppm (mg/l)



Chemical Precipitation Hazards

- **Bicarbonate & pH (above 7.5)**
  - **Low**
    <1.5 meq/l
  - **Moderate**
    1.5 – 2.5 meq/l
  - **High**
    >2.5 meq/l

- **Can Cause Lime Scale**
- **White film around emitters**
- **White precipitate in flush water**

So, which will likely clog?

Water 1

- EC: 2.51 mmhos/cm
- pH: 7.4
- Ca: 306 ppm
- Mg: 121 ppm
- Na: 124 ppm
- Cl: 158 ppm
- HCO_3: 317 ppm
- SO_4: 912 ppm
- Mn: <0.1 ppm
- Fe: <0.1 ppm

Water 2

- EC: 0.87 mmhos/cm
- pH: 7.7
- Ca: 44 ppm
- Mg: 16 ppm
- Na: 127 ppm
- Cl: 70 ppm
- HCO_3: 122 ppm
- SO_4: 226 ppm
- Mn: 2.6 ppm
- Fe: 0.65 ppm

Which will clog? Answer

Water 1

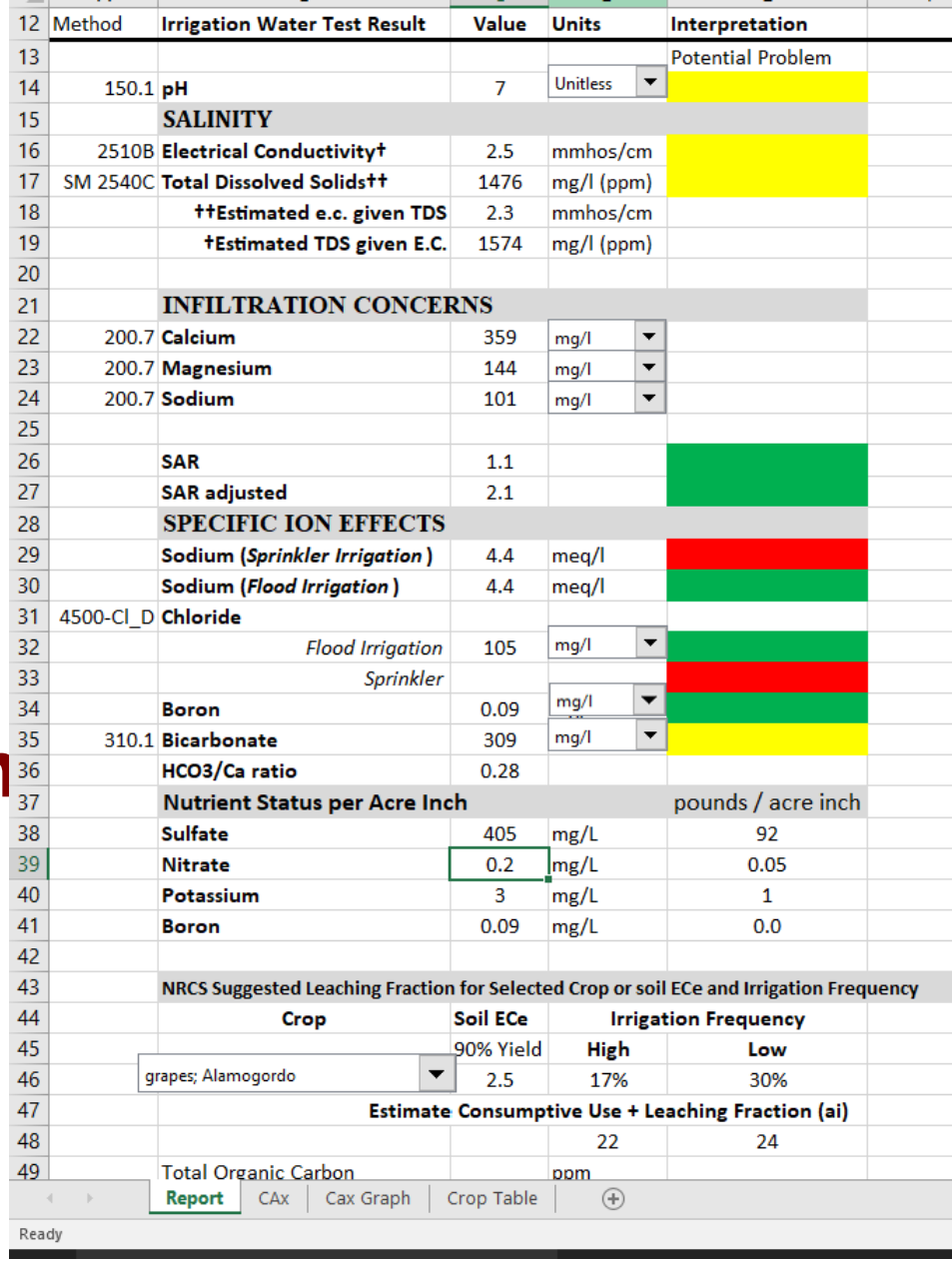
- High salt indicates some clogging potential
- Relatively high bicarbonate + high Ca suggests clogging if pH were to rise for some reason
- Fe and Mn not a problem

Water 2

- Low salt content indicates little clogging from salts.
- pH and bicarbonate indicates the potential to clog due to lime.
- Mn and Fe clogging potential is very high

NMSU H_2O Workbook

- Salinity Rating
- Infiltration Concerns
- Specific Ion Effects
- Nutrient Contribution
- Leaching fraction
  - By crop



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		†Estimated TDS given E.C.	1574	mg/l (ppm)	
		INFILTRATION CONCERNS			
	200.7	Calcium	359	mg/l	
	200.7	Magnesium	144	mg/l	
	200.7	Sodium	101	mg/l	
		SAR	1.1		
		SAR adjusted	2.1		
		SPECIFIC ION EFFECTS			
		Sodium (*Sprinkler Irrigation*)	4.4	meq/l	
		Sodium (*Flood Irrigation*)	4.4	meq/l	
	4500-Cl_D	Chloride			
		Flood Irrigation	105	mg/l	
		Sprinkler		mg/l	
		Boron	0.09	mg/l	
	310.1	Bicarbonate	309	mg/l	
		HCO3/Ca ratio	0.28		
		Nutrient Status per Acre Inch			pounds / acre inch
		Sulfate	405	mg/L	92
		Nitrate	0.2	mg/L	0.05
		Potassium	3	mg/L	1
		Boron	0.09	mg/L	0.0
		NRCS Suggested Leaching Fraction for Selected Crop or soil ECe and Irrigation Frequency			
		Crop	Soil ECe	Irrigation Frequency	
			90% Yield	High	Low
		grapes; Alamogordo	2.5	17%	30%
		Estimate Consumptive Use + Leaching Fraction (ai)			
				22	24
		Total Organic Carbon		ppm	

Report | CAx | Cax Graph | Crop Table

Ready

Ready for some interpretation?

Thank you

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