“I am honored to speak today with Dr. Goos” *or* “Salty language”

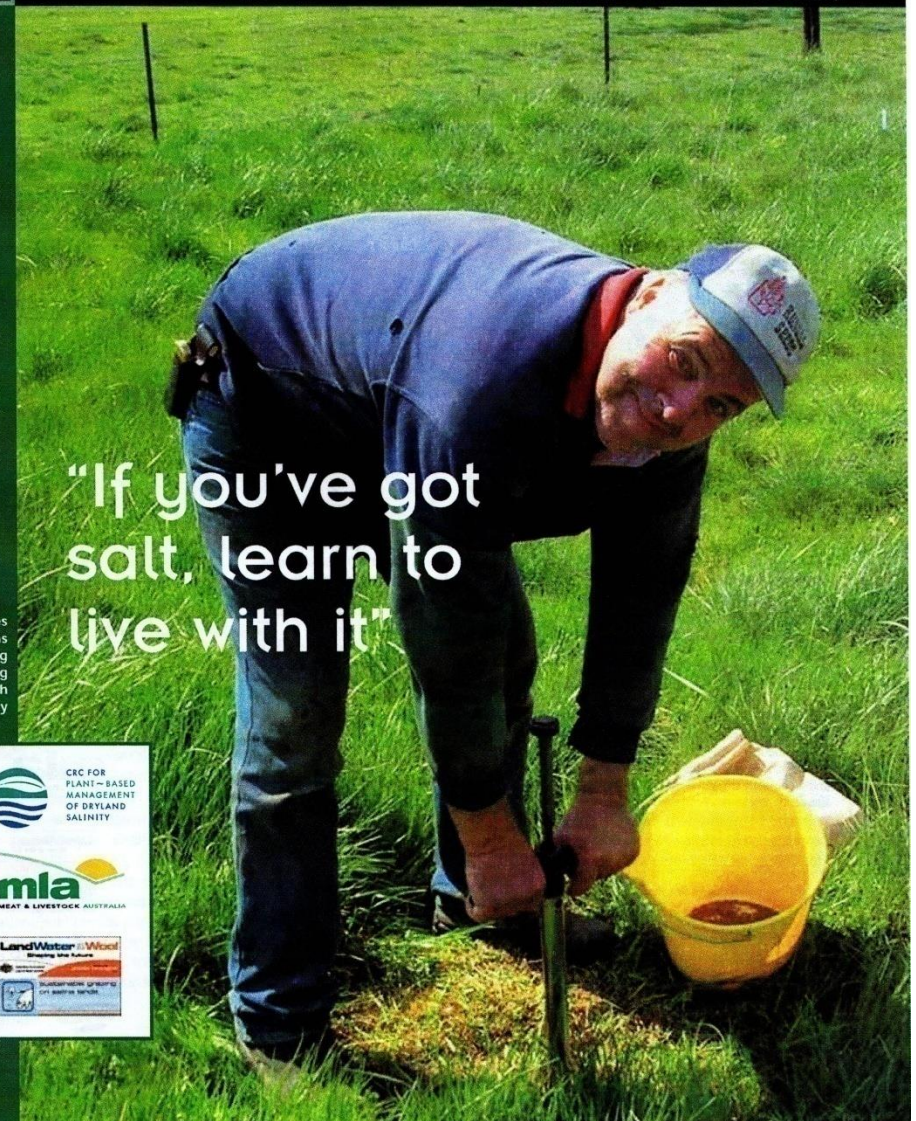
Tom DeSutter
NDSU

Adv. Crop Advisors Workshop
Holiday Inn
13 February 2018

salt magazine

The Magazine of the CRC for Plant-based Management of Dryland Salinity

ISSUE No. 15



"If you've got salt, learn to live with it"

Personal stories of Australians combating and learning to live with dryland salinity

CRC FOR PLANT-BASED MANAGEMENT OF DRYLAND SALINITY

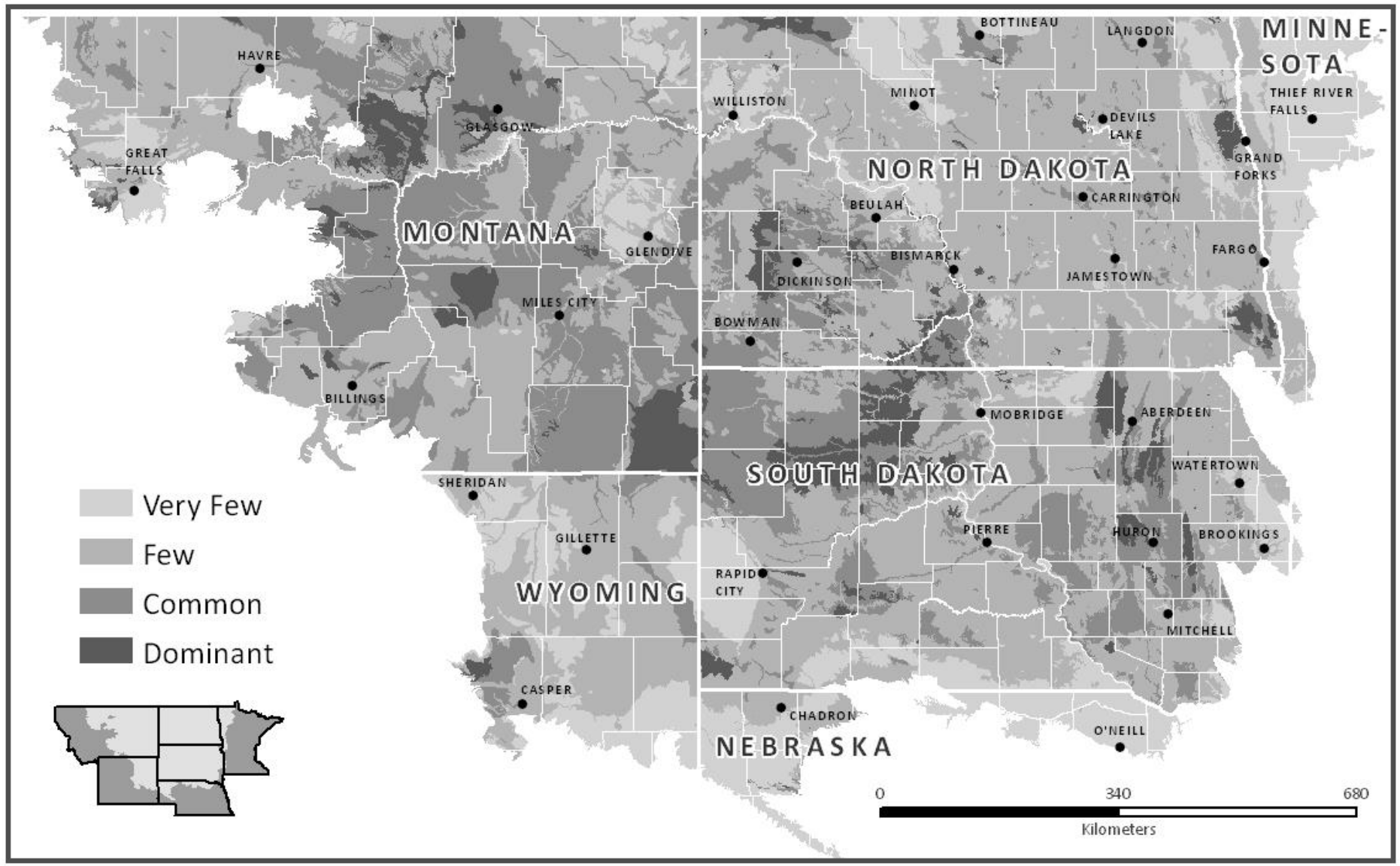
mla MEAT & LIVESTOCK AUSTRALIA

LandWater & Wool

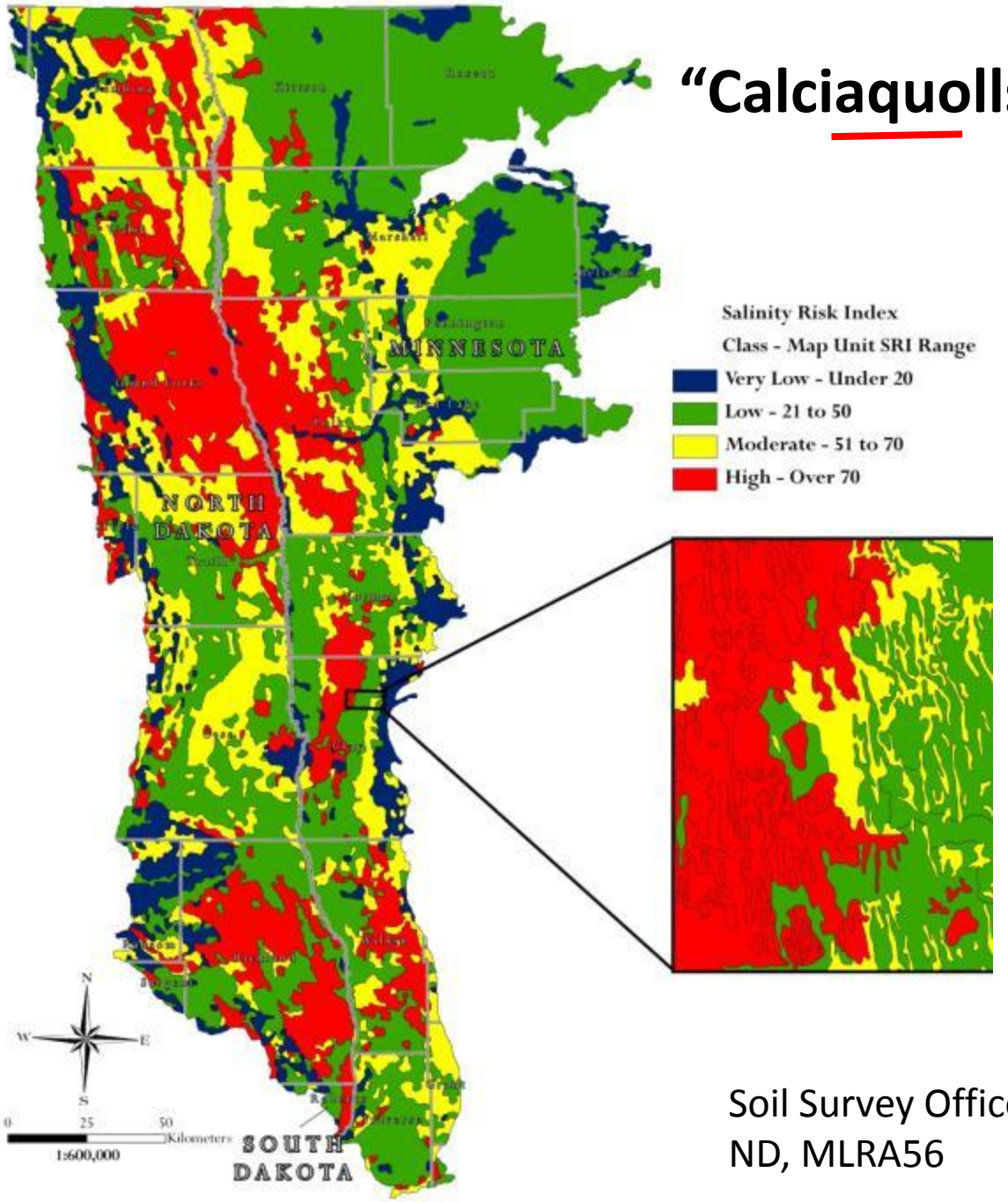
Saline soil (photo by Jay Goos)

Sodic soil (photo by NRCS)

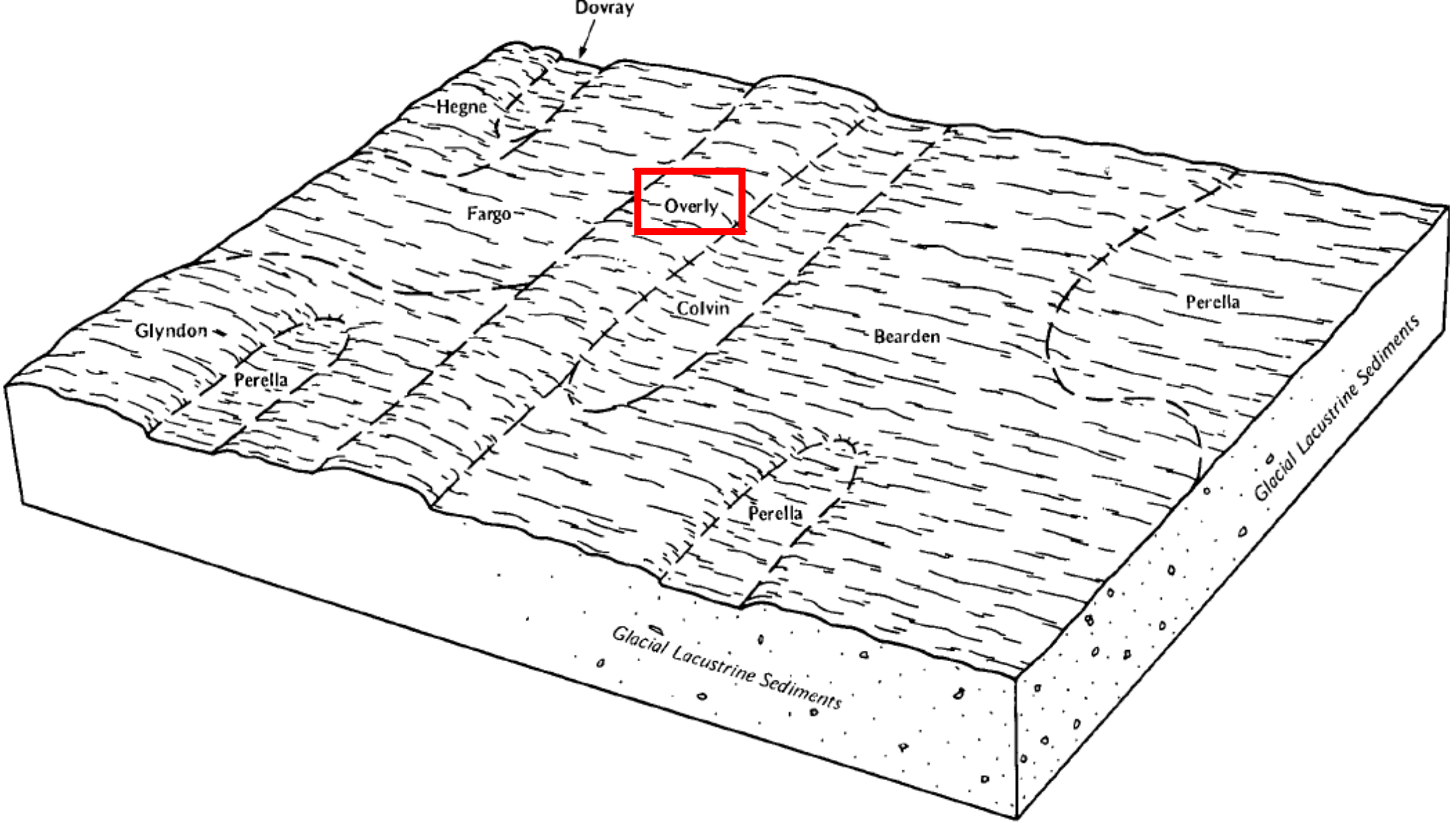
Saline soils, EC > 4 dS/m



“Calciaquolls” or “Calciaquerts”



Soil Survey Office, Fargo, ND, MLRA56


Dovray
Hegne
Fargo
Overly
Colvin
Glyndon
Perella
Bearden
Perella
Perella
Glacial Lacustrine Sediments
Glacial Lacustrine Sediments

“Common” Salts in the Soil

Compound	Common Name	Molecular Formula	Solubility (20° C)
			g/L
Calcium carbonate	Lime	$CaCO_3$	0.06†
Magnesium carbonate		$MgCO_3$	2.51‡
Sodium carbonate	Soda	Na_2CO_3	179
Sodium bicarbonate	Baking soda	$NaHCO_3$	87
Calcium sulfate	Gypsum	$CaSO_4$	1.9
Magnesium sulfate	Epsom	$MgSO_4$	252
Sodium sulfate	Glauber’s salt	Na_2SO_4	161
Magnesium chloride		$MgCl_2$	410
Sodium chloride	Table salt	NaCl	264
Calcium chloride		$CaCl_2$	427

Calcium bicarbonate 1.6 g/L

Solubility, in general:

$$Cl^- > SO_4^{2-} > CO_3^{2-}$$

EC of saturated solutions:

$CaCO_3$

$CaSO_4$

$NaCl$

$NaHCO_3$

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
0-6" Nitrate	5 lb/ac	***			
Olsen Phosphorus	19 ppm	**********	**********	**********	**********
Potassium	374 ppm	**********	**********	**********	**********
0-6'' Chloride	1531 lb/ac	**********	**********	**********	**********
0-6" Sulfur	120 +lb/ac	**********	**********	**********	**********
Boron	11.2 ppm	**********	**********	**********	**********
Zinc	0.94 ppm	**********	**********	**********	
Iron	7.4 ppm	**********	**********	**********	**********
Manganese	3.9 ppm	**********	**********	**********	**********
Copper	0.84 ppm	**********	**********	**********	
Magnesium	991 ppm	**********	**********	**********	**********
Calcium	4000 ppm	**********	**********	**********	**********
Sodium	1500 ppm	**********	**********	**********	**********
Org.Matter	4.2 %	**********	**********	**********	
Carbonate(CCE)	9.4 %	**********	**********	**********	**********
0-6" Sol. Salts	0.33 mmho/cm	********			

1st Crop Choice		
Corn-Grain		
YIELD GOAL		
160 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	172	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	3	Band
Fe	0	
Mn	0	
Cu	0	
Mg	0	
Lime		

2nd Crop Choice		
Corn-Grain		
YIELD GOAL		
170 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	184	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	3	Band
Fe	0	
Mn	0	
Cu	0	
Mg	0	
Lime		

3rd Crop Choice		
Corn-Grain		
YIELD GOAL		
180 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	196	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	3	Band
Fe	0	
Mn	0	
Cu	0	
Mg	0	
Lime		

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.4		35.7 meq	(65-75) 56.0	(15-20) 23.1	(1-7) 2.7	(0-5) 18.2	(0-5)

Nutrient In The Soil			Interpretation			
			VLow	Low	Med	High
0-6" Nitrate	81 lb/ac					
Olsen Phosphorus	43 ppm					
Potassium	203 ppm					
0-6" Chloride	385 lb/ac					
0-6" Sulfur	120 +lb/ac					
Boron	2.9 ppm					
Zinc	0.37 ppm					
Iron	4.1 ppm					
Manganese	2.5 ppm					
Copper	0.77 ppm					
Magnesium	2553 ppm					
Calcium	8652 ppm					
Sodium	70 ppm					
Org.Matter	3.5 %					
Carbonate(CCE)	2.6 %					
0-6" Sol. Salts	4.03 mmho/cm					

1st Crop Choice		
Corn-Grain		
YIELD GOAL		
160 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	81	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	5	Band
Fe	1	Band
Mn	0	
Cu	0	
Mg	0	
Lime		

2nd Crop Choice		
Corn-Grain		
YIELD GOAL		
170 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	93	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	5	Band
Fe	1	Band
Mn	0	
Cu	0	
Mg	0	
Lime		

3rd Crop Choice		
Corn-Grain		
YIELD GOAL		
180 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	105	
P_2O_5	15	Band (2x2) *
K_2O	10	Band (2x2) *
Cl		Not Available
S	0	
B	0	
Zn	5	Band
Fe	1	Band
Mn	0	
Cu	0	
Mg	0	
Lime		

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" 8.1		65.4 meq	(65-75) 66.2	(15-20) 32.6	(1-7) 0.8	(0-5) 0.5	(0-5)

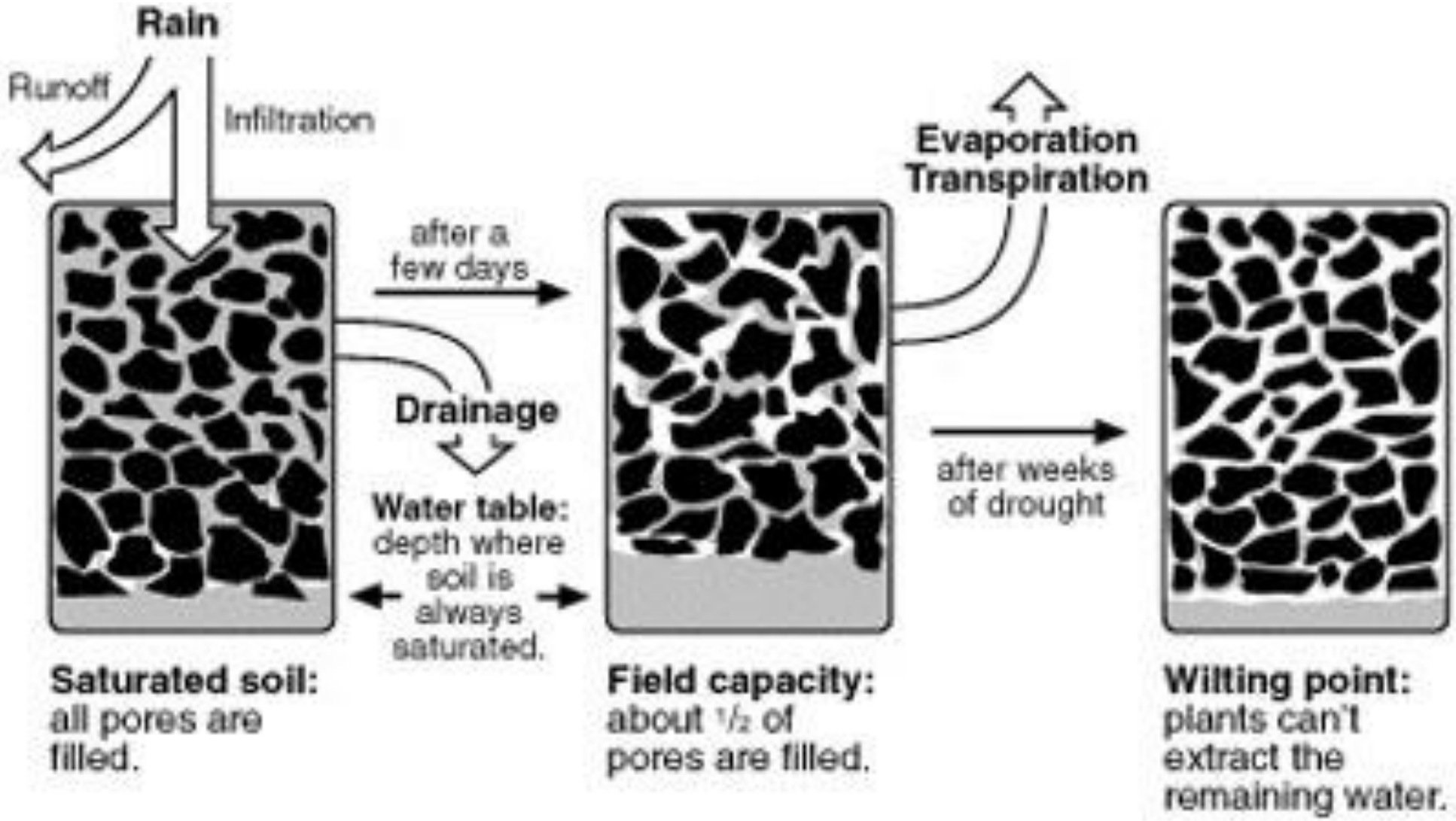
So, which salts will likely move faster in soils?

Depends on:

1)Water flow in soils

-Saturated flow vs unsaturated flow

2)Solubility of the salts

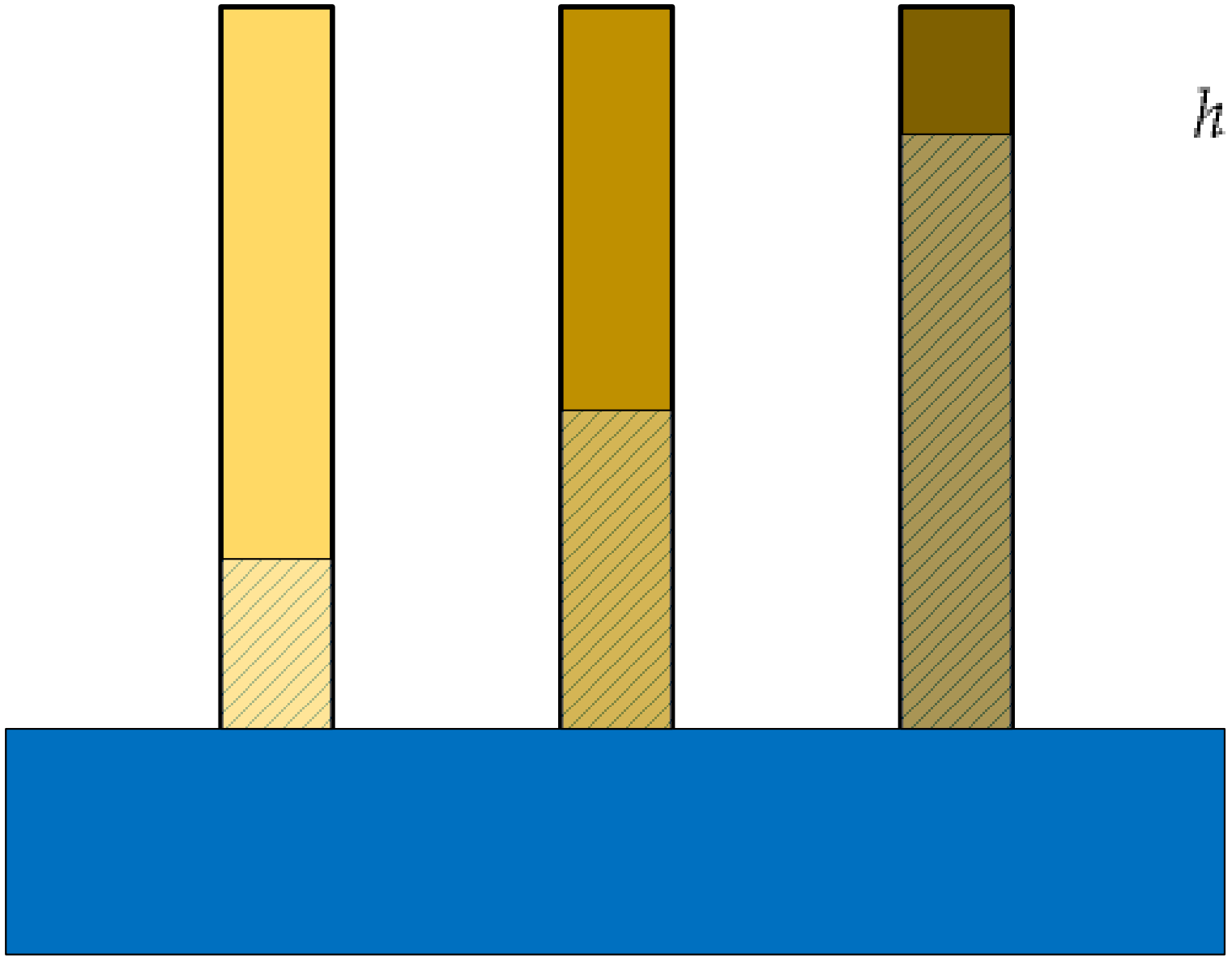


https://www.extension.umn.edu/agriculture/soils/soil-properties/soil-management-series/introduction-to-soil-management/img/changes-in-soil-water.jpg

Coarse-texture

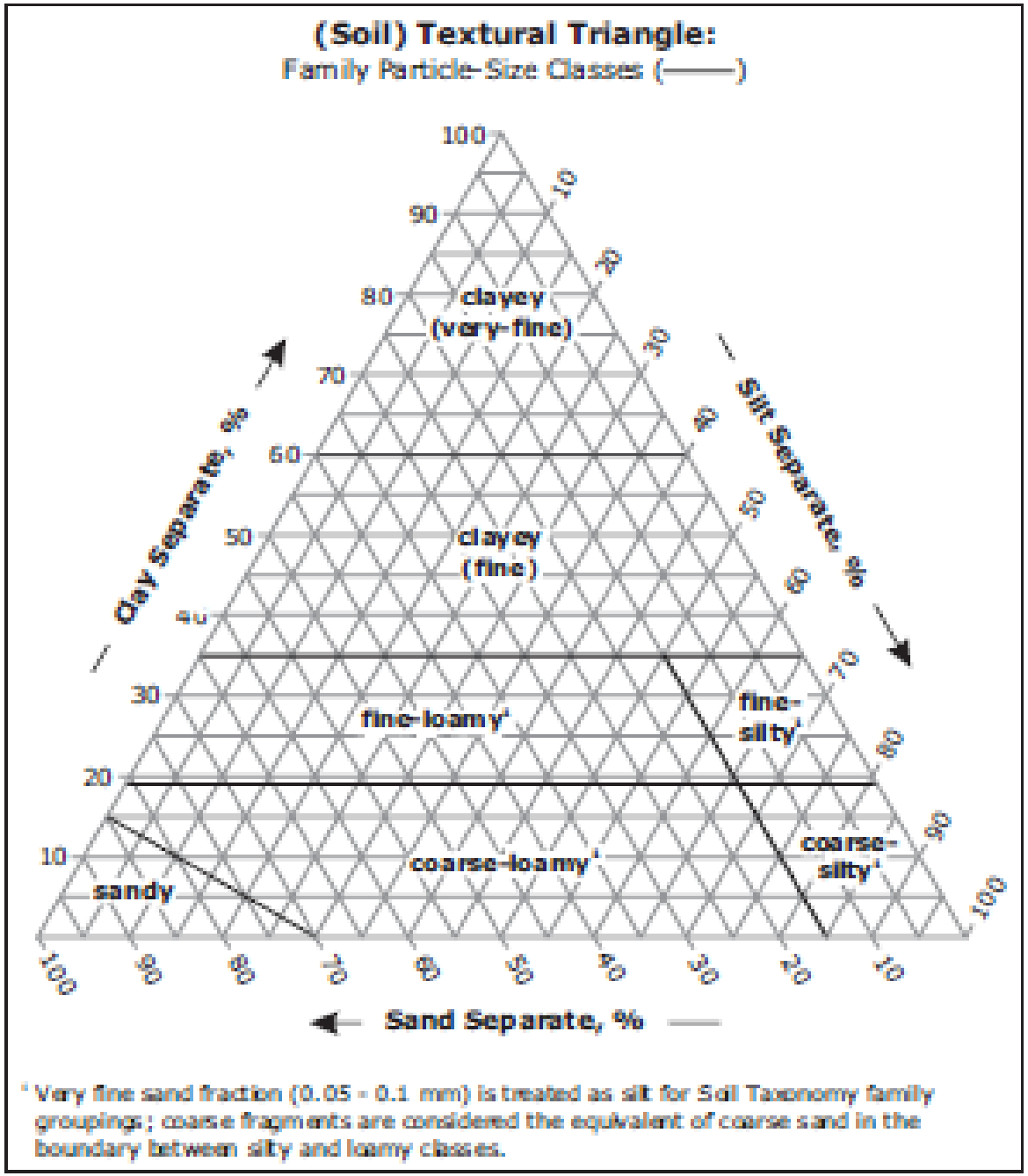
Medium-texture

Fine-texture



$$h\,(\mathrm{cm}) = \frac{0.15\ \mathrm{cm}^2}{r\,(\mathrm{cm})}$$

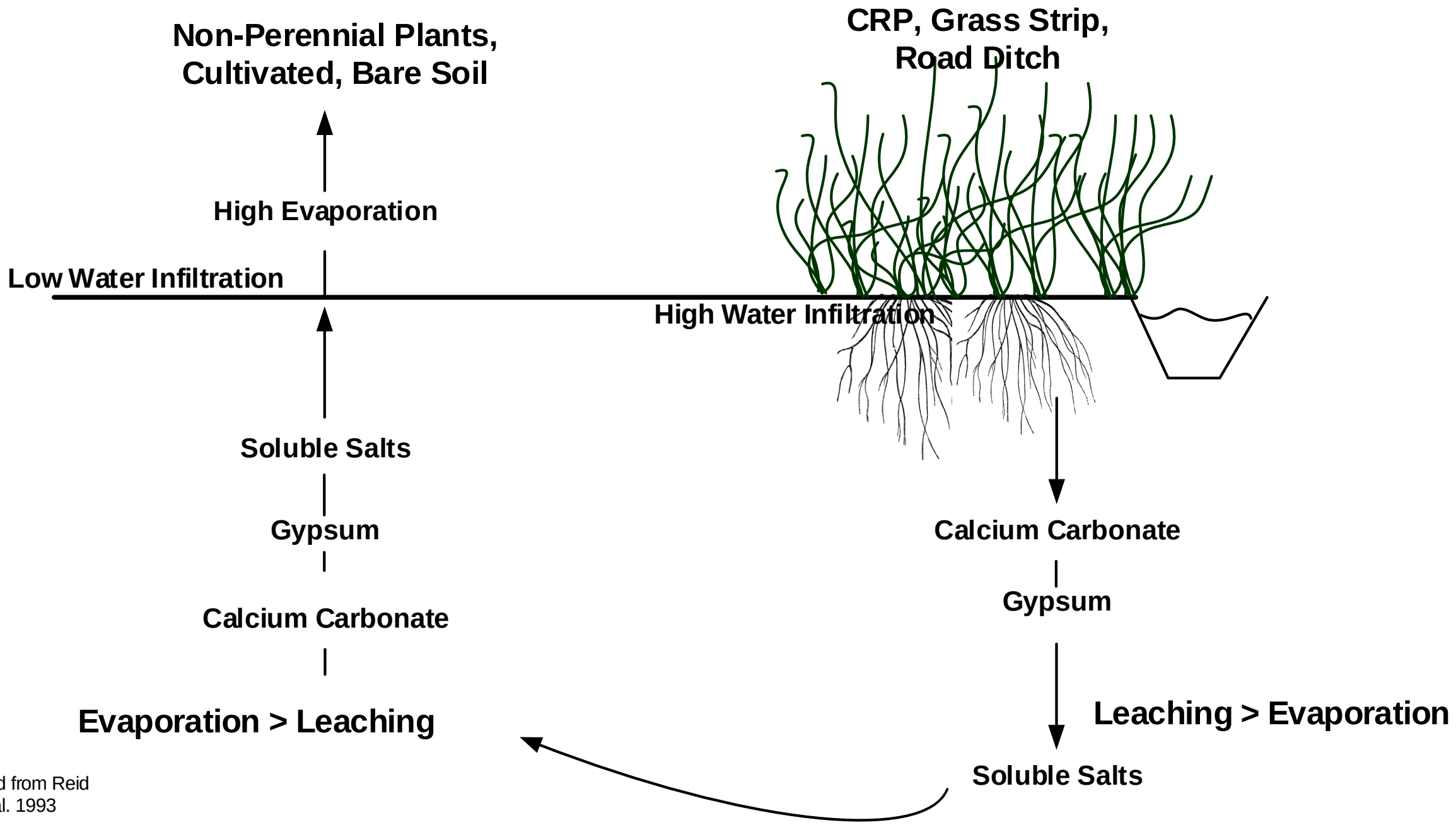
h is the height of rise
r is the radius of the pores



Barnes: FINE-LOAMY

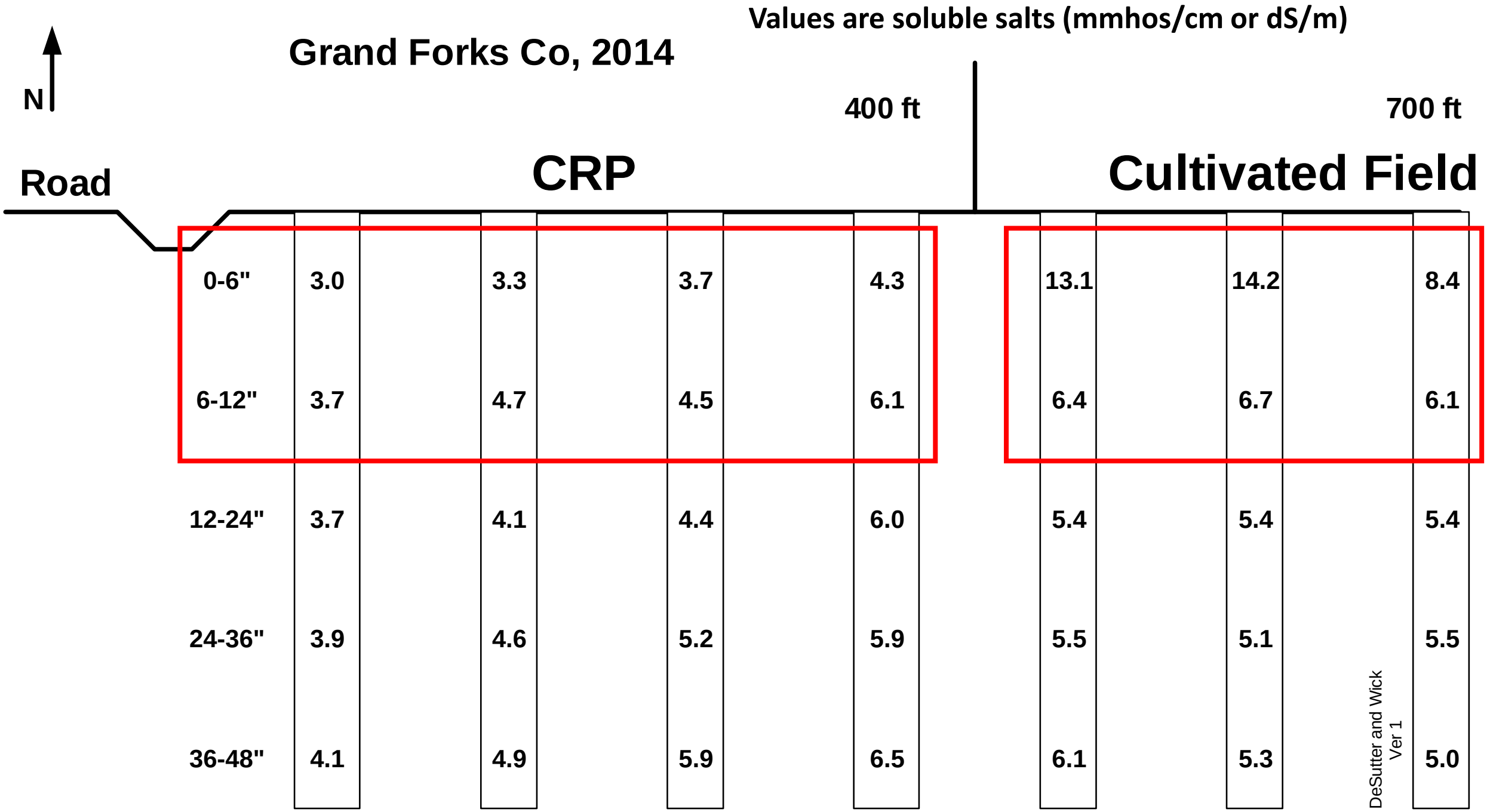
Fargo: FINE

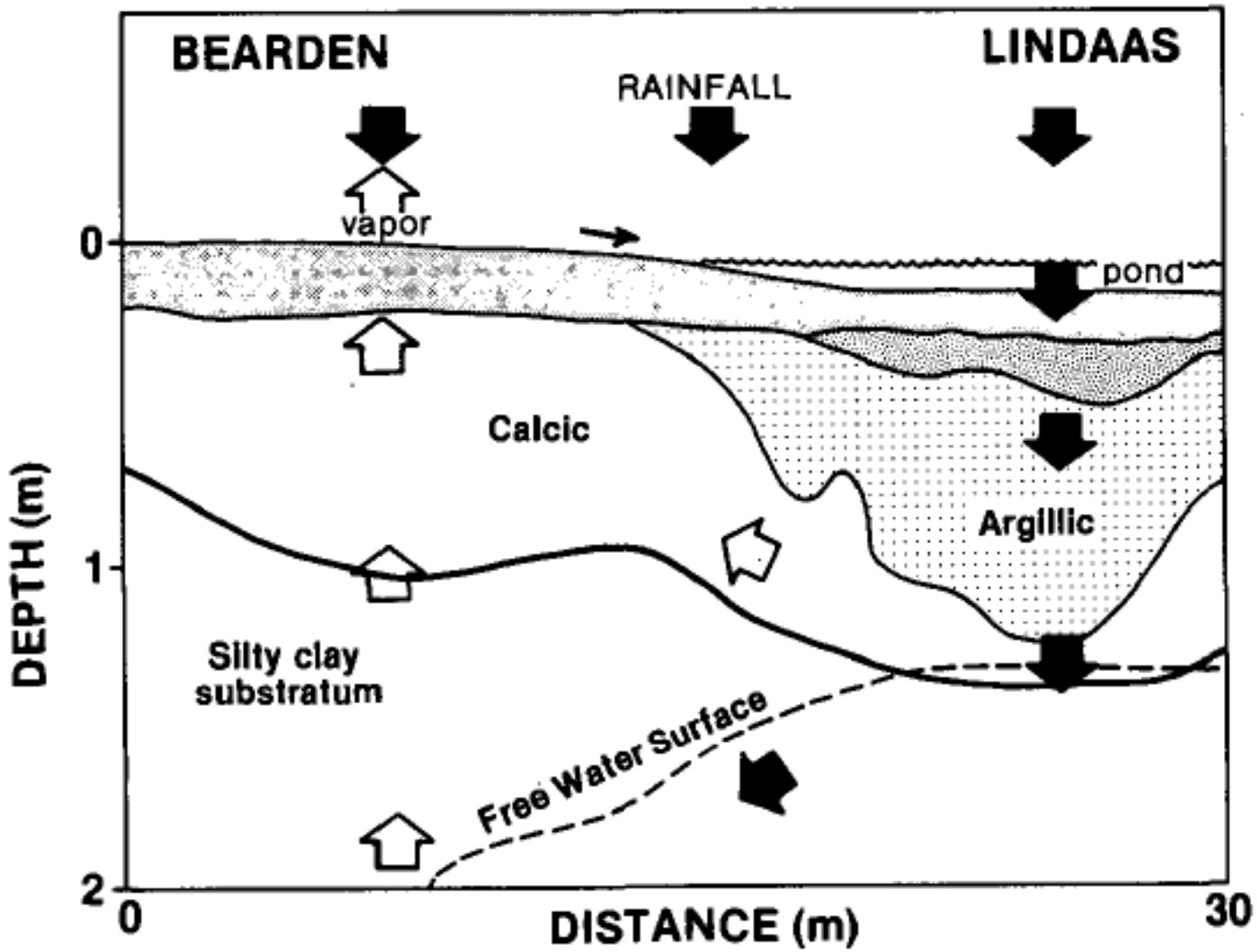
Bearden: FINE-SILTY



Adapted from Reid et al. 1993


18th St NE
18th St NE
14th Ave NE
14th Ave NE
Google


Values are soluble salts (mmhos/cm or dS/m)
Grand Forks Co, 2014
N
400 ft
700 ft
Road
CRP
Cultivated Field
0-6" 3.0 3.3 3.7 4.3 13.1 14.2 8.4
6-12" 3.7 4.7 4.5 6.1 6.4 6.7 6.1
12-24" 3.7 4.1 4.4 6.0 5.4 5.4 5.4
24-36" 3.9 4.6 5.2 5.9 5.5 5.1 5.5
36-48" 4.1 4.9 5.9 6.5 6.1 5.3 5.0
DeSutter and Wick
Ver 1



Knuteson et al., 1989 SSSAJ

Won’t the salts leach by themselves?

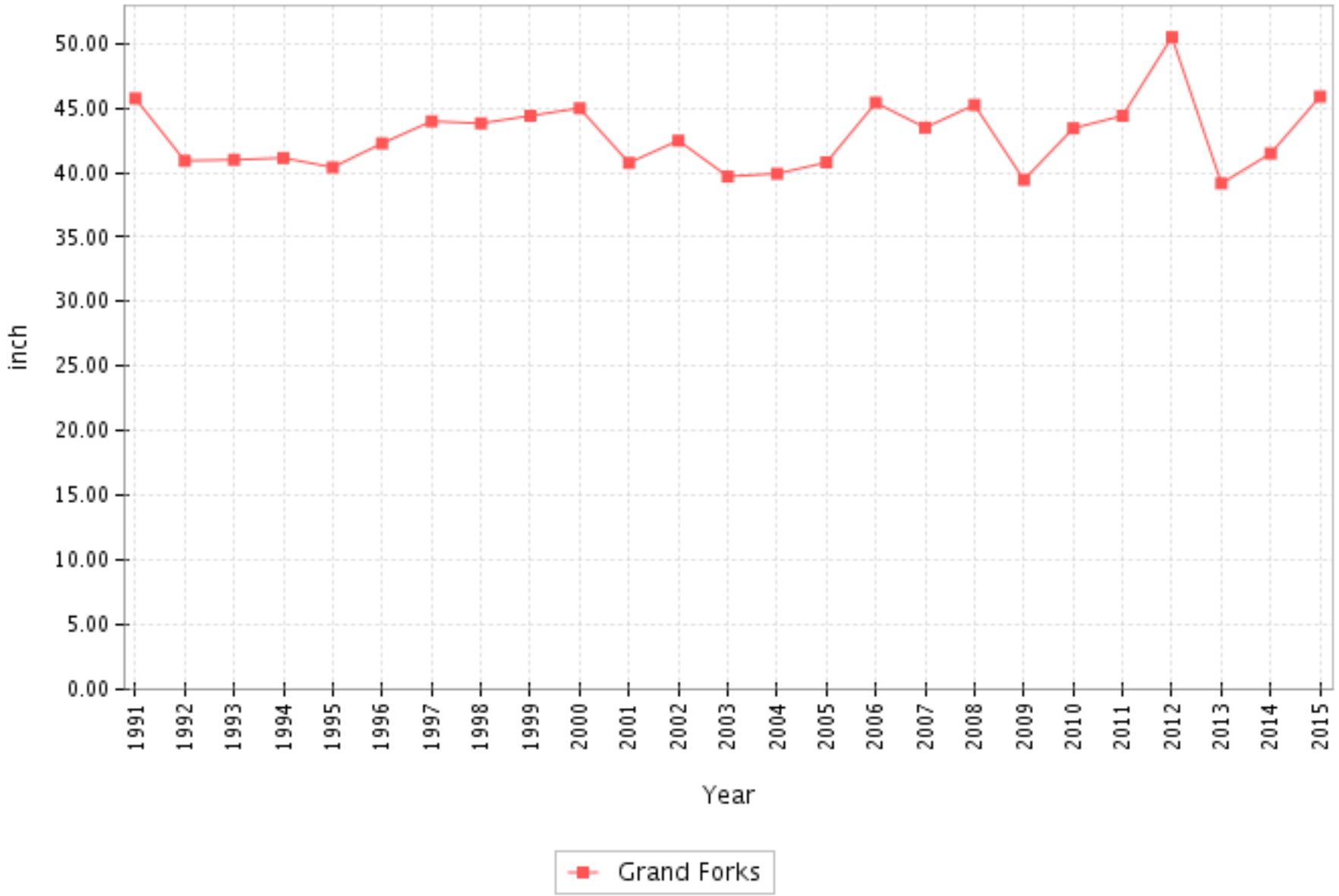
Yes, more or less, but it will take time.

What has to happen to leach salts?

- **More fishing?**
- **Leaching > Evaporation**
- **Ground water level must be below the capillary fringe**

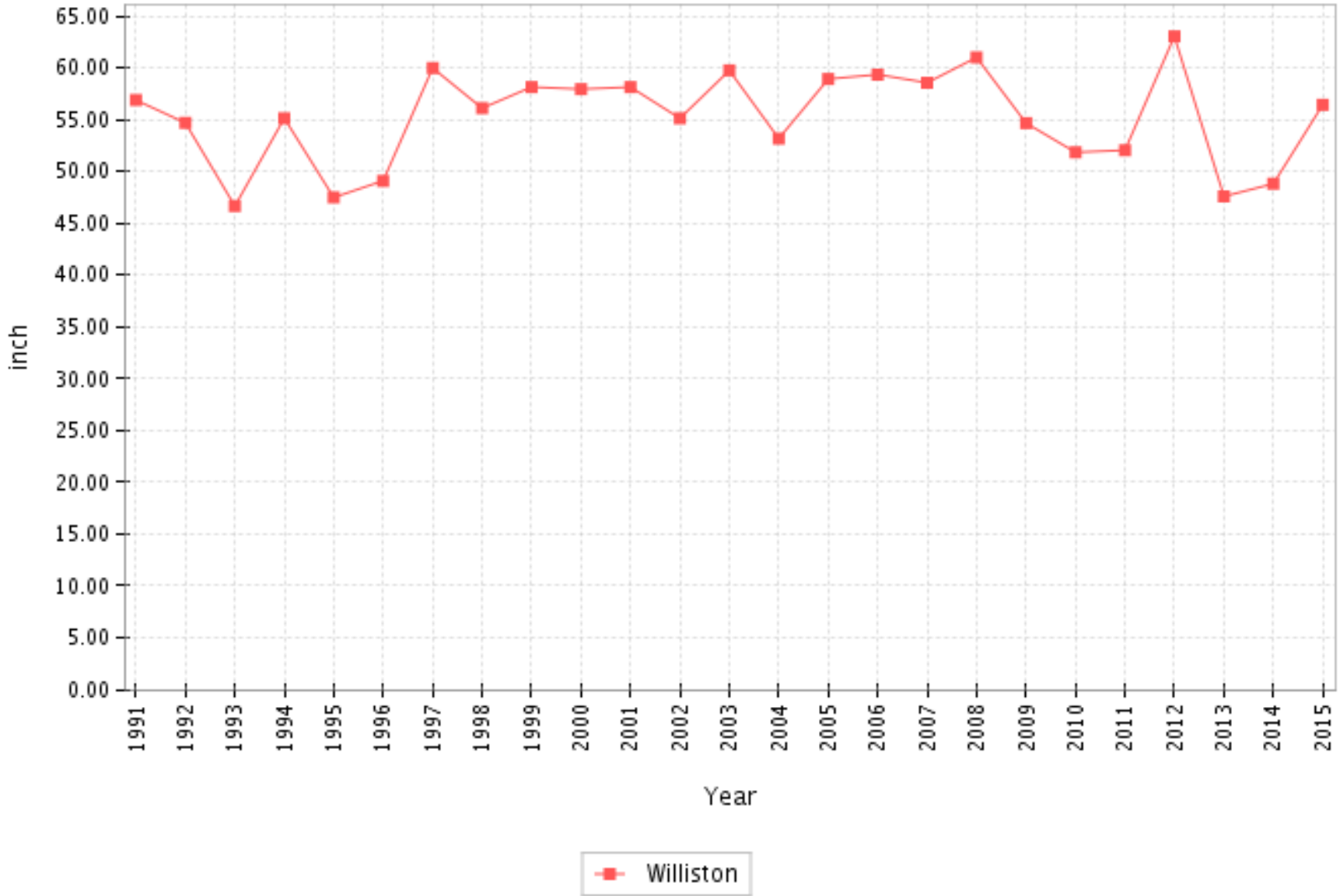
Yearly Total Potential Evapotranspiration (Penman)

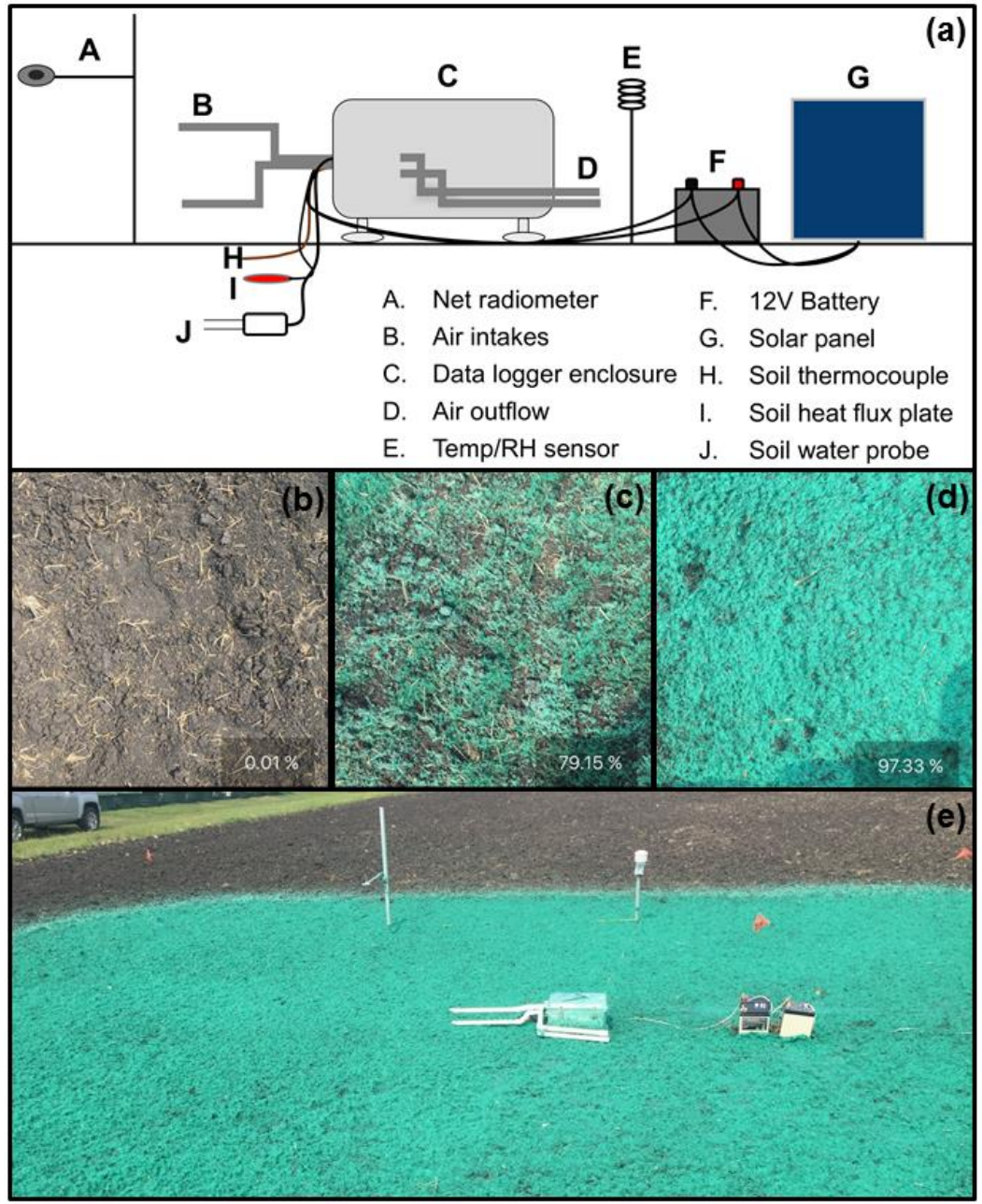
North Dakota Agricultural Weather Network (NDAWN)

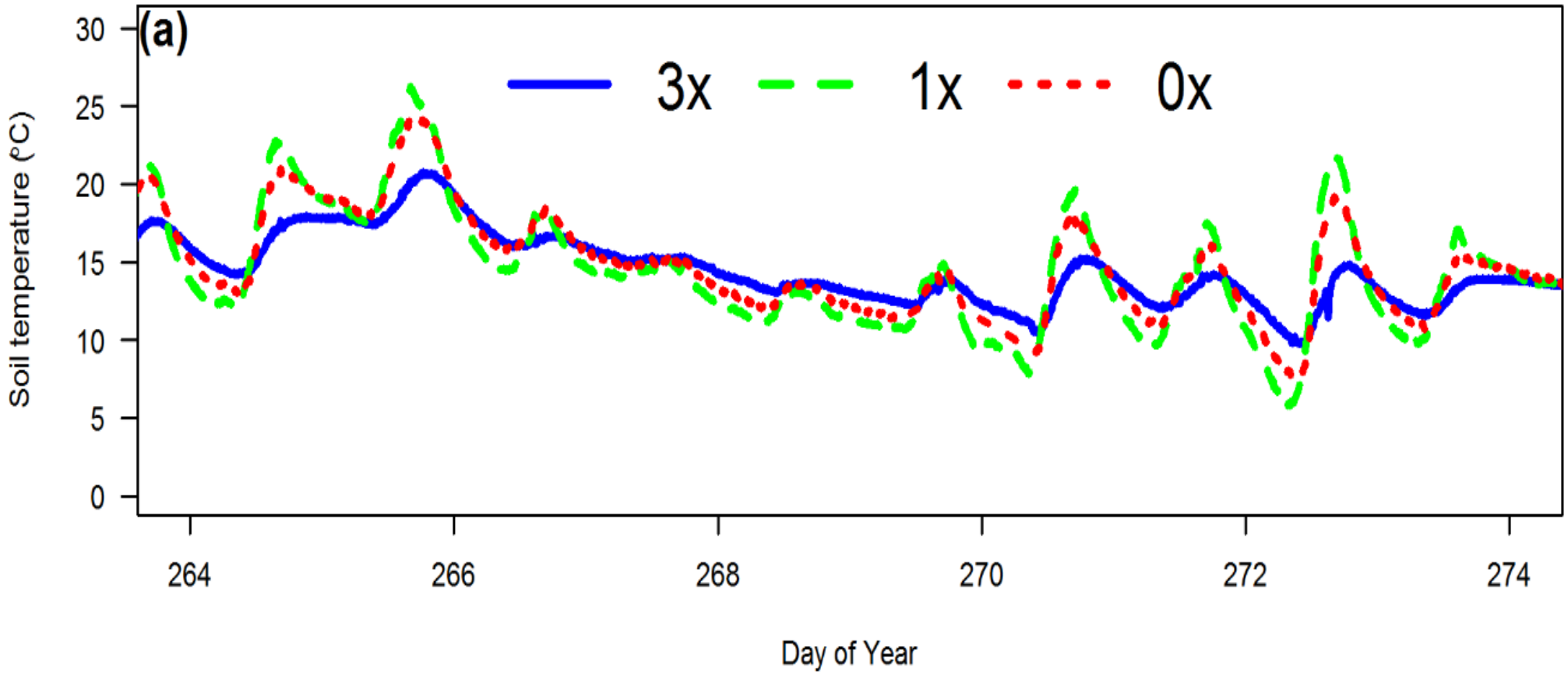


Yearly Total Potential Evapotranspiration (Penman)

North Dakota Agricultural Weather Network (NDAWN)



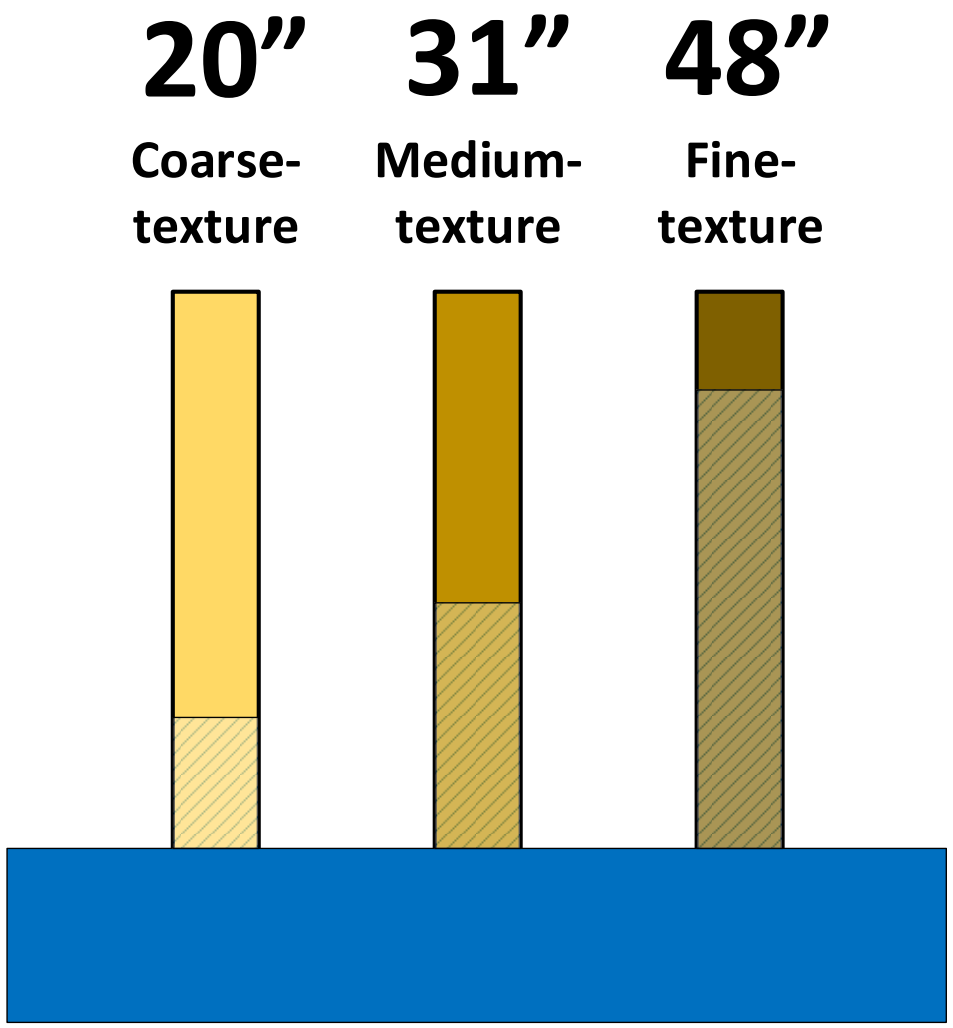

(a)
A
B
C
D
E
F
G
H
I
J
A. Net radiometer
B. Air intakes
C. Data logger enclosure
D. Air outflow
E. Temp/RH sensor
F. 12V Battery
G. Solar panel
H. Soil thermocouple
I. Soil heat flux plate
J. Soil water probe
(b)
0.01 %
(c)
79.15 %
(d)
97.33 %
(e)


(a)
3x
1x
0x
Soil temperature (°C)
30
25
20
15
10
5
0
264
266
268
270
272
274
Day of Year

Sources of water to leach soils with

- **Best case scenarios:**
  - **Slow and steady rainfall**
  - **Melting snow.**
  - **You can’t make more water but you can concentrate it**

Capillary rise:



Summary and Battles

- All salts are not created equal
- If you can understand how water moves in soil you can begin to understand how to manage salinity
- Spend more time fishing, less time working
- Too much water, too cold, too little leaching, too high of groundwater
- Tile drainage must be installed with the correct spacing so that the capillary fringe is not in the root zone