

PITS AND BELOW-GRADE TANKS

OIL CONSERVATION COMMISSION HEARING

CASE 14015

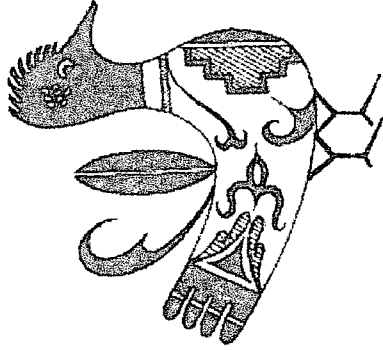
October 22, 2007

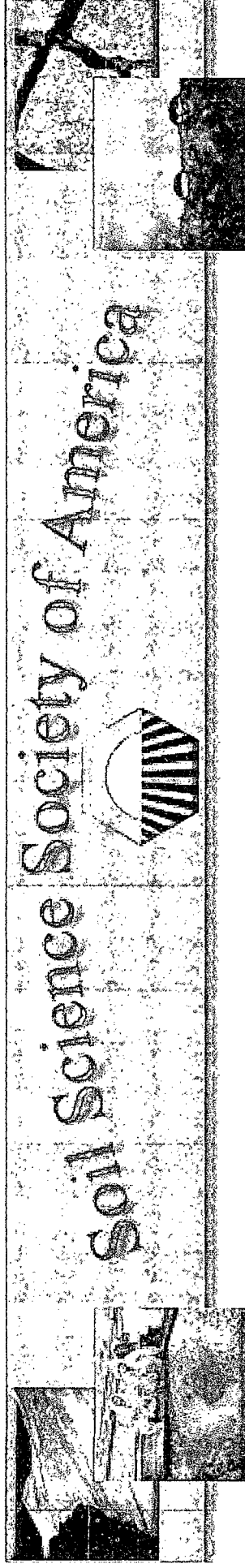
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New Mexico Citizens

for Clean Air & Water

P.O. Box 5 Los Alamos 87544





- Division S01 - Soil Physics
- Division S02 - Soil Chemistry
- Division S03 - Soil Biology & Biochemistry
- Division S04 - Soil Fertility & Plant Nutrition
- Division S05 - Pedology
- Division S06 - Soil & Water Management & Conservation
- Division S07 - Forest, Range, and Wildland Soils
- Division S08 - Nutrient Management & Soil & Plant Analysis
- Division S09 - Soil Mineralogy
- Division S10 - Wetland Soils
- Division S11 - Soils & Environmental Quality

(copied from the society's web page)

BOOKS WITH "SOIL PHYSICS" IN THE TITLE

Los Alamos National Laboratory library, 2007

Title	Author/editor	Publisher	Year
<u>Soil Physics</u>	Jury & Horton	Wiley	2004
<u>Principles of Soil Physics</u>	Lal & Shukla	Dekker	2004
<u>Soil Physics Companion</u>	Warrick	CRC Press	2002
<u>Chemical Soil Physics</u>	anon.	Sandia NL	1999
<u>Environmental Soil Physics</u>	Marshall et al	Cambridge U	1996
<u>Soil Physics with BASIC</u>	Campbell	Elsevier	1985
<u>...Techniques in Soil Physics</u>	various	IAEA	1983
<u>Applied Soil Physics</u>	Hanks & Ashcroft	Springer	1980
<u>Fundamentals of Soil Physics</u>	Hillel	Academic	1980
<u>Applications of Soil Physics</u>	Hillel	Academic	1980
<u>Soil Physics</u>	Baver, et al	Wiley	1972
<u>Physics of the Soil</u>	Nerpin	transl.	1970

OUTLINE

- 1. What is in the pits?**
- 2. At what level is it damaging?**
- 3. If it moves, how fast, how far?**
- 4. Is trench burial secure?**
- 5. Can it be treated or cleaned up?**
- 6. Implications of these questions for the rule.**

1. WHAT IS IN THE PITTS?

A brief review of sampling of pits ready for closure.

Sampling by industry

Sampling by the OCD

INDUSTRY SAMPLING

AVERAGE OF 3 PITS EACH REGION

NORTHWEST

	Average mg/kg	Range mg/kg
<u>ANION</u>		
CHLORIDE	3,926	280 - 15,000
SULFATE	3,324	0 - 11,000

<u>CATION</u>		
CALCIUM	2,814	140 - 15,000
POTASSIUM	2,156	380 - 5,200
SODIUM	5,717	1,900 - 11,000

<u>HYDROCARBONS</u>		
GRO	45	0 - 160
DRO	1,727	110 - 8,000
OIL & GREASE	2,673	0 - 26,000

SOUTHEAST

	Average mg/kg	Range mg/kg
	126,278	0 - 420,000
	33,056	0 - 72,000

	14,903	0 - 31,000
	6,409	0 - 38,000
	75,928	6,400 - 250,000

	477	1 - 2,500
	7218	17 - 26,000
	4992	240 - 19,000

INDUSTRY PIT SAMPLING -- NORTHWEST

AVERAGES IN A SINGLE PIT

Pit	Aver. Chloride mg/kg	Range mg/kg	Aver. DRO mg/kg	Range mg/kg	Aver. O&G mg/kg	Range mg/kg
SJC-1	1342	330- 2600	1151	200- 2300	982	250- 2200
SJC-2	6083	2200- 14000	597	110- 2500	1595	0- 11,000
SJC-3	4072	960- 6100	3433	720- 8,000	5443	320- 26,000
landfarm closure standards.	500 or 1000		GRO+DRO 500		TPH 2500	

CORRECTED OCD PIT SAMPLING -- NORTHWEST

Sample	TPH mg/kg	Chloride mg/kg	Sodium mg/kg	Na/Cl atomic ratio	TDS mg/L
DP3 -01 Soil	<10	704	1570	3.44	17200
DP3 -03 Soil	957	417	2900	10.72	16800
DP3 -08 Soil	1280	962	2080	3.33	8170
DP3 -09 Soil	598	927	3270	5.44	6135
DP3 -10 Soil	1280	5290	5290	1.54	8000
PP3 -01 Soil	848	1990	3460	2.68	7860
Landfarm closure	2500	1000			
	TPH mg/L	Chloride mg/L	Sodium mg/L	Na/Cl atomic ratio	TDS mg/L
T3 - 01 Water	385	2050	2330	1.75	17200
DP3 - 04 Water	329	7810	4540	0.90	16800
DP3 -05 Water	84.8	3400	2150	0.97	8170
DP3 - 02 Water	10.2	1210	2780	3.54	6135
DP3 -06 Water	277	4280	2130	0.77	8000
DP3 -07 (dup.06)	419	3940	2170	0.85	7860

OCD PIT SAMPLING -- NORTHWEST

Sample	TPH mg/kg	Chloride mg/kg	Sodium mg/kg	Na/Cl atomic ratio	TDS mg/L
DP3 -01 Soil	<10	704	12590	27.56	17200
DP3 -03 Soil	957	417	2900	10.72	16800
DP3 -08 Soil	1280	962	2080	3.33	8170
DP3 -09 Soil	598	927	3270	5.44	6135
DP3 -10 Soil	1280	5290	5290	1.54	8000
PP3 -01 Soil	848	1990	3460	2.68	7860
Landfarm closure	2500	1000			
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DP3 -06 Water	277	4280	2130	0.77	8000
DP3 -07 (dup.06)	419	3940	2170	0.85	7860

REVIEW

1. What is in the pits?

In the northwest, chlorides sometimes meet landfarm standards, but sodium and other cations have higher concentrations. Petroleum hydrocarbon concentrations sometimes exceed landfarm closure standards.

In the southeast, salt is an overwhelming contaminant.

Next: 2. At what level is it damaging?

2. AT WHAT LEVEL IS IT DAMAGING?

The most immediate effects are often on the surface of the ground, where plants and animals live.

EFFECTS OF SALT ON
BIOTA and SOILS
(*SALINITY* and *SODICITY*)

SALT TOLERANCE OF PLANTS
ELECTRICAL CONDUCTIVITY (EC) AS AN INDICATOR
EC COMPARED WITH CHLORIDE CONCENTRATION
OSMOTIC PRESSURE and PERMANENT WILT POINT
SODIUM ABSORPTION RATIO (SAR) AS AN INDICATOR

EC tolerance levels of crops

Test values in mmhos/cm

Interpretation

0-2

Satisfactory for Crops

2-4

Affects sensitive Crops

4-8

High for many Crops

above 8

Very high for most Crops

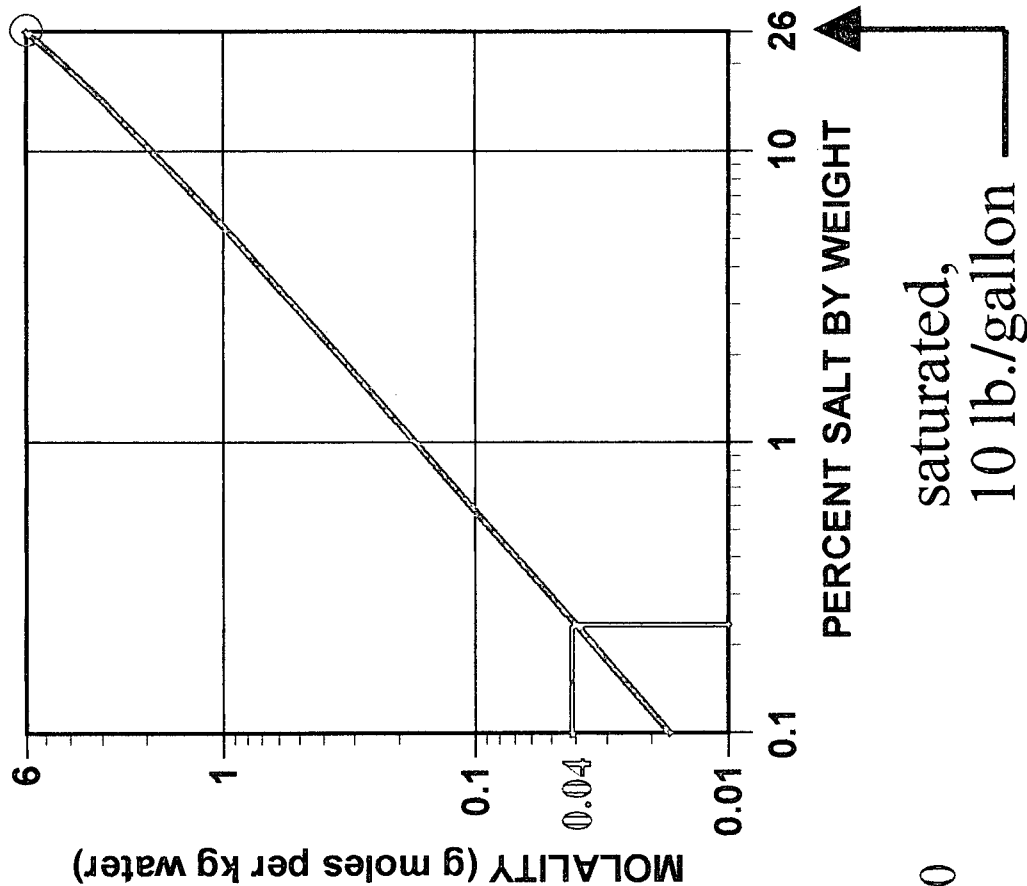
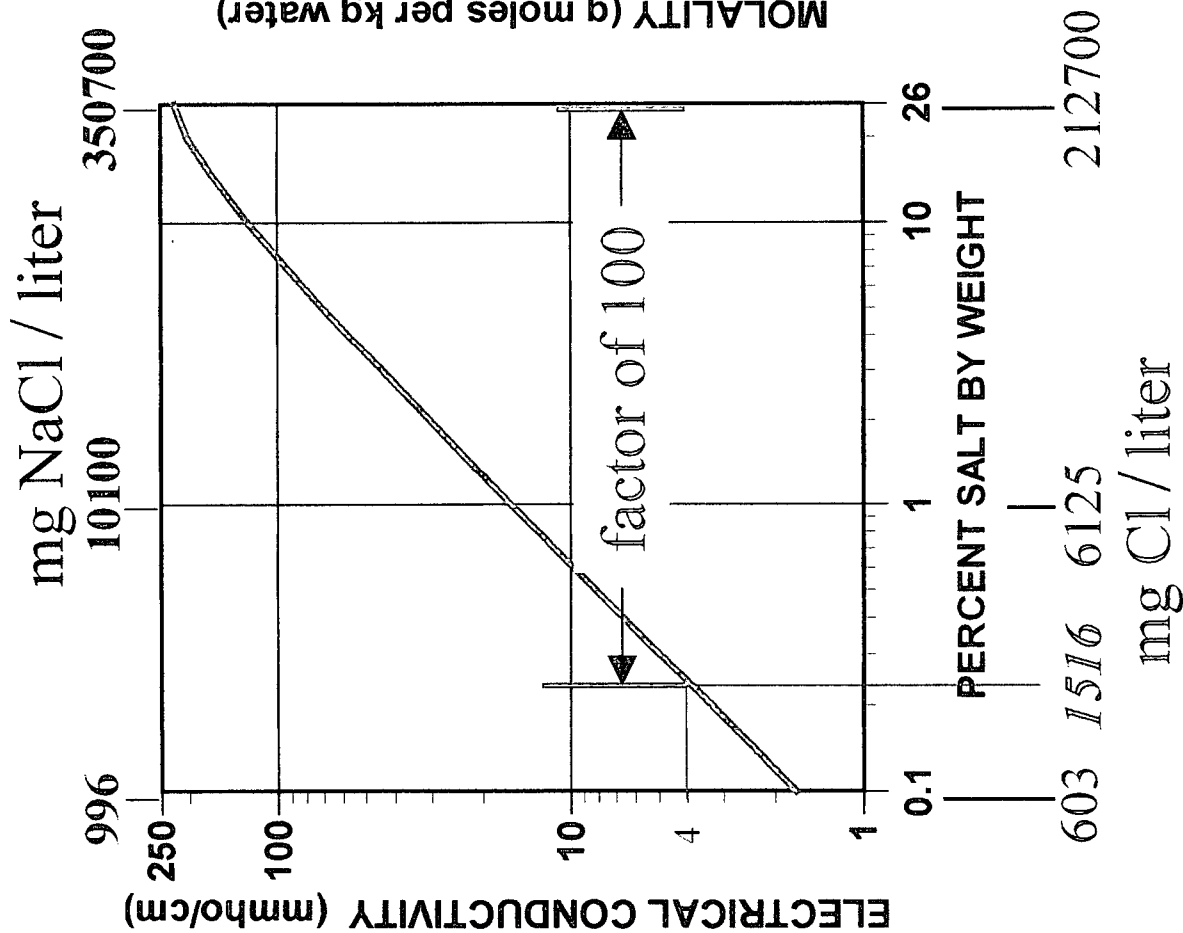
Adapted from: P. N. Soltanpour and R. H. Follett,
"Soil Test Explanation," Colorado State University,
<http://www.ext.colostate.edu/pubs/crops/00502.html>

EC

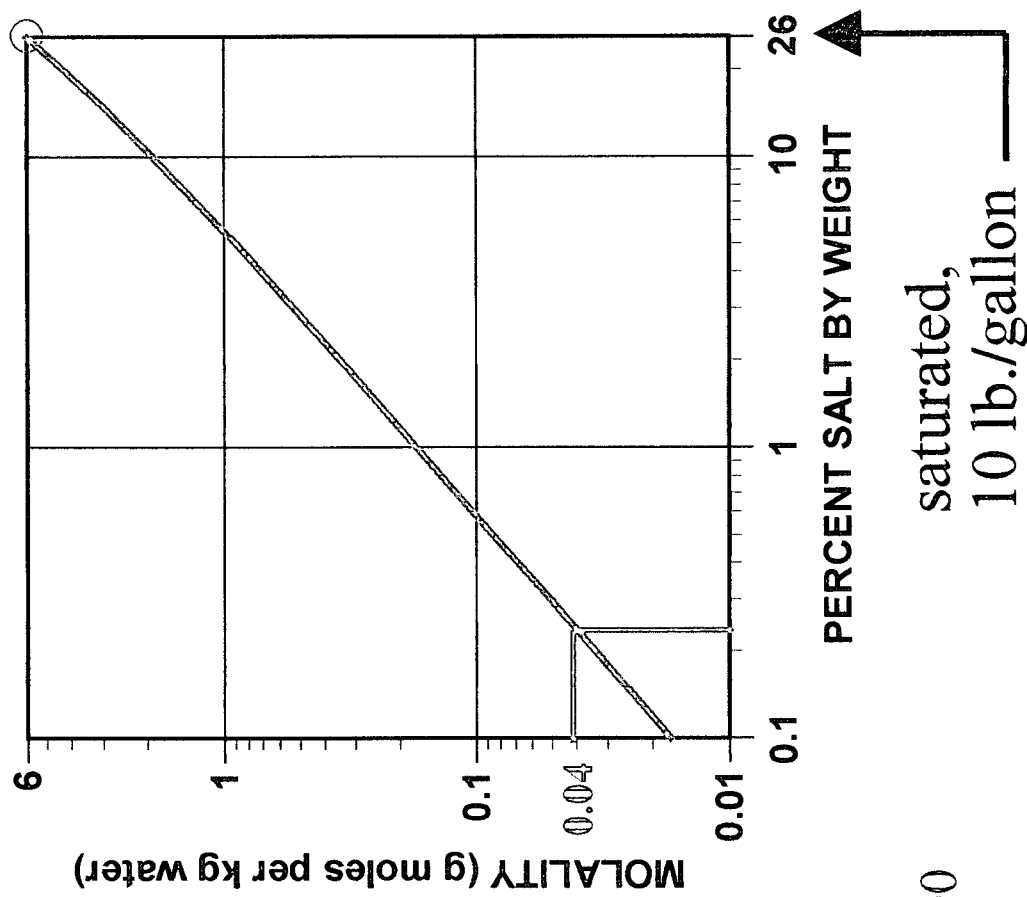
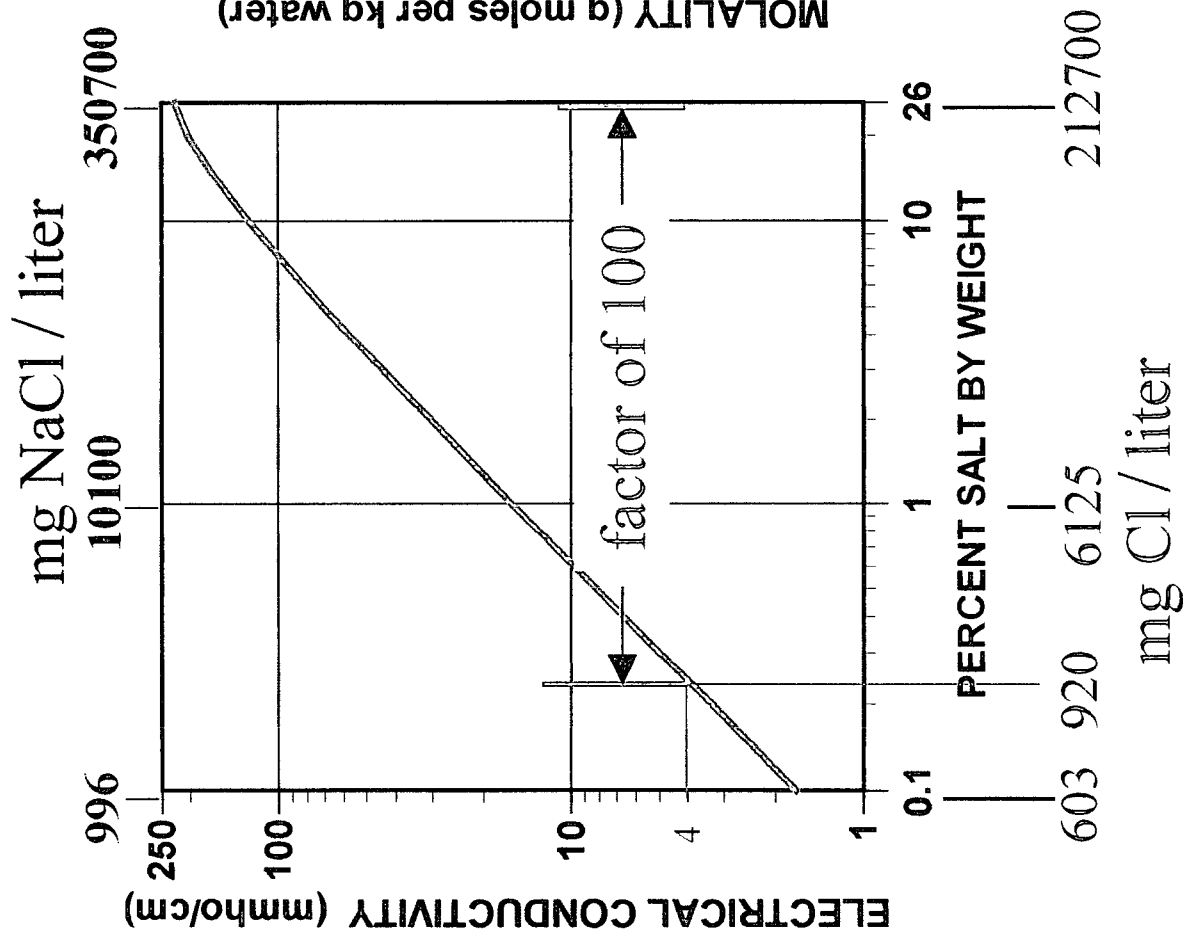
"The traditionally accepted objective criteria ... for all plants ...has been to decrease the salinity ... to less than 4 mmhos/cm ..."

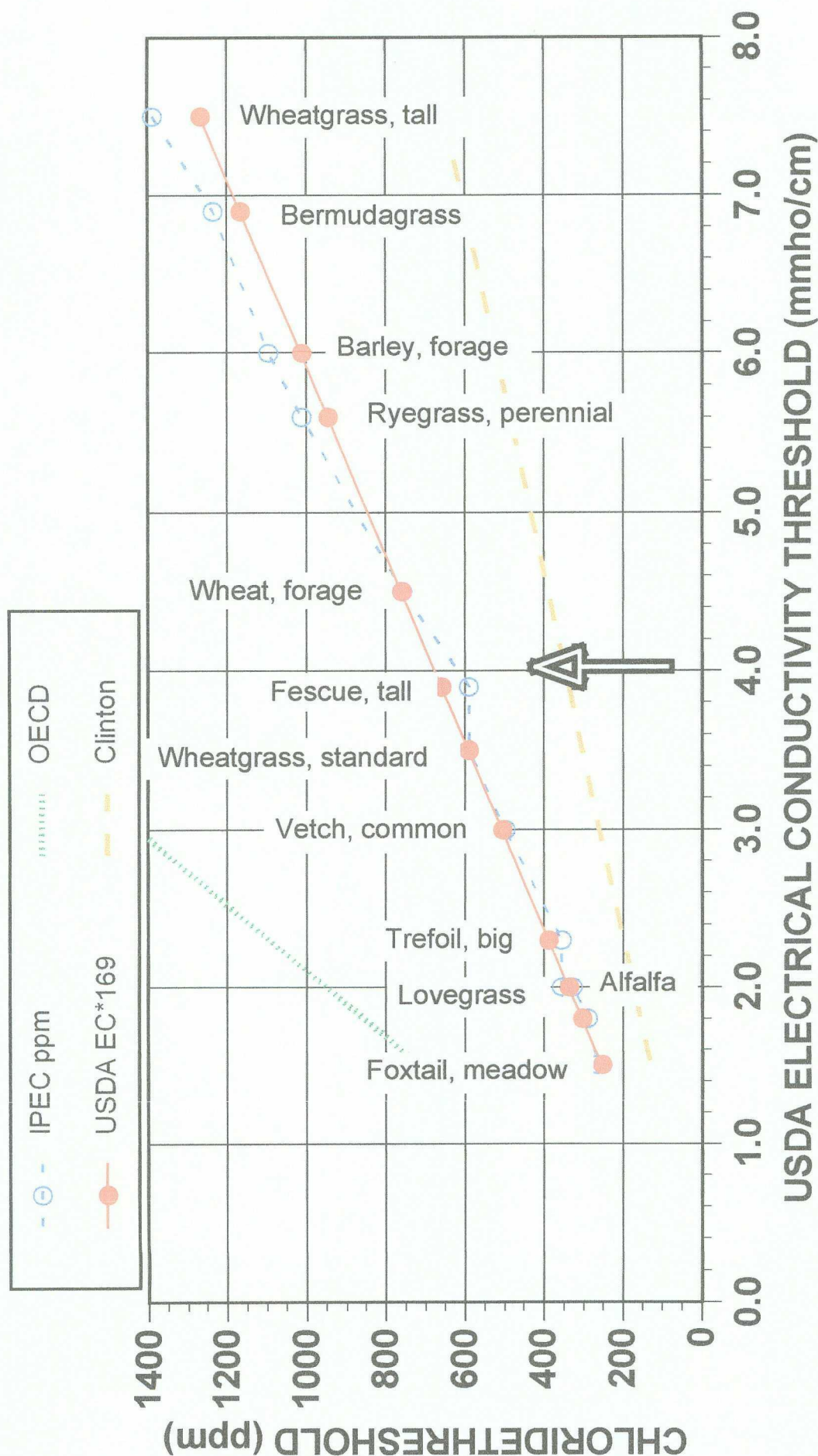
**American Petroleum Institute, Publication 4663,
"Remediation of Salt-Affected Soils at Oil and Gas
Production Facilities" (1997).**

PROPERTIES OF SALT SOLUTIONS



PROPERTIES OF SALT SOLUTIONS

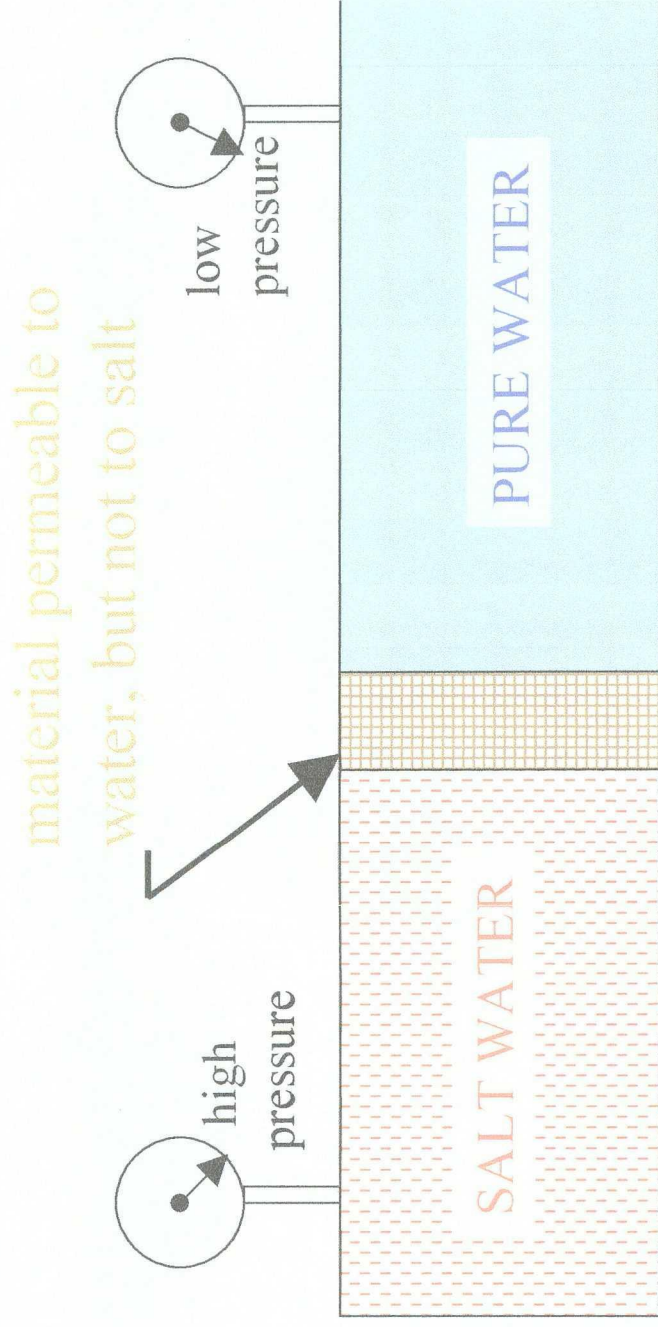




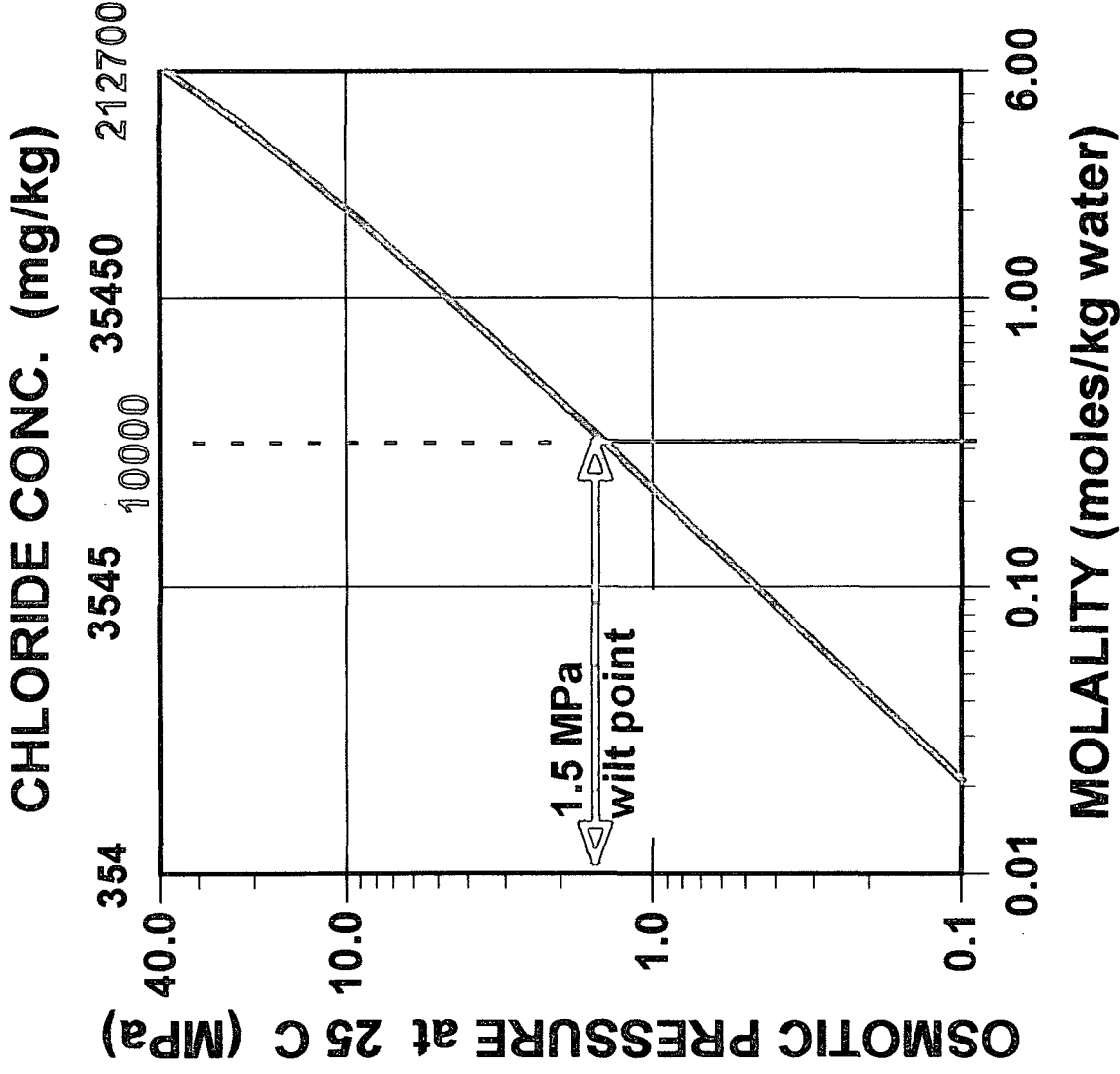
Threshold for chloride damage to grasses, as EC of paste by the USDA or as soil chloride by IPEC. Dashed lines are the outer limits of EC versus soil chloride reported by Bright and Addison, 2002.

OSMOTIC PRESSURE

Although chloride is chemically toxic, and sodium is more toxic to various plant species, a major effect of salt in the pore water is to increase the osmotic pressure, making it difficult or impossible for a plant to acquire water.

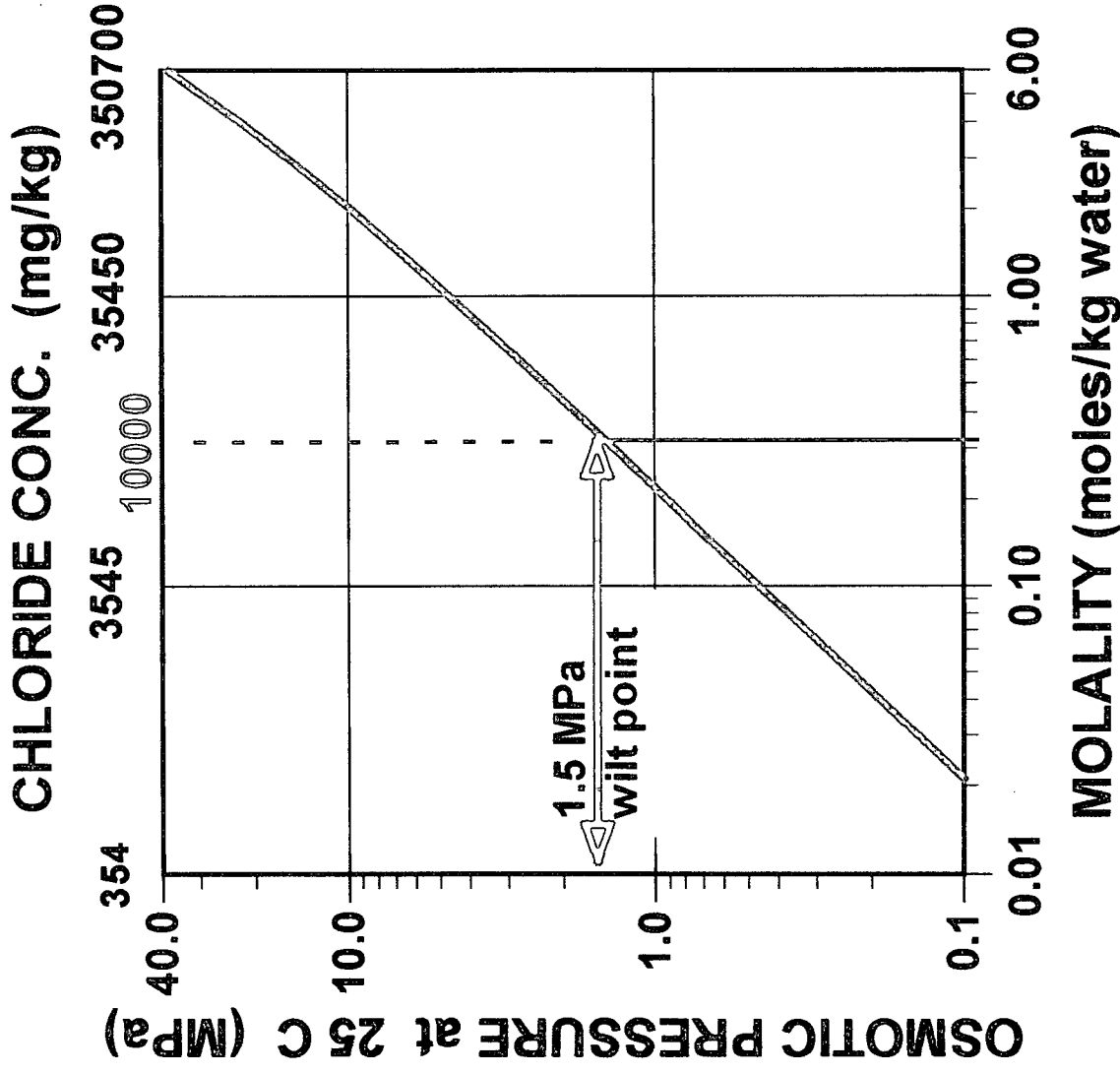


OSMOTIC PRESSURE OF A NaCl SOLUTION



Soil with 1,000 mg/kg chloride at 15% volumetric moisture has 10,000 mg/kg chloride in the pore water.

OSMOTIC PRESSURE OF A NaCl SOLUTION



Soil with 1,000 mg/kg chloride at 15% volumetric moisture has 10,000 mg/kg chloride in the pore water.

SODIUM ABSORPTION RATIO

An excess of sodium in relation to calcium and magnesium damages the structure of soils, reducing water-holding capacity, causing “sodic” soils.

“An SAR value of 15 or greater can cause soil to be hard and cloddy ... (Sodium) ... can produce adverse effects on soil structure even when the SAR is near 5 due in part to type and content of clay. Montmorillonite, vermiculite, illite and mica-derived and ... clays are more sensitive to Na^+ than other clays.”

C. E. Swift, *Sodium Absorption Ratio (SAR)*
Colorado State University Cooperative Extension,
<http://www.colostate.edu/Depts/CoopExt/TRA/PLANTS/sar.html>

INTERPRETIVE GUIDELINES FOR IRRIGATION WATER ANALYSIS

Parameter	Units	Potential Problems		
		None	Increasing	Severe
Sodium (Na)	mg/l	< 70	71 - 180	> 180
Chloride (Cl)	mg/l	< 70	71 - 300	> 300
pH	---	5.5 - 7.5	< 5.5 or > 7.5	< 4.5 or > 8.5
Bicarbonate (HCO_3)	mg/l	< 40	41 - 180	> 180
Carbonate (CO_3)	mg/l	< 15	16 - 20	> 20
Conductivity	mmhos/cm	< 0.75	0.76 - 3.0	> 3.0
Boron (B)	mg/l	< 0.5	0.6 - 2.0	> 2.0
Sodium Absorption Ratio (SAR)		< 3	4 - 6	> 6

A&L Canada Laboratories Inc.

Technical bulletin. <http://www.al-labs-can.com/main.html>

REVIEW

1. *What is in the pits?*

2. *At what level is it damaging?*

Salt is damaging to plants when the concentration is such that EC exceeds 4. Much of the damage is due to osmotic pressure added to the matric suction; therefore plants are more sensitive to salt in dry soils.

Sodium is toxic, but also is damaging to soils when SAR exceeds 15. In clay soils, SAR should be no more than 5.

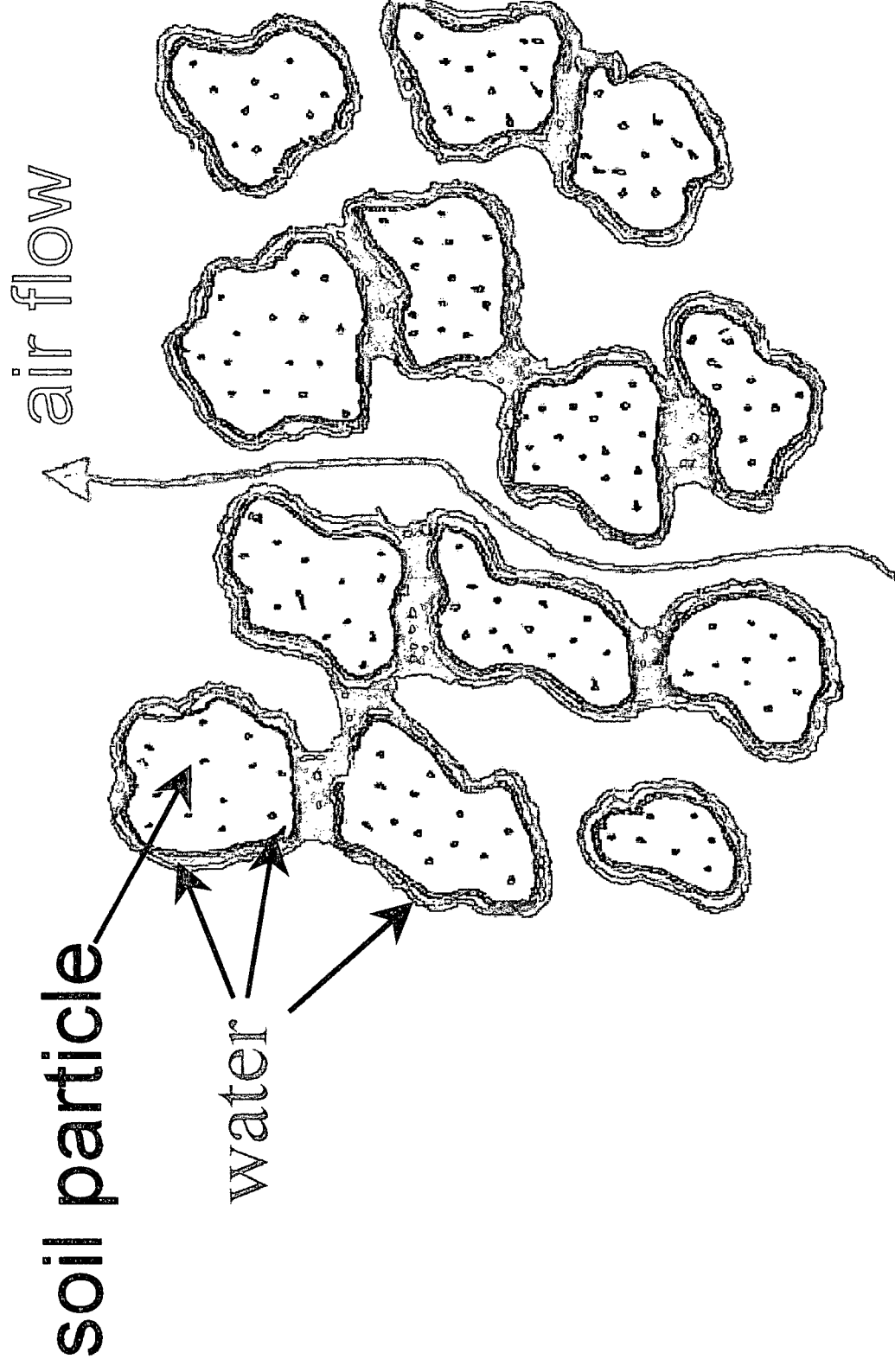
NEXT: 3. *If it moves, how fast, how far?*

3. HOW FAST, HOW FAR?

UNSATURATED HYDROLOGY

- a) Porous structure of the soil**
- b) Moisture potential (suction)**
- c) Osmotic pressure, matric suction and flow**
- d) Transport of water and contaminants**

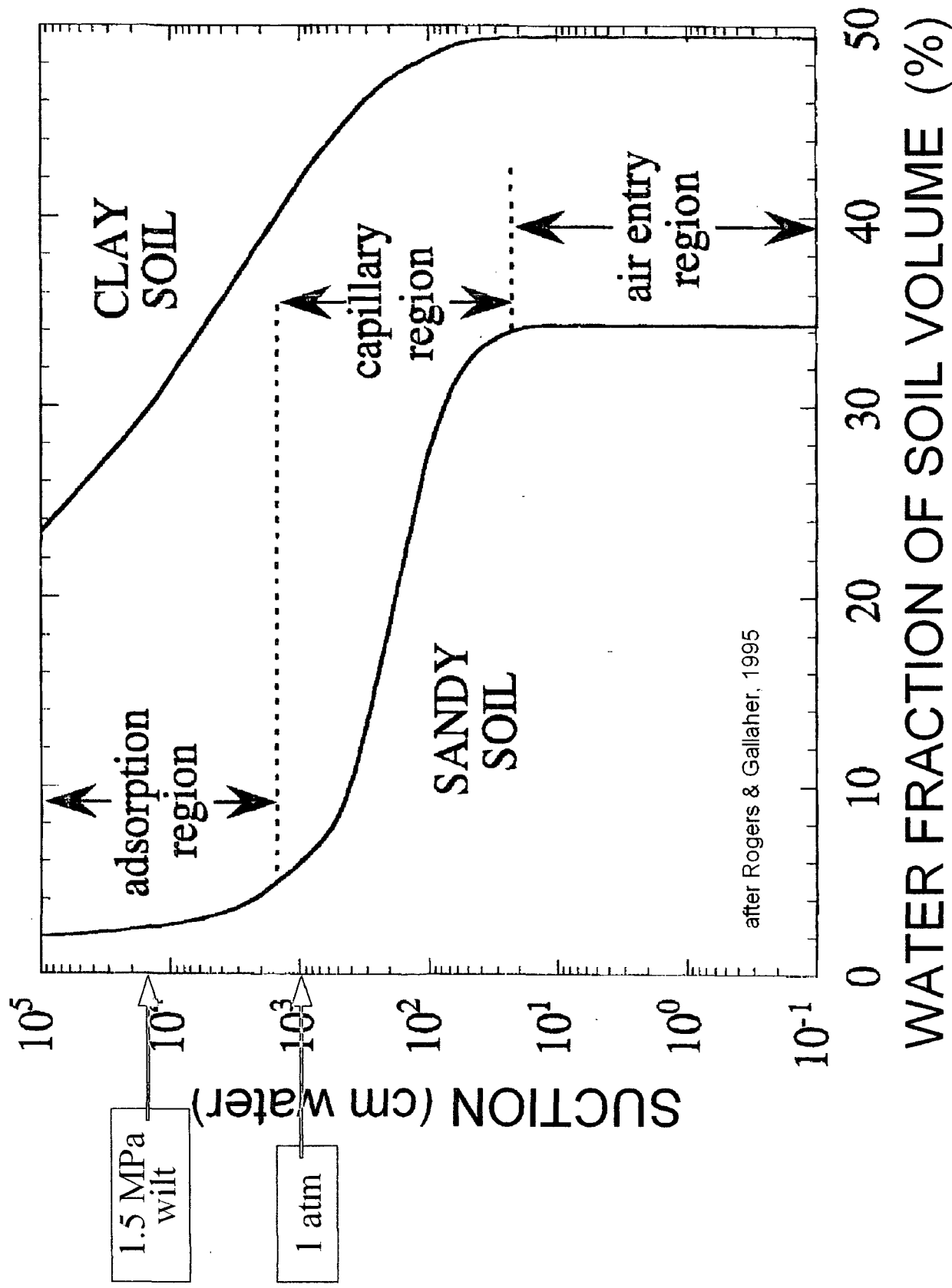
a) POROUS STRUCTURE OF THE SOIL



VOLUMETRIC MOISTURE: fraction of *total volume* occupied by water.

SATURATION: fraction of *pore volume* occupied by water.

b) MOISTURE POTENTIAL



C) OSMOTIC PRESSURE, **MATRIC SUCTION, AND FLOW**

The osmotic pressure and the matric suction add to form the total potential--the energy per volume needed to extract pure water from the porosity of the soil.

For a salt solution, the osmotic pressure may be much greater than the matric suction--and even much greater than the permanent wilt point of 1.5 MPa (15 atmospheres, equivalent to about 500 ft. head).

Osmotic pressure kills plants, but in most soils, the osmotic pressure is **INEFFECTIVE** for causing flow.

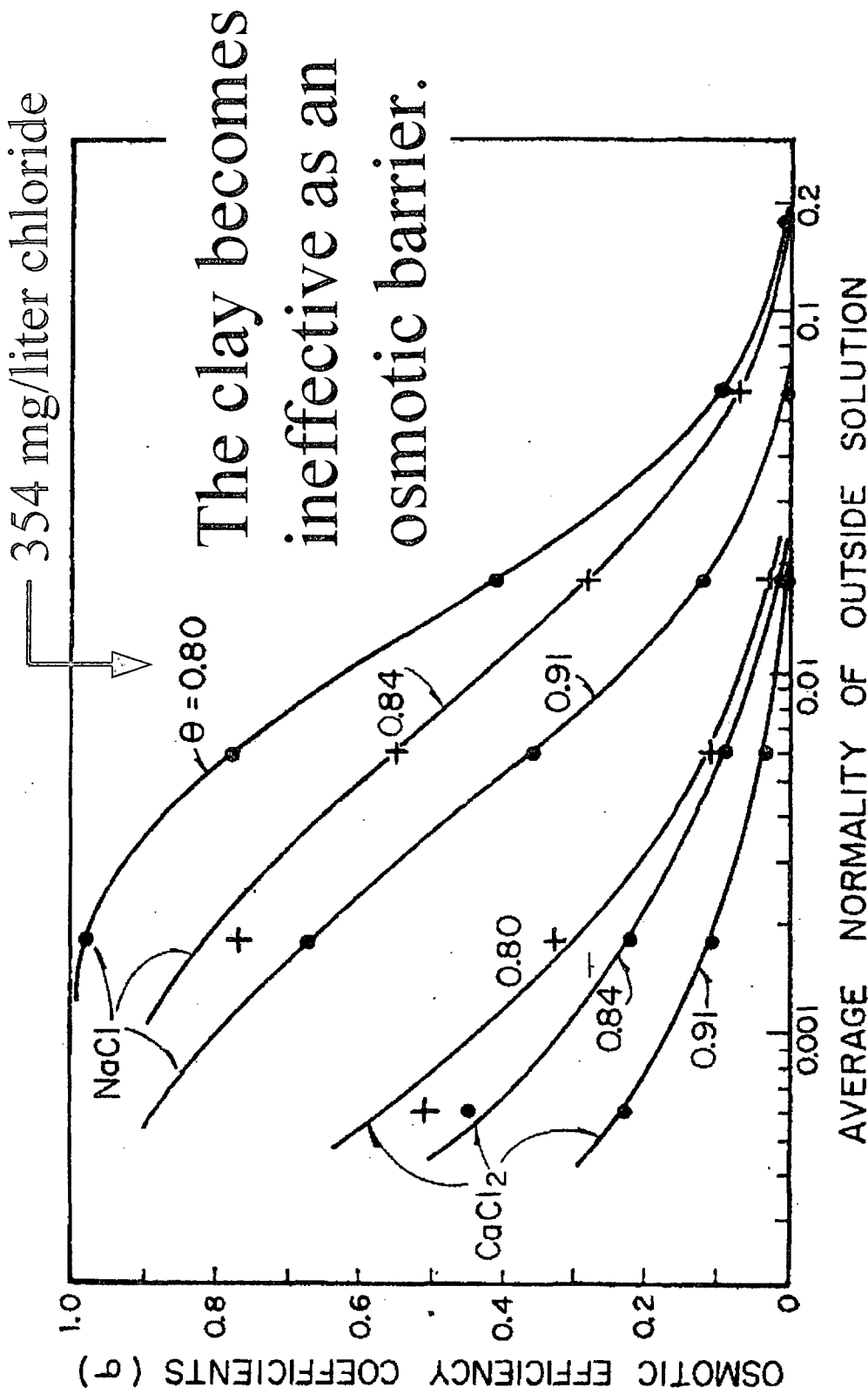


Fig. 4—Osmotic efficiency coefficients of clay at various moisture contents when between NaCl and CaCl₂ solutions of the indicated average concentrations.

(θ indicates volumetric moisture)

from W. D. Kemper and J. B. Rollins, Soil Sci. Soc. Amer. Proc. 30, 529-534 (1966)

“Throughout the soil moisture range encountered by growing plants, salt concentration gradients will not be an important factor causing movement of soil solution. However, at evaporating surfaces or freezing surfaces in soils, salt concentration gradients may be large and water film thicknesses may be very thin. Under these conditions salt gradients may become a major factor causing solution movement.”

quoted from W. D. Kemper and J. B. Rollins,
Soil Sci. Soc. Amer. Proc. 30, 529-534 (1966)

Conclusion:

At the burial depth of a “burrito,” osmotic water flow and anion exclusion are negligible.

d) Transport of water and contaminants

Saturated flow

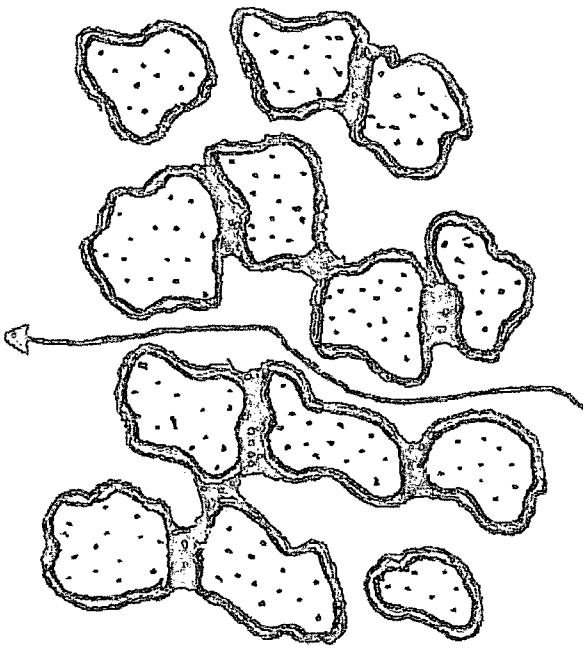
Unsaturated flow

Diffusion of water vapor

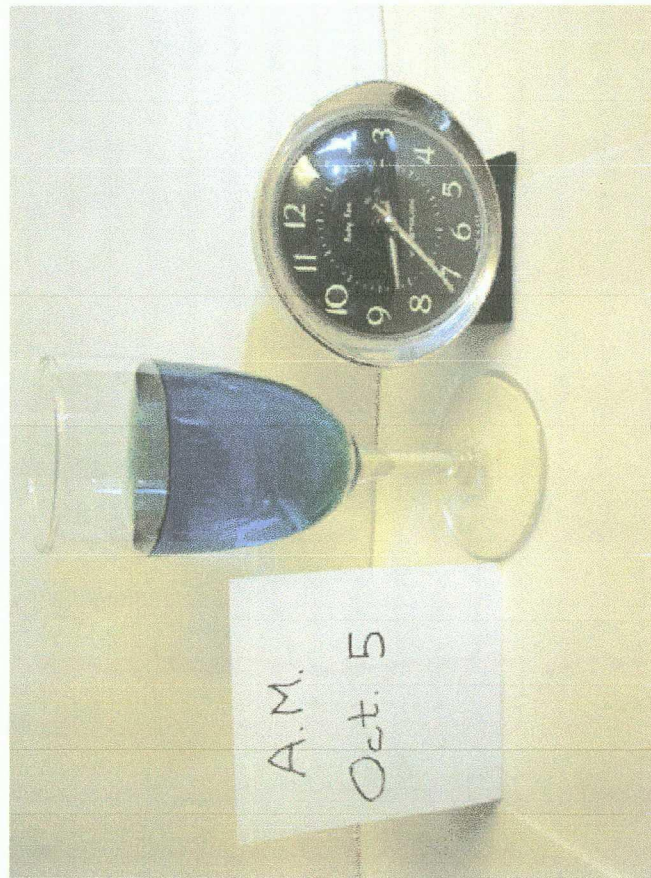
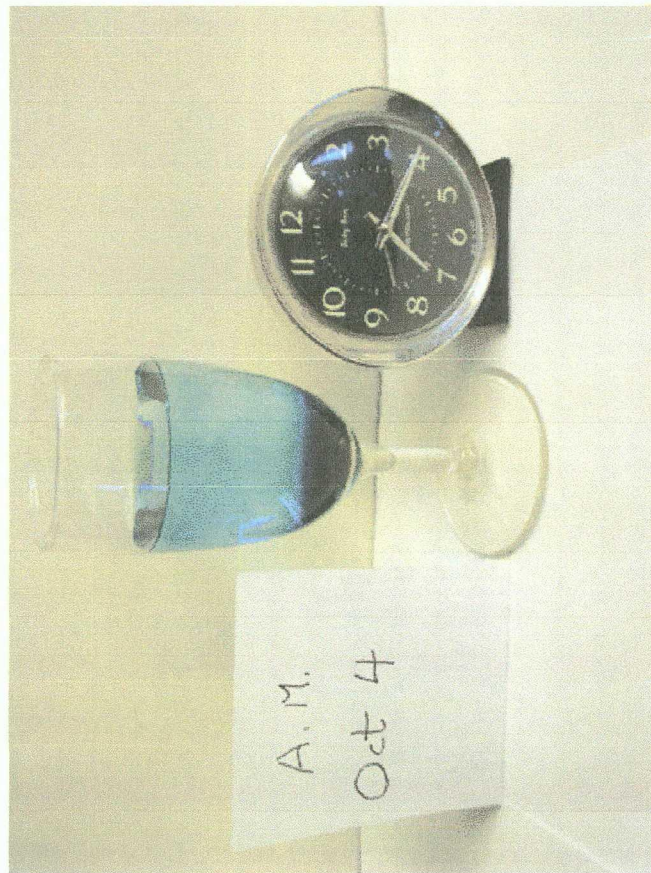
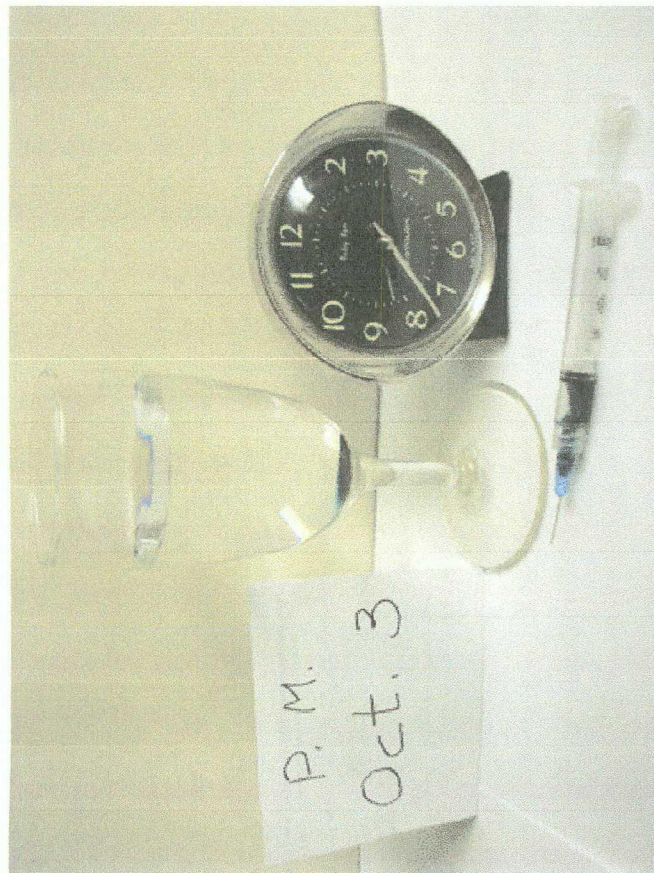
Enhanced diffusion of water vapor

Evaporation & transpiration of water

Diffusion of contaminants



DIFFUSION OF CONTAMINANTS THROUGH WATER



CHARACTERISTIC DISTANCES FOR DIFFUSION OF SALT through WATER

<u>Distance</u>	<u>Time</u>
1 cm	18 hours
1 m	21 years

Time increases with the square of the distance.

Conclusion: Over decades, diffusion can move salt a significant distance through pore water, even in the absence of water motion.

$$\text{diffusivity} = 1.5\text{E-}9 \text{ m}^2/\text{s}$$

COLLIGATIVE EFFECTS ON TRANSPORT

(Effects of dissolved salt in water)

OSMOTIC PRESSURE: Uncompressed clay is ineffective as a semi-permeable membrane, leaving liquid flow unaffected except in thin films.

WATER VAPOR PRESSURE: Salt reduces vapor pressure as much as 24%, increasing the movement of water vapor within a salt gradient.

ENHANCED VAPOR DIFFUSION: The enhancement factor varies from 0 to 13x, depending on saturation. Salt can double that factor.

SURFACE TENSION: Salt increases the surface tension by as much as 13%. This increases the suction at regions of high salt content.

LIQUID DENSITY: Salt increases liquid density by as much as 20%, increasing gravity flow.

NOTE: Lab experiments show these effects can be very significant for salt transport in dry soil near ground surface.

How fast, how far ...

SOME MODELING SIMULATIONS

One-dimensional

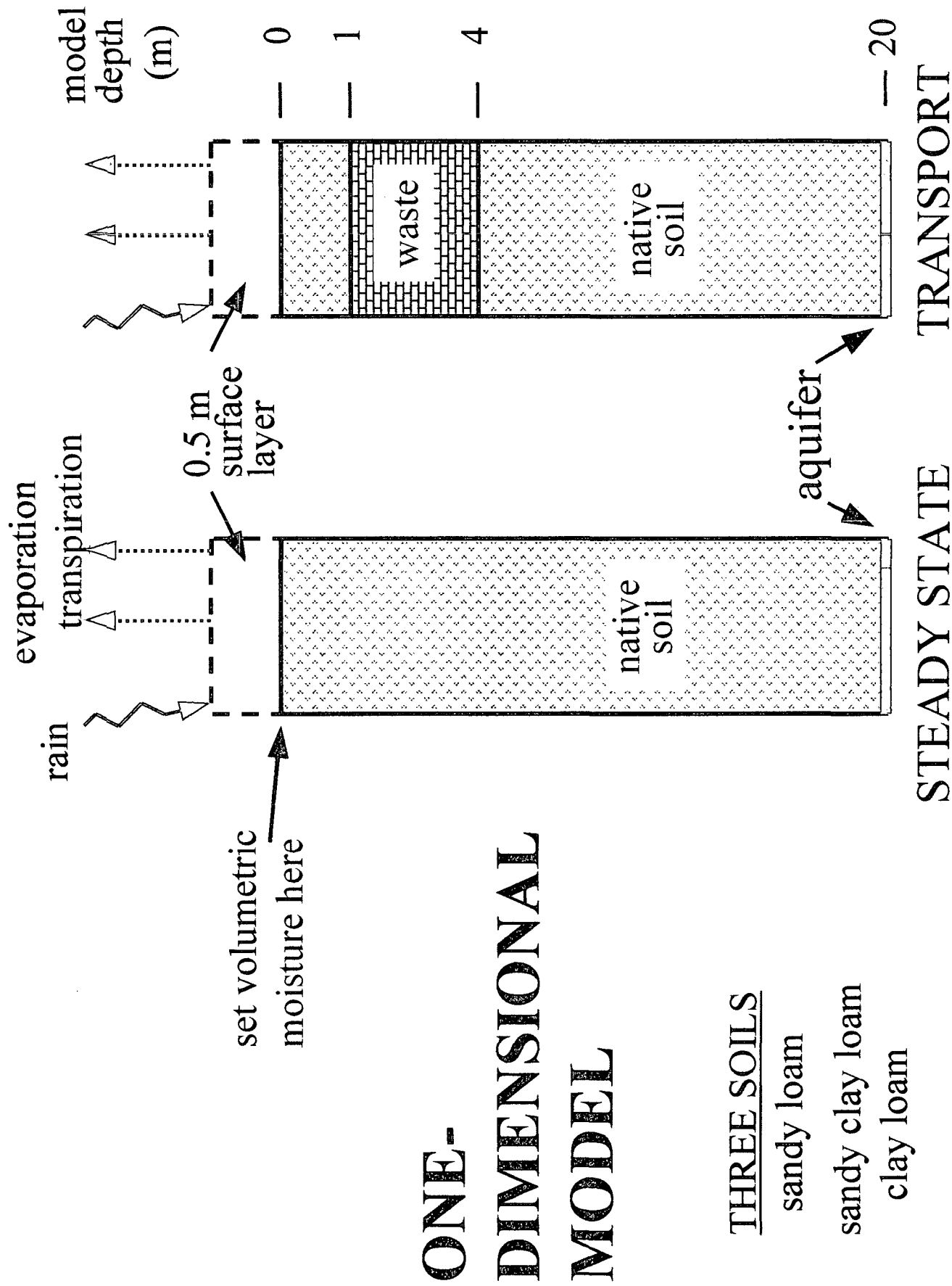
Unsaturated

Typical soil parameters for three soils

Measured soil moisture data input

Ignoring colligative (solution) effects

Modeling reveals that chlorides move preferentially *downward* in sandy soils and *upward* in clay-like soils.



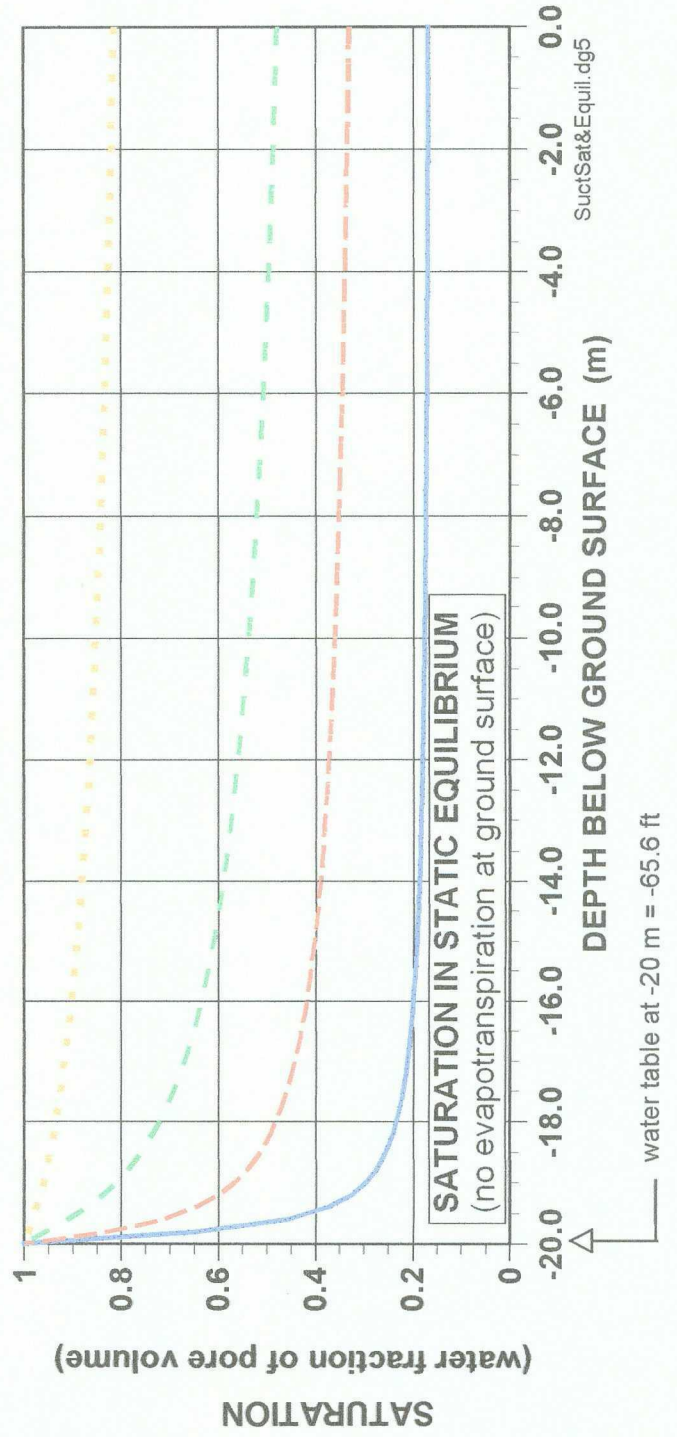
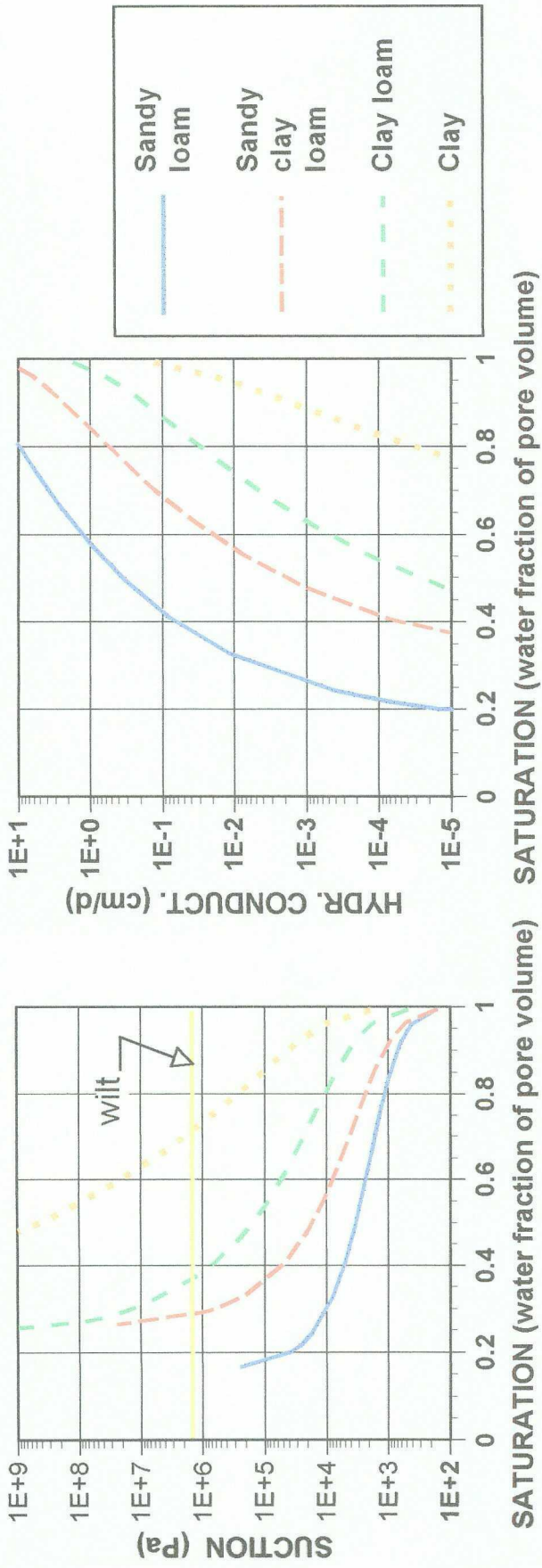
PROPERTIES OF SOME TYPICAL SOILS

TEXTURE	<u>Vol moisture</u>		<u>parameters</u>		<u>SAT</u>	<u>CALCULATED</u>
	RESID	SATUR	alpha (1/cm)	n	flow Ksat (cm/d)	mid-saturation Kunsat (cm/d)
1 Sand	0.045	0.43	0.145	2.68	713.	25.
2 Loamy sand	0.057	0.41	0.124	2.28	350.	7.6
3 Sandy loam	0.065	0.41	0.075	1.89	106.	1.0
"loose"						
4 Loam	0.078	0.43	0.036	1.56	25.	0.05
5 Sandy cl loam	0.10	0.39	0.059	1.48	31.	0.035
"moderate"						
6 Silt loam	0.067	0.45	0.02	1.41	11.	0.005
7 Silt	0.034	0.46	0.016	1.37	6.0	0.0019
8 Clay loam	0.095	0.41	0.019	1.31	6.2	0.00074
"tight"						
9 Sandy clay	0.10	0.38	0.027	1.23	2.9	0.000044
10 Silty cl loam	0.089	0.43	0.01	1.23	1.7	0.000026
11 Silty clay	0.07	0.36	0.005	1.09	0.5	1.2E-10

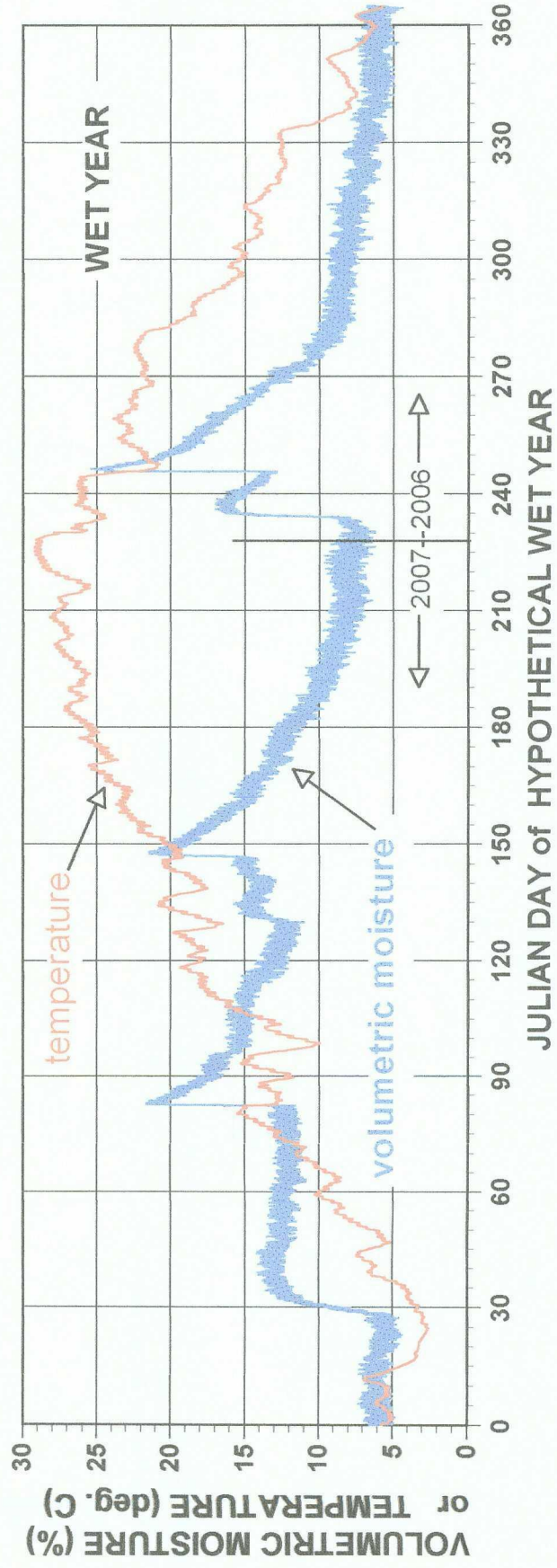
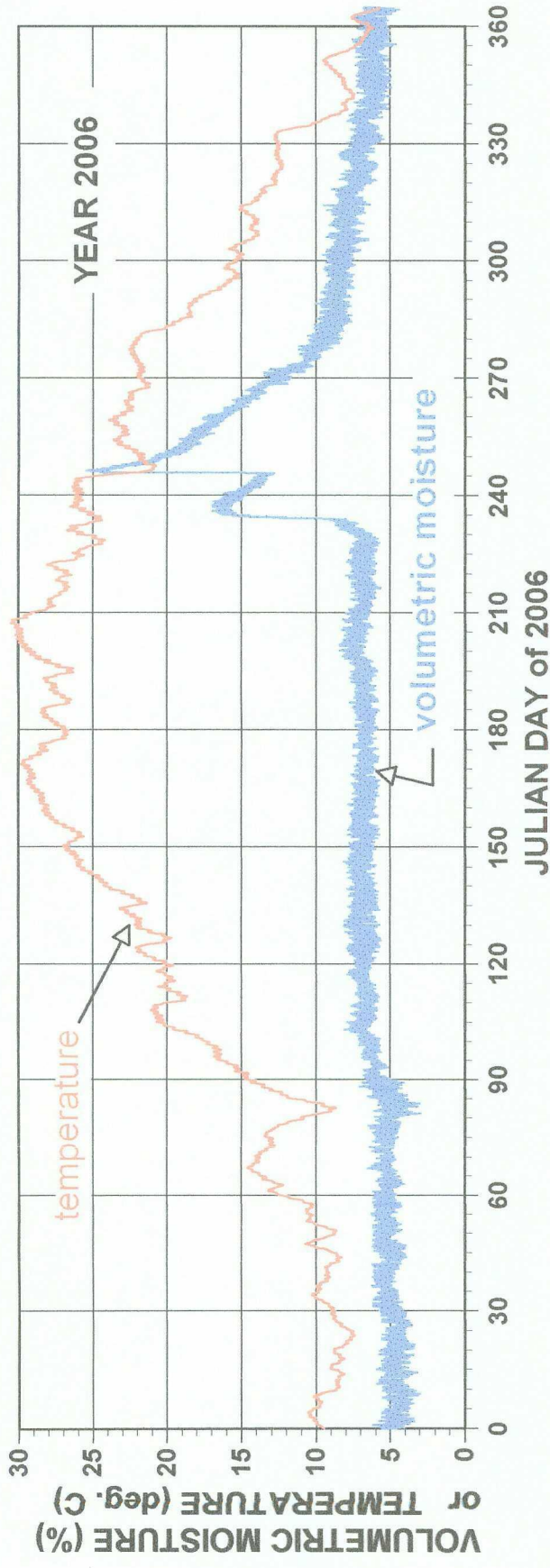
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Volumetric moisture, parameters, and Ksat are from the U.S. Environmental Protection Agency, Unsaturated Soil Hydraulic Database, EPA/600/R-96/095, August, 1996.

SUCTION, HYDRAULIC CONDUCTIVITY, AND EQUILIBRIUM SATURATION

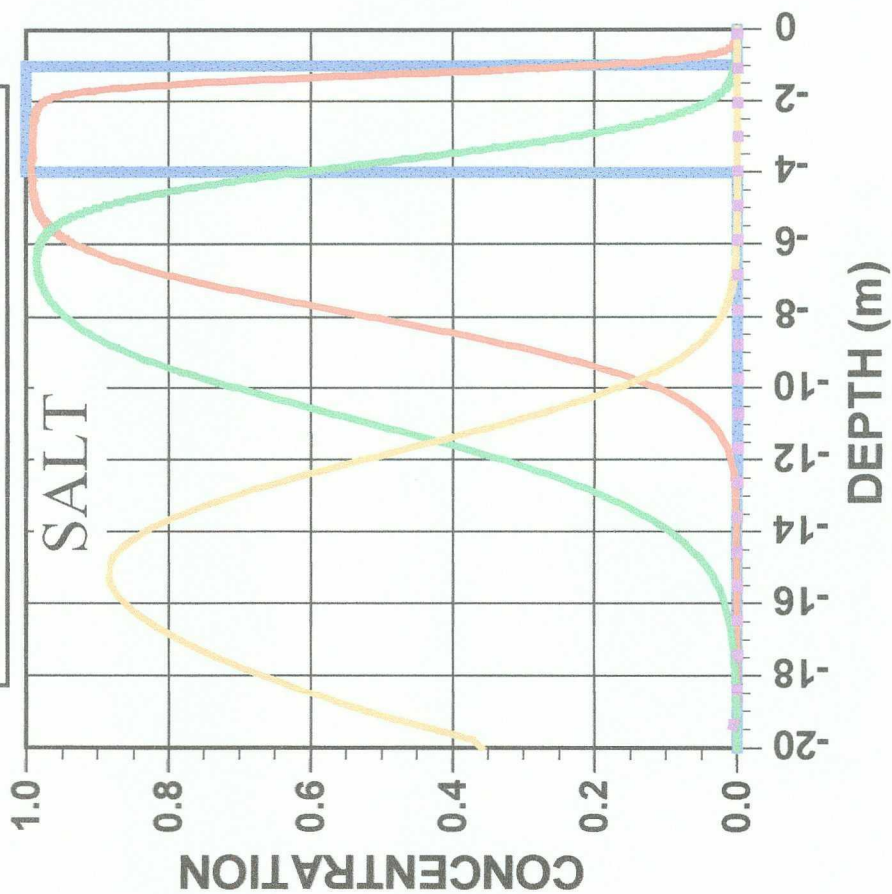
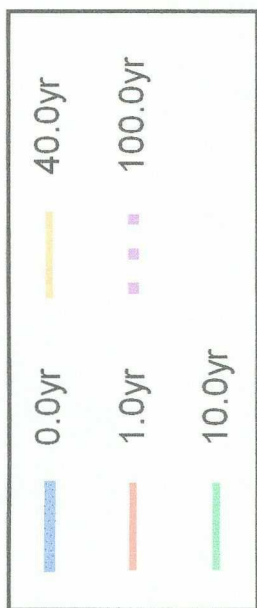
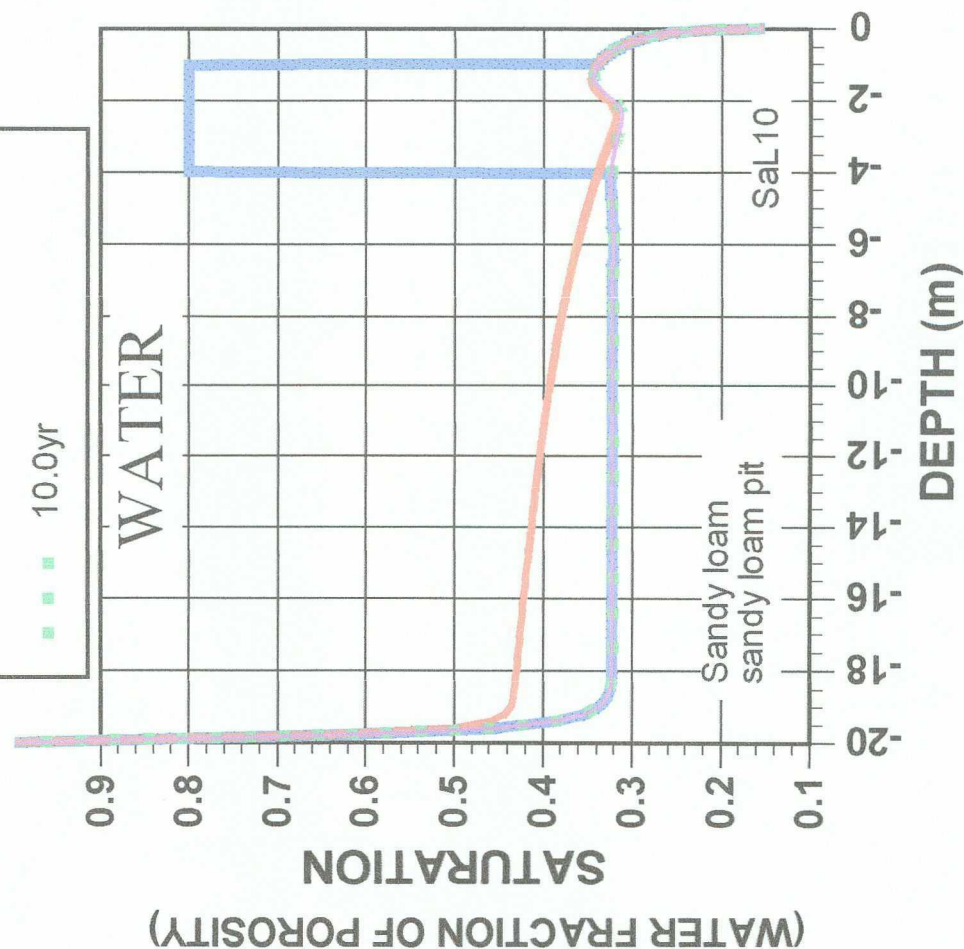
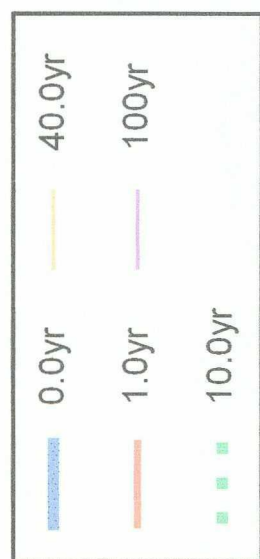


SuctSat&Equil.dg5

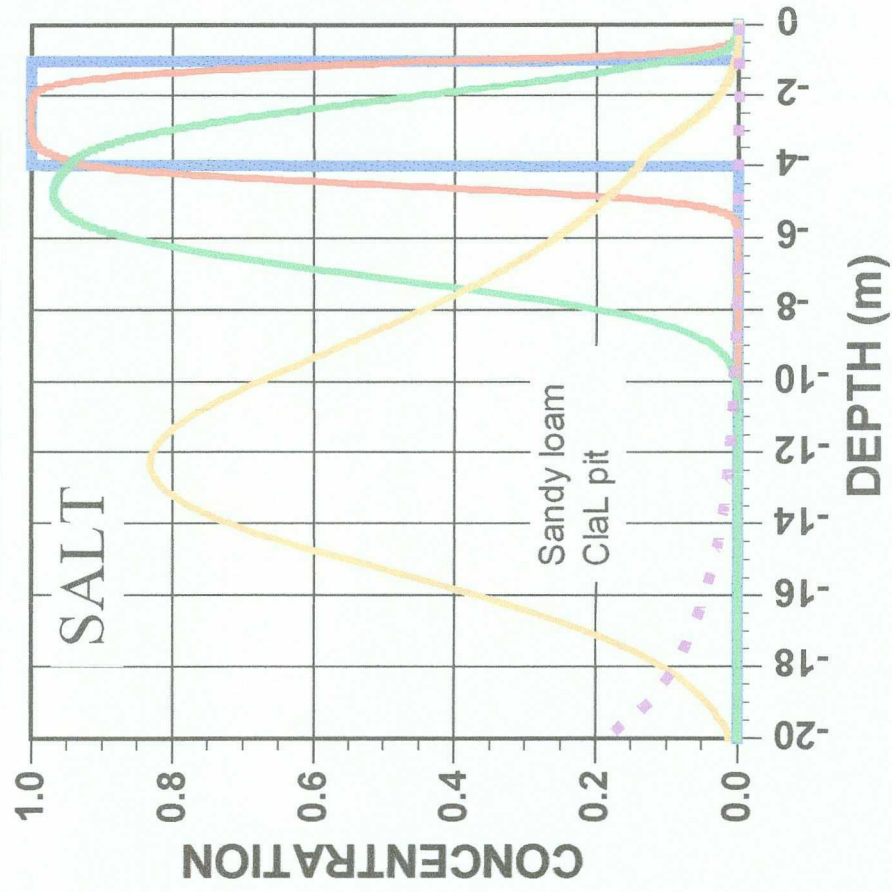
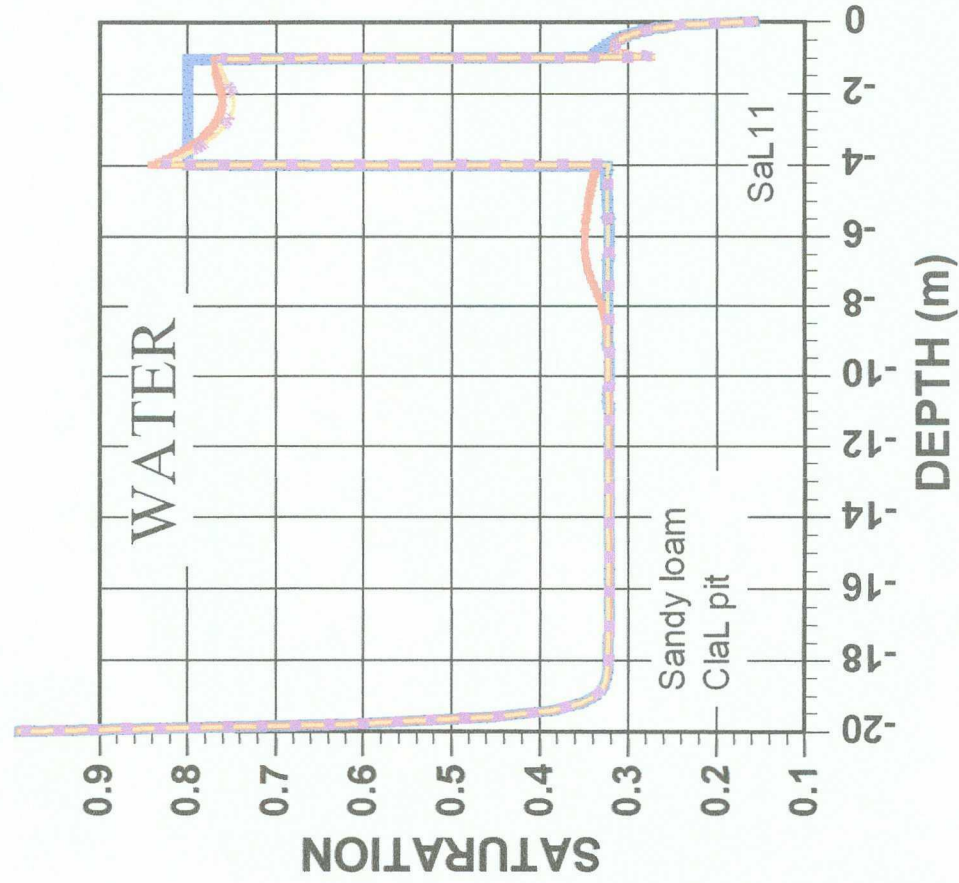
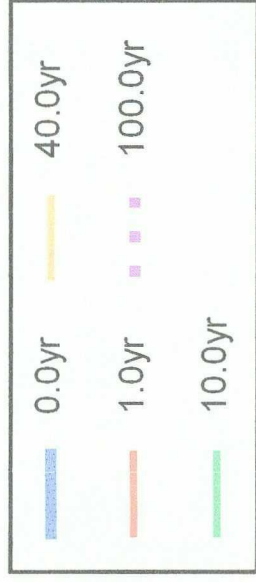


Data from: Natural Resources Conservation Service, Pedon 2107, Crossroads, NM

SANDY LOAM ("loose") SOIL & PIT

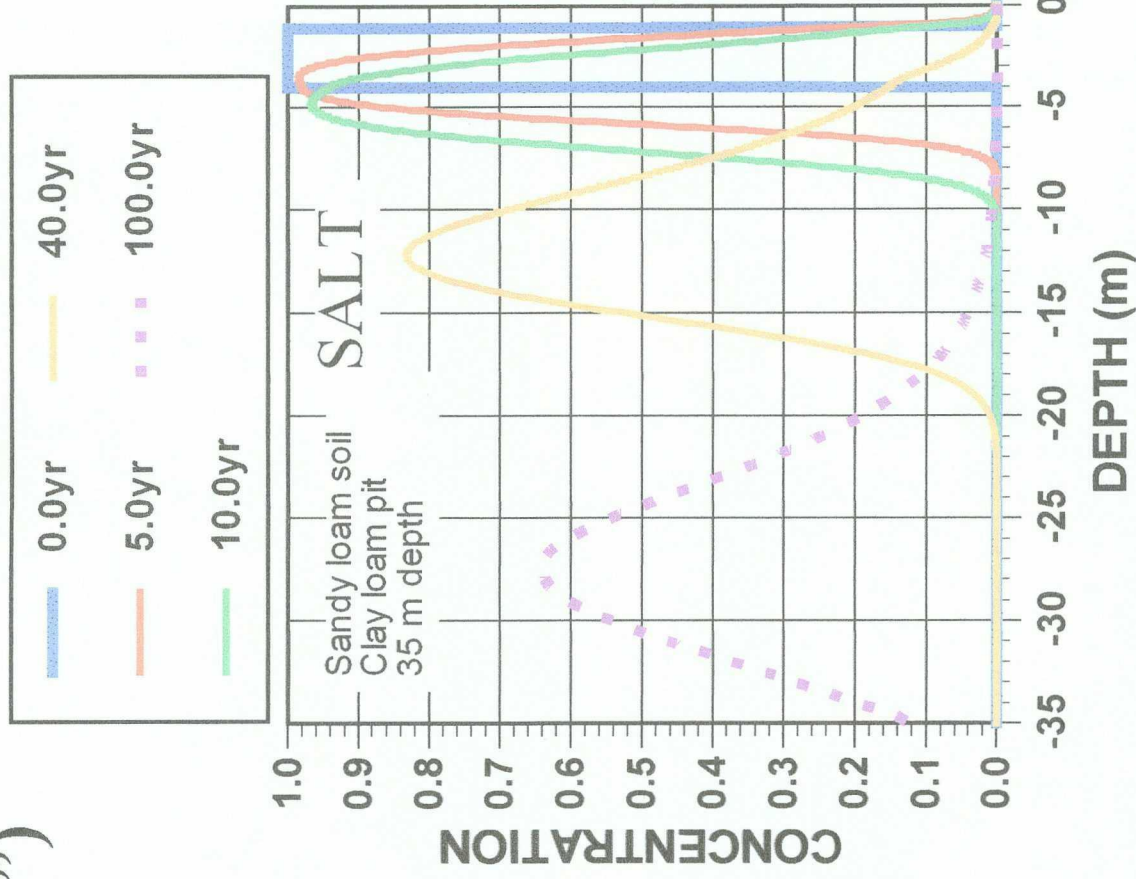
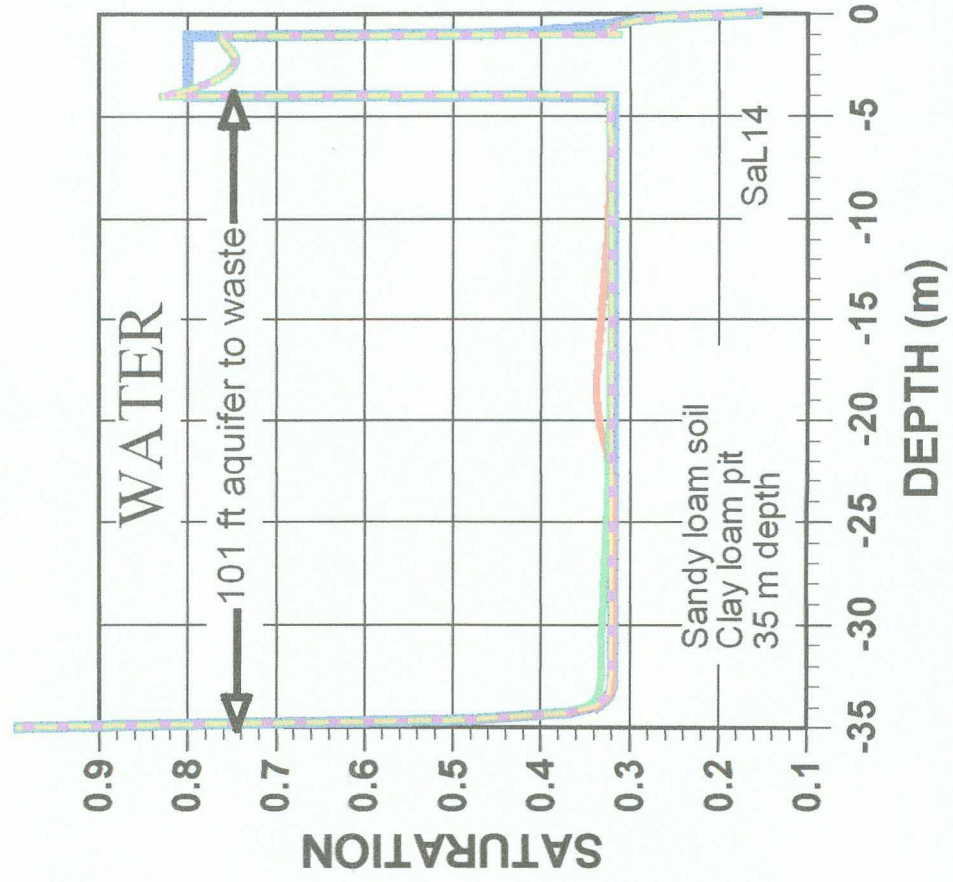


SANDY LOAM SOIL (“loose”) **CLAY LOAM PIT (“tight”)**

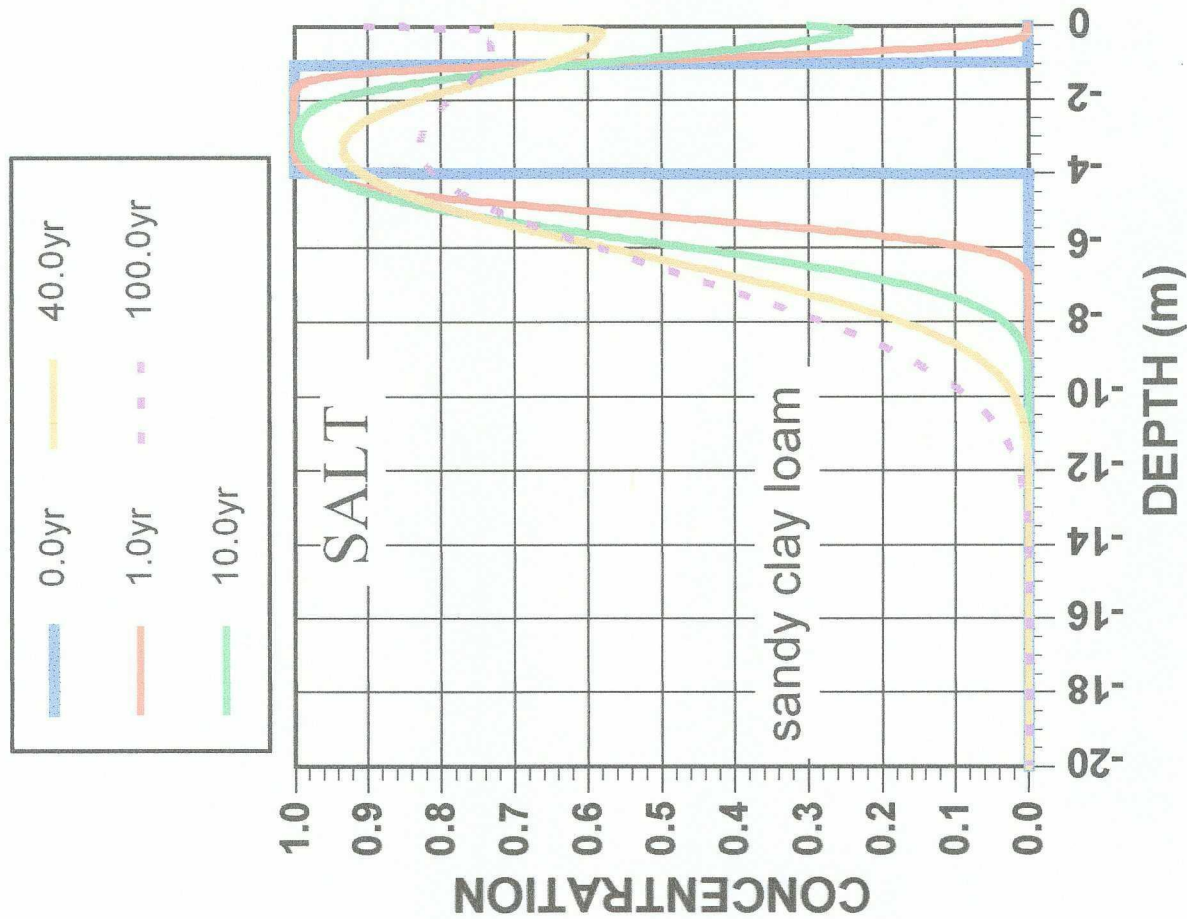
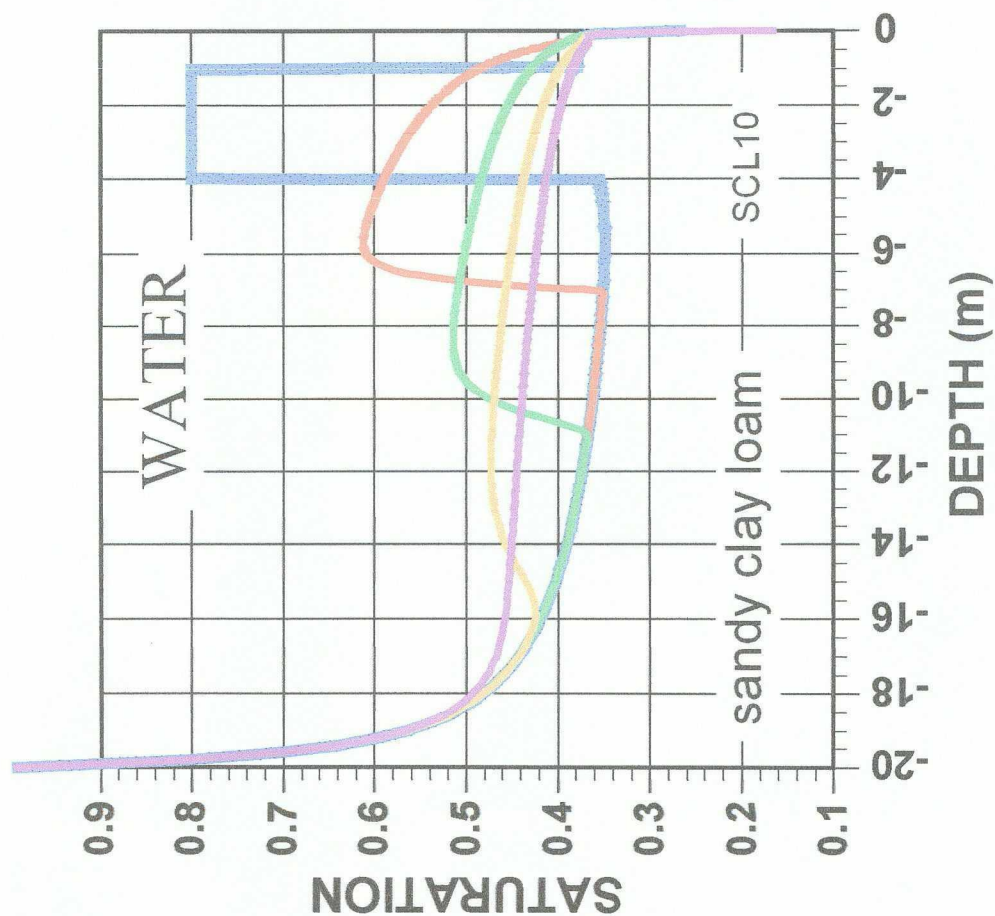


SANDY LOAM SOIL (“loose”) CLAY LOAM PIT (“tight”)

35 m depth

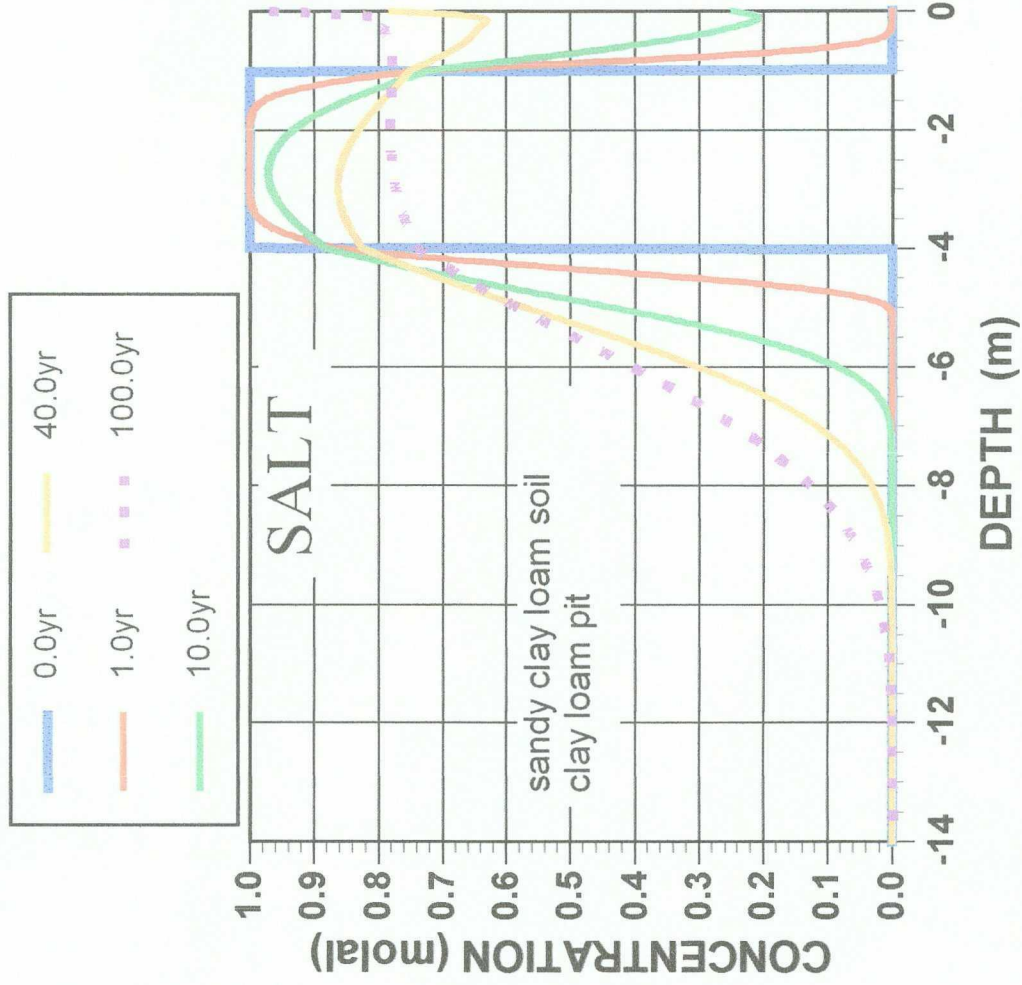
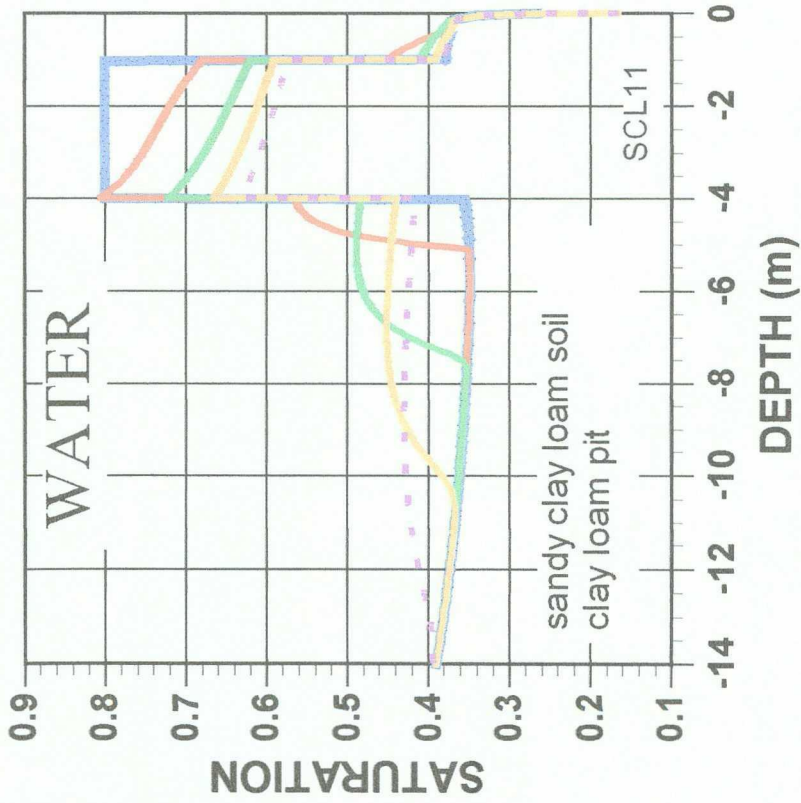


SANDY CLAY LOAM ("moderate") SOIL & PIT

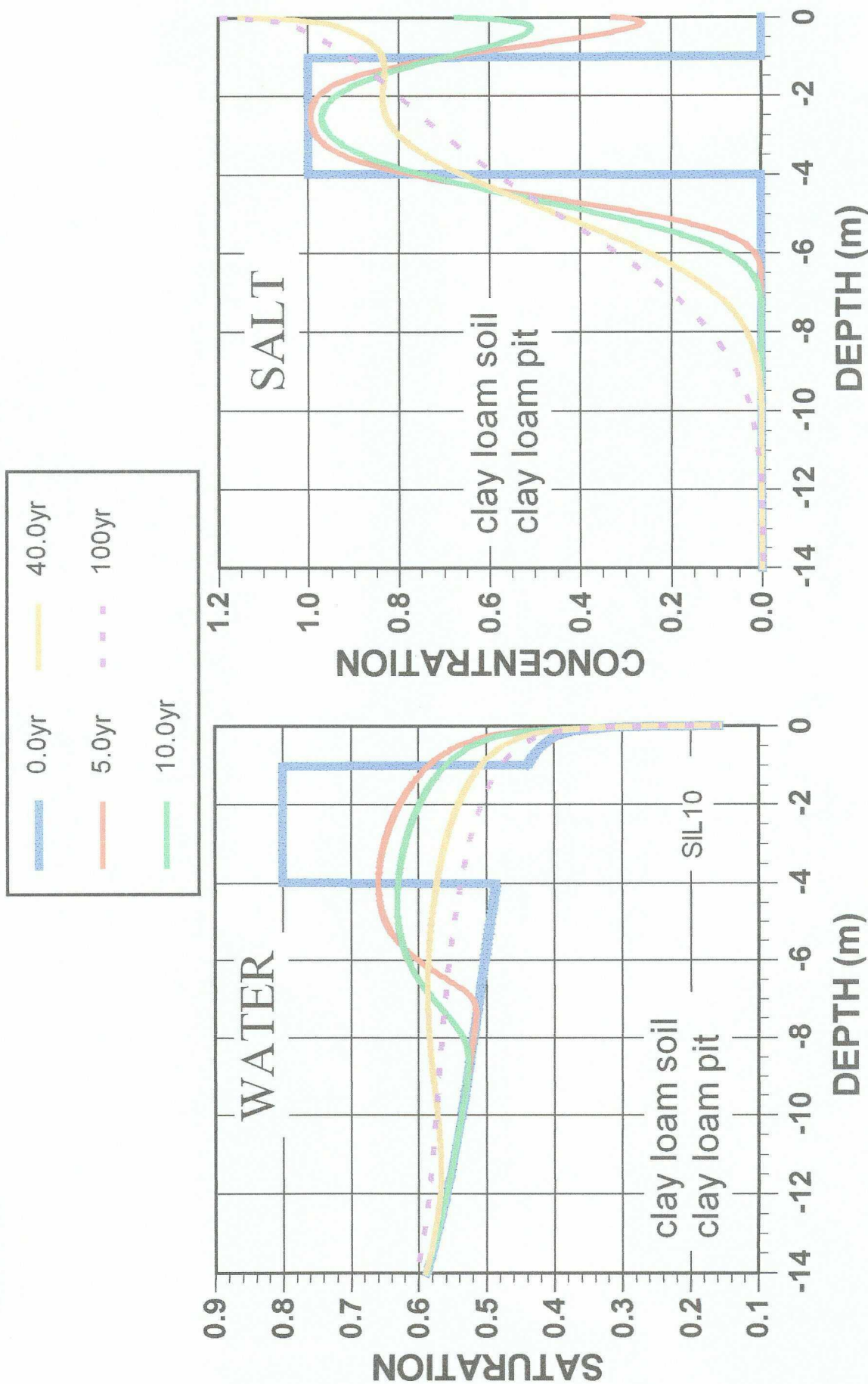


SANDY CLAY LOAM SOIL (“moderate”) **CLAY LOAM PIT (“tight”)**

(Little difference if every
 7th year is “wet.”)



CLAY LOAM ("tight") SOIL & PIT



RESULTS OF THE MODELING

In loose soil, chloride travels from a pit to groundwater at 52 ft below the wastes in 40 years, and to groundwater at 101 ft below the wastes in 100 years.

In moderate soil, the chloride reaches 16 ft below the wastes in 40 years and 20 ft below the wastes in 100 years.

In tight soil, the chloride reaches 13 ft below the wastes in 40 years and 20 ft in 100 years.

RESULTS ...

The moisture profile in the soil is dominated by the long-term average receipt of moisture from the surface, rather than by upward flow from groundwater at model depths of 20 or 35 m (67 or 116 ft from ground surface, 20" above model zero).

In loose soil, the calculated recharge at 67 ft is between 1.4 and 3.5 inch/yr, depending on details of moisture input. In moderate and tight soils, the recharge is less than 0.05 inch/yr.

HOW REALISTIC IS THIS MODEL?

The model provides the size and time scales of activity-- how much, how far, how fast. It does not provide exact quantitative estimates, which are sensitive to the numerical values of parameters (e.g. permeability).

The measured volumetric moisture at 20" depth injects and withdraws water. The data from deeper measuring points suggests the instruments are in loose soil. A tighter soil with greater suction would have shown greater volumetric moisture. Therefore, the model probably has too little moisture in the subsurface profile of moderate and tight soils, leading to an UNDERESTIMATE of chloride transport.

HOW REALISTIC ...?

Three-dimensional dispersion from a pit would allow chloride to move horizontally, creating a broader, initially faster plume, less impeded by the assumed low permeability of the pit material.

2007 had greater rainfall than 2006. We used 2006 as a supposedly typical year of rainfall. Higher average soil moisture would increase rate the chloride transport. However, insertion of a wetter year at 7-year intervals had little effect on transport in the moderate and tight soils.

HOW REALISTIC ... ?

The model did not include the colligative influences on surface tension, vapor pressure, vapor diffusion, density, viscosity, and osmotic pressure in thin films of liquid. These effects might have slightly **INCREASED** the chloride transport beneath the wastes, and significantly **INCREASED** the transport toward ground surface.

We did not attempt detailed modeling of the region near ground surface. The model confirms that, except in loose soils, chloride accumulates in significant concentrations in the two feet of soil immediately beneath ground surface.

BROAD CONCLUSIONS FROM THE MODEL

In loose soil, chloride moves downward. In moderate and tight soils, it moves downward more slowly, but moves upward to ground surface more rapidly.

In the absence of preferential pathways that may provide rapid infiltration of rainfall, the time scales for migration from the pit region are ~40-100 years.

The graphs show concentrations on January 1 of particular years. The chloride concentration near ground surface varies seasonally, being smaller during seasons of rainfall.

DOES THE MODEL COMPARE WITH REALITY?

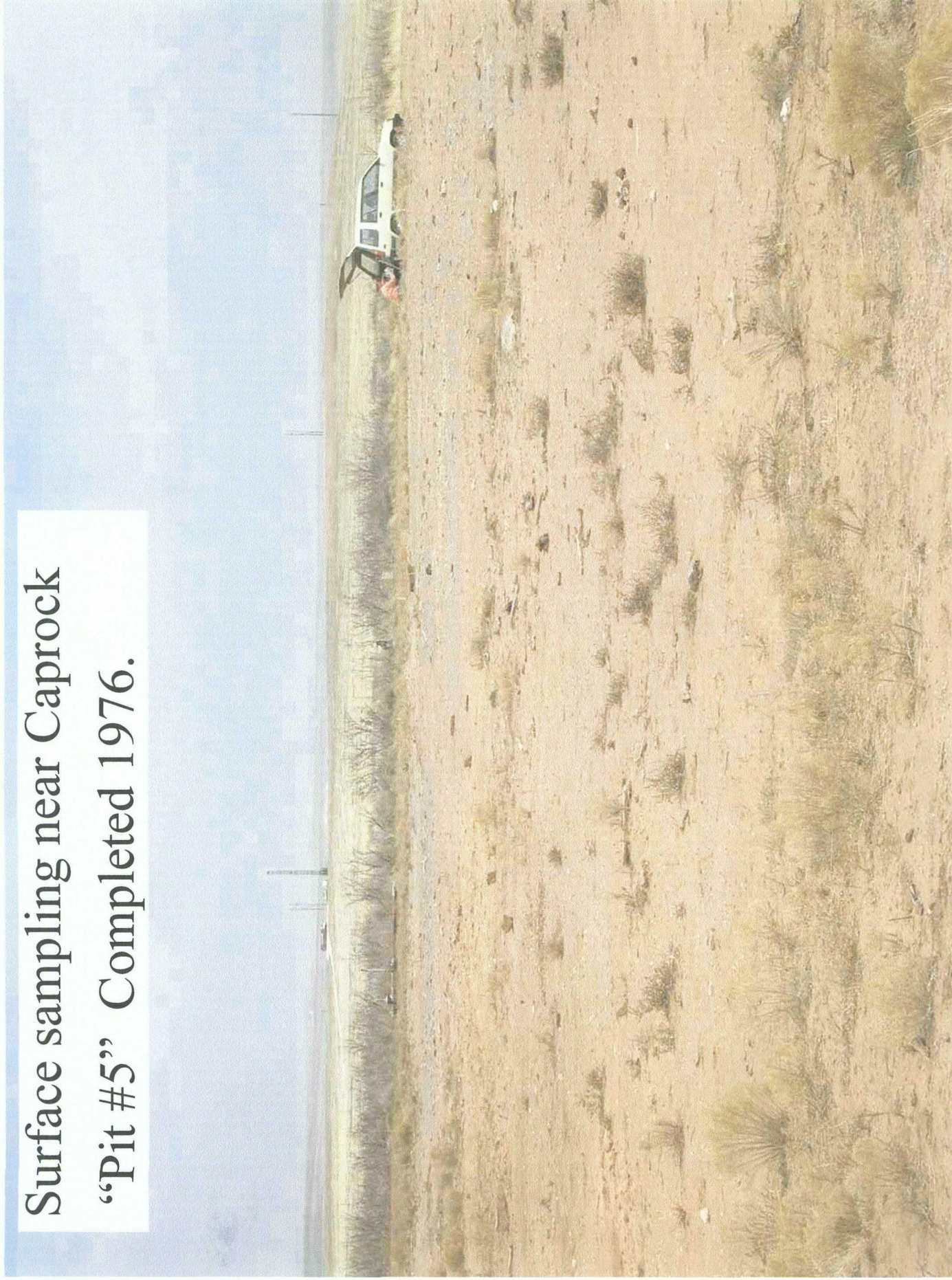
Modeling calculations are consistent with the results of three field exercises to test surface and subsurface soil samples for chloride.

Surface sampling near Caprock, March-April, 2006

Subsurface sampling near Caprock, April 3, 2007

**Subsurface sampling near Loco Hills, June 30, 2007
supported by Marbob Energy Corp.**

Surface sampling near Caprock
“Pit #5” Completed 1976.



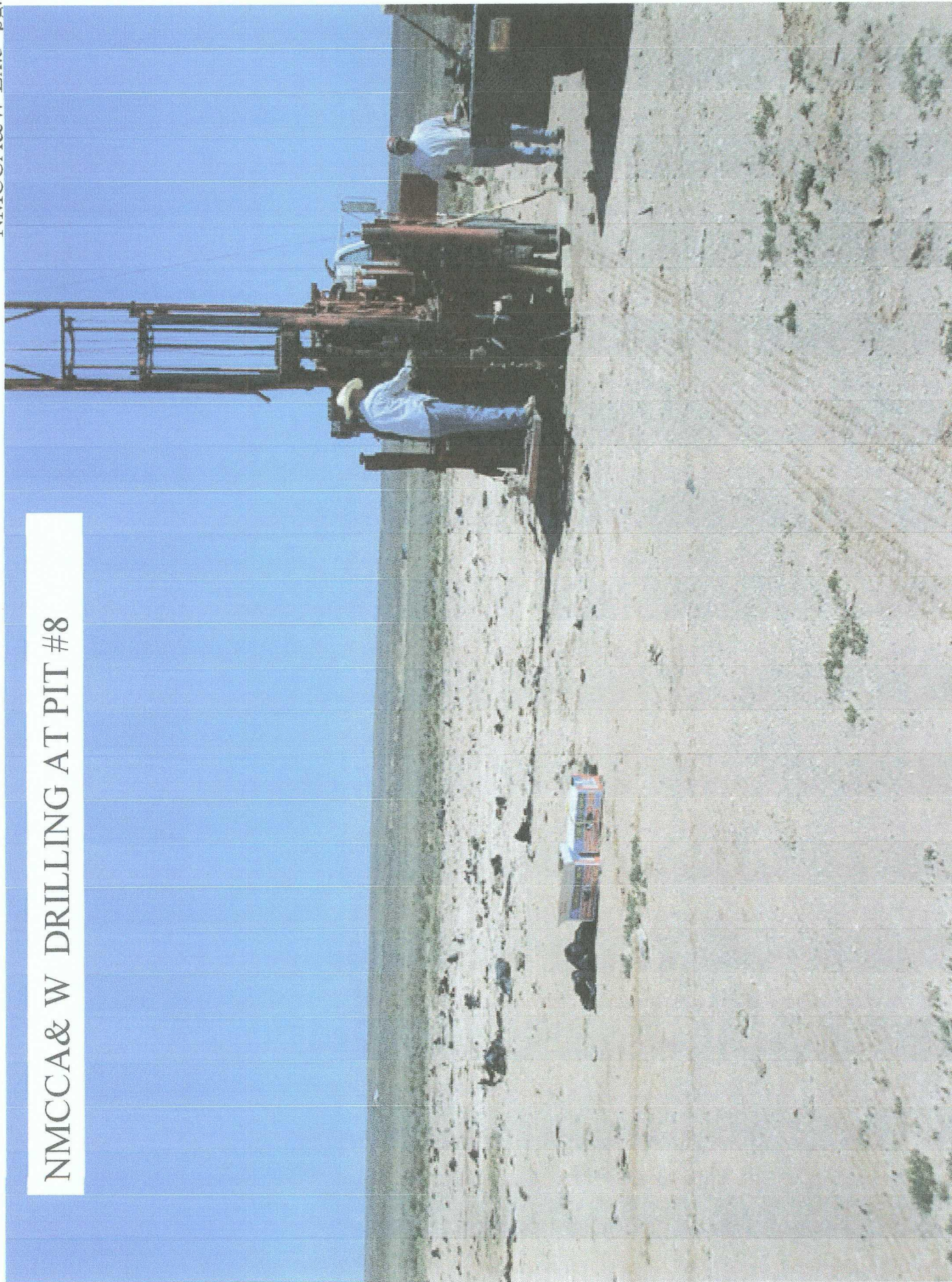
Surface sampling near Caprock
“Pit #8” Completed in 1996.



NUMBER OF SAMPLES IN EACH CATEGORY OF VEGETATION AND CHLORIDE CONTENT

CHLORIDE (mg/kg)	March-April, 2006 Surface sampling near Caprock												
	4000 to 2000	2000 to 1000	1000 to 400	400 to 250	250 to 100	100 to 0	dead area	edge of snake weed	sparse snake weed	dense snake weed	sparse grass	dense grass	undis- turbed grass
3	1												
1		1		2	2						1	5	1

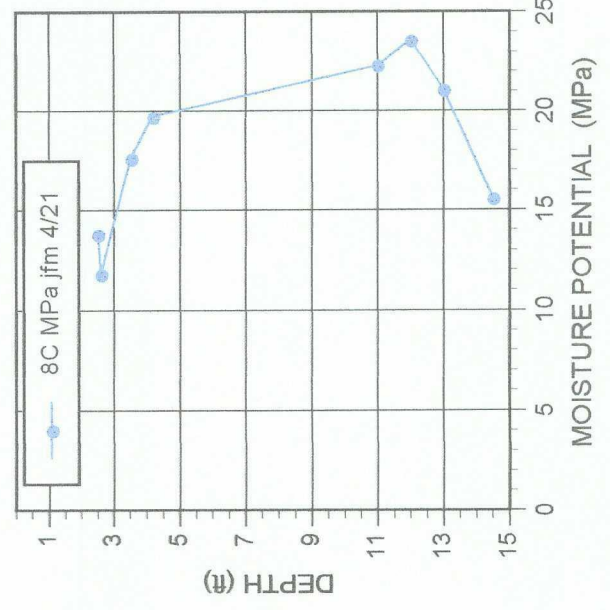
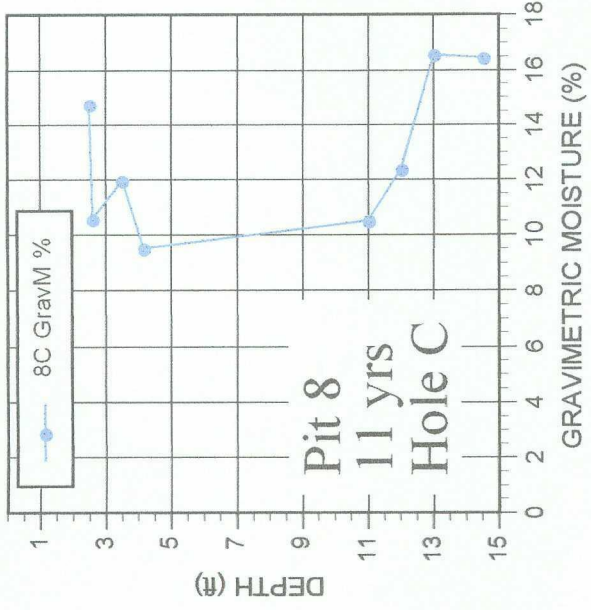
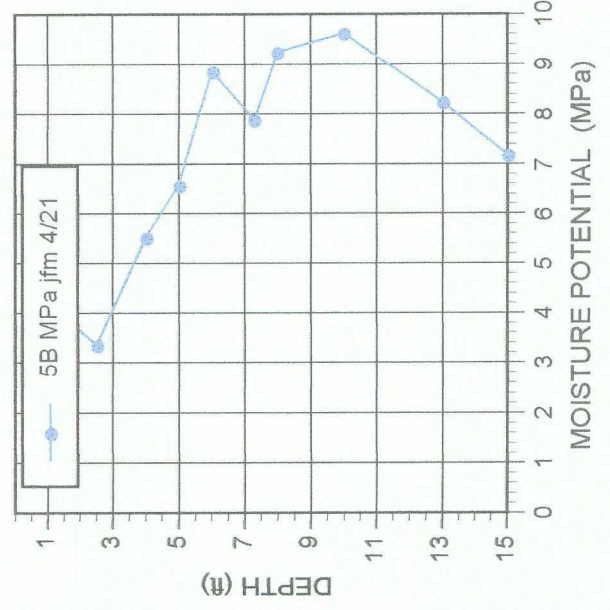
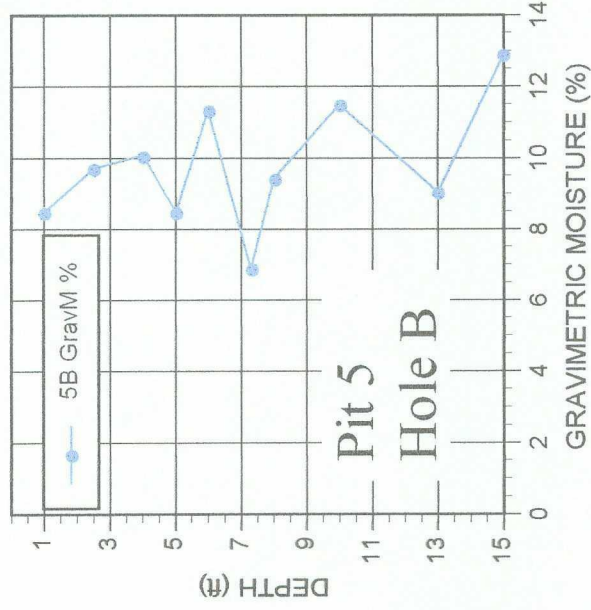
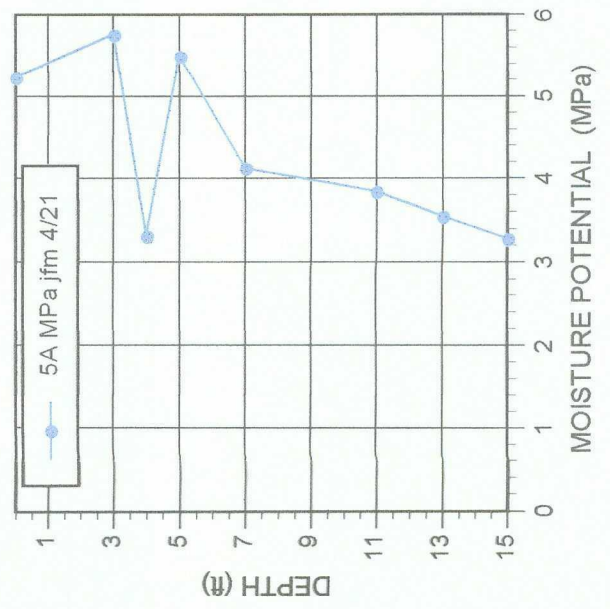
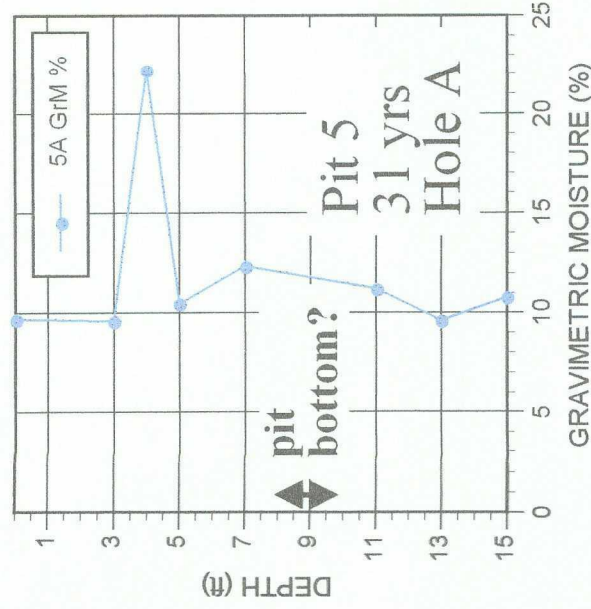
NMCCA&W DRILLING AT PIT #8





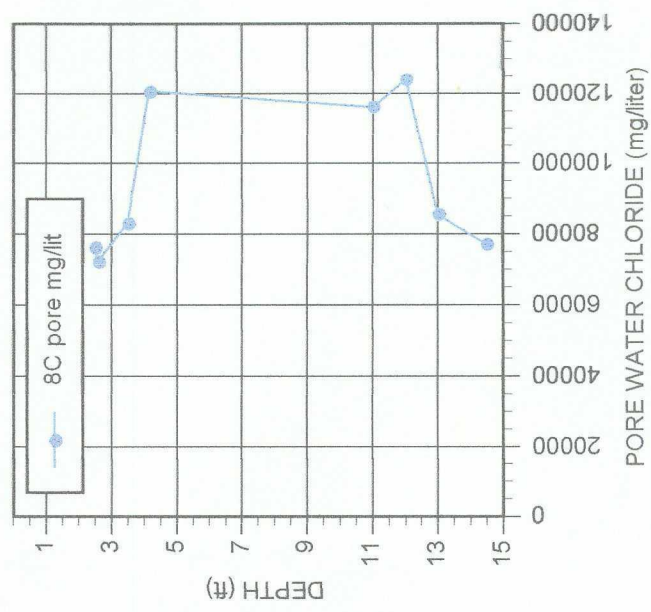
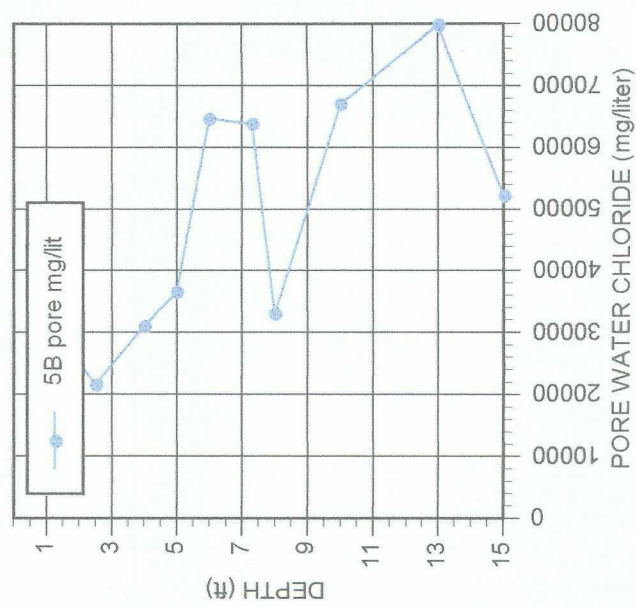
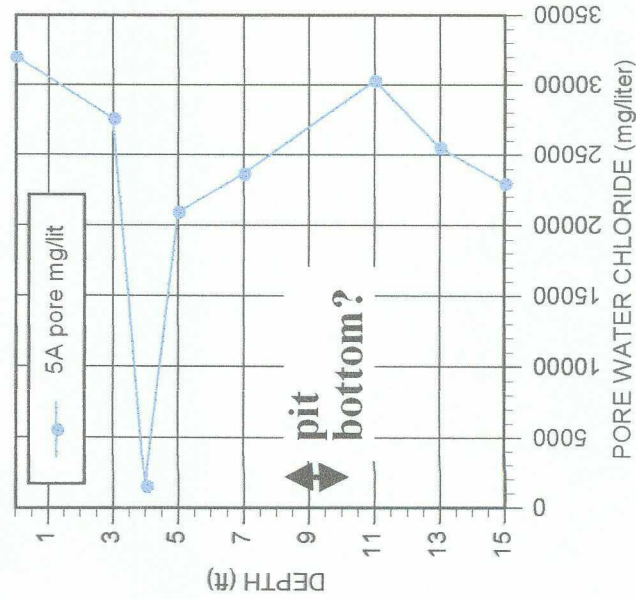
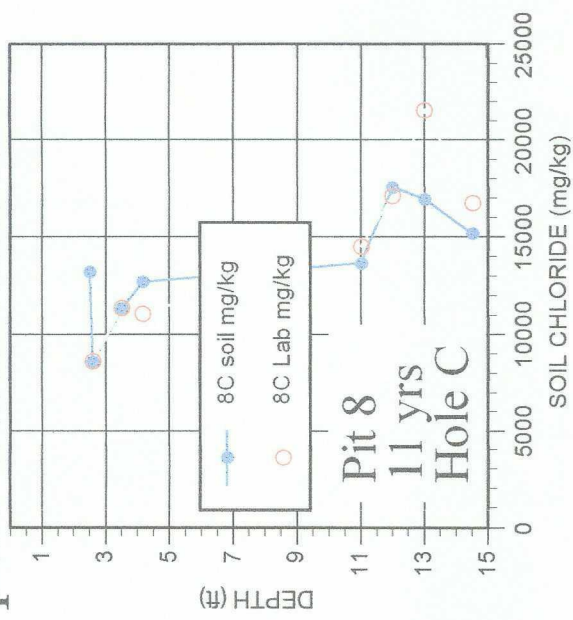
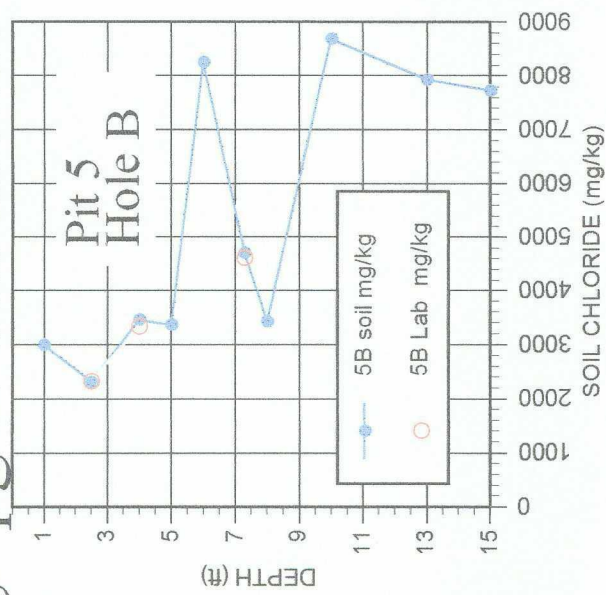
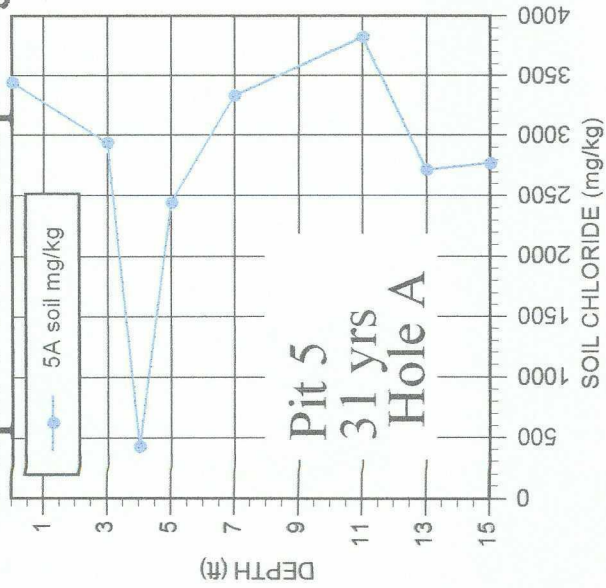
Caprock sampling.

Gravimetric moisture & potential.



Caprock sampling.

pg 2. Soil chloride & pore water chloride.



Caprock sampling. SUMMARY

Surface chloride ~3,000 mg/kg in bare area.

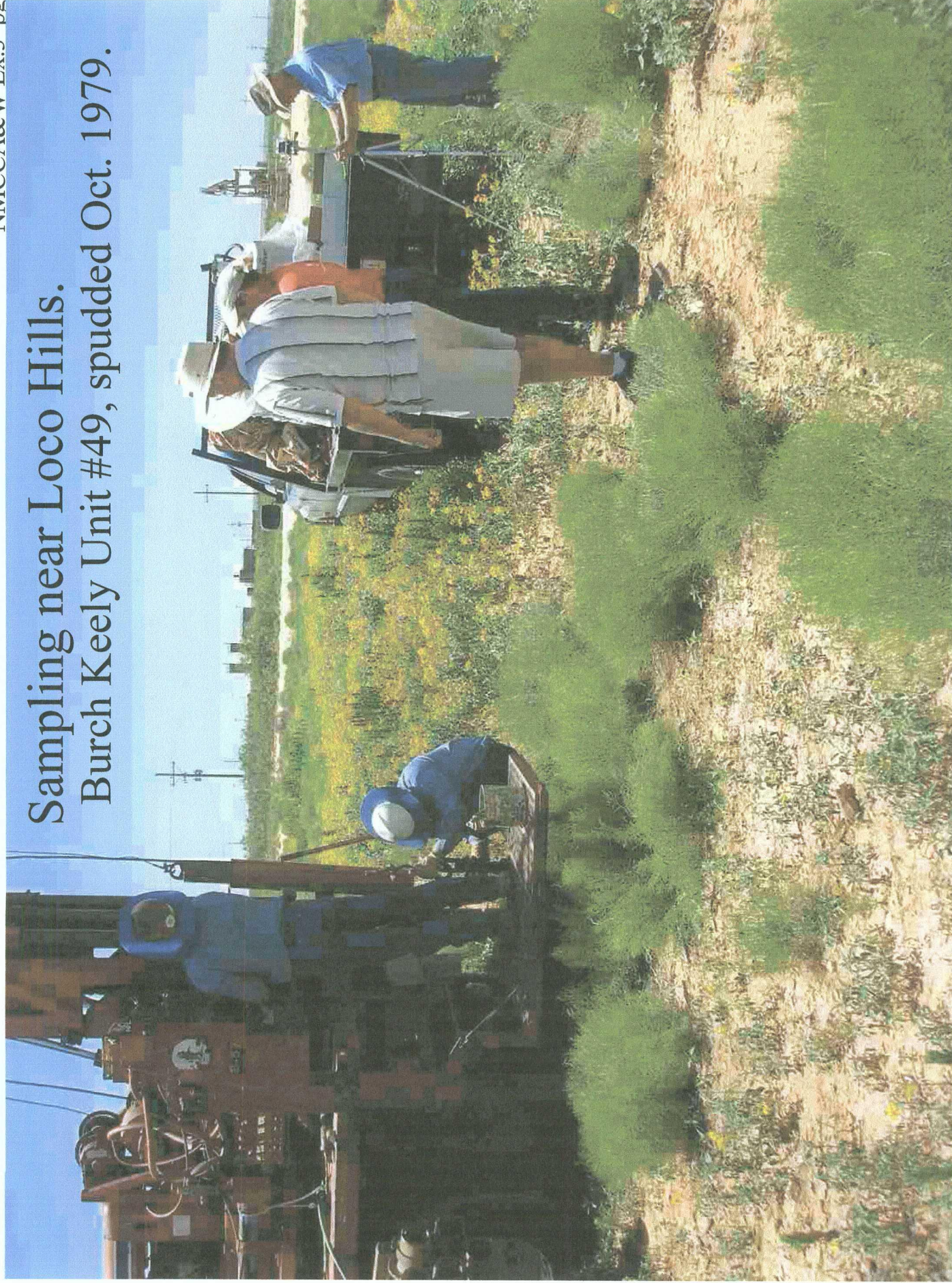
Subsurface moisture appears normal.

Chloride shows no sign of plume edge at 15 ft.

Moisture potentials (not shown), are consistent with matric potential + NaCl osmotic pressure.

A new monitor well approx. 150 ft south of Pit #5 shows approximately 2400 mg/liter chloride in groundwater at 30 ft. The source of contamination has not been officially established. A tank spill occurred nearby.

Sampling near Loco Hills. Burch Keely Unit #49, spudded Oct. 1979.

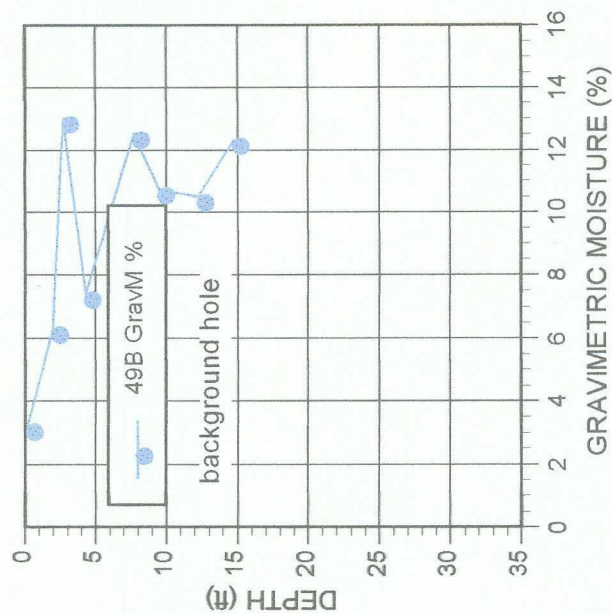
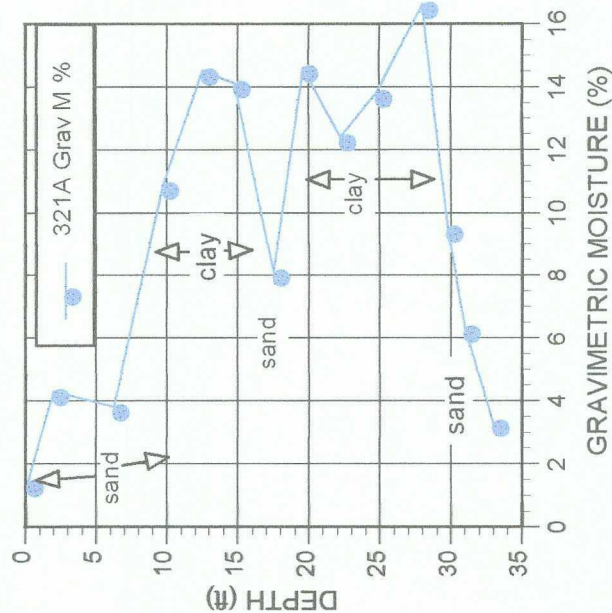
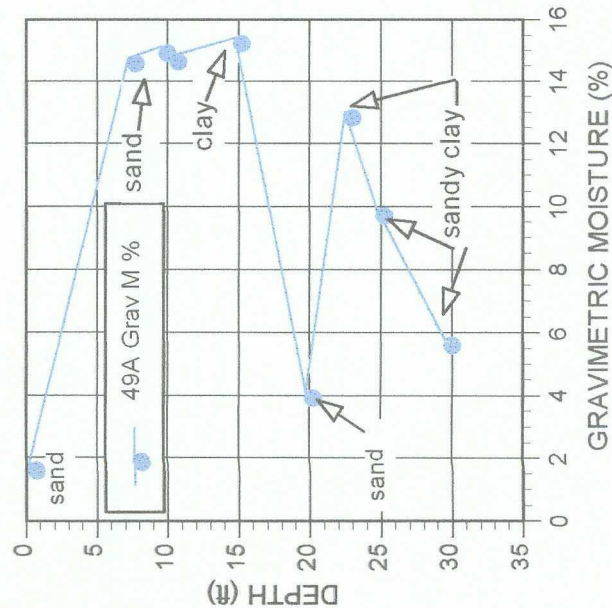


Loco Hills (Burch Keely Unit) sampling results pg. 1

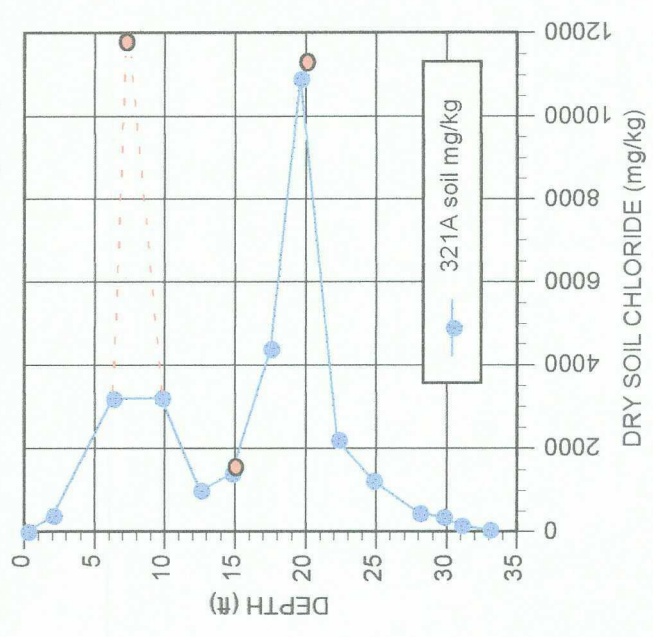
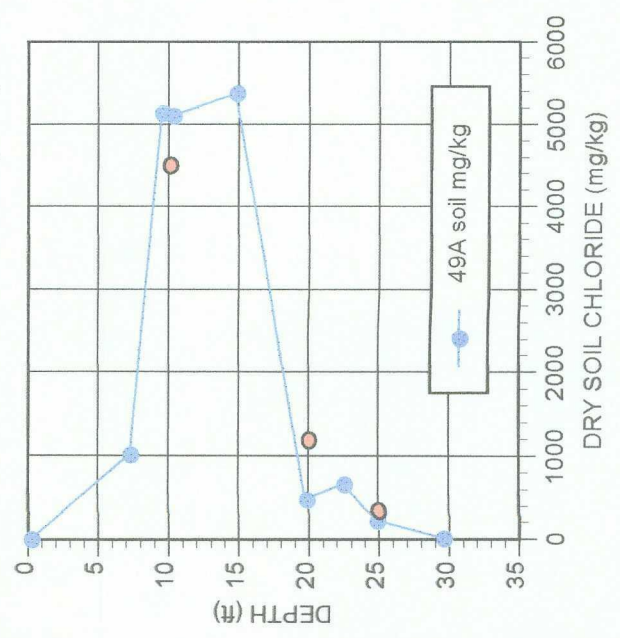
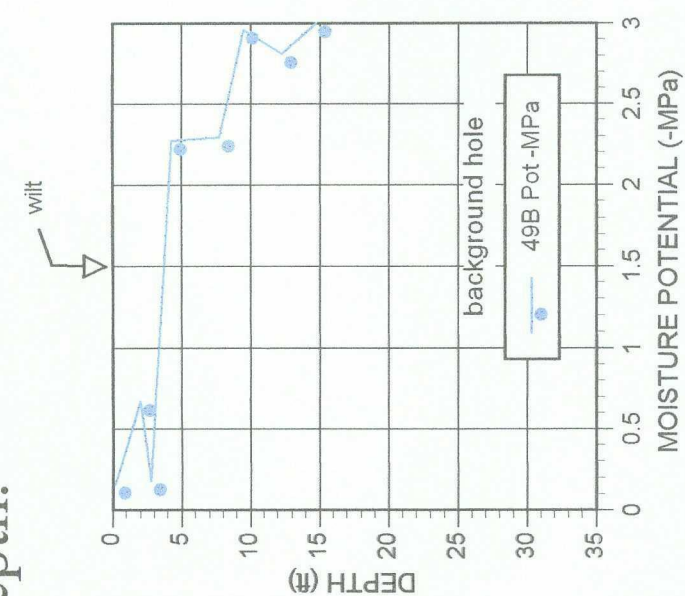
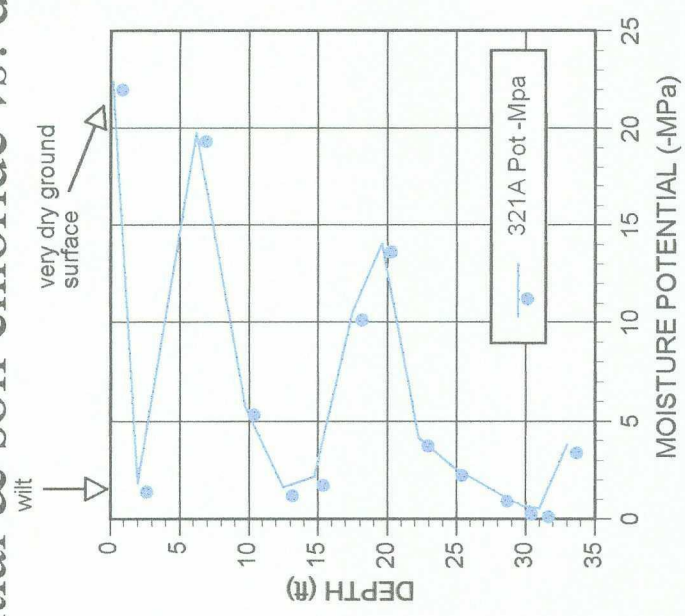
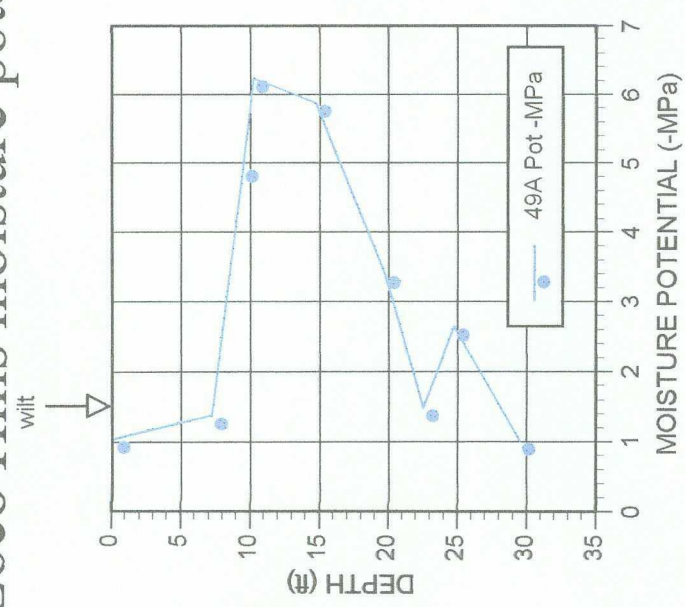
Well 49 spudded 10/1976. Unlined pit 31 years old.

Well 321 spudded 11/2001. Lined pit 6 years old.

Gravimetric moisture as a function of depth.



Loco Hills moisture potential & soil chloride vs. depth.



Chloride in background hole less than 200 mg/kg.

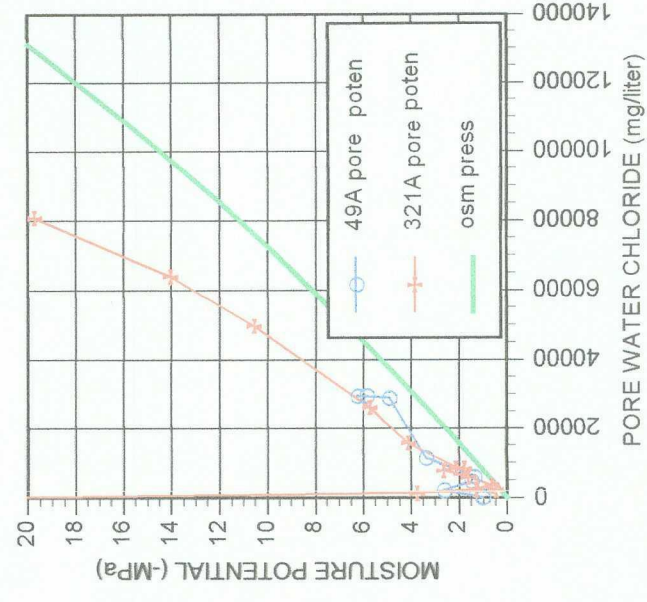
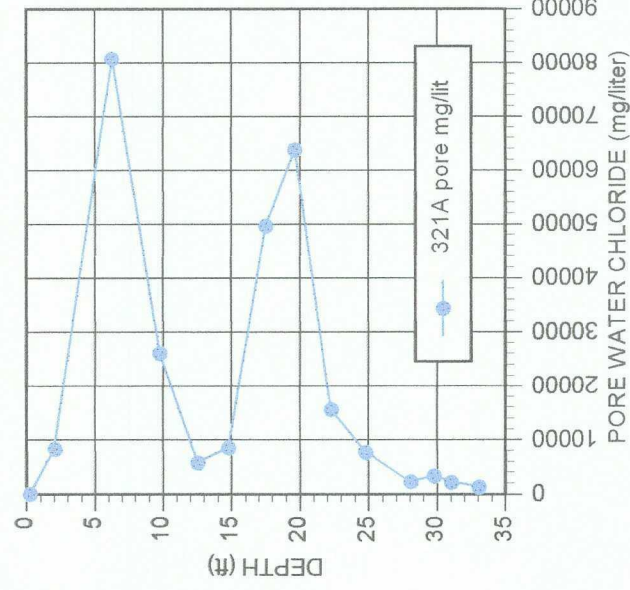
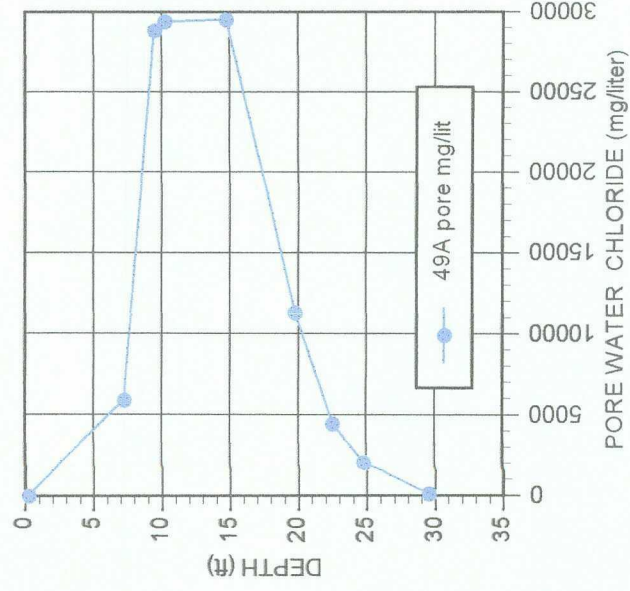
Red points are lab samples.

Loco Hills: Pore water chloride vs. depth.

Moisture potential vs. pore water chloride.

Note penetration of chloride to 30 ft.

Comparison of potential with osmotic pressure of NaCl suggests presence of additional dissolved substances, as found in the industry and OCD sampling of current pits.



Caprock and Loco Hills sampling

CONCLUSIONS

Variation of soil properties with depth, both within and outside of a pit, make quantitative agreement with a model unlikely. However, both the older and newer pits confirm that chlorides are not retained by the hydrologic properties of the pit material, but can move several meters in a time scale of decades.

Caprock: Chloride concentrations extend past 15 feet total depth at pits #5 and #8, which are 31 and 11 years old, respectively.

Loco Hills: Pit #49 is 30 years old and Pit #321 is 6 years old. Sandy surface soils are not contaminated. Both pits show a leading edge of chloride plume at 25-30 feet.

REVIEW

1. *What is in the pits?*
2. *At what level is it damaging?*
3. **IF IT MOVES, HOW FAST, HOW FAR?
How fast? In sandy soil, several meters per decade.
In tighter soils, perhaps only one meter per decade.
It moves downward in all soils, and upward unless
rain washes it downward out of a sandy surface soil.
How far? Until diluted to background or carried
away by surface or ground water.**

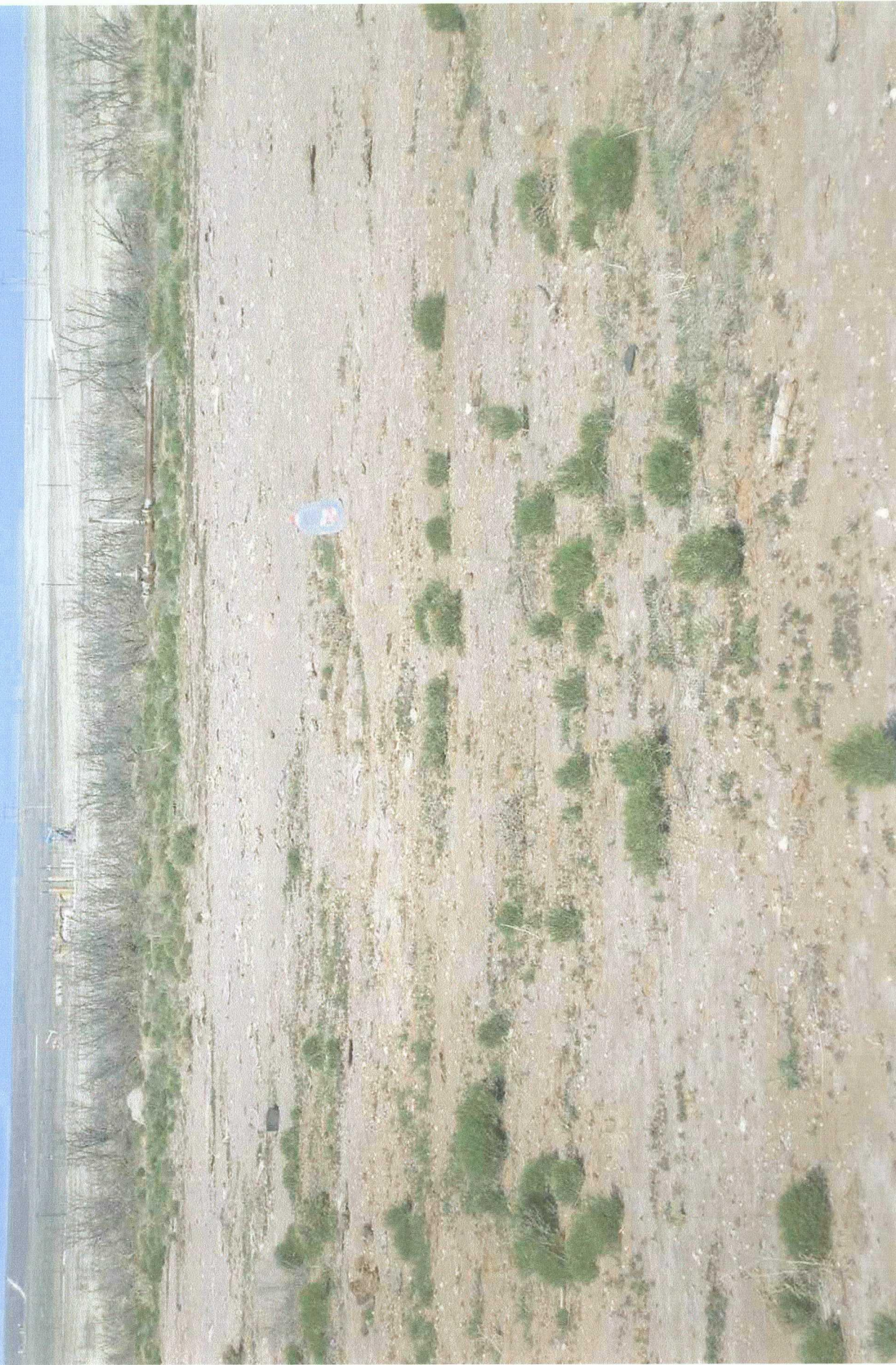
NEXT: 4. *Is trench burial secure?*

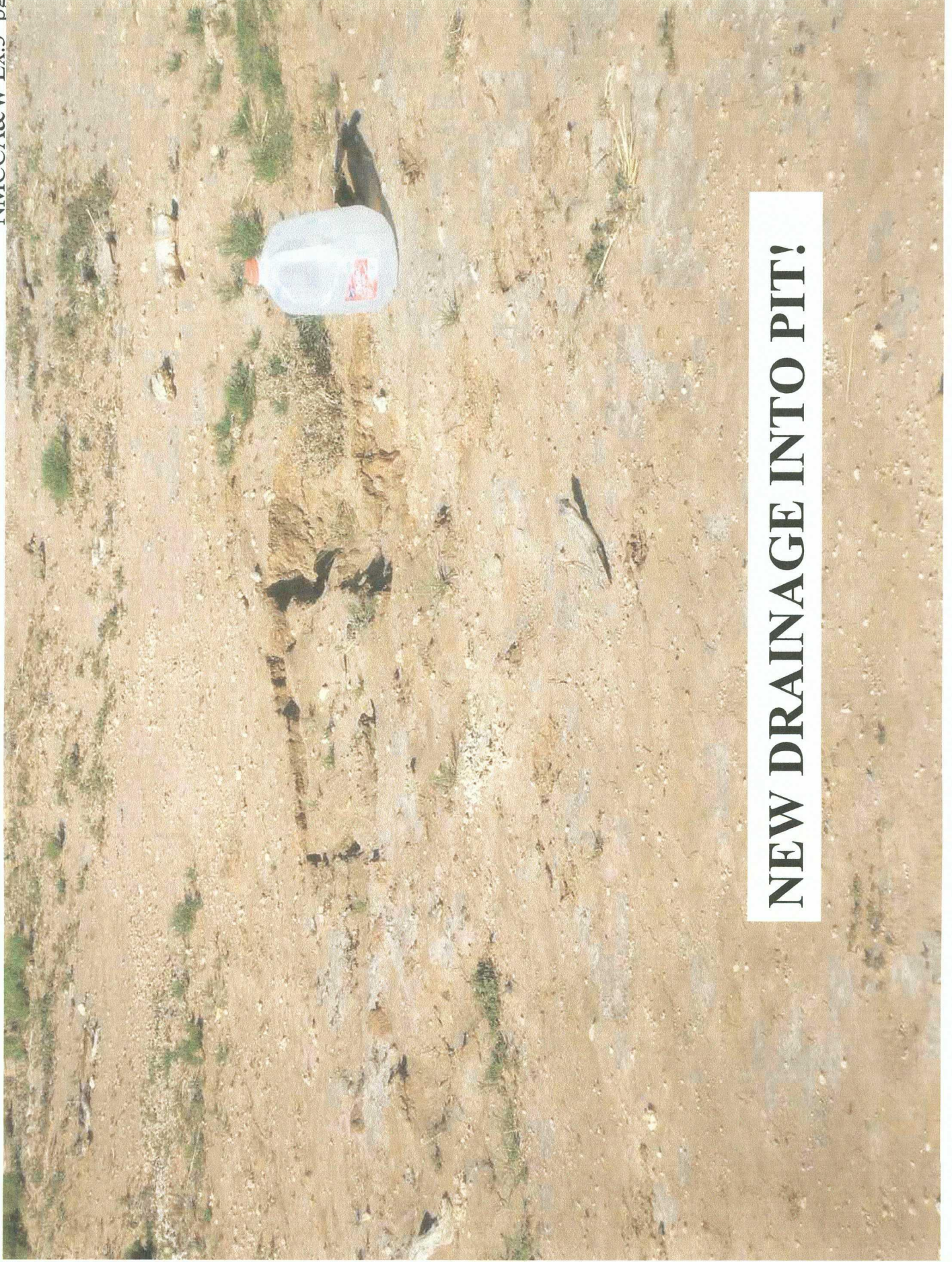
4. IS TRENCH BURIAL SECURE?

2 lb. Hammer, gentle swing onto ball hammer resting on 12 mil liner over 2 inch hole. A similar test on a double layer of 12 mil liner did not penetrate.



Caprock Pit # 5 during subsurface sampling, 2007.

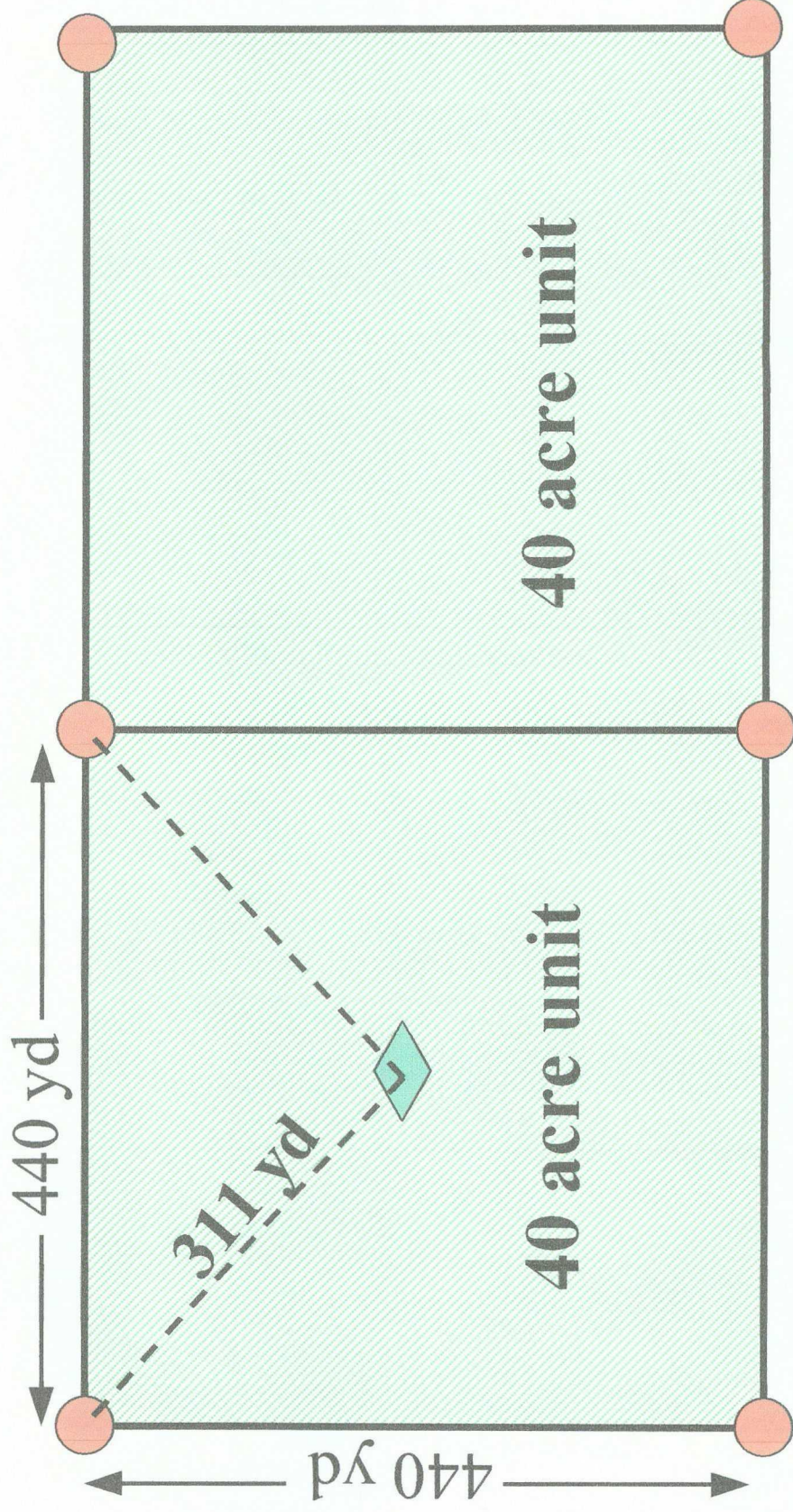




NEW DRAINAGE INTO PIT!

Burial units “almost everywhere.”

At 40-acre well spacing, the longest distance to a burial unit could be 311 yards.



REVIEW

1. *What is in the pits?*
2. *At what level is it damaging?*
3. *If it moves, how fast, how far?*

4. Is trench burial secure?

A liner may be penetrated by protruding rocks or fragments of caliche. Although one small hole would not generate much unsaturated flow, the durability of the entire liner throughout centuries concerns us. “Burritos” are time bombs.

Subsidence within the trench can lead to ponding at the surface and infiltration, as seen at Caprock Pit #5.

The existence of entombed waste units throughout the landscape places a future prejudice on the land--for all time.

NEXT: 5. *Can it be treated or cleaned up?*

5. CAN IT BE TREATED OR CLEANED UP?

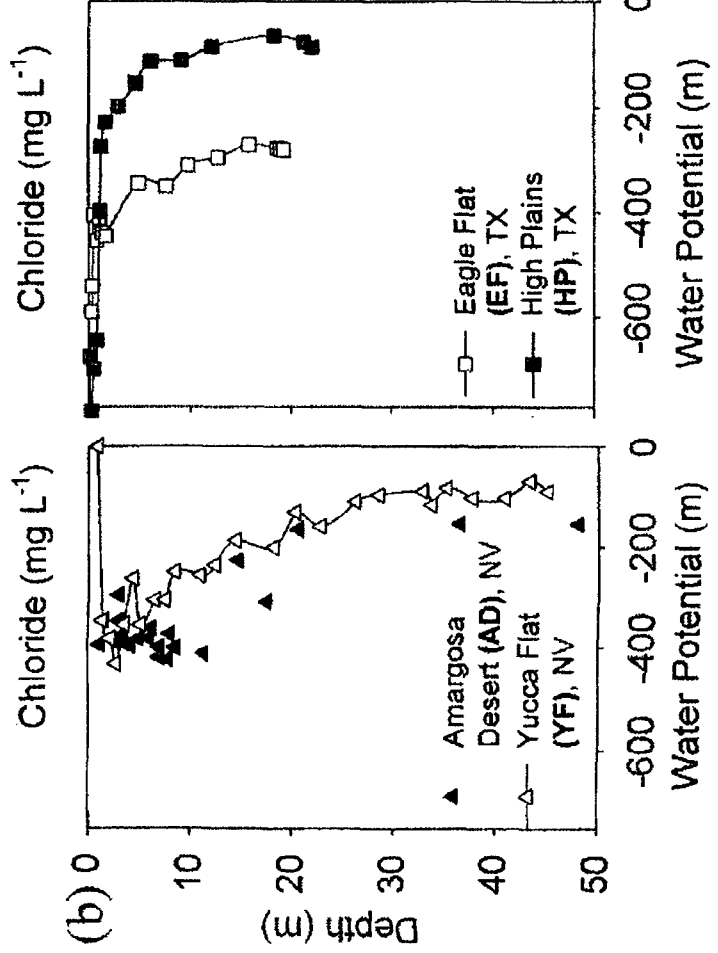
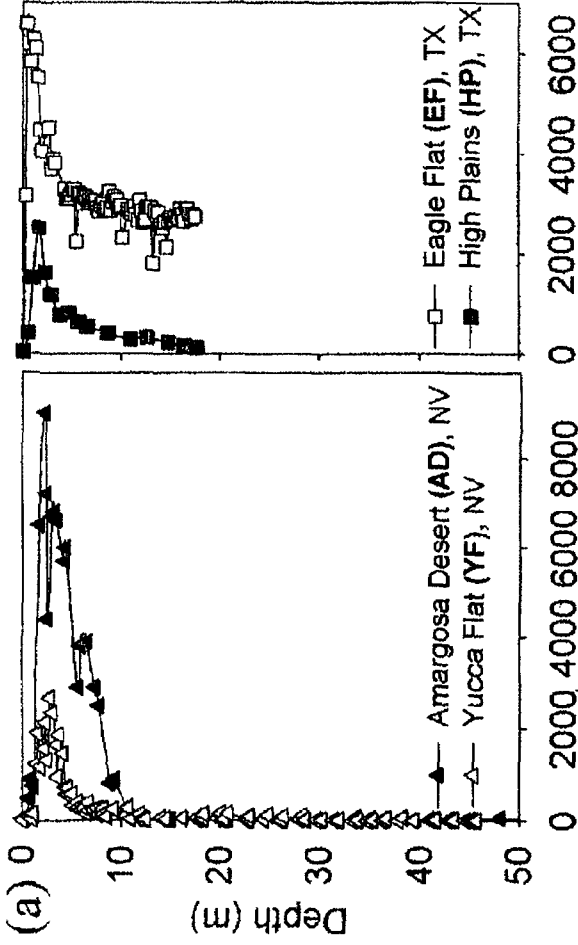
SOME TREATMENT OPTIONS

Natural encapsulation as a “chloride bulge.”

Cementation.

Heap leaching.

NATURAL CHLORIDE BULGE



From: M. A. Walvoord and B. R. Scanlon, "Hydrologic Processes in Deep Vadose Zones ..." in Groundwater Recharge in a Desert Environment, Hogan, et. al, eds, Amer. Geophys. Union, 2004.

CEMENTATION SOLIDIFICATION STABILIZATION

NMCCA&W encouraged trial of cementation and subsequent burial of drilling wastes in New Mexico.

However, we were disappointed that no reports of material tests, in-situ monitoring, or drillback of in-place wastes appeared.

We do not imply that cementation has NO benefits. Rather, the available data suggests cementation does not sufficiently retain salty wastes.

**Argonne National Laboratory,
Drilling Waste Management Information System
Fact Sheet--Solidification and Stabilization**

<http://web.ead.anl.gov/dwm/techdesc/solid/index.cfm>

"... In contrast to these examples, others (in particular, ChevronTexaco, one of the companies that partnered with Argonne to develop this website) have tested different additives and found that they either did not achieve the desired goals once the solidified or stabilized wastes were placed into the environment or that the cost of using the additives was prohibitive. Most of the solidification/stabilization systems produce conditions both of high pH and high total alkalinity. Much concern has been expressed about the long-term stability of the processes. Of greatest concern is the failure of the additives to keep the waste constituents from releasing into the environment over the long term or the sudden release of contaminants due to breakdown of the matrix. No long-term data are available because the technology has only been practiced for about 20 years, although ChevronTexaco has tested about 8 different commercial products and found that all failed leachate testing (Fleming 2000)."

CEMENTATION ...

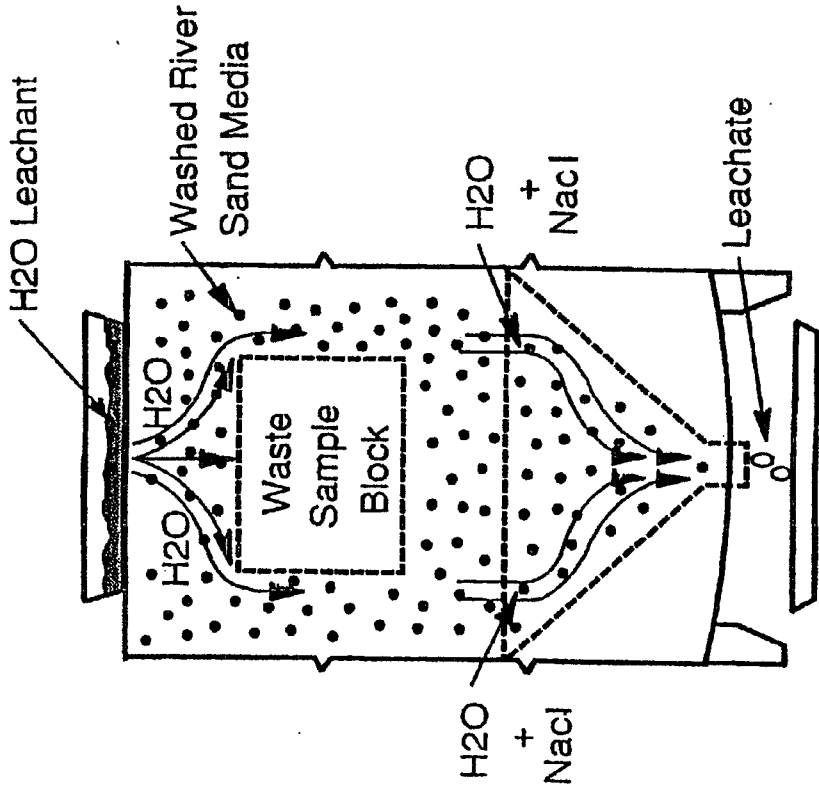
**A Study of the Leachate Characteristics of Salt
Contaminated Drilling Wastes Treated with a
Chemical Solidification/fixation Process**

L. Roberts,
Mobil Exploration & Producing, Inc., U.S.
G. Johnson, Oklahoma State University

Presented at the PROCEEDINGS OF THE FIRST
INTERNATIONAL SYMPOSIUM ON OIL AND GAS
EXPLORATION AND PRODUCTION WASTE
MANAGEMENT PRACTICES, September 10-13, 1990, New
Orleans, Louisiana.

CEMENTATION, con't.

A surrogate drilling waste sample was solidified with the SOLI-BOND process, placed in a drum of sand, and repeatedly leached with 2-inch applications of water until the unit had received 24 inches of water. Results with and without a rain cap on the samples were compared to results using samples without the solidification treatment.



FRACTION OF SALT REMOVED

WITHOUT RAINCAP

WITH RAINCAP

untreated "4x Soli-bond"

untreated "4x Soli-bond"

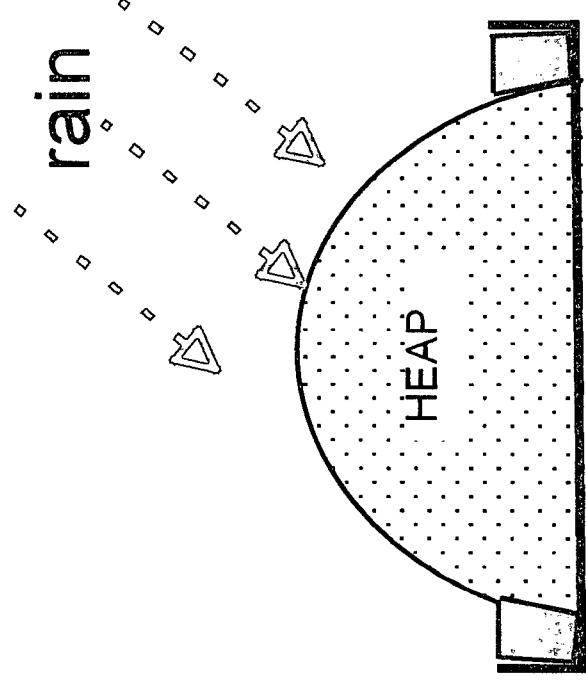
46.1%

17.7%

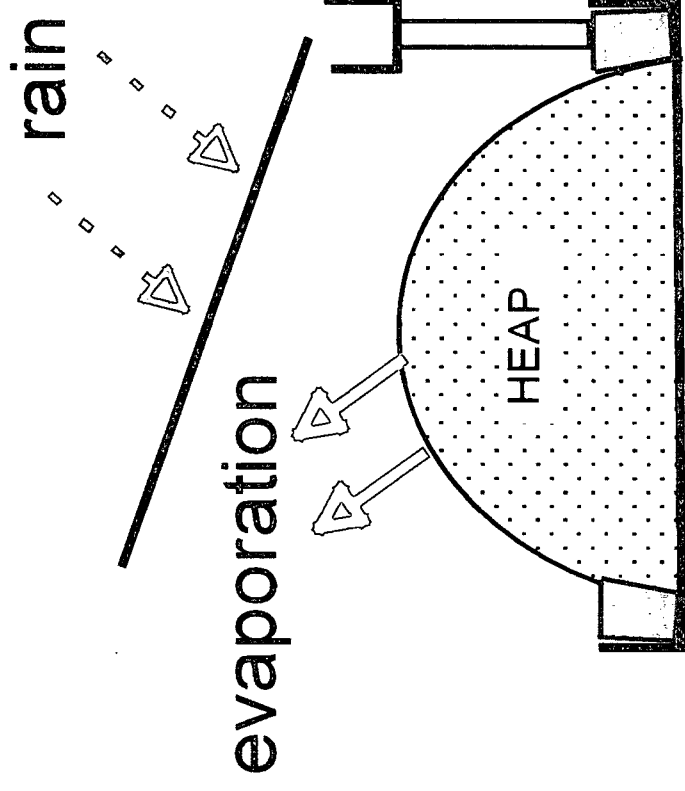
31.5%

9.0%

ARE THERE POSSIBILITIES FOR INNOVATIVE TREATMENTS, SUCH AS HEAP LEACHING?



CONVENTIONAL

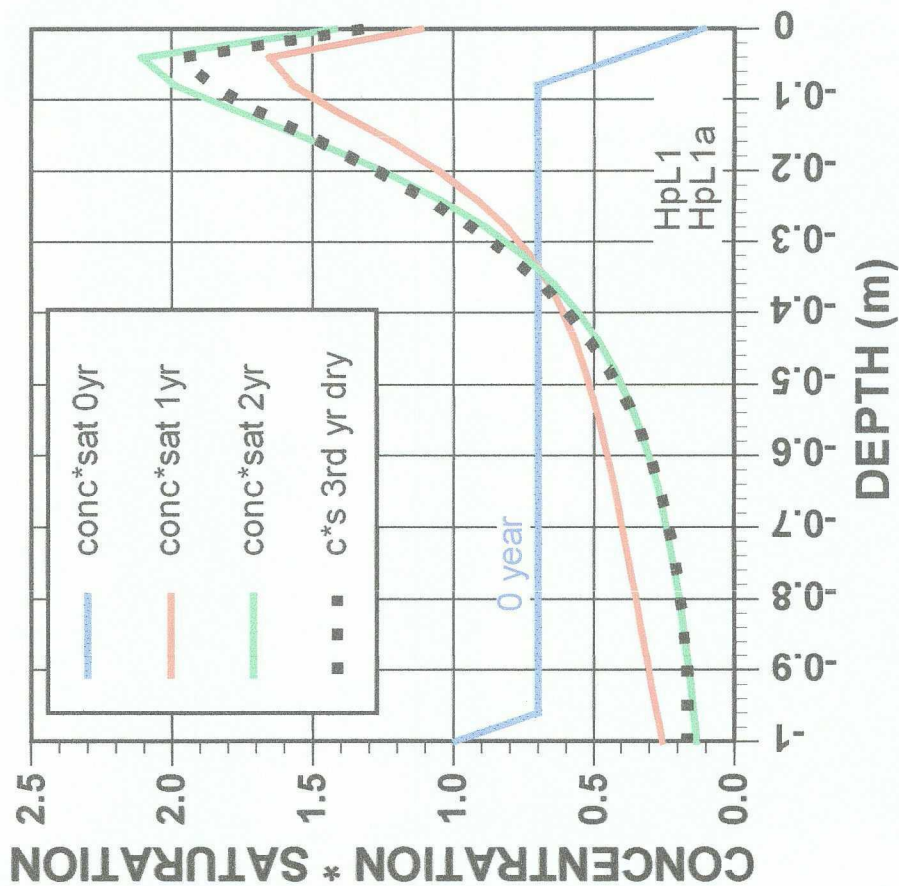
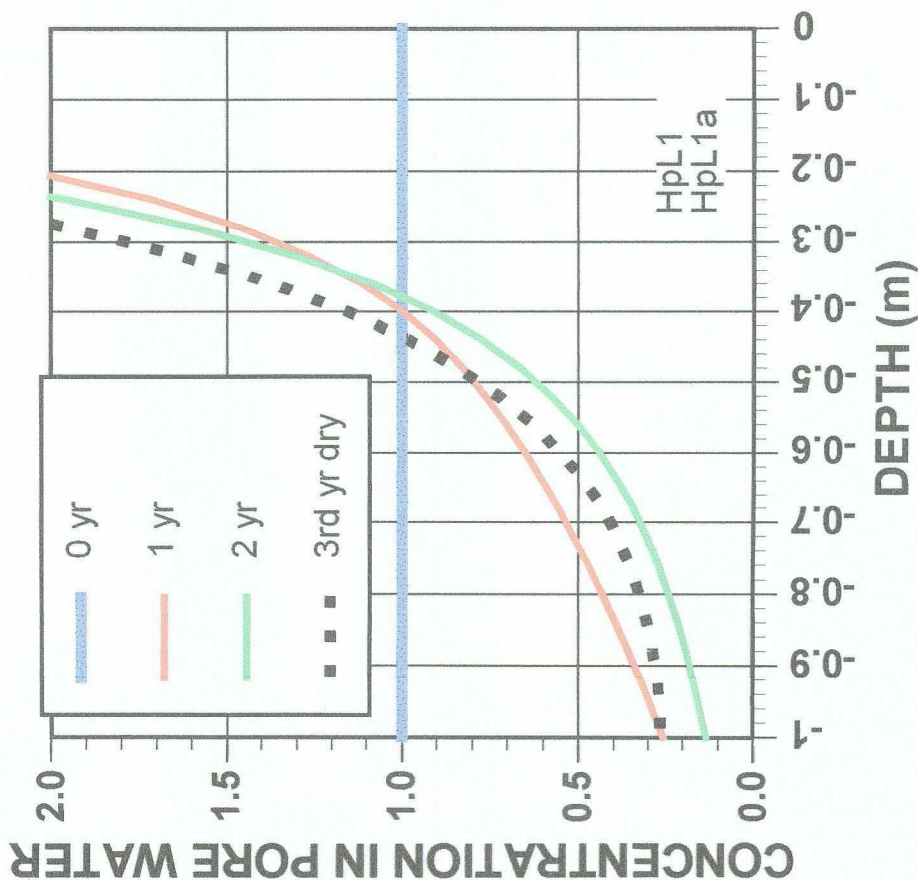


INVERTED

INVERTED HEAP LEACH

MODELING RESULTS

sandy clay loam waste characteristics



REVIEW

1. *What is in the pits?*
2. *At what level is it damaging?*
3. *If it moves, how fast, how far?*
4. *Is trench burial secure?*

5. Can it be treated or cleaned up?

We find no data showing successful long-term retention of salts by cementation.

We encourage regulation that offers motivation for development of new methods of waste treatment or reduction, such as heap leaching.

NEXT 6. *Implications of these questions for the rule.*

6. THE RULE

1. *What is in the pits?*
2. *At what level is it damaging?*
3. *If it moves, how fast, how far?*
4. *Is trench burial secure?*
5. *Can it be treated or cleaned up?*

DAMAGED PIT LINERS

For a double-lined permanent pit, the proposed rule is unclear regarding whether both liners must maintain integrity.

Replace “the liner” with “any liner” in 19.15.17.12 A(4) and (5)

... ~~the~~ any liner ...

DISPOSAL

No on-site disposal of harmful wastes.

No prohibition of on-site disposal of wastes that have been treated and proven harmless

Buried wastes, if harmful, will probably cause some harm in the future.

Buried encapsulated wastes of highly concentrated contaminants are, in effect, time bombs.

The largest concern is the vision of a future with mini-landfills “almost everywhere,” leaving a prejudice on the future uses of the land.

DISPOSAL ...

**If on-site disposal is allowed, then no disposal
where ground water is less than ~~50~~ 100 ft.
below the bottom of the waste**

19.15.17.10 C(1)

In sandy loam soil, modeling predicts that dissolved contaminants can reach groundwater at 50 feet in 40 years, and can reach groundwater at 100 feet in 100 years.

EXCEPTIONS TO THE RULE

19.15.17.15 A(2)

Notice of application for exception goes only to the surface owner and to one-time publication in a local newspaper. Exception to the pit rule is likely to be of state-wide interest, both because it may benefit other operators, and because it may, in effect, nullify the rule.

Notice should be:

Published in a newspaper of state-wide circulation.

Published on OCD's web site at the time the notice is approved.

Distributed to OCD's email list of persons receiving docket notices., or other list of concerned persons.

EXCEPTIONS...

19.15.17.15 A(2)

The rule provides that, if an objection to an exception has technical merit or if there is significant public interest, then the director may set the application for a hearing.

The rule should require a hearing if requests for a hearing have technical merit, or there is significant public interest.

An exception is likely to affect the relative costs of different operators, as well as potentially improving or diminishing environmental protection.

MODIFICATIONS

19.15.17.16 (E):

A modification may, in effect, be a significant exception to the intent and provisions of the rule. We suggest the following sentence be added to 19.15.17.16 (E):

Any modification that is equivalent to an exception of any paragraph of 19.15.17 shall be subject to the notice and approval procedures required for an exception.