Drip Distribution Research in Texas

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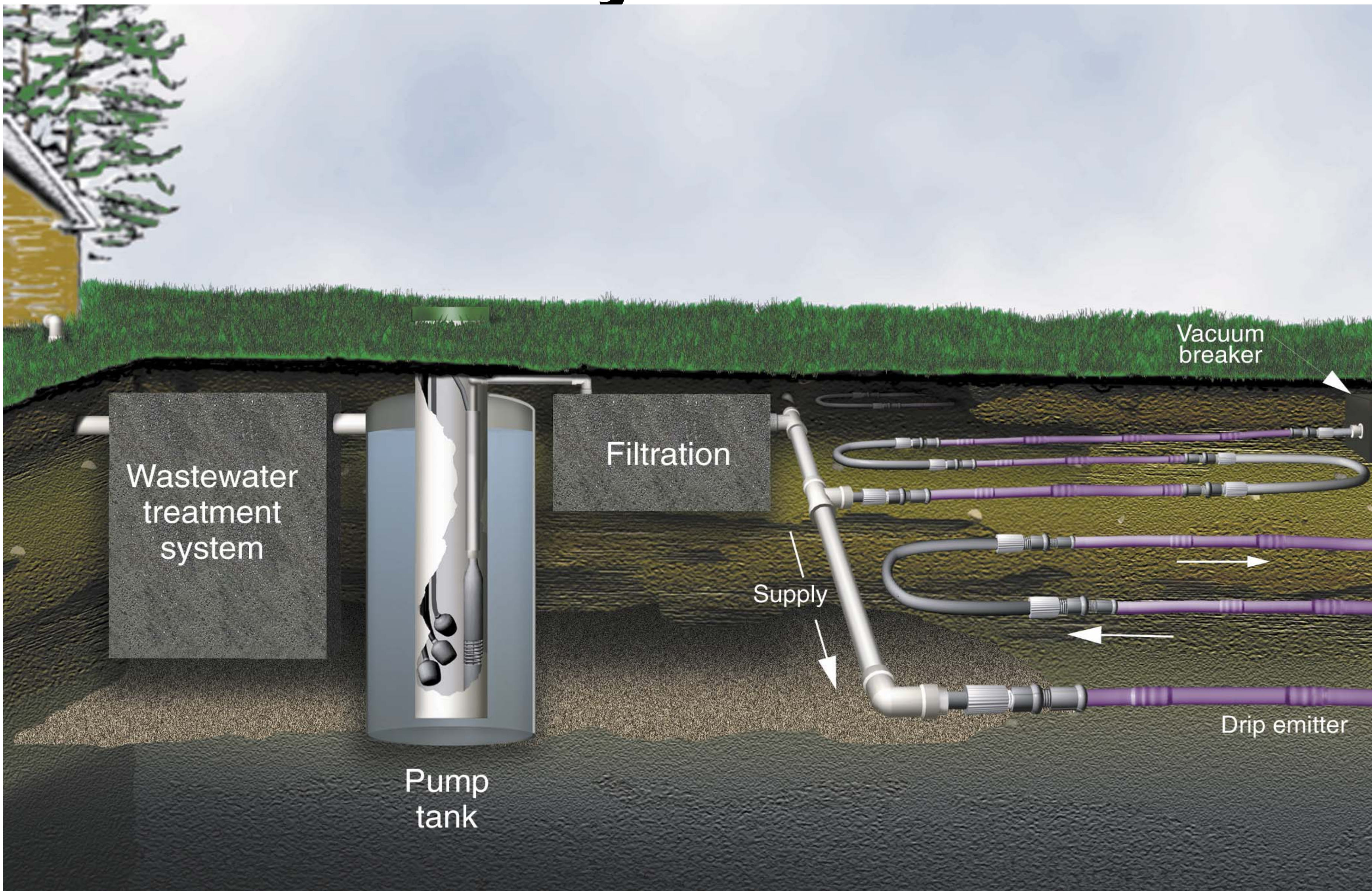
Subsurface Drip Distribution System



Why Drip Distribution?

- Uniform application of the effluent.
- Control application rate.
- Shallow soil
- Steep slopes
- High groundwater
- Full use of landscape area.
- Reuse wastewater in the landscape.

Wastewater Treatment Approach

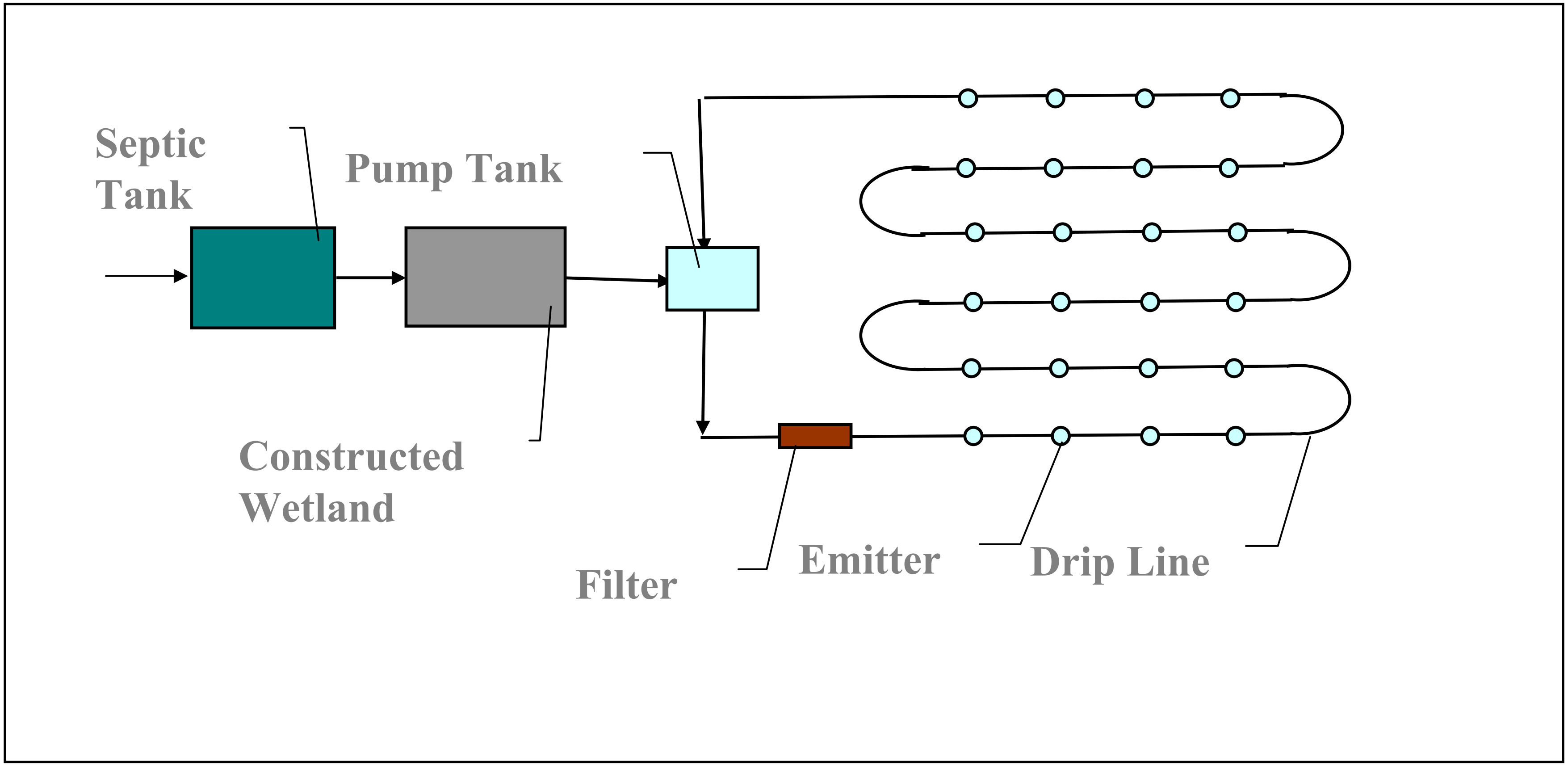
- Small doses of wastewater into the soil.
- Wastewater moves through soil under unsaturated flow conditions, thus effectively treating the wastewater.
- Wastewater can be dosed into the active surface layer of the soil.
- Maximizes reuse of nutrients and water.

Objective

Conduct a field study to characterize changes in soil hydraulic properties caused by application of septic tank effluent through subsurface drip systems.

Laboratory evaluation of water movement around an emitter.

Site Description



Wetland Pretreatment System

Weslaco Subsurface Drip Fields

Operation Data

Emitter Flow Rate, liters/hr	Average Application Rate , liters/day/m^2	Emitter Depth, cm	System Operation , year
3.4	1.83	7.5	6

Applied Effluent Quality

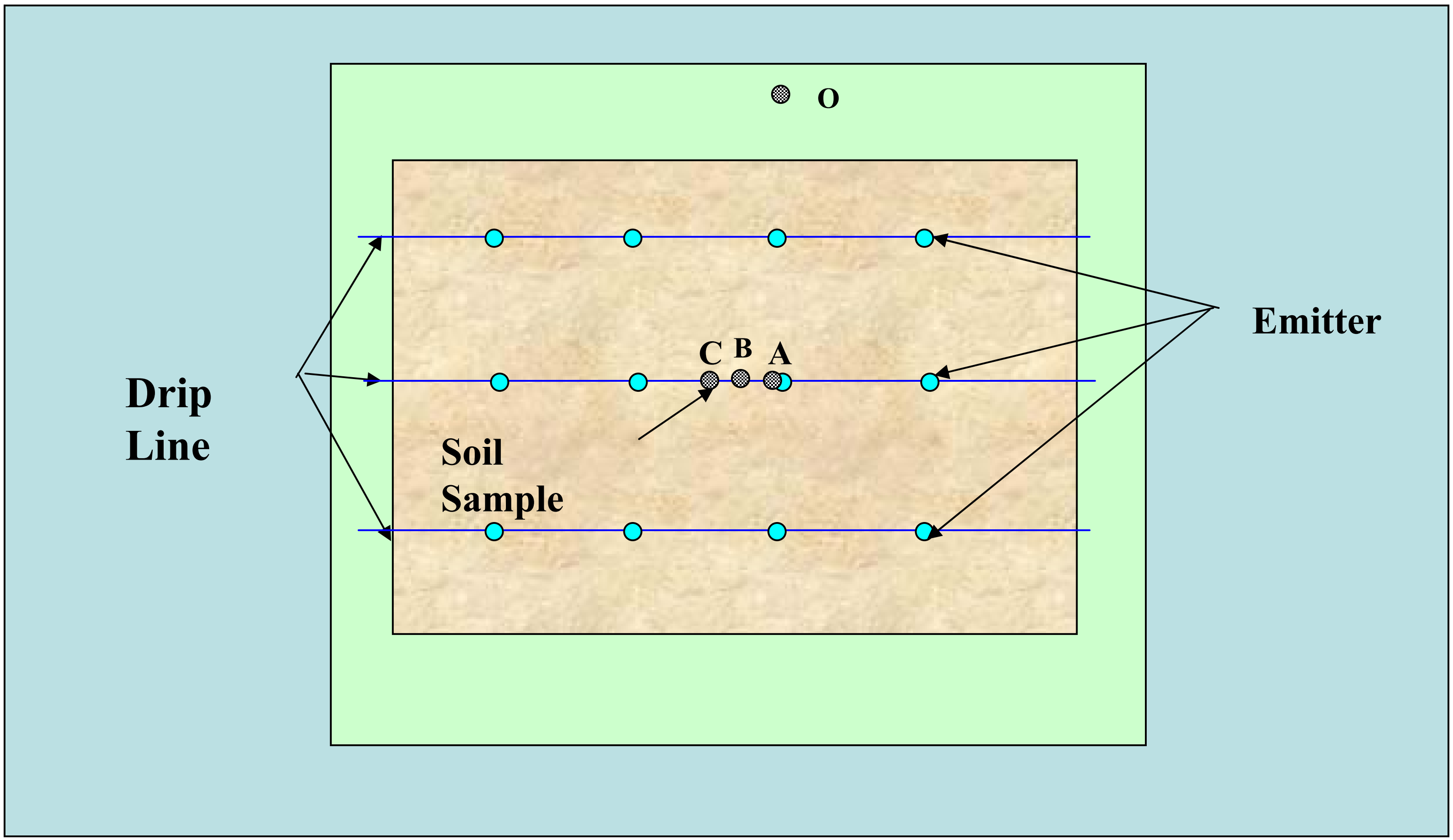
Constituent	Average
TN (ppm)	29.2
P (ppm)	0.6
K (ppm)	28.5
Ca (ppm)	113.0
Mg (ppm)	31.6
Na (ppm)	305.0
SO_4 (ppm)	280.2
Cl (ppm)	199.0
HCO_3 (ppm)	578.0
COD (ppm)	76.1
NH_4 (ppm)	30.9
BOD_5 (ppm)	23.0
Fecal (cfu/100ml)	22777
EC (ds/cm)	1.2
SAR	6.5
PH	7.2

Soil Sample

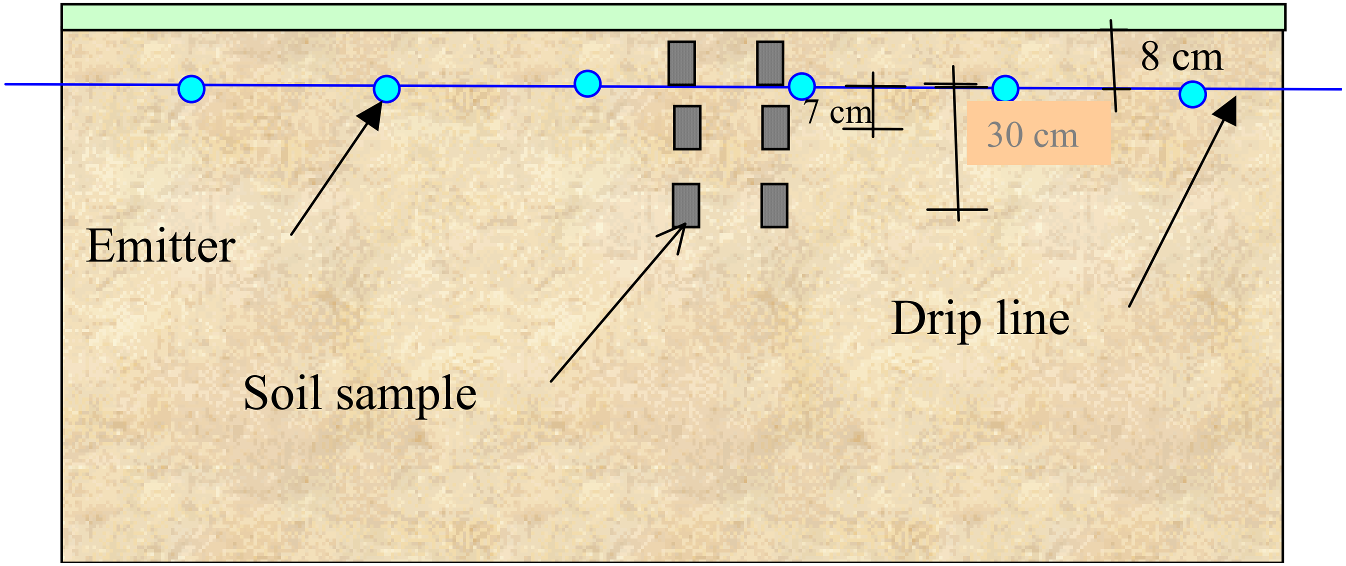
- Seven replicates of undisturbed soil cores 7.6 cm diameter by 7.6 cm long were obtained from three different locations and from three different depths around the drip emitter

Collecting Soil Samples

Location of the Soil Samples



Location of Soil Samples in Soil Profile



Soil Core Sample Tests

- Hydraulic conductivity was tested using constant head method, and
- Soil retention curve was determined using pressure cell method.

Pore Size Distribution

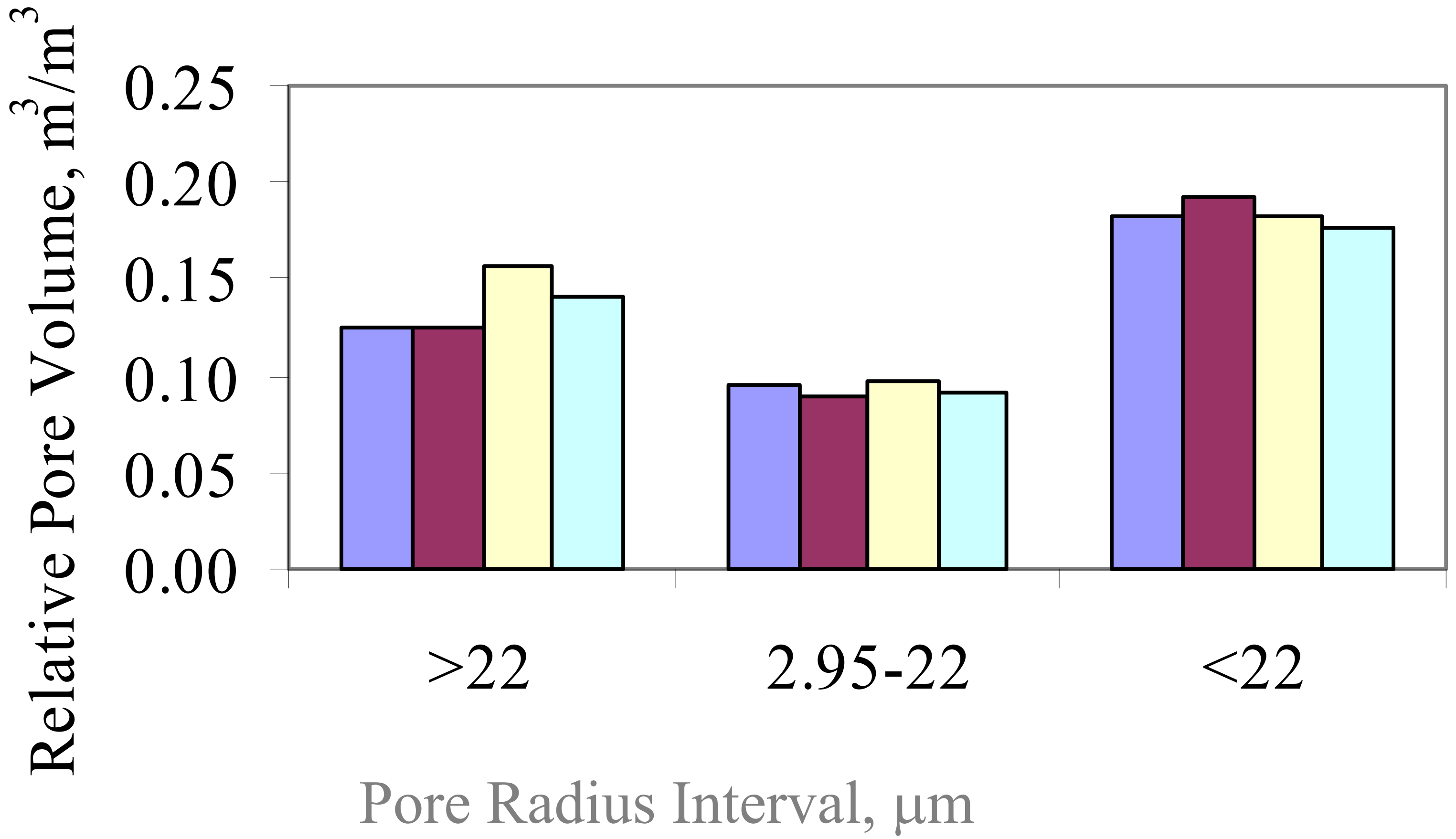
– Pore size distribution was determined from retention data using the following equation:

$$r = \frac{2\sigma \cos \varphi}{h \rho g}$$

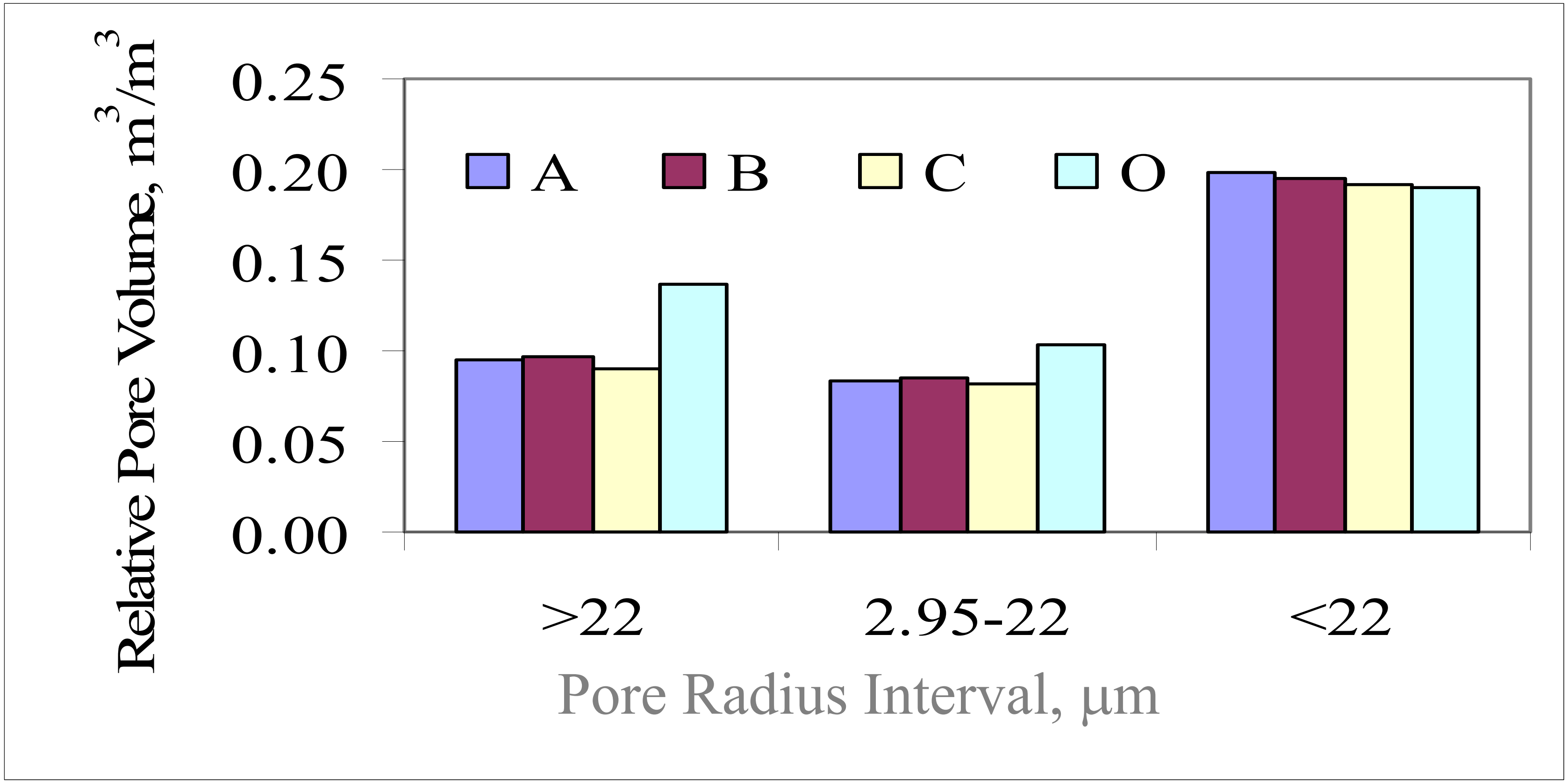
– r is the mean pore radius, h is the capillary potential, σ is the water surface tension, φ is the contact angle between liquid and solid, g is the acceleration due to gravity, and ρ is the density of water.

Results of Soil Hydraulic Properties Analysis

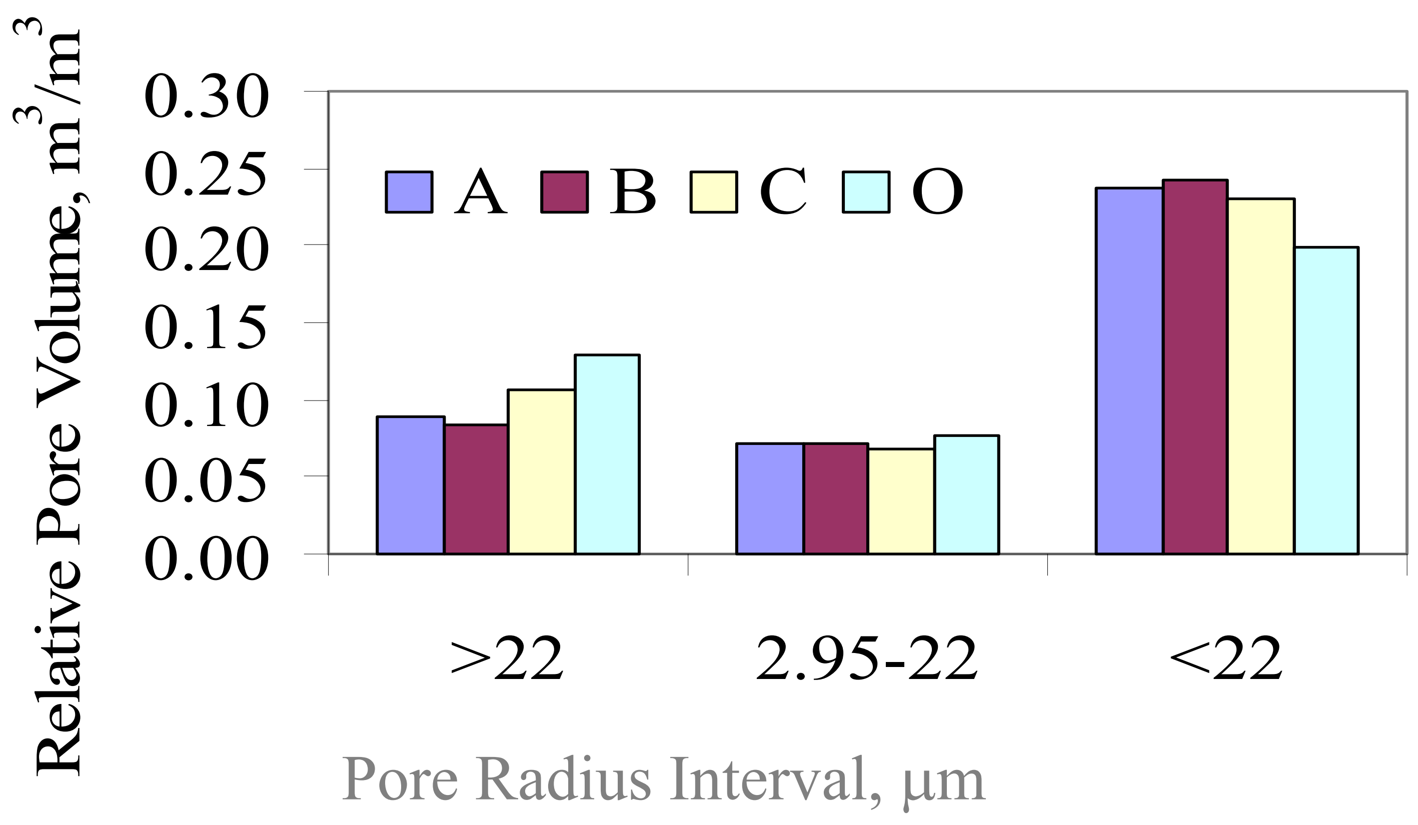
Pore Size Distribution at 3 cm Above the Emitter



Pore Size Distribution at 7 cm Below the Emitter



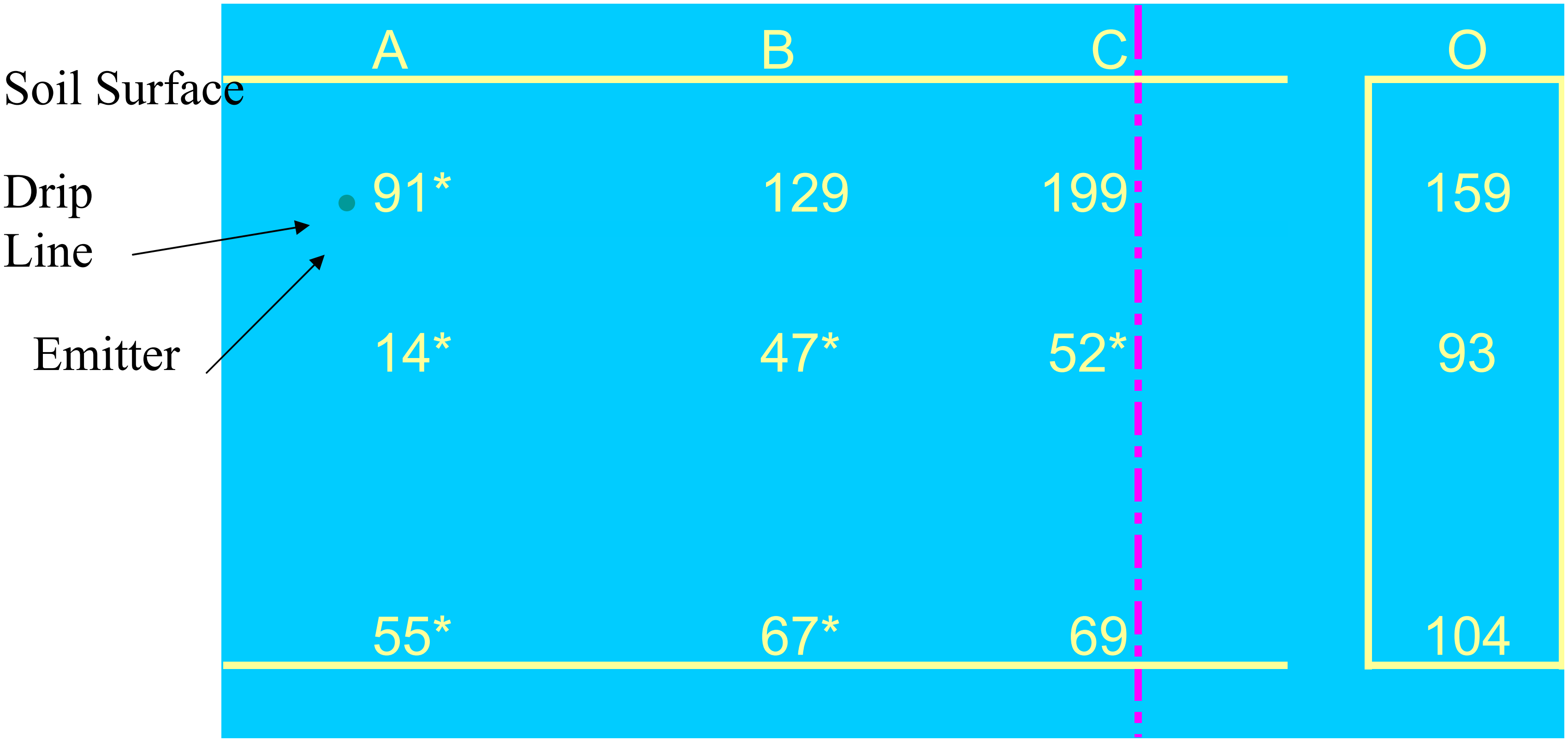
Pore Size Distribution at 30 cm Below the Emitter



Change in the Concentration of Selected Chemicals in the Irrigated Area Compared to That in the Control Area (%).

Constituents	Location A	Location B	Location C
At 3 cm above the emitter			
Na	247	165	237
Ca	2	-5	2
Mg	97	87	187
TOC	7	3	3
At 7 cm below the emitter			
Na	500	450	475
Ca	-19	-38	-49
Mg	59	32	23
TOC	-6	-5	-20
At 30 cm below the emitter			
Na	418	600	380
Ca	-60	-42	-70
Mg	-25	246	76
TOC	-85	-47	-43

Saturated Hydraulic Conductivity

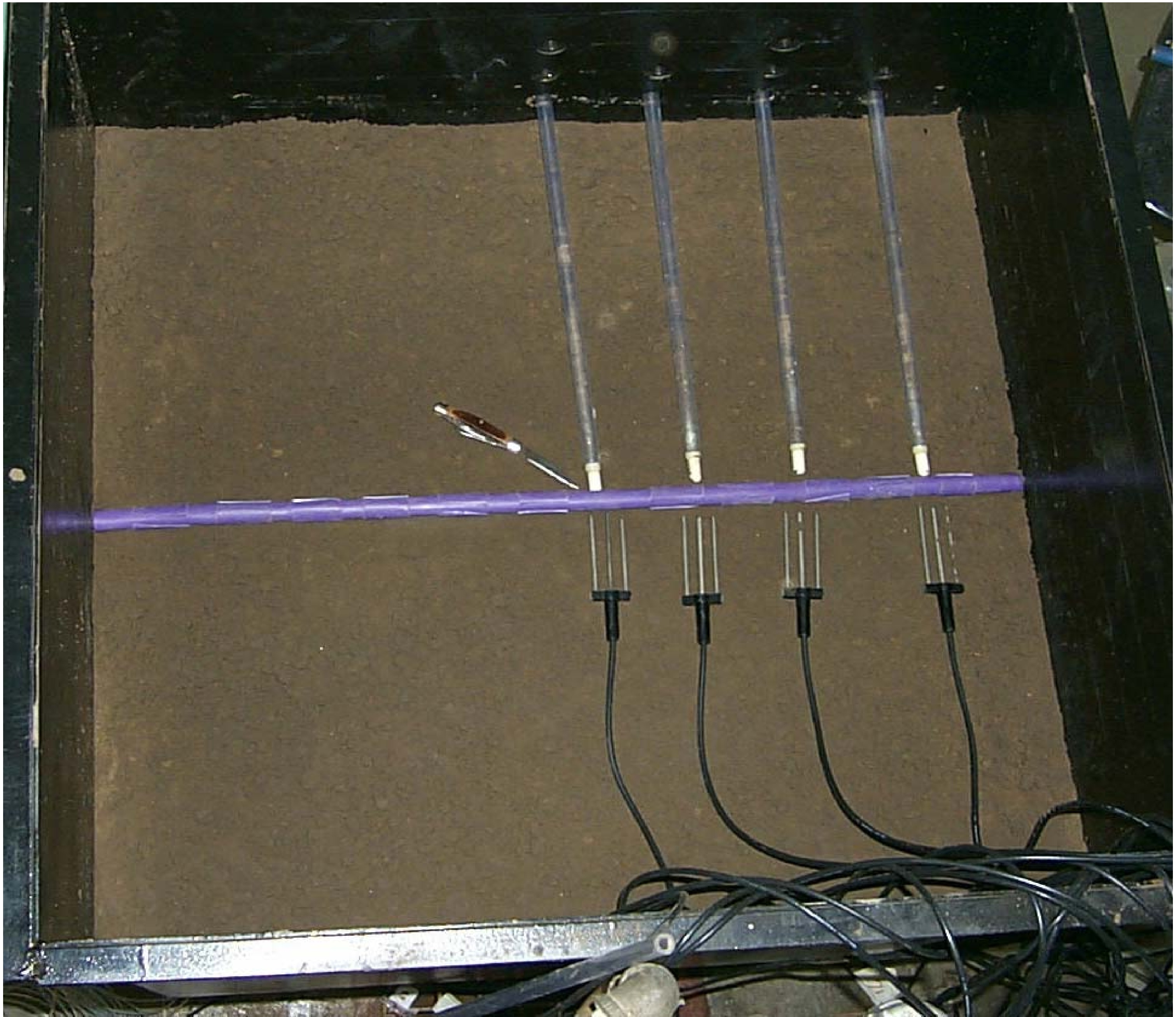


Laboratory Hydraulic Study

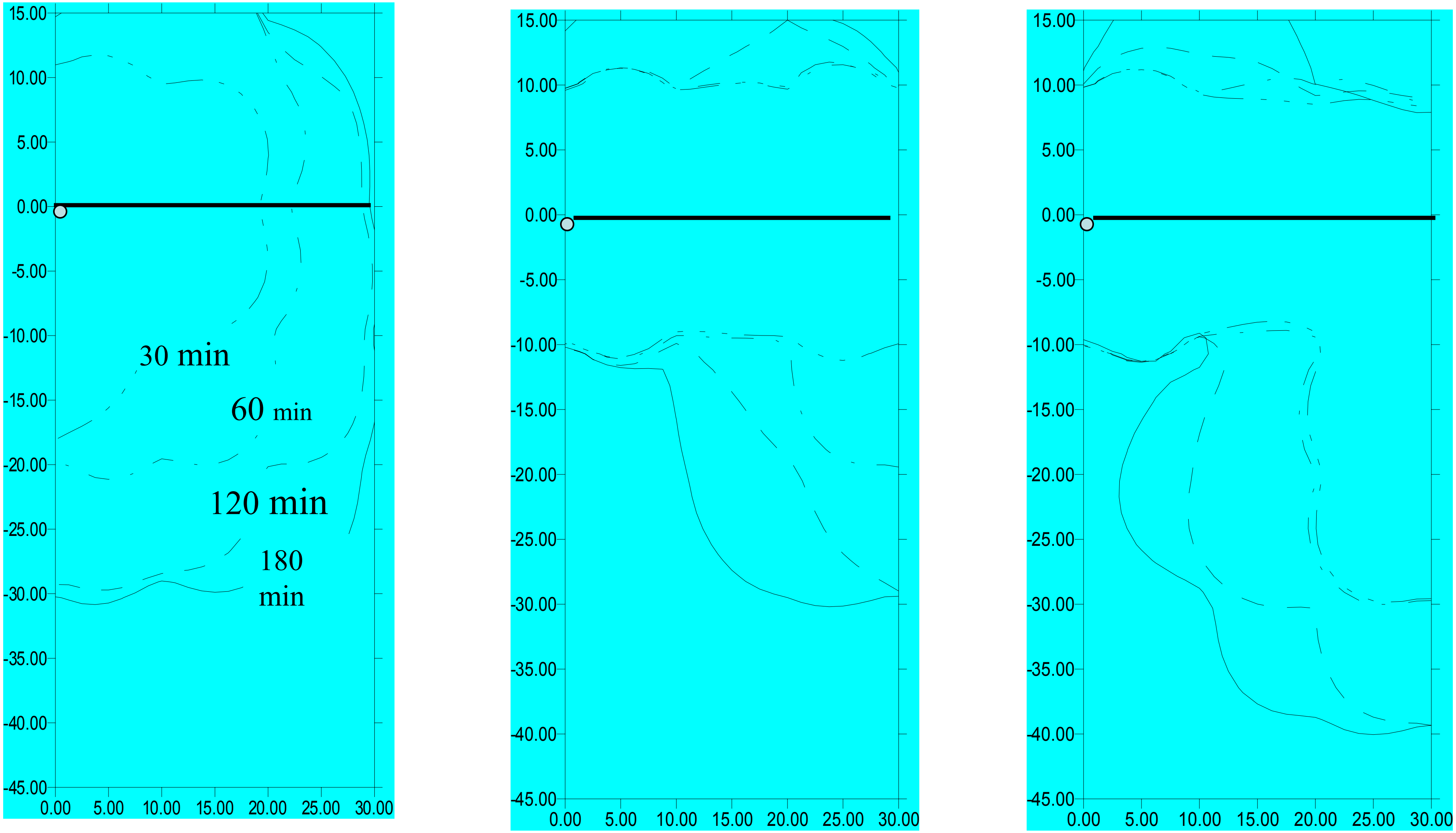
- Soil bins packed with loamy fine sand.
- Water measurement using tensiometers and TDR sensors
- Application of effluent at 0.2 g/ft^2-d
- Effluent applied to soil through drip emitter for 103 days and then additional 70 days.
- Stopped effluent application to determine water movement pattern: dried soil, turned on pump and applied water through 0.62 gph emitter for 180 minutes continuously

Laboratory Study Apparatus

Soil Moisture Sensors



Water Movement From An Operating Drip Emitter



Horizontal distance, cm

Horizontal distance, cm

Horizontal distance, cm

Hydraulic Study Discussion

- Lower conductivity below the emitter.
- Water movement below emitter is hindered
- Water moving along the drip lateral.
- After relatively long emitter run time, water moving toward surface

Vegetation Response in Drip Fields

Conclusions

- Application of treated effluent resulted in increased soil water retention, decreased volume of pores with large radii, and decreased saturated hydraulic conductivity.

- The major influence of applied effluent on soil hydraulic properties occurred in the area below the emitter.

- The impact of treated effluent on soil hydraulic properties decreased with increasing distance from the emitter.

Conclusions

- Sodium could be a major factor in altering soil hydraulic properties.
- The subsurface drip field did not exhibit a severely clogged layer similar to those associated with a biomat in a conventional septic system.