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Testimony in the matter of the application of the
New Mexico Oil Conservation Division for repeal of existing rule 50 concerning pit waste management and adoption of new rules governing pit waste management
Case No. 14015

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Summary of Testimony

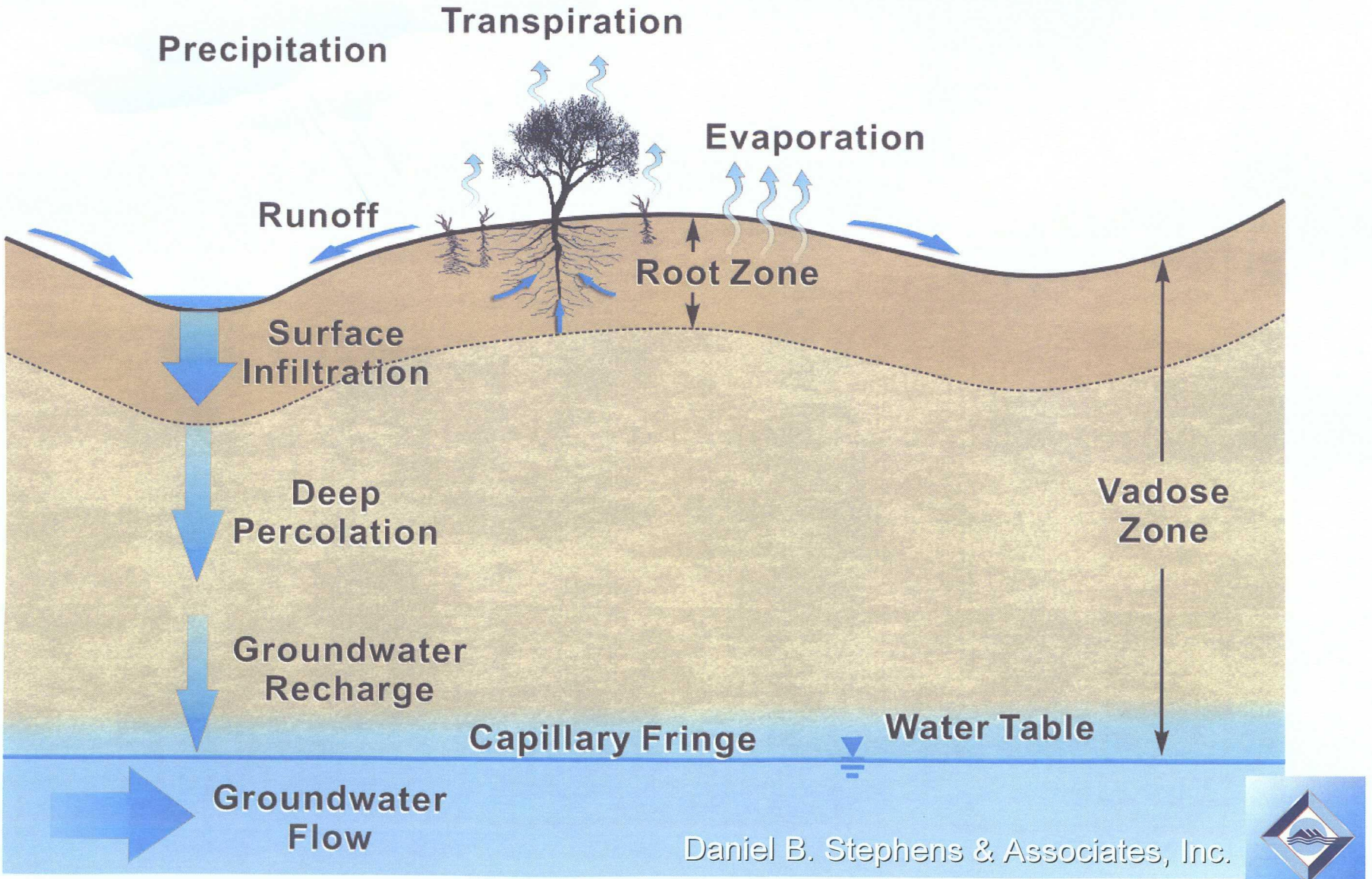
- Regulations should be internally consistent, reasonably protective to public health and environment, and implementable

Natural Recharge

- Water percolation below the root zone which reaches the groundwater table

- Important to assessing potential for chloride in pit to reach groundwater and exceed standards

Hydrologic Cycle



Proposed Siting Requirements for Pits

- 100 feet from water courses
- Pit location is required to be in an area of potential diffuse recharge, between water courses
  - Depending on site characteristics, diffuse natural deep soil-water movement may be:
    - Downward (recharge to groundwater)
    - Upward
    - Zero

Diffuse Natural Recharge

- Sevilleta National Wildlife Refuge, Bernardo, NM
  - Floodplain of Rio Salado
  - Unconsolidated sand
  - Salt bush dominant
  - Precipitation = 200 mm/yr
- Recharge: 2.5- 8.4 mm/yr

Diffuse Natural Recharge

- NMSU Ranch Site
  - Sandy loam, carbonate zones
  - Grass, yucca, shrubs
  - Precipitation = 230 mm/yr
- Recharge: 1.5-9.5 mm/yr
- Phillips et al. 1988

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Example of Site with Upward Gradient in Deep Vadose Zone

- Sunland Park, NM
  - Rain: 8 inches/yr
  - Potential Evapotranspiration: 50 in/yr
  - Santa Fe Group
  - Creosote
  - Terrace-Floodplain transition zone
- Upward gradient (9-39 ft bgs), no recharge
- Stephens & Coons (1994)

Summary

- Vegetation is important in evaluating recharge
- Diffuse recharge is a few mm per year.
- Pits will be sited in diffuse recharge areas
- Note dry and wet fronts, no constant unsaturated flow

Natural Chloride Soil Profiles

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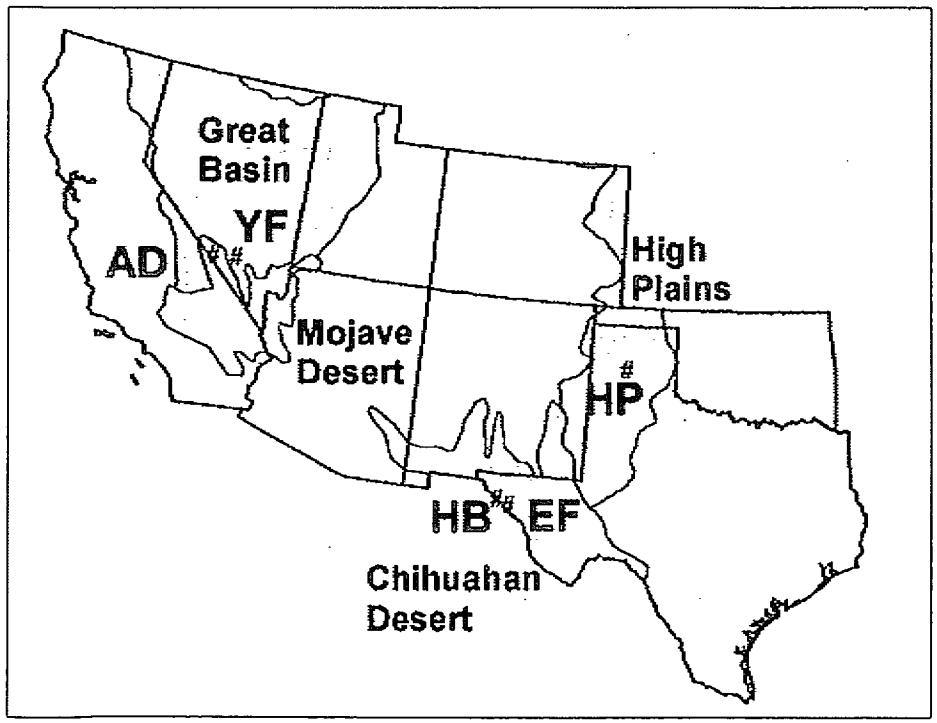
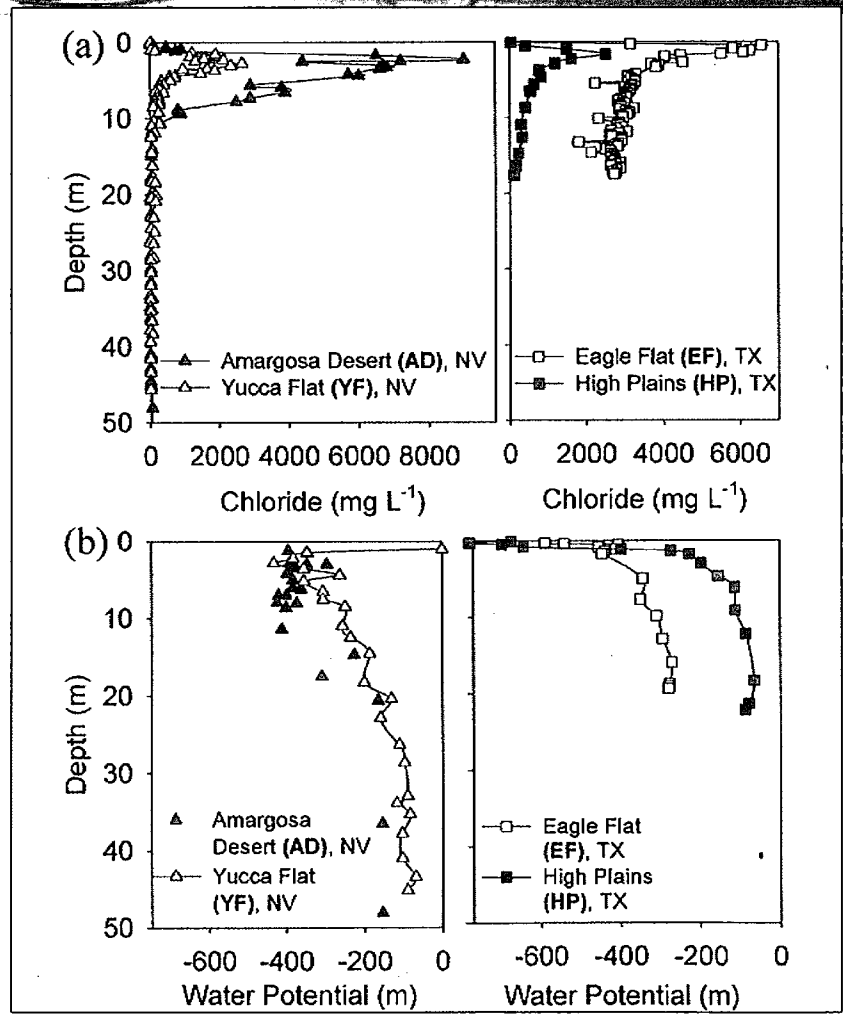
Natural Soil Chloride 'Bulges'



Source: Walvoord & Scanlon, 2004



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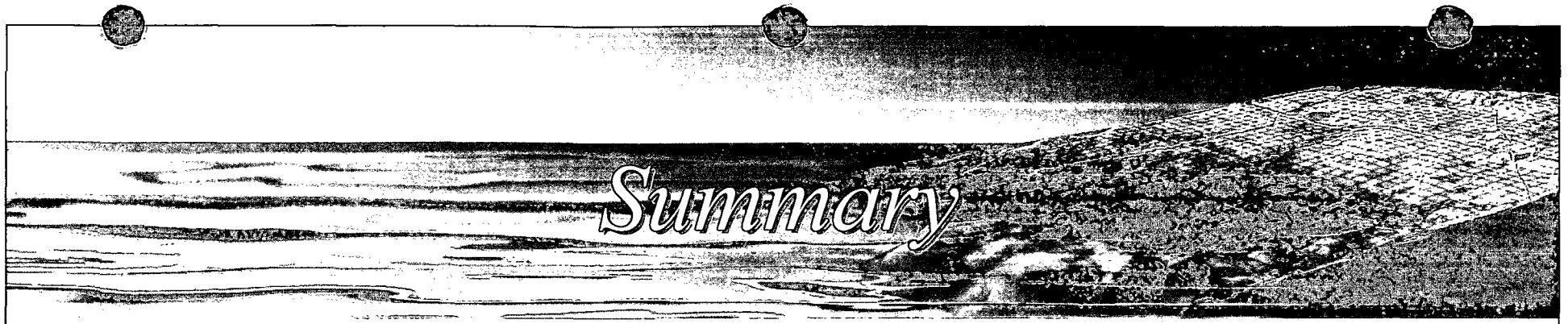
Natural Soil Chloride Profile

- Varies depending on:
  - Soil texture; soil moisture
  - Vegetation; ET
  - Net infiltration; age/time of accumulation
  - Proximity to oceans
- Concentrations vary considerably with depth; up to 540 mg/kg at 3 ft bgs;
- Useful for interpreting recharge
  - Chloride mass balance method

Chloride Bulges in Soil Occur over Large Areas in New Mexico

Location	Depth to Cl^- Peak bgs (ft)	Pore Water Cl^- at Peak (mg/L)	Soil Cl^- at Peak (mg/kg)	Reference
Chihuahan Desert, TX and NM	6 to 22	480 to 6,500	50 to 290	Stephens and Coons, 1994; Scanlon, 1991; Phillips et al., 1988
San Juan Basin, NM	2 to 28	490 to 4,170	50 to 540	Stone, 1984; Scanlon and Goldsmith, 1997
Santa Fe County, NM	2 to 16	1,170 to 9000	150 to 440	Scanlon, 1991; USGS 1994; Stone, 1984; Moore, 2003
Socorro County, NM	0.5 to 14	740 to 1,860	70 to 230	Stone, 1984c; Stonestrom and Akstin, 1998; Phillips et al., 1988
Southern High Plains of TX and NM	3 to 31	640 to 2,900	80 to 260	USGS 1994; Scanlon and Goldsmith, 1997



Summary

- Chloride bulges common in the Southwest
  - Indicates scant recharge for the past 10,000 years

Diffuse Recharge in Southwest

Site	Estimated Annual Recharge (mm/yr)	Reference
San Juan Basin, New Mexico	0.25 - 2.29	Stone, 1986
Socorro, New Mexico	2.0-7.0	Phillips et al., 1988
El Paso, Hudspeth County, Texas	0.9-7.0	Scanlon, 1992
Las Cruces, New Mexico	1.5-9.5	Phillips et al., 1988
Sunland Park, New Mexico	0.066-0.19	Stephens & Coons, 1994
Ogallala Aquifer of Texas High Plains	2.3	Baker & Wall, 1976
Ogallala Aquifer at Portales, New Mexico	3.2-16.9	Theis, 1937
Ogallala Aquifer in Lea County, New Mexico	9.6	McAda, 1984

Source: API 1996

Reestablished Vegetation

- Low levels of diffuse natural recharge are the result of transpiration by vegetation
- Reestablished vegetation at pits enhances water extraction and restrict recharge

Summary

- Recharge is low in diffuse areas of the Southwest
- Vegetation reduces recharge

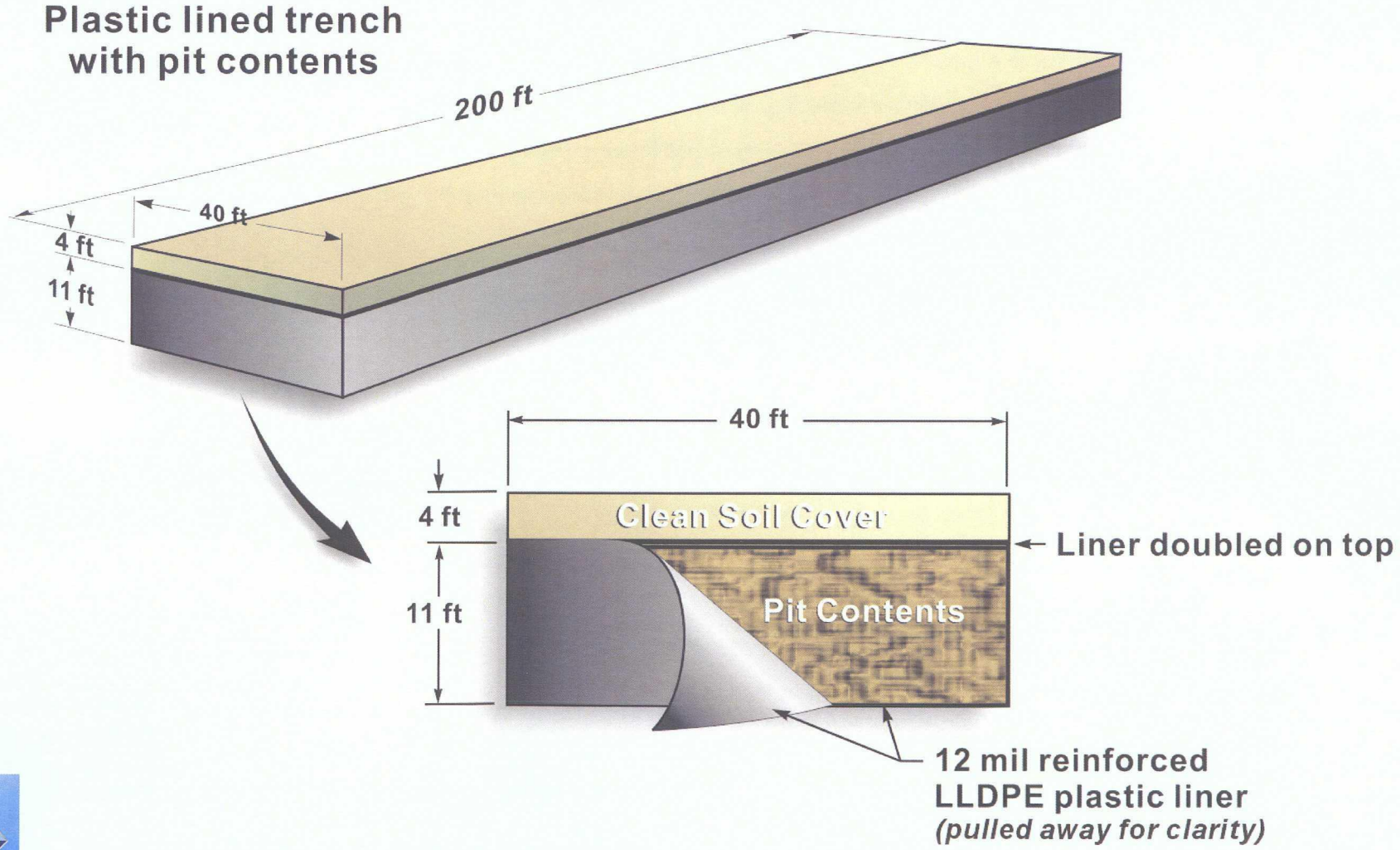
Pit Operations

- Southeast, New Mexico
- Northwest, New Mexico

Southeast Pit Operation

- Placed on natural soil surface
- Vadose zone water flow dynamics created over 10,000 + years;
- Pit lined on all sides (e.g., deep trench burial) with 12 mil reinforced LLDPE plastic liner
- Pit covered with 4 feet of clean soil
- Vegetation on cover is well established by time pit liner begins to fail in 270 years (Koerner et al 2005)

Current Practice in Southeast New Mexico



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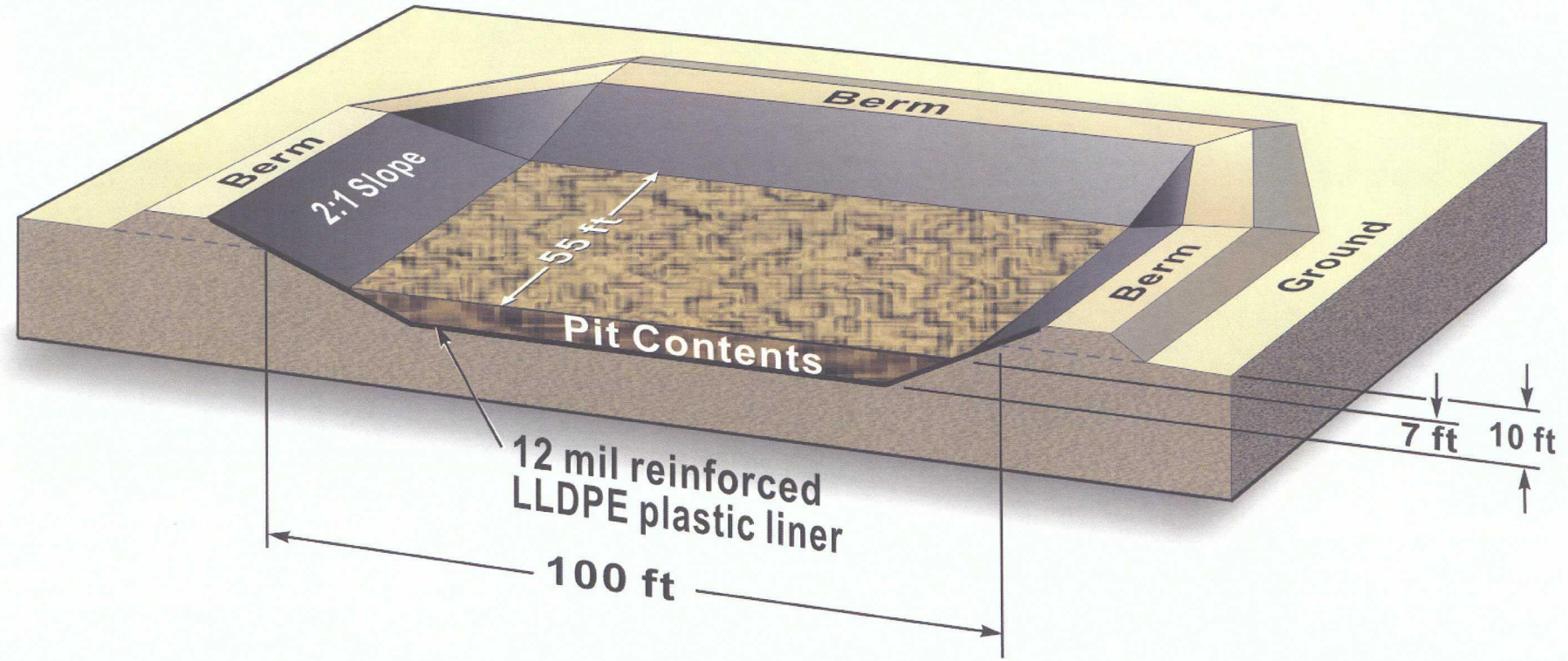
Northwest Pit Operation

- Placed on natural soil surface
- Vadose zone water flow dynamics created over 10,000 + years;
- Pit lined on bottom, top and sides with 12 mil reinforced LLDPE plastic liner
- Pit covered with 4 feet of clean soil
- Vegetation on cover is well established by time pit liner begins to fail in 270 years (Koerner et al 2005)

Operating Pit in Northwest New Mexico



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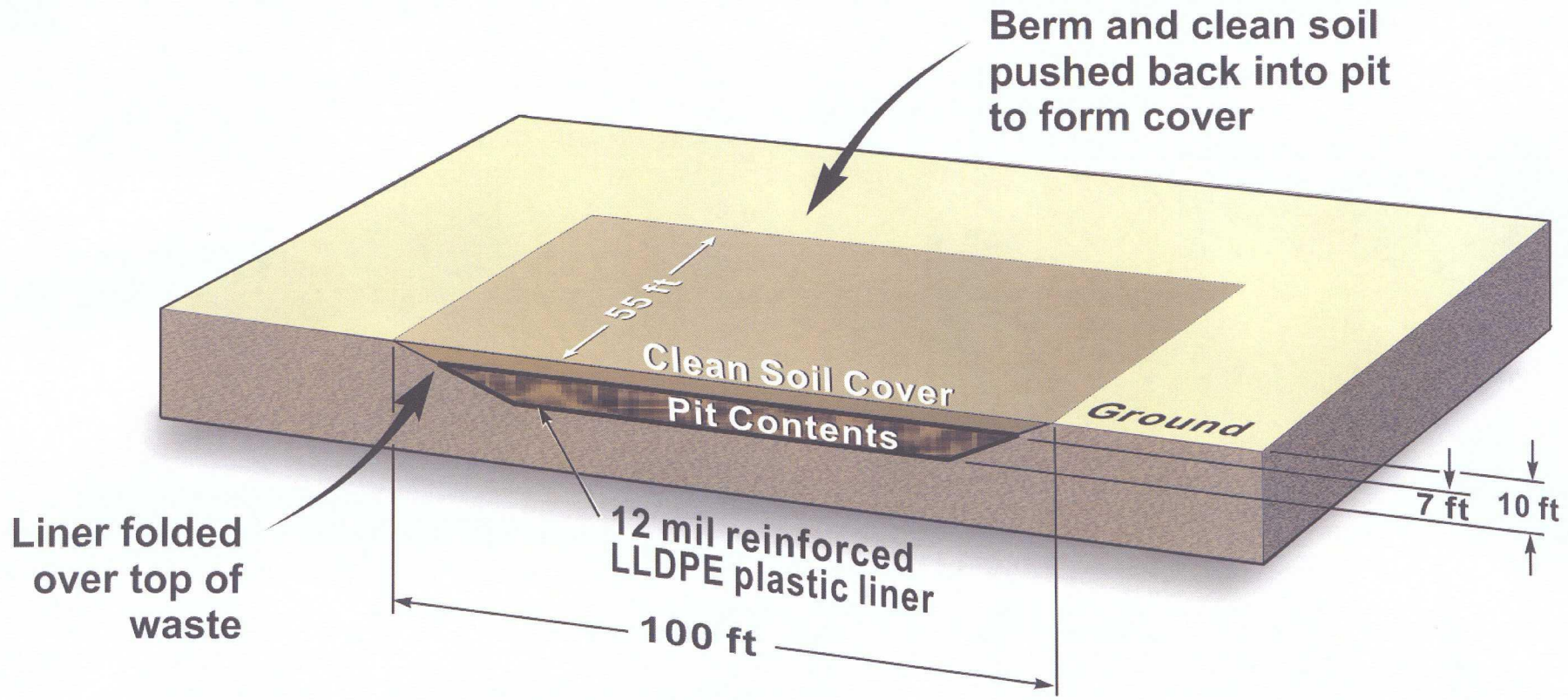
Pit Closed in Place in Northwest New Mexico



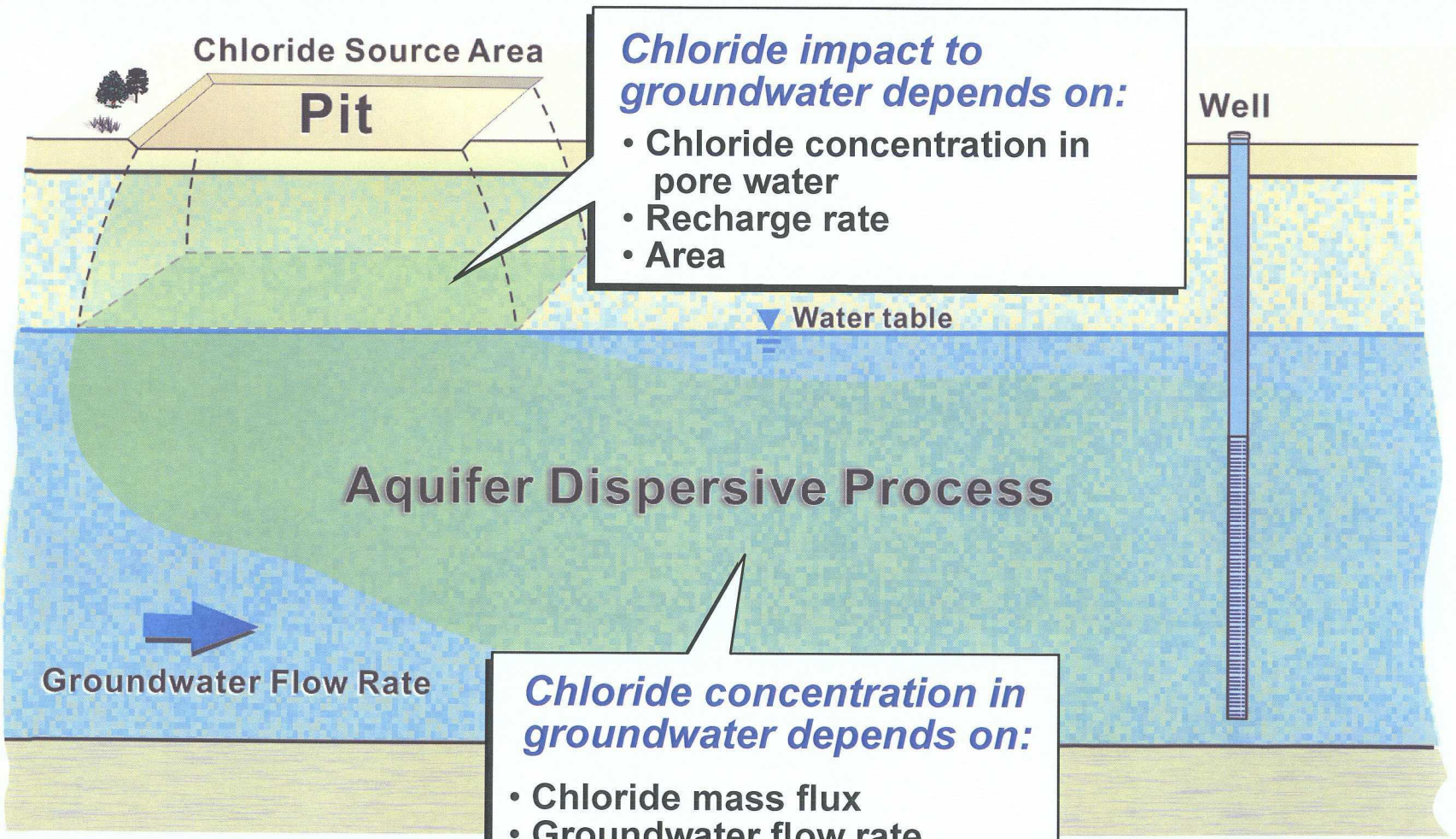
Modeling of Chloride Impact

- Used models to predict soil concentration in pit soil that would be protective of human health and groundwater.
- Models begin simulation in 270 years when it is assumed that pit liners completely and instantaneously fail.

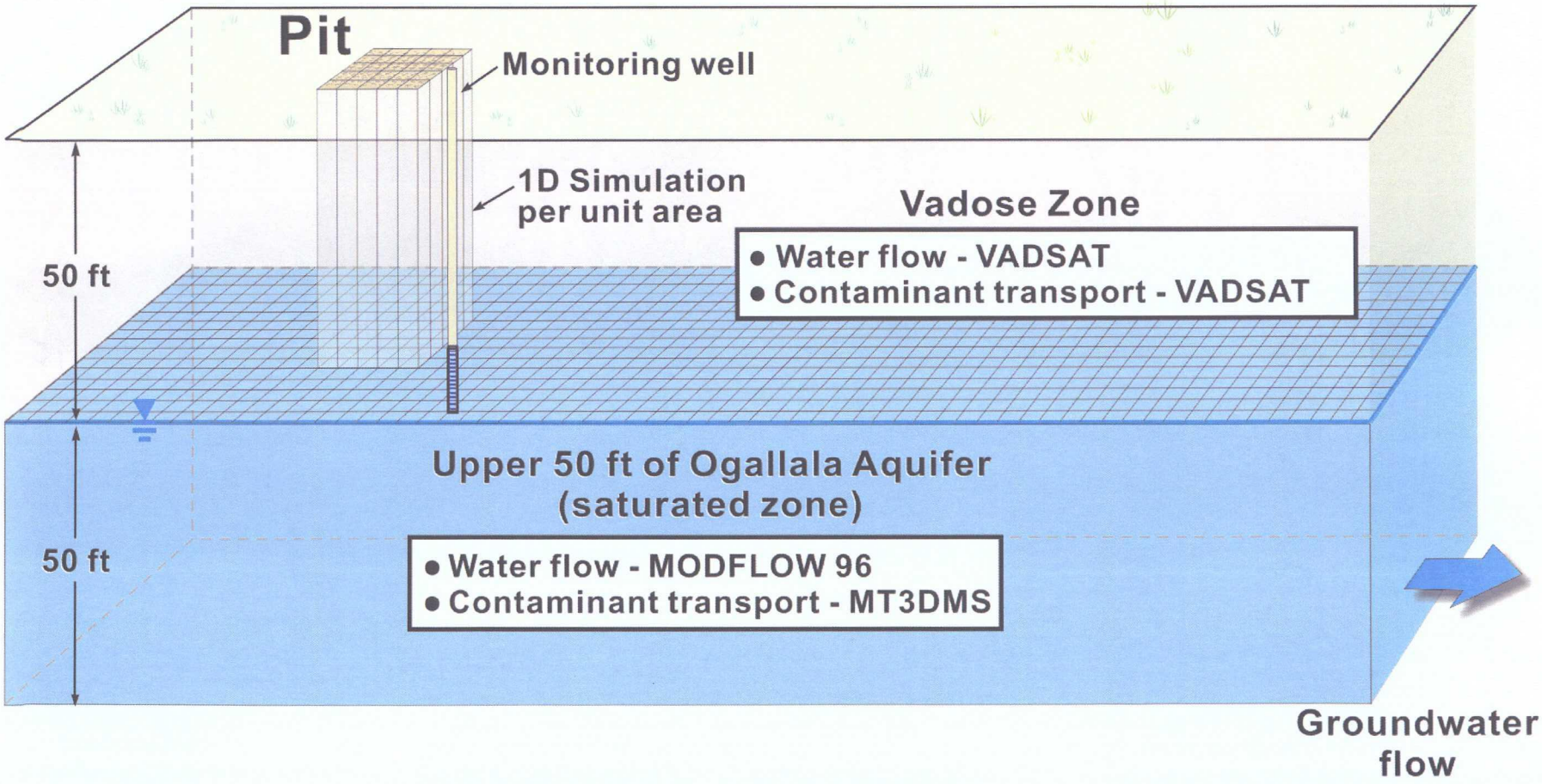
Conservative Modeling Assumptions

- Pit liners completely and instantaneously fail after 270 years (based on Koerner et al 2005).
- Pit and natural soils are uniform in type, which enhances infiltration.
- Recharge is steady and downwards

Aquifer Dispersive Processes



Conceptual Model for Vadose and Saturated Zone Modeling



Model Input Parameters

- Loamy sand; Carsel and Parrish, 1988
  - Saturated hydraulic conductivity of 11.5 ft/d is consistent with
    - Ogallala geometric mean of 6.8 ft/d (Blandford et al 2003) and
    - the range published for the San Juan basin alluvium (3 - 3000 ft/d; Walvoord et al 1999)

Model Input Parameters

- Recharge is 2.5 mm/yr for all simulations (Phillips 1988),
  - exceeds the recharge reported for San Juan basin (Stone, 1986)
  - exceeds recharge estimated in interplaya regions of the southwest where plants are well established in sufficiently deep soils (0.03 to 0.1 mm/yr; Walvoord and Scanlon, 2004).
- Simulations used larger and thicker southeast pits. Impacts from northwest pits will be less.

Predicted Chloride Concentration Which is Protective of Groundwater

Soil Mixing Ratio Required At Closure	SPLP Chloride Standard (mg/L)
None	1240
1:1	2480
2:1	3720
3:1	4960
4:1	6200
Average	3720

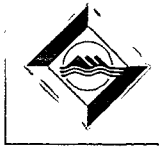
- Leaching procedure is EPA SW846 Method 1312 (Synthetic Precipitation Leaching Procedure [SPLP])

Modeling of Benzene and PCE to represent organic 3103 constituents

- Modeling was conducted to estimate the maximum allowed soil concentration of volatile organics
- Initial conditions are with the pit well mixed and aerated prior to closure.
- Modeling allowed for adsorption and volatilization but not biodegradation
- Results showed that all VOC mass volatilizes within 10 days.

Summary

- Deep percolation/recharge in arid and semi-arid areas of New Mexico is limited
- Modeling was conducted to determine pit contents protective of ground water.
  - Modeling results show that the leaching standard could be 1,240 mg/L to 6,200 mg/L depending upon amount of mixing
- Modeling shows that VOCs volatilize to the atmosphere within 10 days after mixing



Recommendations

- Based on model results, chloride SPLP leaching standard should be 3,500 mg/L
- Small, dispersed closure of pit contents is preferable to concentration of contents in commercial landfills
- Modeling shows that organics are not at levels of concern.