CASE NO. 14015
OCD EXHIBIT 21

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

Pit Release Modeling for the Permian and San Juan Basins

Conducted by

Environmental Bureau
Oil Conservation Division
New Mexico Energy, Mineral and Natural Resources Department

Predictive Models

- Hydrologic Evaluation of Landfill Performance (HELP) Model
  - Water balance model with several computer codes including: run-off, evaporation, transpiration, soil water storage, etc.
  - Developed by the U.S. ACE for the U.S. EPA

- Multimedia Exposure Assessment (MULTIMED) Model
  - Pseudo two-dimensional computer codes including: vadose zone and aquifer transport
  - Developed by the U.S. EPA

Predictive Models

- HELP Model
  - Use of actual daily weather data
  - Determination of release rates at the bottom of unlined and lined pits
  - One of the most accurate predictors of release rates from waste disposal areas
  - Used by other States and industry

- MULTIMED Model
  - Use of HELP's output for the input of the most sensitive parameter (i.e., the infiltration rate)
  - Determination of release concentrations over time at the bottom of the vadose zone and in the aquifer
  - A conservative predictor of release concentrations and times

HELP Conceptual Model (inputs)

- Weather data
  - Daily precipitation
  - Daily temperatures
  - Daily solar radiation indexes
  - Daily evaporation indexes

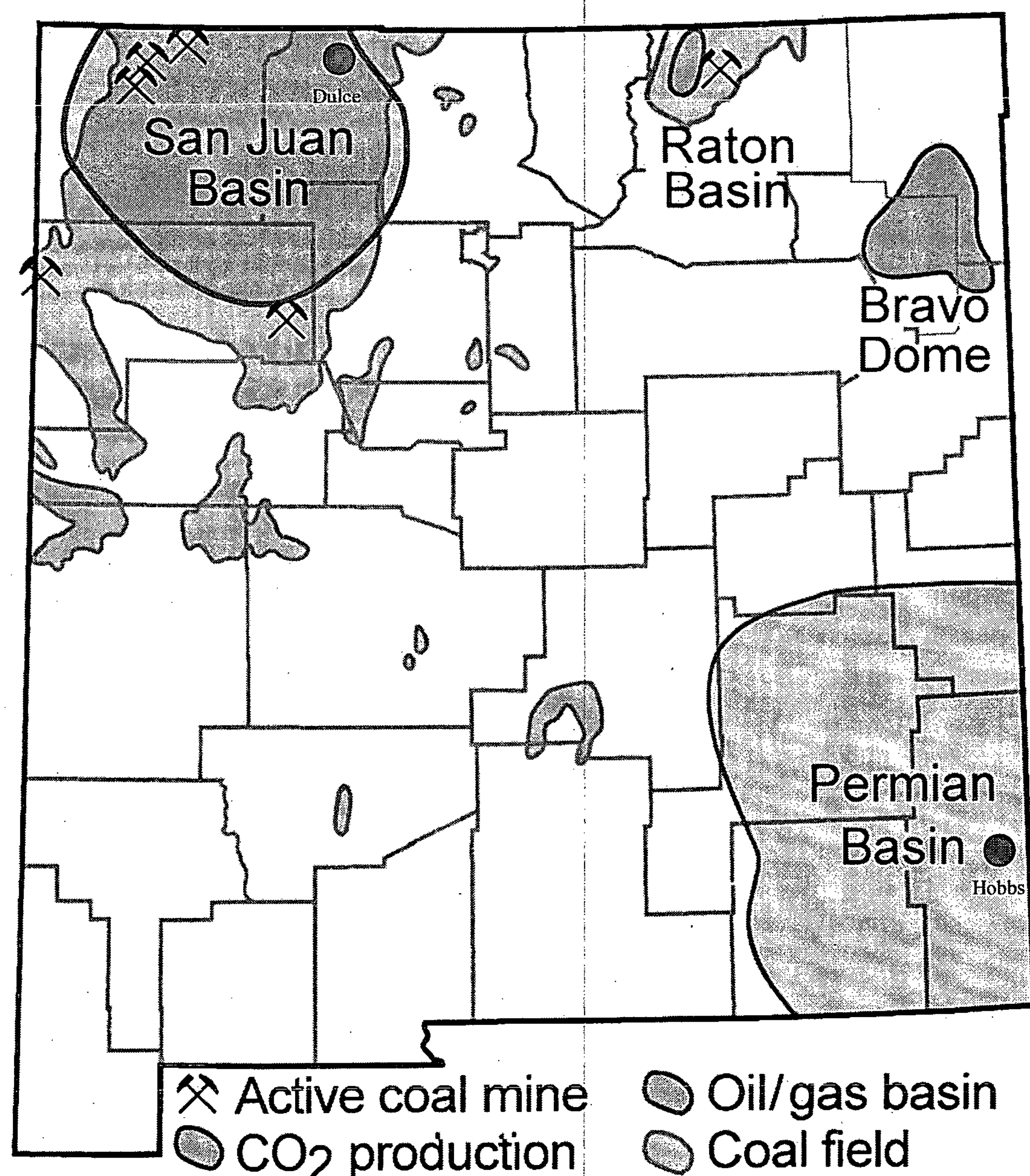
- Soils data
  - Number of layers
  - Type of layer
  - Layer thickness
  - Soil type
  - Soil porosity
  - *Soil field capacity*
  - Soil wilting point
  - Soil initial moisture
  - Soil saturated hydraulic conductivity
  - Quality of liner installation
  - Type of cover material
  - Slope of cover material

HELP Conceptual Model (inputs)

- Two sets of weather data* for 50 years (1951 -2000):
  - Permian Basin (Hobbs at an average precipitation of ~16"/y)
  - San Juan Basin (Dulce at an average precipitation of ~17"/y)

*Climatedata™ by Hydrosphere Data Products, Inc. (data obtained from National Climate Data Center)

Conceptual Models
Weather Data



HELP Conceptual Model (inputs)

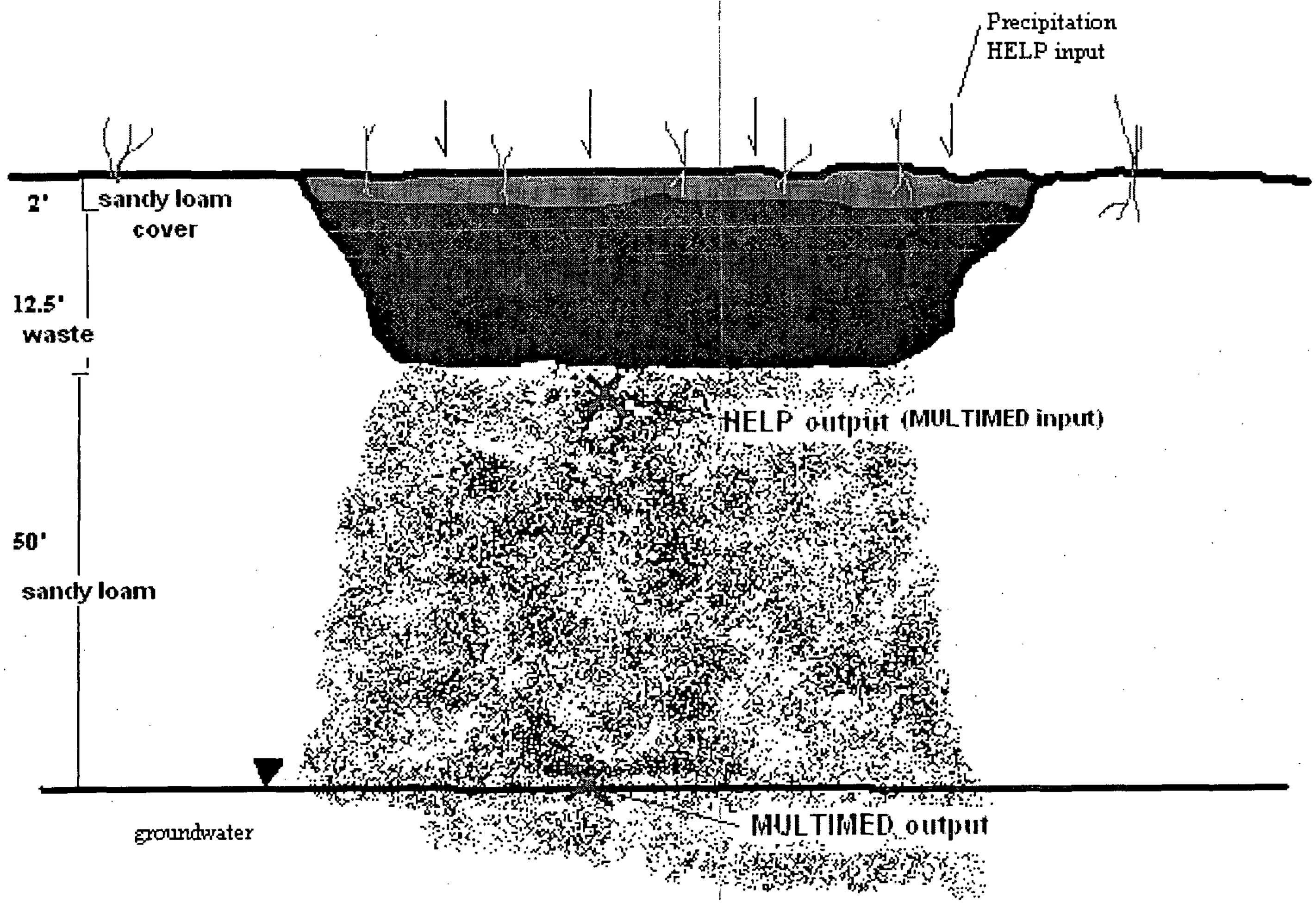
- A release from an unlined pit or a pit where the liner has been destroyed during closure (a common occurrence)
  - 2 feet of soil cover (with poor vegetation)
  - Waste

- A release from an on-site deep trench burial (proposed Rule)
  - 4 feet of soil cover (with poor vegetation)
  - Liner* on top of the waste
  - Waste
  - Liner* at the bottom (and sides) of the waste

*liners have a "good" or "poor" installation

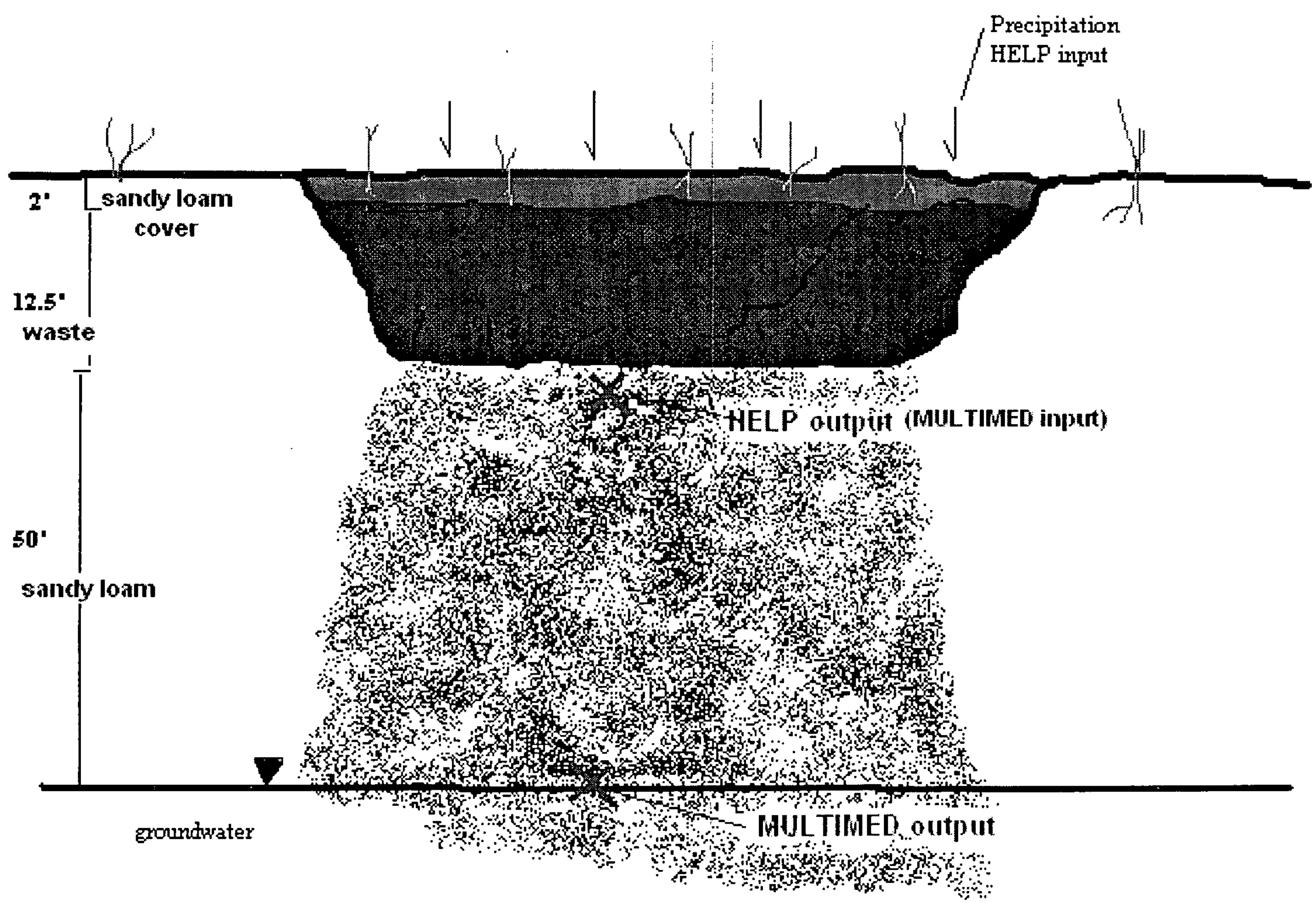
Conceptual Models

In-place Disposal (unlined)



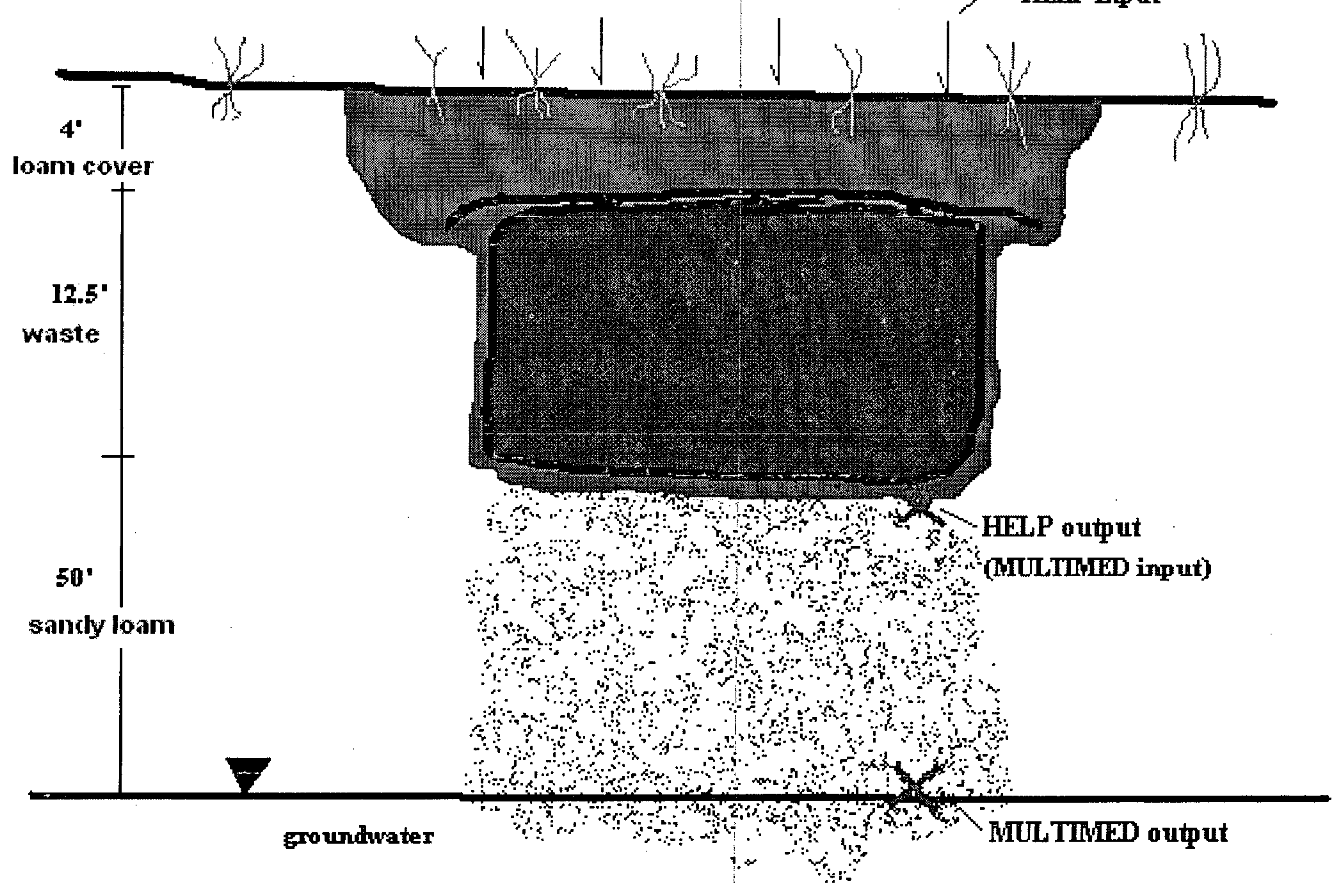
Conceptual Models

In-place Disposal (unlined)



Conceptual Models

On-Site Deep Trench Burial (top and bottom lined)



HELP Conceptual Model (outputs)

- Annual average of release rate:
  - at the bottom of an In-place disposal (“**No Liner**”)
    (Permian Basin: 1.2”/y & San Juan Basin: 0.5”/y); or
  - through the bottom of a poorly installed liner of an on-site deep trench burial (“**Poor Liner**”)
    (Permian Basin: 0.19”/y & San Juan Basin: 0.12”/y); or
  - through the bottom of a well installed liner of an on-site deep trench burial (“**Good Liner**”)
    (Permian Basin: 0.09”/y & San Juan Basin: 0.06”/y);
- This output was used for the input value for the infiltration rate in the MULTIMED model.

MULTIMED Conceptual Model (inputs)

- Vadose Zone variables
  - Thickness
  - Saturated hydraulic conductivity
  - Effective porosity
  - Residual water content
  - Longitudinal dispersivity
  - Percent organic matter
  - Bulk density of soil
  - Biological decay coefficient

- Source specific variables
  - *Infiltration rate*
  - Area of waste disposal unit
  - Duration of pulse
  - Initial concentration

- Aquifer specific variables
  - Effective porosity
  - Bulk density
  - Thickness
  - Conductivity
  - Gradient
  - Longitudinal, transverse, vertical dispersivities
  - Well distance from site

MULTIMED Conceptual Model (inputs)

- Infiltration Rate
  - Output from HELP model
- 50’ feet of vadose zone (bottom of pit or trench to groundwater)
  - Including type of soil
- Chloride concentration of release
  - For the Permian Basin using 10,000 mg/L, 50,000 mg/L and 100,000 mg/L initial concentrations
  - For the San Juan Basin using 1,000 mg/L, 10,000 mg/L and15,000 mg/L initial concentrations

MULTIMED Conceptual Model (inputs)

- Chloride concentration of release
  - 100,000 mg/L initial concentration is equivalent to 5,000 mg/L using the Synthetic Precipitation Leaching Procedure (SPLP) analysis (proposed rule) because that analysis requires a 20:1 dilution and chloride is very soluble.
  - 5,000 mg/L ensures minimum treatment of the highest typical chloride concentrations that occur in pit contents in New Mexico.
  - SPLP is a standard analytical method for waste disposal (there are other constituents of concern in the pit contents; e.g., hazardous contaminants).
  - The SPLP extraction must be performed for the other constituents; therefore, no additional cost for chloride analysis.

EPA Batch Leachate Testing Procedures

- TCLP -Toxicity Characteristic Leaching Procedure (EPA Test Method 1311) is a single batch extraction method used for the "mismanagement scenario" in which potentially hazardous wastes would be co-disposed with municipal solid waste (MSW) in a landfill with actively decomposing material.
  - Predominant use is to classify waste as characteristically hazardous
  - Hazardous waste may not be placed in a MSWL
  - Requires treatment before being land disposed
- SPLP -Synthetic Precipitation Leaching Procedure (EPA Test Method 1312) is a single batch extraction method used to assess the leaching potential of a waste exposed to rainfall in a monofill environment.

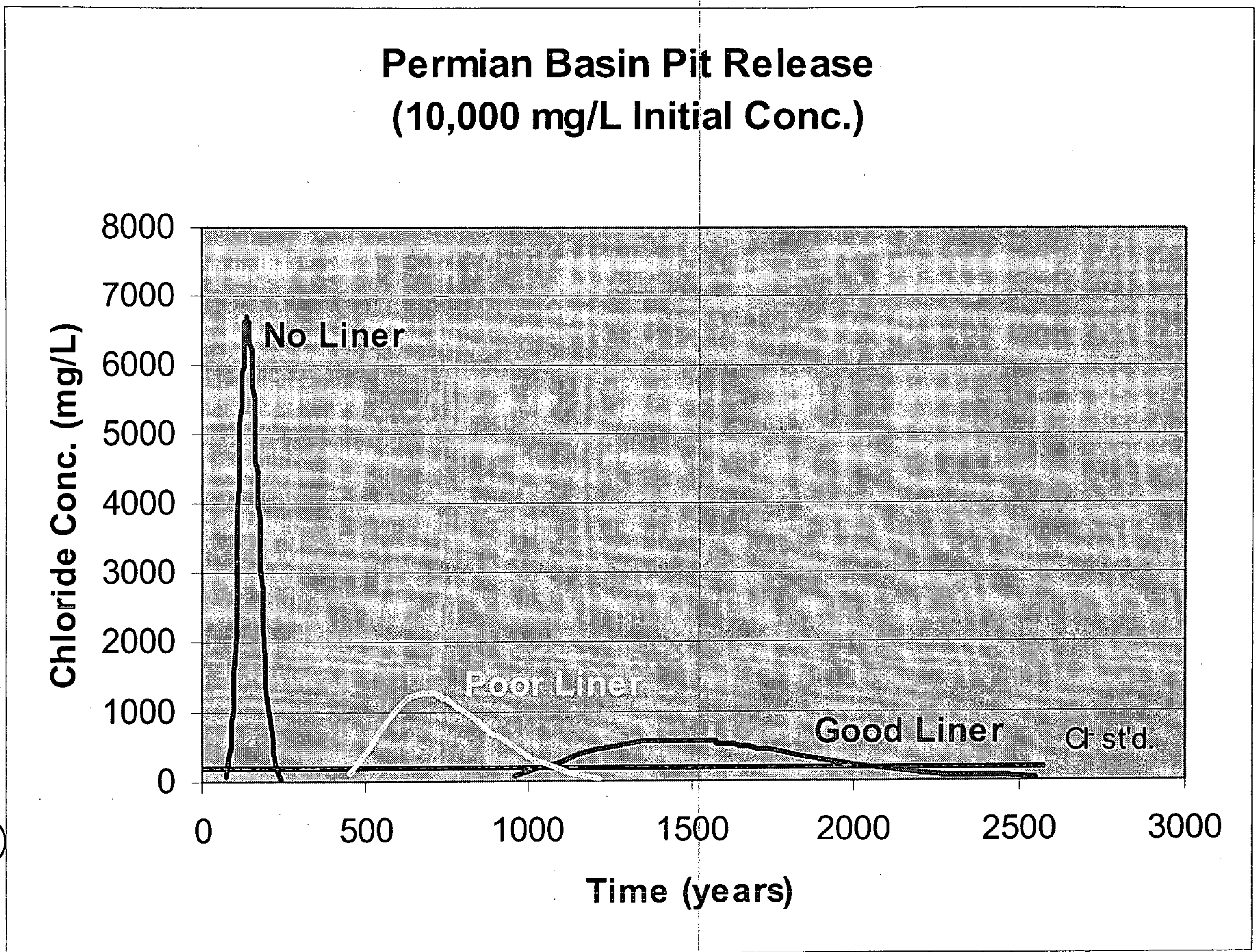
Similarities Between TCLP and SPLP

- Both tests use a 20:1 dilution
- Test for short time frame (18-20 hours)
- Both tests may under or over estimate certain constituents
- Neither test can accurately predict mobility or bioavailability – that is not the intent of either test

MULTIMED Conceptual Model (outputs)

- Chloride concentration over time at the bottom of the vadose zone and in the groundwater

Modeling Results



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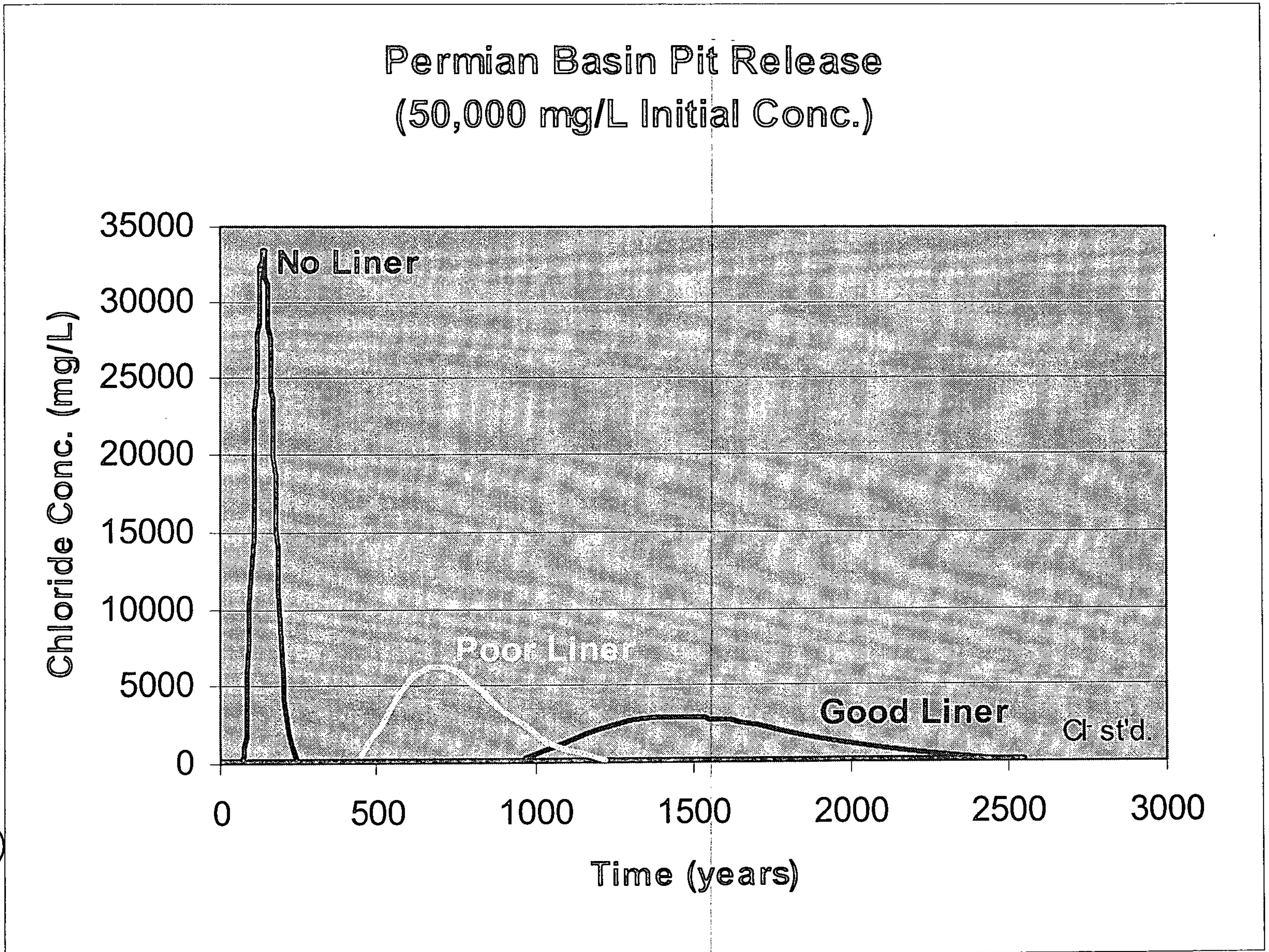

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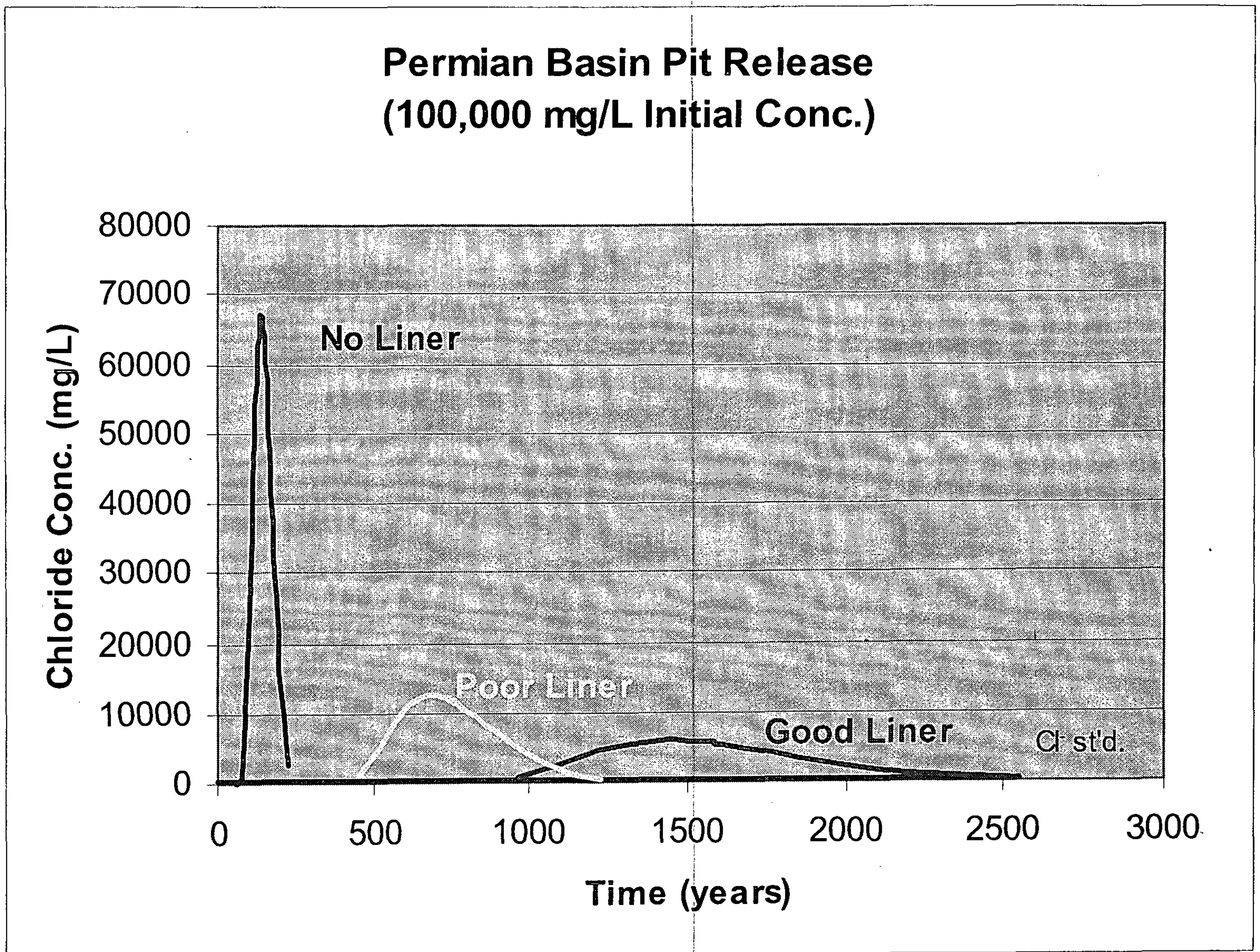

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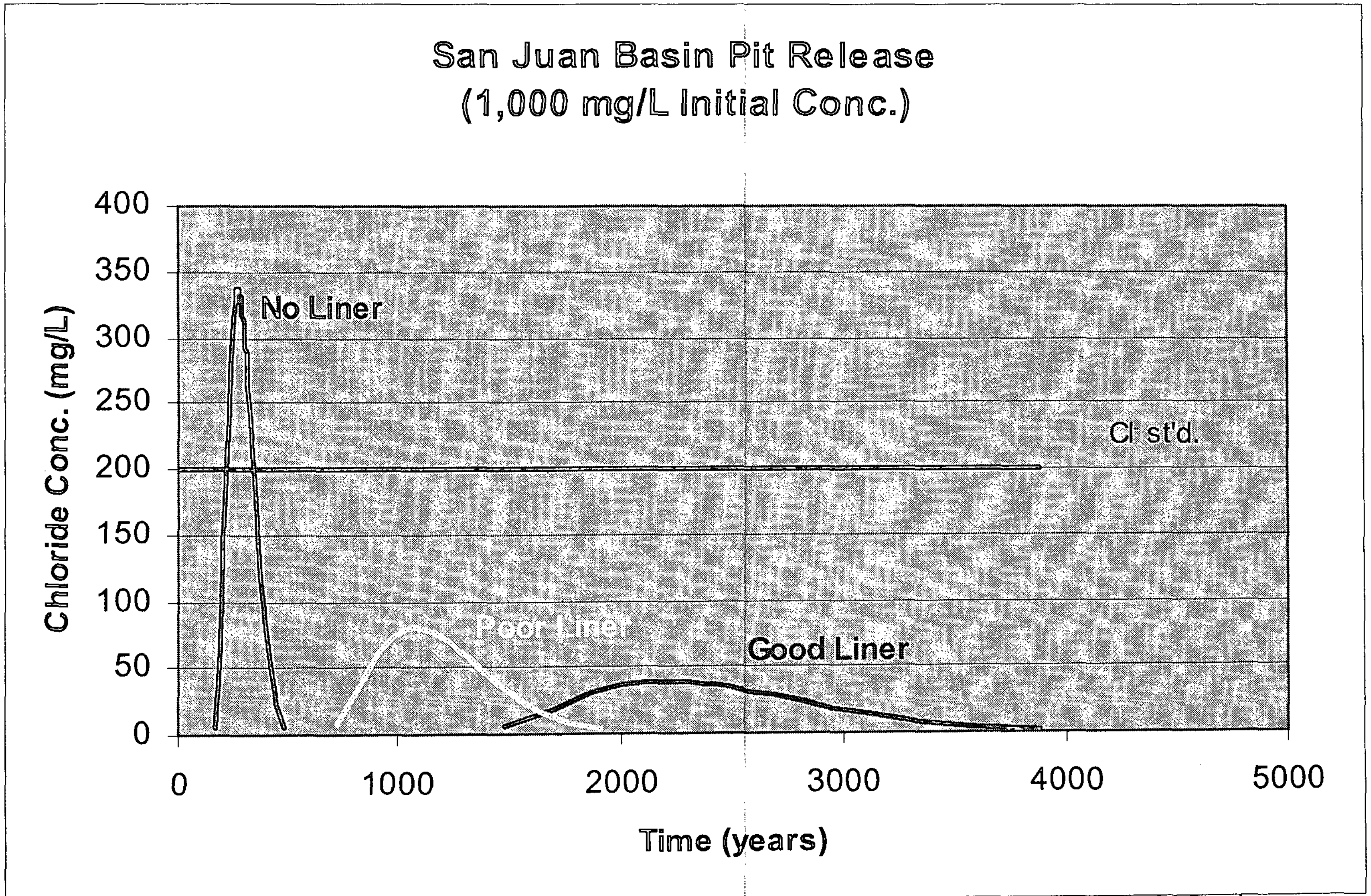

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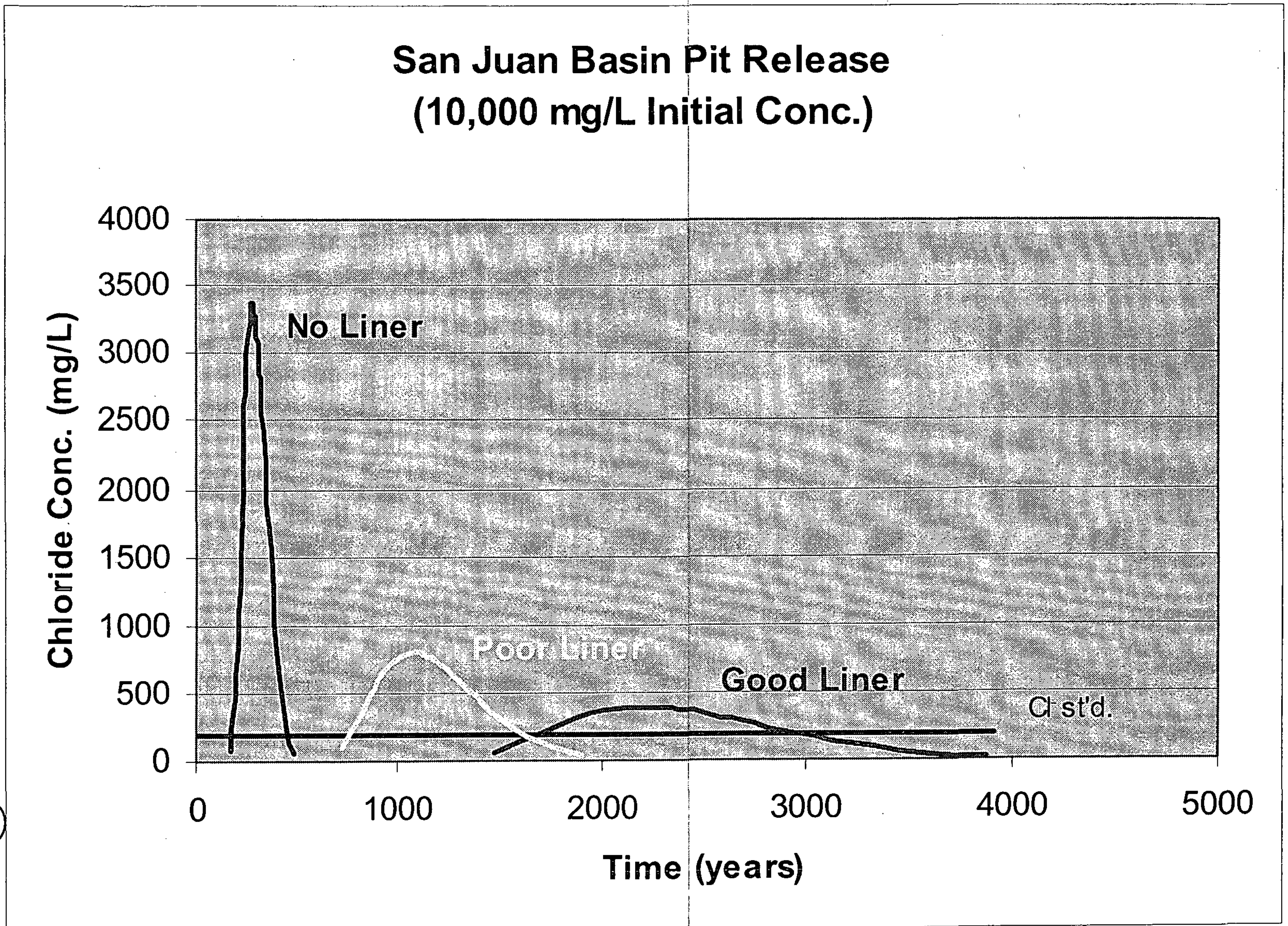

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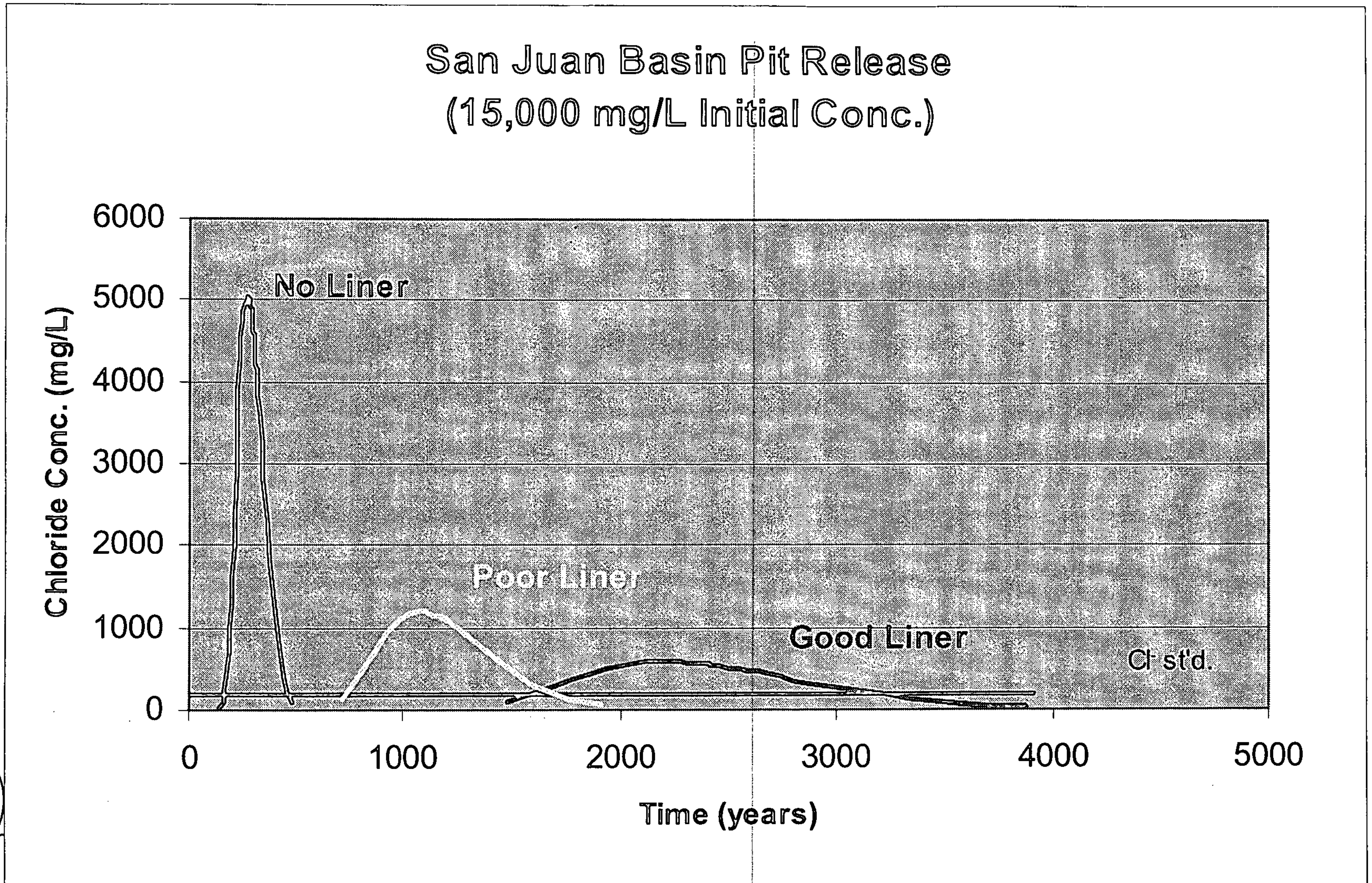

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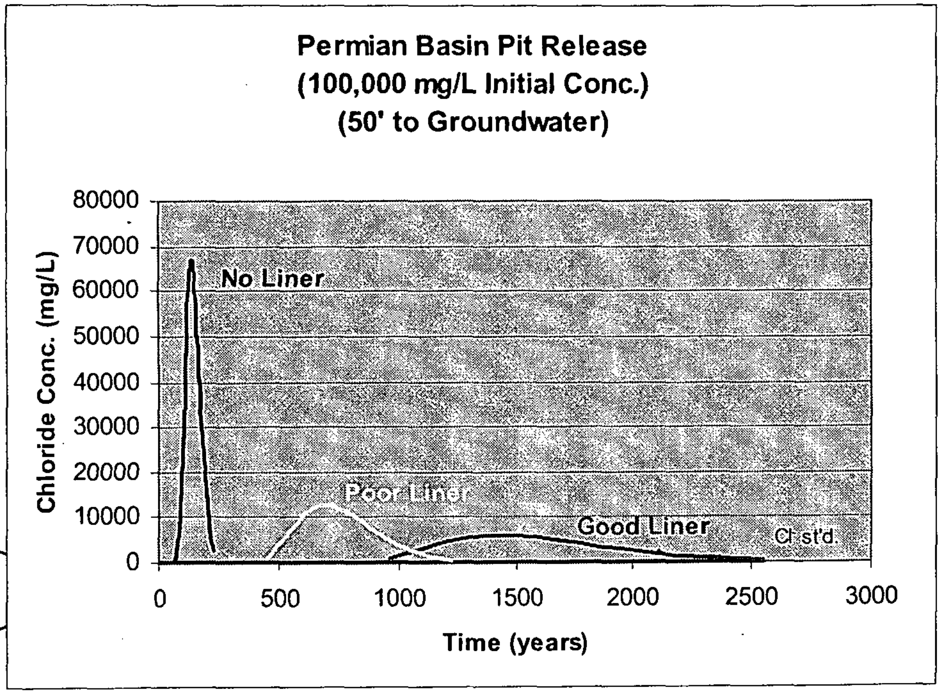

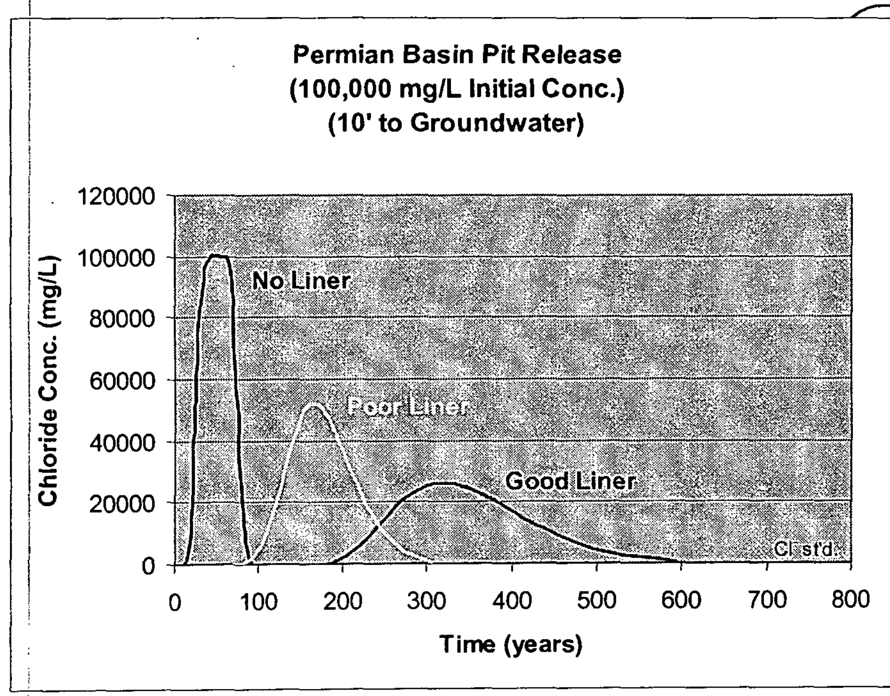

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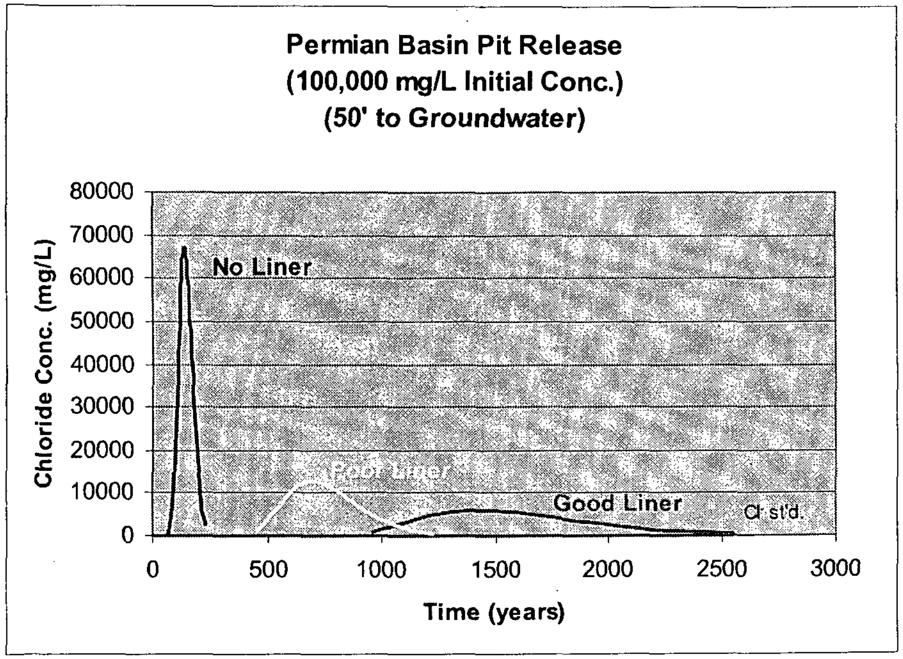

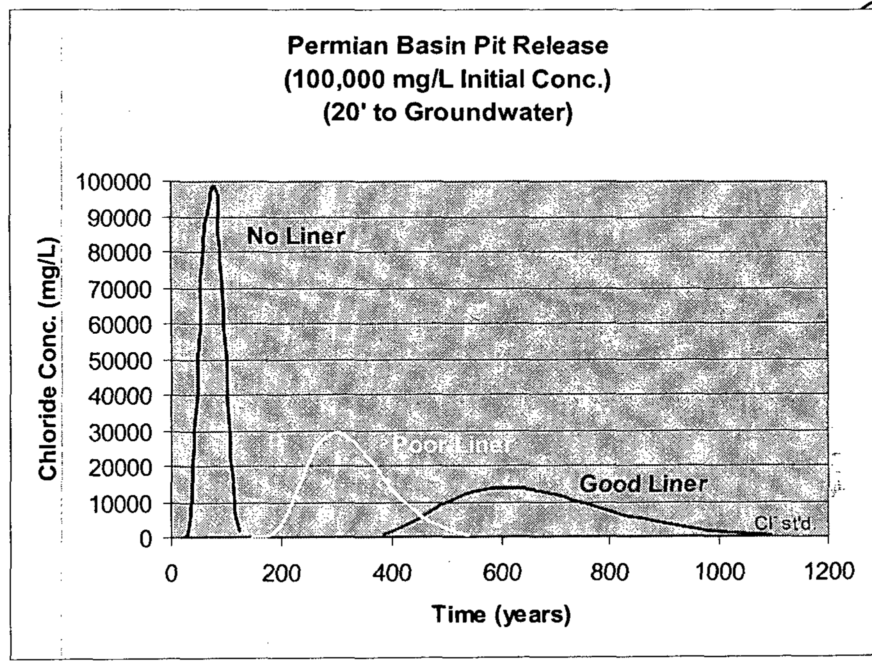

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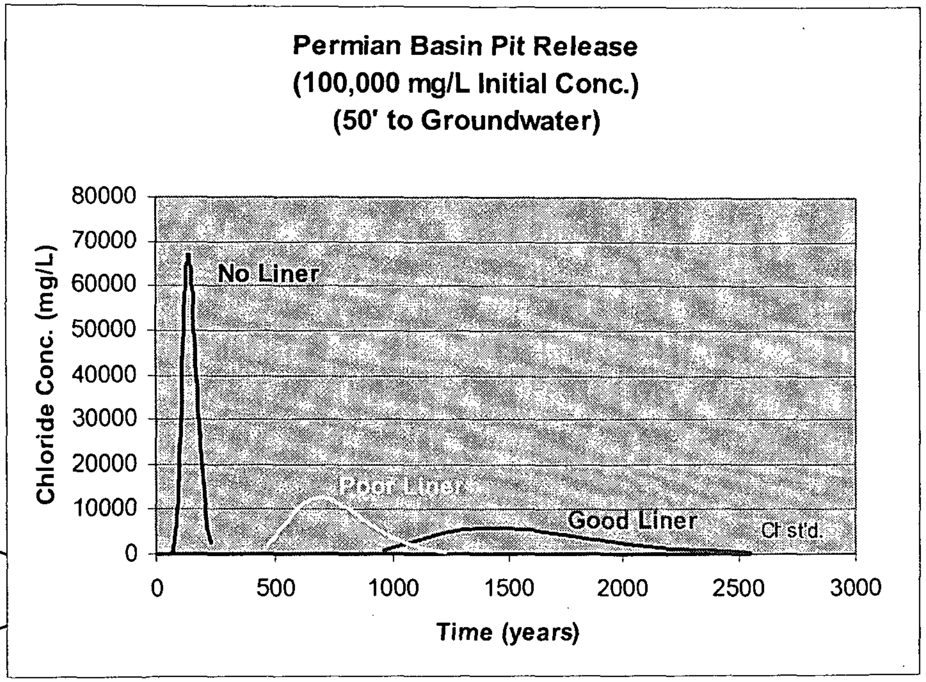

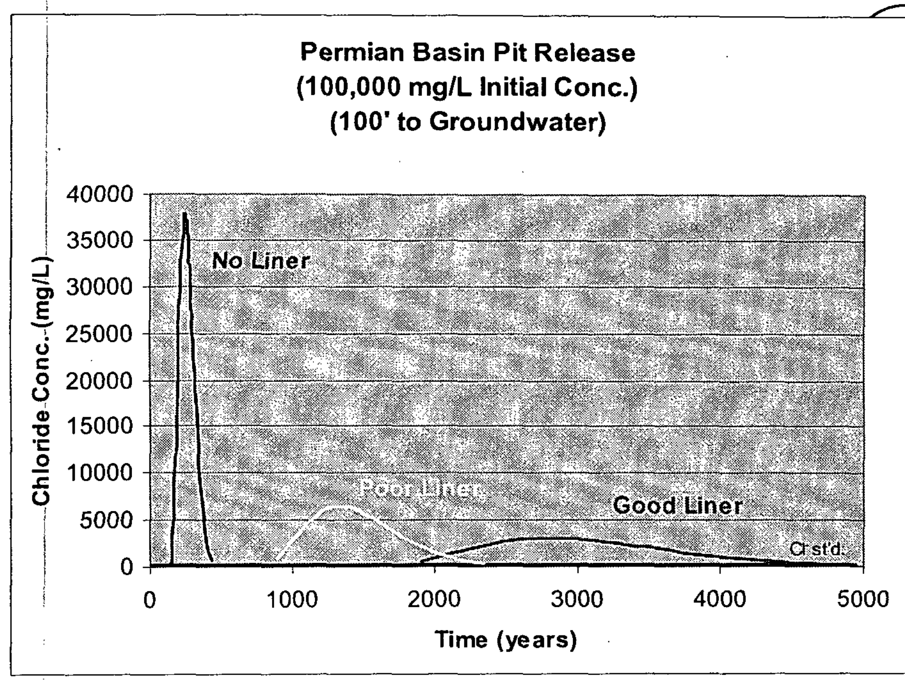

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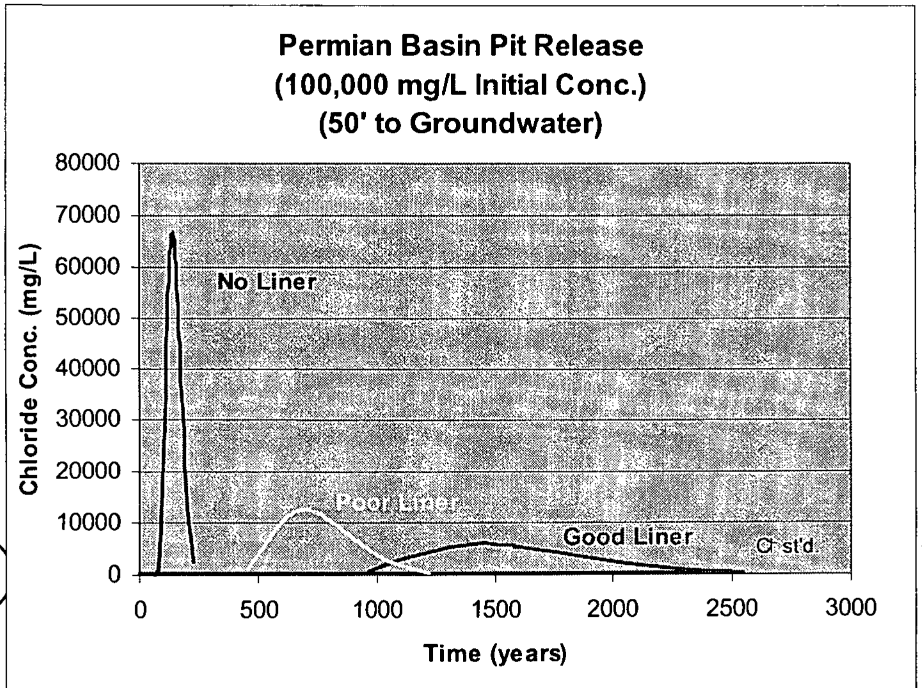

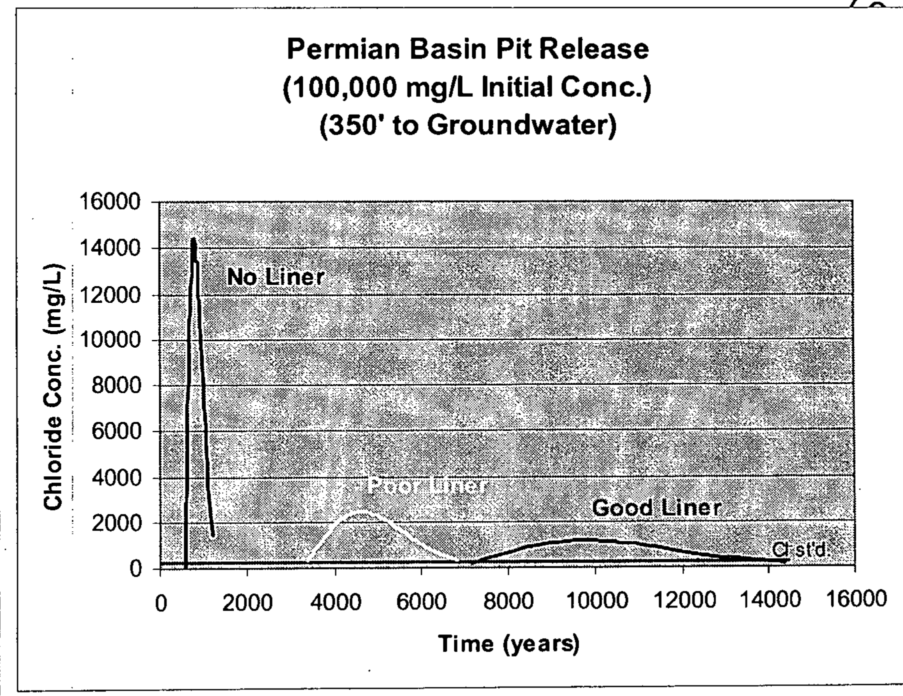

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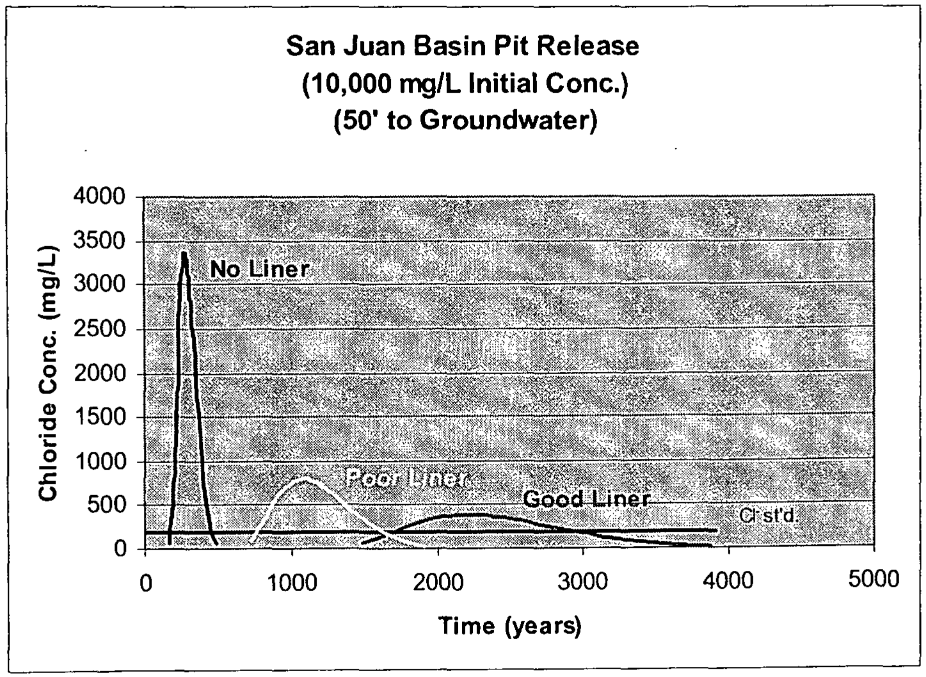

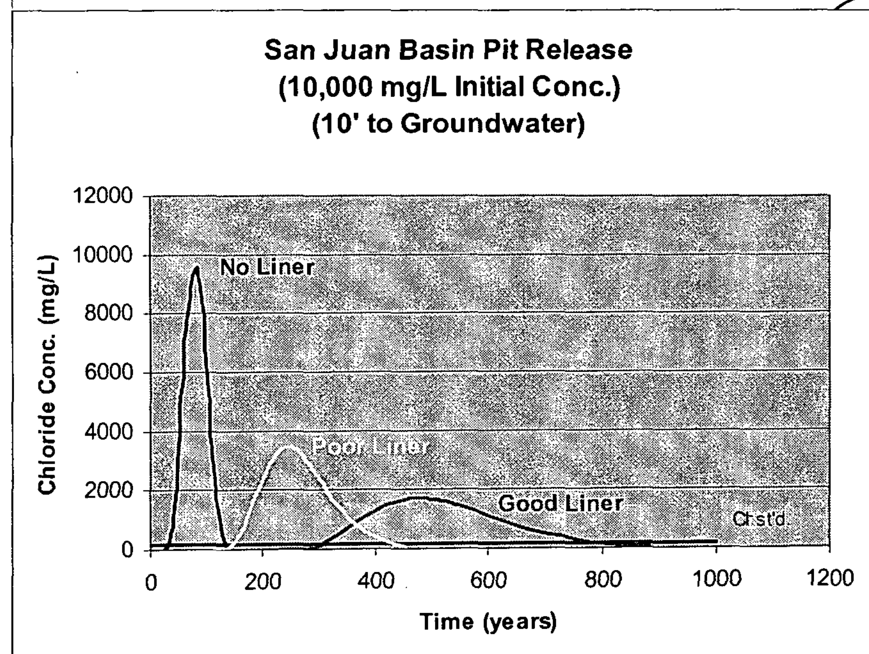

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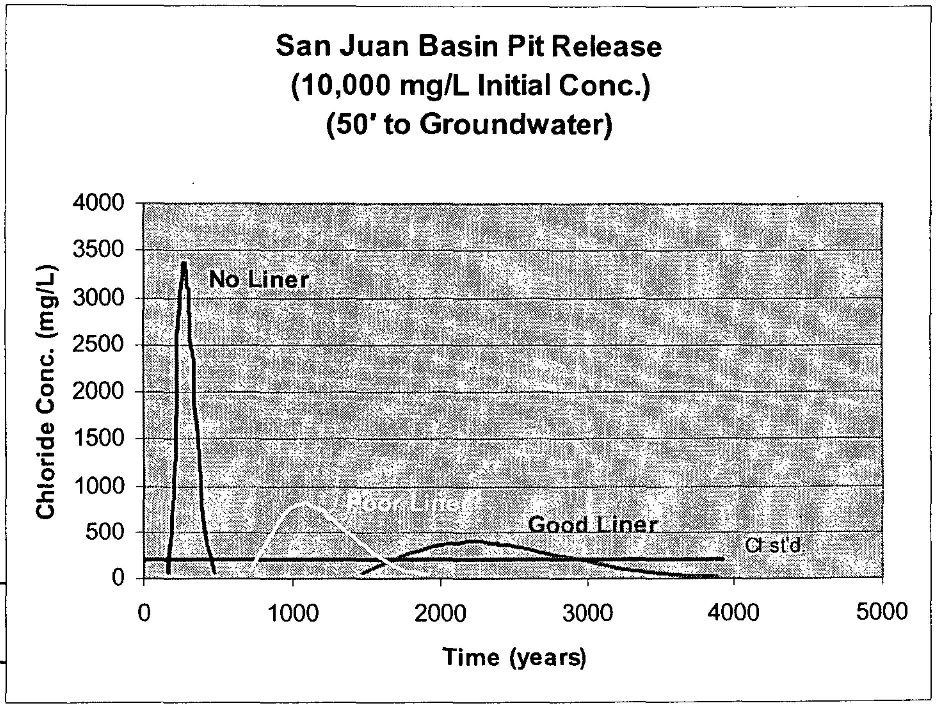

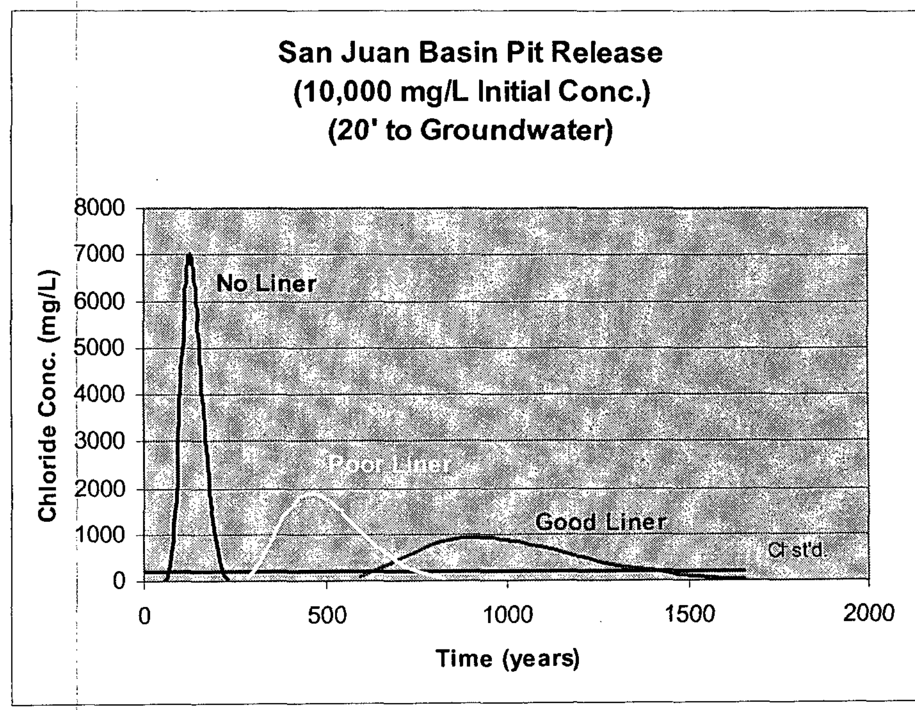

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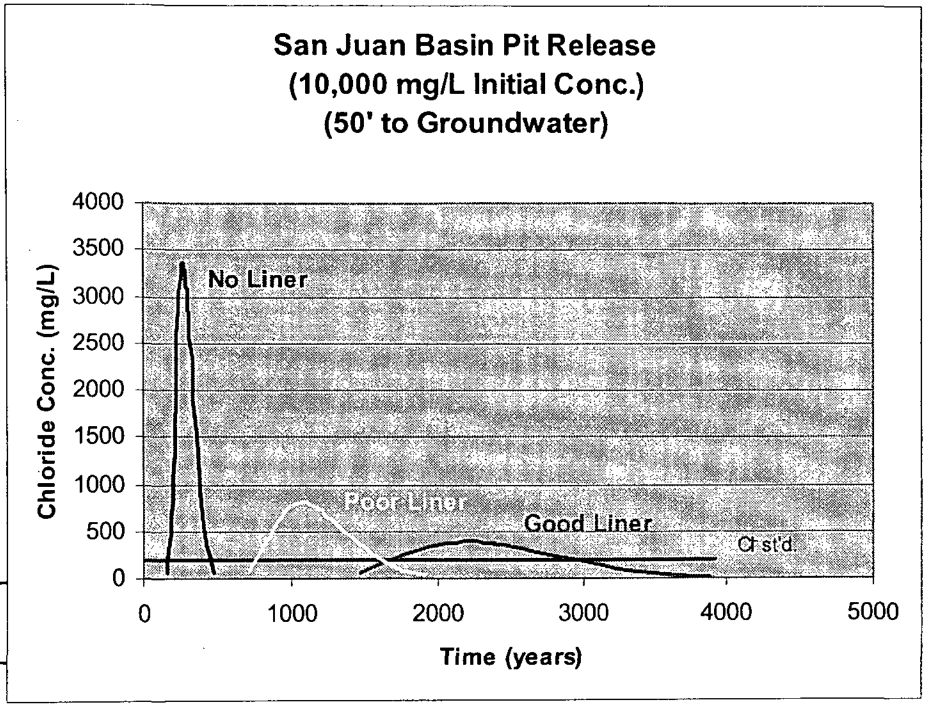

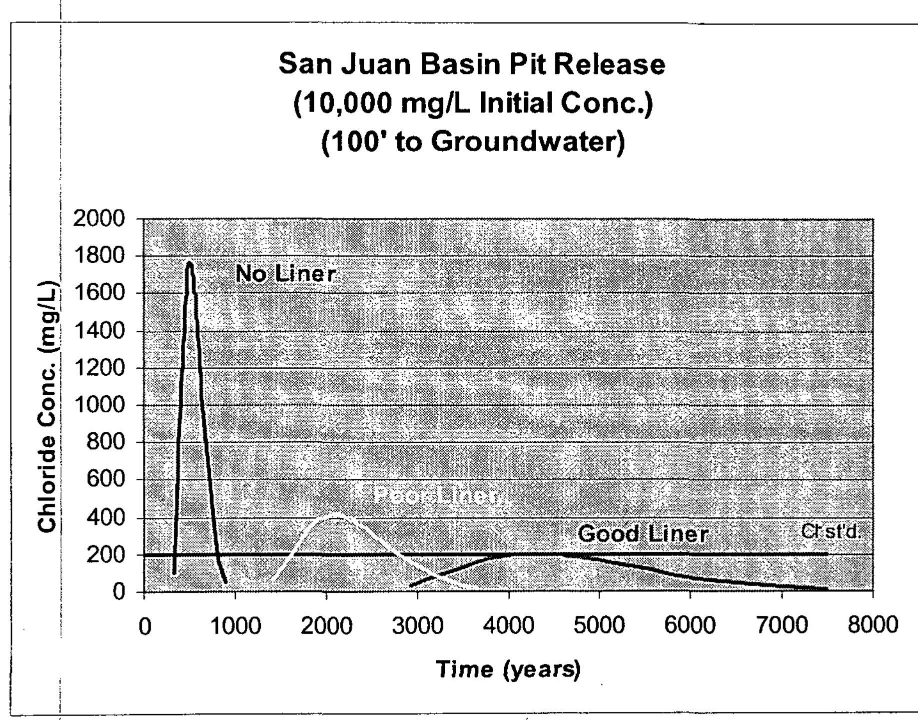

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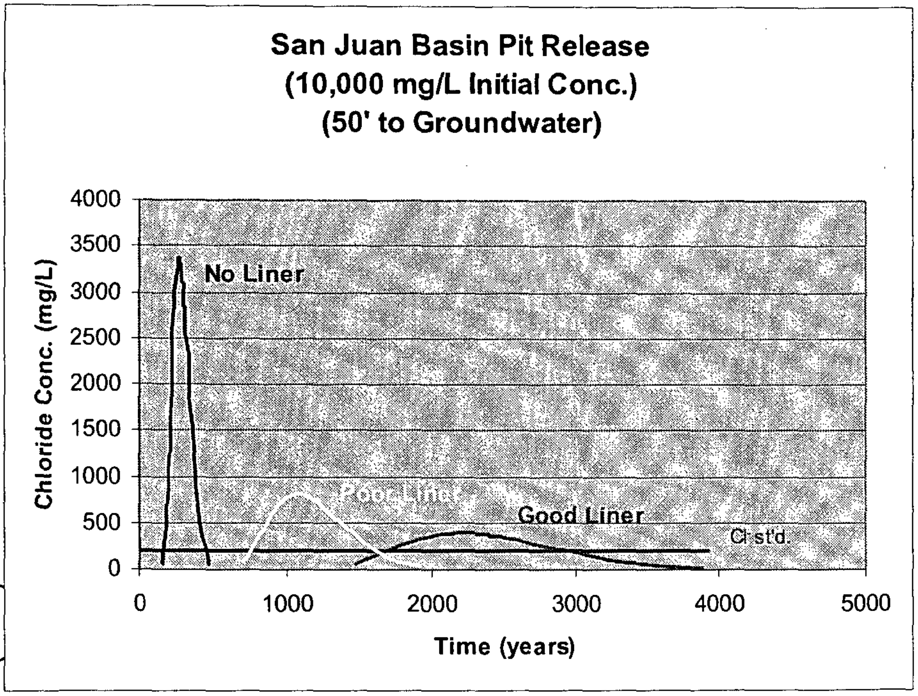
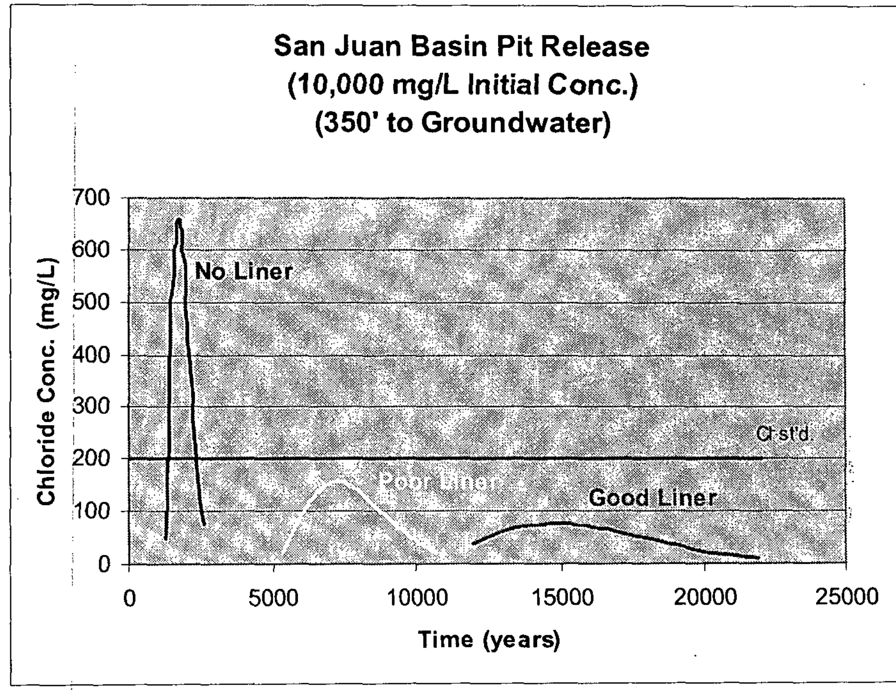




<u>Modeling Results (summary)</u>

- Releases from unlined pits contaminate groundwater ~10X <u>faster</u> than releases from lined deep trenches.

- Releases from unlined pits contaminate groundwater ~6 to 11X <u>more</u> than release from lined deep trenches.

- Releases from deep trenches with liners that have "*poor*" installations contaminate groundwater ~2 to 3X <u>faster</u> and ~2 to 4X <u>more</u> than releases from deep trenches with liners that have "*good*" installations.

Modeling Results (summary)

- In-place disposal (unlined) of pit contents will contaminate groundwater (50' below the bottom of the pit) in <80 years.

- In-place disposal (unlined) of pit contents will contaminate groundwater (50' below the bottom of the pit) exceeding the chloride standard many times over in <200 years.

- On-site deep trench burial (lined) of pit contents will contaminate groundwater (50' below the bottom of the pit) at ~1,000 years.

Modeling Results (summary)

Time until groundwater contamination*

Depth to Groundwater	Rationale for Depth to Groundwater	In-place Disposal (unlined)	On-site deep trench burial (lined)
10 feet	(close proximity to groundwater)	~15	~200
20 feet	(current practice in the San Juan Basin)	~30	~400
50 feet**	(current practice in the Permian Basin / currently in OCD guidelines / 20:1 dilution with liner)	~80 years	~1,000 years
100 feet	(a comment from some Task Force members / OCD acceptable)	~140	~2,000
350 feet	(an Industry comment to OCD)	~560	~7,000
Median	50 feet	80 years	1,000 years
Geometric Mean	~51 feet	~78 years	~1,023 years

*exceeding the WQCC standard for chloride (assuming a background conc. of 50 mg/L chloride)
**Proposed Rule

Modeling Results (summary)

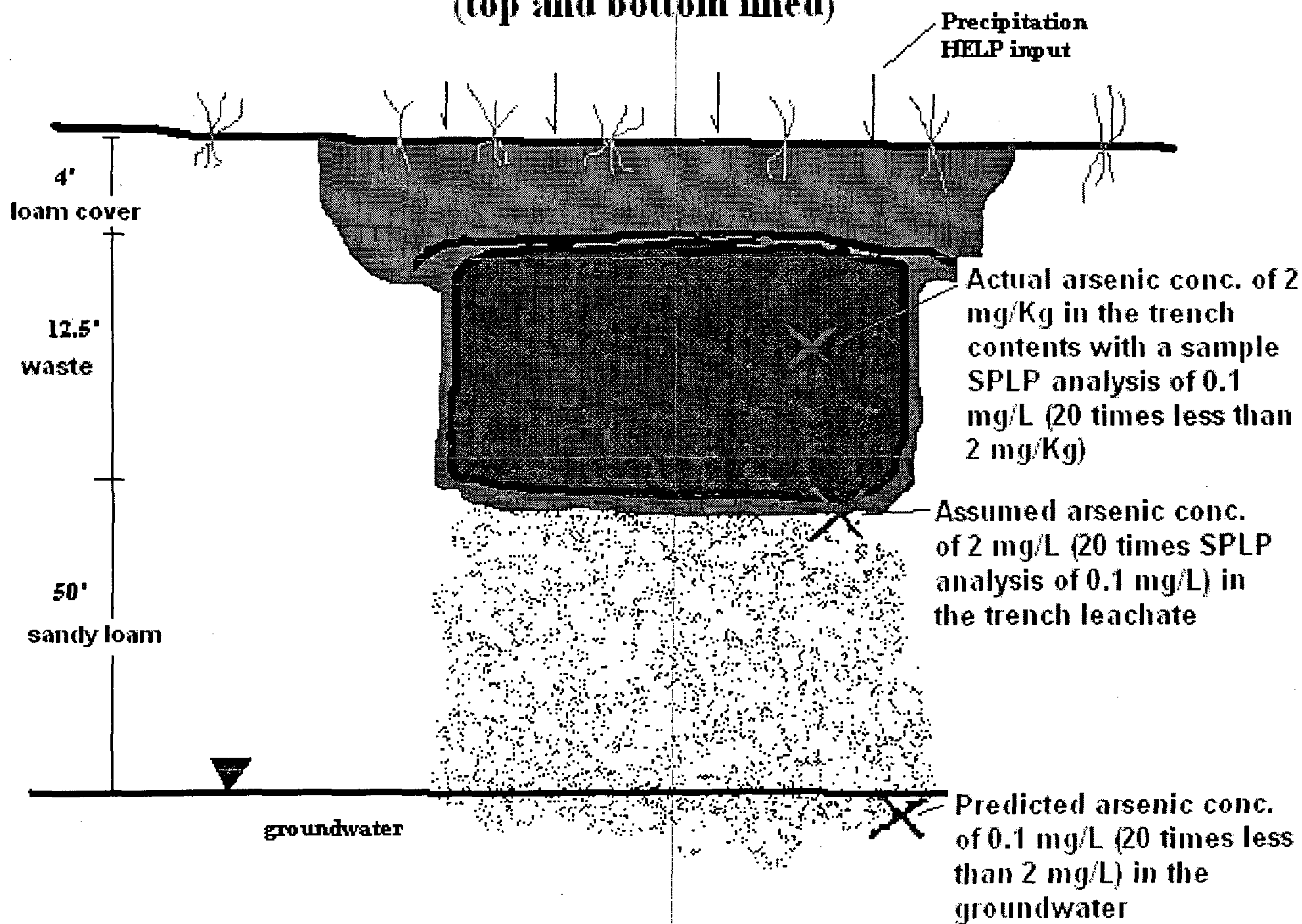
- Releases from on-site deep trench burials with "good" liners have an ~20:1 dilution to groundwater at 50 feet.

- Releases from on-site deep trench burials with "good" liners have less than 20:1 dilution to groundwater at less than 50 feet (e.g., ~9:1 dilution at 20 feet).

- The SPLP analysis 20:1 dilution will be accounted for with the 20:1 dilution from the 50 feet to groundwater; i.e., a release from the trench contents should not exceed the groundwater standard if the trench contents do not exceed the standard using the SPLP analysis. For example, if the SPLP analysis result for arsenic of a pit (after treatment) is 0.1 mg/L (the groundwater standard for arsenic), then we know the trench contents may be 2 mg/Kg or more (i.e., 20X the SPLP analytical result), but the groundwater should not be contaminated above the standard since the arsenic that would leach out of the trench contents would be diluted 20X before it could reach groundwater at 50 feet.

Hypothetical Example

On-Site Deep Trench Burial
(top and bottom lined)



Conclusions

- In-place disposal (unlined) should not be allowed in order to prevent groundwater and soil contamination.
- On-site deep trench burials (lined) should be minimized and only allowed if the trench is lined in order to prevent groundwater and soil contamination.
- Liners should be properly installed to prevent failure.

Conclusions

- On-site deep trench burials (lined) should be allowed only if there is at least 50 feet to groundwater from the bottom of the trench.
- On-site deep trench burials (lined) should be allowed only if the chloride concentration of the pit contents is less than 5,000 mg/L (SPLP analysis) or less.
- SPLP analysis should be used for other constituents of concern to ensure protection of groundwater and soils.

References

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