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# Project Summary

# Land Treatment Field Studies

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**A field study was conducted of land treatment at six sites receiving industrial wastes for ultimate disposal. Each site received one waste--petroleum wastewater pond bottoms, oily sludge from a petroleum refinery, leather tannery sludge, secondary wastewater treatment plant sludge from batch organic chemical synthesis, or inorganic pickling liquor waste. The study identified the factors that determine the environmental acceptability of land treatment for each waste and outlined what research is needed to establish guidelines and criteria for land cultivation of these sludges.**

***This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate six-volume report of the same title (see Project Report ordering information at back).***

## Introduction

Land treatment is the application and incorporation of solid or semi-solid waste into surficial soils. Essentially, this process is a physical/chemical/biological waste treatment method that uses the natural capacity of the soil system to degrade, assimilate, and immobilize certain waste constituents.

This field study examined six land treatment sites receiving industrial wastes for ultimate disposal. Each site received one waste only — petroleum wastewater pond bottoms, oily sludge from a petroleum refinery, leather tannery sludge, secondary wastewater treatment plant sludge from a synthetic manufacturing plant, wastewater treatment sludge from batch organic chemical synthesis, or inorganic pickling liquor waste. The object of the study was to identify the factors that determine the environmental acceptability of land treatment for each waste and to identify what research is needed to establish guidelines and criteria for land cultivation. Environmental acceptability was determined by significant increases in waste constituents in the treated soils compared with controls, and by the potential for environmental contamination resulting from a combination of waste, site, and management factors. These factors include waste characteristics (percent solids, salt content, etc.), site characteristics (topography, climate, etc.), and landfarm management procedures (soil aeration, frequency of waste application, etc.). A brief description of these factors and the results of the field studies at each site are given here. Results of the field studies are site-specific and cannot be generalized for other locations. But they do provide insight into the factors that should be considered when planning land treatment facilities.

## Petroleum Wastewater Pond Bottoms

Field measurements and observations were made at a land treatment site for managing waste bottoms from a petroleum wastewater treatment pond. The site was sampled twice. Organic and inorganic analyses were conducted on the waste and soil/waste mixtures, and inorganic analyses were performed on plant samples.

### *Waste Characteristics*

The waste landfarmed at this site is made up of sludges from wastewater holding ponds for petroleum refining wastes (SIC Code 2911). These oily sludges that collect in the aerated wastewater holding pond are typically 13% solids, 25% oil, and 62% water as spread.

### *Site Description*

The selected site is a 20-acre parcel of land in the western region of the United States.

Criteria included isolation of the site from populated areas, relatively flat terrain, and a suitable distance from drinking water (both ground and surface). The geophysical characteristics of the site (topography, meteorology, hydrology, etc.) pose no significant concerns about possible contamination of the surrounding environment.

### *Management Practices*

Management methods included monitoring of the soil, waste, and an experimental alfalfa crop, and recording waste application information. Waste is infrequently applied at the site—once a year at most. Applications were made in 1973, 1974, 1978, and 1979. No commercial crops were grown on the site, but an experimental crop of alfalfa was grown in 1974 on the 1973-74 application area. The waste generator applied fertilizers (urea and phosphate) experimentally to optimize the carbon/nitrogen ratio for microbial degradation of wastes.

### *Results and Conclusions*

Significant increases in soil concentrations for several heavy metals, (chromium, copper, sodium, selenium, and zinc) were predicted and measured. Measurements also indicated that organic wastes were being biodegraded. Sodium levels in alfalfa plants grown in the application area were greater than those in alfalfa plants grown in the control area. This increase might have been due to subsurface saline seeps in the area, however. More controlled studies of plant uptake of pollutants should be conducted to provide data for post closure considerations.

## Oily Waste from a Petroleum Refinery

Field measurements and observations were made at a land treatment site operated for the disposal of petroleum refinery waste sludges. The waste consisted primarily of API separator bottoms and was land-treated in an area that had long been used for waste disposal. The site was sampled once. Organic and inorganic analyses were conducted on the waste and soil/waste mixture, and inorganic analyses were performed on plant samples.

### *Waste Characteristics*

A number of different oily wastes are landfarmed at this site, about 90% of which originate from oil/water API separator bottom sludges. These sludges, which are held in settling ponds for 2 to 4 weeks before disposal, are composed of 34% solids, 11% oil, and 55% water as spread.

### *Site Description*

The 20-acre site is a portion of a man-made fill in the southern United States bordered by an estuary, wastewater lagoon, and heavily industrialized land. The site was once a wetland, but over the years it was filled with spoils from dredging, construction, and earthmoving activities. The proximity of surface waters and the low-level topography make possible the direct contact of water with the waste.

### *Management Practices*

This site receives large quantities of waste — on the order of 5.75 million gal/yr. The plots of land are aerated monthly, and monitoring occurs frequently. But monitoring results are not used as the basis for the rate and quantity of further waste applications.

### *Results and Conclusions*

Soil analysis indicated that the waste on the site was not undergoing optimum degradation because of the heavy loading. Accumulation of heavy metals and organic compounds was observed in the top 12 in. of soil. Further research should be directed at monitoring the degradation rate of these wastes by reducing the loading rate on the site and by using fertilizer to create a better nitrogen-to-carbon ratio for degradation.

## Leather Tannery Sludges

Field observations and measurements were made for a land treatment site that incorporates sludge generated from air pollution control scrubbers of a leather tannery operation. Because the waste contains a high concentration of nitrogen and has other soil amending qualities, it has been used on this site for 20 years to improve the growth of crops, including wheat, corn, and hay. The site was sampled once. Organic and inorganic analyses were conducted on the waste and soil/waste mixture, and inorganic analyses were performed on plant samples.

### *Waste Characteristics*

A variety of leather tannery wastes (SIC Code 3111) were applied at the site until 1967. Since then, a scrubber sludge from an air pollution system at the tannery has been the major waste applied. The latter contains 6% solids, and 94% water as delivered. Waste constituents include nitrogen (8.1% dry weight basis), sodium, chromium, and organic species.

### *Site Description*

This land treatment site is owned by a local farmer and leased to the farm operator. Topography consists of rolling hills with slopes of 3% to 8%. The groundwater table is seasonally high (1½ to 3 ft below grade), and field visits revealed a shallow, possibly intermittent pond in one corner. Most soils on the site are deep, well-drained silt loam, grading to fine sandy loam in the substratum.

### *Management Practices*

An estimated 200,000 gal. of tannery sludge are applied annually to each acre, usually in the spring and fall. Wastes are initially dewatered in a holding basin before application, but they may occasionally be applied directly to open fields. In addition to waste application, chemicals are applied to the soil for pH amendment and fertilizing purposes.

### *Results and Conclusions*

The area of the site sampled had received only one waste application, and therefore results may not be representative. A significant increase (20-fold) of chromium was observed in the application soil, but no significant increase was identified in the crop samples grown on the application area. A monitoring program is recommended to identify the development of potential problems.

## Secondary Wastewater Treatment Plant Sludge from a Synthetic Manufacturing Plant

Field measurements and observations were made at a land treatment site for managing secondary wastewater treatment sludge from a synthetic manufacturing plant. The site was sampled once. Organic and inorganic analyses were conducted on the waste and soil/waste mixture, and inorganic analyses were performed on plant samples.

### *Site Description*

This 180-acre parcel of land is owned by the synthetics manufacturing plant

and is leased to farmers to cultivate wheat and corn. Though the geophysical characteristics pose no significant concerns about contamination of the surrounding environment, soil texture deterioration is possible as a result of combining a high-clay soil with a high-sodium waste.

### *Management Practices*

The site is managed to minimize salt buildup and maximize plant yield and growth. Management methods include monitoring the soil and waste, and recording the frequency and location of waste application. The waste was incorporated into the soil according to normal agricultural practice. Thus, the waste/soil mixture was well aerated and irrigated, which promotes rapid degradation of waste organic constituents.

### *Results and Conclusions*

The site had received waste for only a short period before sampling, so differences between control and application plots were not expected to be significant. Wheat on the waste application site grew taller and greener than that on the control site. This result may be due to the nitrogen and cellulose in the waste. Inorganic and organic analyses indicated no significant differences between the plots. A possible, but statistically insignificant, trend was noted toward accumulation of salt and aliphatic and aromatic hydrocarbons in the top 6 in. of soil.

## Sludge from Batch Organic Chemical Synthesis

Field measurements and observations were made at a land treatment operation using a sludge generated from organic chemical manufacture. The sludge is applied to a turf farm with acidic soil to reduce the lime addition requirements for pH adjustment. The site was sampled once. Organic and inorganic analyses were conducted on the waste and soil/waste mixture, and inorganic analyses were performed on plant samples.

### *Waste Characteristics*

The wastes at this site consist of combined wastewater treatment sludges from clarifier and activated sludge lagoons of an organic chemical manufacturer (SIC Code 2865). Sludges contain about 7% solids and are a supplementary source of lime and a beneficial soil amendment.

### *Site Description*

The site is located in an area of prime agricultural soils, with about 3 ft of silt loam covering stratified sand and gravel. Natural soils in this area tend to be acid. Groundwater, which is 20 to 30 ft below the ground surface, is pristine. Topography of the farm is generally flat.

### *Management Practices*

Sludge is applied when open, harvested field are available from mid-May to early September or November, depending on the weather. Little monitoring or record-keeping is done at the site. Though 6 million gal. of sludge is produced annually by the generator, some is landfilled when the storage capacity at the plant is full.

### *Results and Conclusions*

Study results show increased levels of copper in the application area soils and grass when compared with the controls. Since waste application rates are not based on waste composition, and since little monitoring or record-keeping is done, further study is recommended to determine waste migration and organic degradation at the site.

## Pickling Liquor Waste

Field measurements and observations were made at a land treatment site for managing an inorganic pickling liquor waste. The site was sampled twice. Organic and inorganic analyses were conducted on the waste and soil/waste mixture, and inorganic analyses were performed on plant samples.

### *Waste Characteristics*

Wastes applied to this site consist of neutralized pickling liquor from a producer of fabricated metal products (SIC Code 349). The waste is spread as a 20% solids sludge, with sulfate and iron as major constituents and a negligible organics content.

### *Site Description*

This 300-acre site is leased to the generator and dedicated solely to land treatment of the pickling liquor waste. Another portion of the farm is leased to a city for use as a sanitary landfill. The immediate vicinity of the farm is rural, and the owner intends to return the land to cultivatable condition after land treatment operations are complete.

### *Management Practices*

Management of this site is highly informal. Once waste is delivered to the site by the generator and either applied to the field or placed in the storage pond, all additional activities are taken care of by the site owner. Monitoring of the soil/waste mixture for pH amendment requirements is done three times a year by the State.

### *Results and Conclusions*

Runoff poses a possible contamination threat to adjacent farms. Also, the waste/soil mixture at the site is acidic and could promote the migration of acid-soluble metals. The land treatment operation could be improved by eliminating the surface runoff problems and instituting more frequent monitoring and adjustment of the waste/soil pH. Better record-keeping should also begin and be used to plan continued site activities and post-closure measures.

The full six-volume reports were submitted in fulfillment of Contract No. 68-03-2602 by Arthur D. Little, Inc., under the sponsorship of the U.S. Environmental Protection Agency.

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***Robert E. Landreth** is the EPA Project Officer (see below).*
*The complete report consists of six volumes, entitled "Land Treatment Field Studies:" all six volumes are available as a set: Order No. PB 83 241 265; Cost: $48.50, or individually as—*

*"Volume 1. Petroleum Wastewater Pond Bottoms," (Order No. PB 83-241 273; Cost: $10 00)*
*"Volume 2. Oily Waste from a Petroleum Refinery," (Order No. PB 83-241 281; Cost: $10.00)*
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*"Volume 6. Inorganic Pickling Liquor Waste," (Order No. PB 83-241 323; Cost. $8.50)*
*Volumes 1 through 6 are also available as a set: Order No. PB 83-241 265; Cost: $48.50*

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