ALTERNATIVES
TO THE
LAND DISPOSAL
OF
HAZARDOUS WASTE

PRESENTED TO:

HOUSE STATE AFFAIRS COMMITTEE

COLORADO LEGISLATURE

APRIL 1983

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PHYSICAL TREATMENT TECHNOLOGIES

Physical treatment technologies include processes to separate components of a waste stream or change the physical form of a waste without altering its chemical structure. Physical steps are often used for primary separation followed by reuse, chemical or biological treatment or destruction by incineration.

These processes are very useful for:

separating hazardous materials from an otherwise non-hazardous stream

separating various hazardous components for different treatment processes

preparing a waste stream for ultimate destruction or treatment

The list below summarizes the available techniques:

Solid-Liquid Separation

Screening	rotating drum vibratory bar screen wedge wire
Sedimentation	coagulating flocculating emulsion breaking
Flotation	dissolved air induced air froth (foam)
Filtration	granular media pressure leaf plate and frame press rotary vacuum belt coil
Centrifugation	sedimentation type (continuous) filtration type (batch) solid bowl disk basket

Membrane Separation

Dialysis	high concentrations, low MW
Electrodialysis	ionic components
Reverse osmosis	high pressure
Ultrafiltration	high MW

Liquid-Liquid Separation

Distillation	steam heated direct fired oil heated batch continuous azeotrope extractive
Evaporation	solar ponds vertical tube multiple effect falling film vacuum
Adsorption	activated carbon synthetic resins destructive regeneration washed regeneration starch xanthate
Oil-water	gravity emulsion breaking coalescing
Stripping	steam air
Extraction	single stage multistage stagewise continuous

Electrolytic techniques

CHEMICAL TREATMENT TECHNOLOGIES

Chemical treatment technologies treat waste by altering the chemical structure to produce a less hazardous material. Chemical processes are attractive because they produce minimal air emissions since they are usually enclosed. Often they can be constructed as mobile units to perform processing at the sites of waste generators. They are most effective on unmixed waste streams.

The list below summarizes the available techniques:

Neutralization	mix acids with bases to form salts
Precipitation	hydroxide sulfide cyanide carbonate borohydride/hydrosulfide
Ion exchange	concurrent fixed bed countercurrent fixed bed continuous countercurrent
Chemical dechlorination	metallic sodium reagent
Chemical reduction	sodium metabisulfite ferrous sulfate
Ultraviolet photolysis	catalyses oxidation processes
Chemical oxidation	wet air nitrous acid chlorine dioxide hydrogen peroxide calcium hypochlorite chlorine potassium permanganate bromide-nitrate catalysed ozone

BIOLOGICAL TREATMENT TECHNOLOGIES

Biological treatment is a generic term applied to types of processes that use living organisms to decompose organic wastes to water, carbon dioxide, simple inorganics, or into simpler organics such as aldehydes and acids.

Because biological systems contain living organisms, they require sufficient nutrients and water to support the growth. The organisms tend to thrive in relatively steady state environment in which organic wastes are added slowly, and temperature, pH and light are maintained fairly constant. For this reason, biological systems are usually preceeded by primary physical treatment and large flow equalization facilities.

The list below summarizes the avaiable techniques:

Activated sludge	complete mix tapered aeration step aeration contact stabilization oxidation ditch pure oxygen system
Activated carbon	combined with activated sludge sequential with activated sludge
Aerated lagoon	subsurface diffusers surface aerators
Trickling filters	rock media synthetic media
Stabilization ponds	aerobic facultative anaerobic
Aerobic digestion	wet air oxidation
Anaerobic digestion	sludge reduction methane production
Biological seeding	select microbial cultures
Fluidized bioreactor	dilute organic streams
Deep-shaft aeration	increased aeration time
Rotating Biological Contactor (RBC)	modular construction low head loss
Nitrification/ denitrification	suspended growth reactor fixed film reactor

INCINERATION AND PYROLYSIS TECHNOLOGIES

Incineration and pyrolysis are processes for reducing the volume or toxicity of organic wastes by exposing them to high temperatures. If the hazardous organic waste stream is heated with oxygen present, combustion occurs in a process called incineration. The main products from complete incineration include water, carbon dioxide, ash and certain acids and oxides depending on the waste.

In oxygen-starved high temperature environments,the process is called pyrolysis. The products of pyrolysis are a range of less complex organic compounds and a char or ash.

The list below summarizes the available techniques:

Single chamber liquid systems	atomizing 1300-3000 F 0.5 to 2 seconds residence
Rotary kiln	scrubbers 1500-3000 F
Cement kiln	cement neutralizes off-gas 2600-3000 F
Fluidized bed incineration	840-1600 F
Multiple hearth incineration	long residence time sludge incineration 1400-1800 F
Molten salt combustion	Liquids, solids with low ash combustion self-supporting 1400-1850 F
At-sea incineration	99.9% efficiency required
Co-incineration	supplemental boiler fuel
Wet air pyrolysis	400-600 F reduces sludge volume copper catalyzed
Plasma arc torch	90,000 F
High temp. fluid wall	radiant heat 4000 F inert gas shielded wall
Spouted bed combustor	low Btu wastes

SOLIDIFICATION/STABILIZATION TECHNOLOGIES

"Solidification" and "stabilization" are treatment systems designed to accomplish one or more of the following:

improve handling of wastes
improve waste physical characteristics
decrease surface area for transfer of contained pollutants
limit solubility of waste hazardous constituents
detoxify hazardous waste constituents

Solidification implies that these results are obtained primarily by the production of a monolithic block of treated waste with high structural integrity.

Stabilization techniques limit the solubility or detoxify waste contaminants even though the other physical characteristics of the waste may not be changed. Stabilization usually involves the addition of materials that ensure that hazardous constituents are maintained in their least soluble and/or toxic form.

The list below summarizes the available techniques:

Cement based	mix with cement and water
Pozzolanic	fly ash ground blast furnace slag cement kiln dust
Thermoplastic	dispersed in hot plastic
Organic polymer	pre-polymer & catalyst
Sludge encapsulation	inert coating or jacket

RETRIEVABLE STORAGE

Retrievable storage describes a secure system for the long-term storage of waste prior to recycling, treatment or destruction. Such a system provides an alternative for those wastes which have been determined to be unsuitable for landfill, but for which there currently does not exist economical treatment technologies.

There are several characteristics of an acceptable system for retrievable storage:

Safe long-term storage of waste
Large capacity without endangering personnel and equipment
Easy waste removal when technology becomes available

Retrievable storage systems include tanks, drums or, for certain non-volatile wastes, ponds which are equipped with liners. The liner systems must be durable and compatible with the waste, have very low permeability over an extended period of time, and be easy to unstall and maintain.

LANDFARMING

Landfarming is a waste treatment technique using naturally occurring microorganisms in the soil to biodegrade organic wastes. Waste is applied on top of disked soil, or injected several inches beneath the surface. Periodically the land is plowed to increase the exposure to oxygen needed by the microorganisms to effectively degrade the wastes.

Landfarming is suitable for only a few organic wastes. If the farm is poorly designed, runoff can occur during heavy rain before the waste has time to fully decompose. Another problem may be accumulation of heavy metals in the soil. Landfarming can be a source of air pollution from volatile products of biodegradation of certain oily wastes. During application of the waste there can be a short term odor problem.

The list below summarizes the available techniques:

Slow rate	N, P, BOD removal
Rapid infiltration	filtering
Overland flow	denitrification sedimentation
Wetlands	existing artificial peatland
Subsurface	soil mound subsurface filter

DEEPWELL INJECTION

Deepwell injection disposes of wastes by injecting them deep in the ground into suitable geologic formations. To prevent plugging of the injection equipment, wastes are usually pretreated to remove solids.

Since not enough is yet known about the long-term effect of geological disturbances on deepwell injection systems, and it is extremely difficult to monitor the subsurface migration of deep liquid wastes, use of this disposal technique is not recommended as an alternative treatment technology.

AFFECTED INDUSTRIES

In a study by the Office of Appropriate Technology in California it was determined that eleven industries generate over 70 % of all the high-priority wastes going to California landfills.

It was estimated that if the total cost of using safer waste management technologies was borne exclusively by the consumer, each person would pay $0.75 more per year in product costs.

Current disposal costs represent 0.6% of the value-added for these industries (except agricultural chemicals). Alternate methods would approximately double these costs, although it should be noted that proposed state surcharge fees for land disposal would also make land disposal more expensive.

In the list below are the industries studied for application of alternate technologies.

Industrial organic chemicals

Plastics materials and resins

Industrial organic chemicals

Agricultural chemicals

Chemical preparations

Petroleum refining

Primary metal

Metal services

Electric and electronic equipment

Combination utility services

REFERENCES

"Alternatives to the land disposal of hazardous wastes - an assessment for California" Toxic Waste Assessment Group, Office of Appropriate Technology, California, 1981

"Treatibility Manual", Office of Research and Development, EPA, Washington, (EPA-600/2-82-001a through e), September 1981

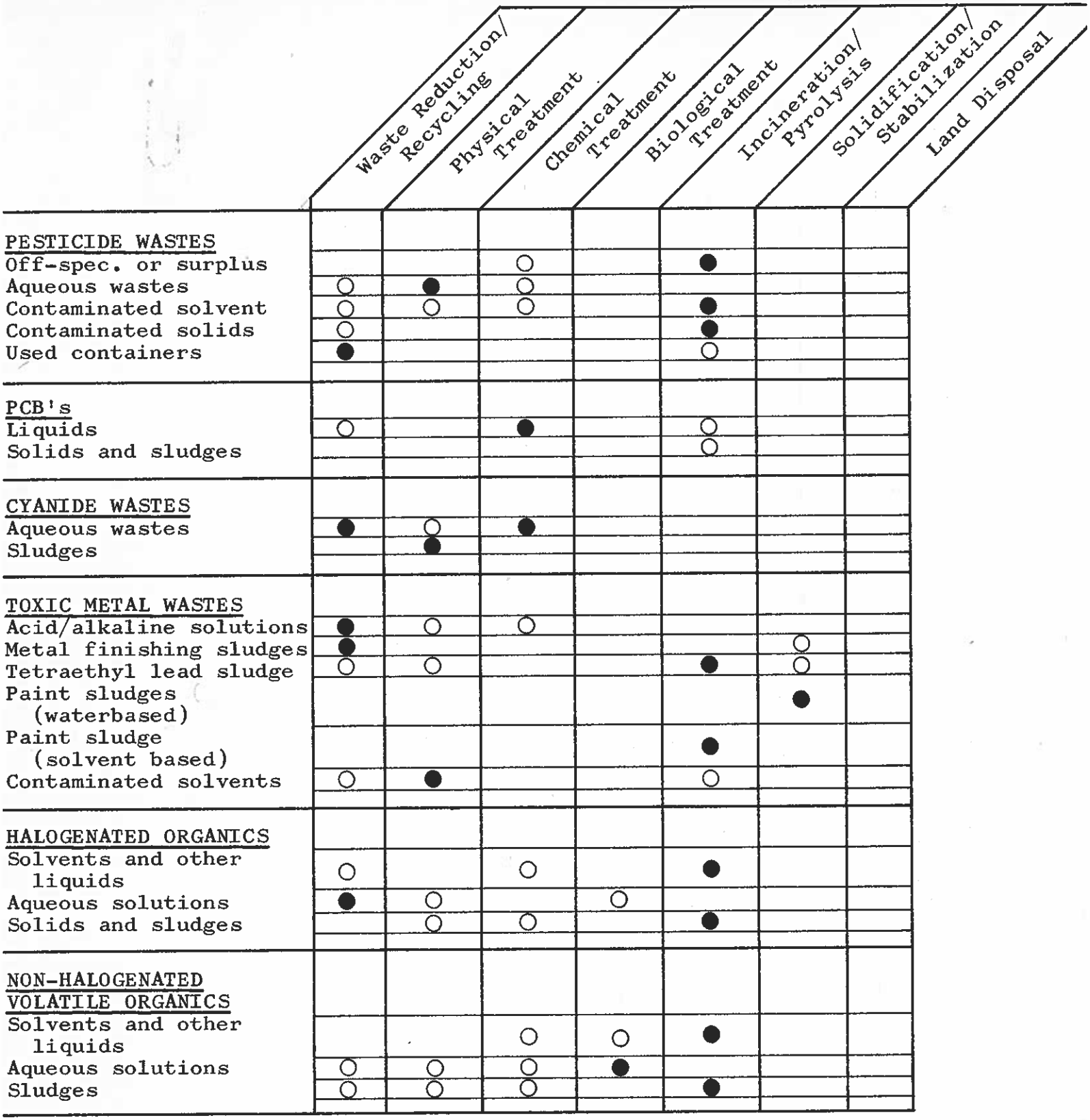
"Chemical Hazards Response Information System", U.S. Coast Guard, Department of Transportation (CG-446-1 through 4)

"Industrial and Hazardous Waste in the Pikes Peak Region", Pikes Peak Area Council of Governments, February 1981

	Pesticide Wastes	PCB's	Cyanide Wastes	Toxic Metal Wastes	Halogenated Organics	Non-halogenated Volatile Organics
Industrial Inorganic Chemicals	S	S		○	○	○
Plastics Materials and Resins				S	●	●
Industrial Organic Chemicals	○	S		○	●	○
Agricultural Chemicals	●			S	○	○
Chemical Preparations			○	S	○	○
Petroleum Refining		○	○	●	○	●
Primary Metal Industries			●	○	S	S
Metal Services			●	○	S	S
Electric & Electronics Equip.			●	●	○	○
Motor Vehicles and Equipment			S	○	S	○
Combination Utility Service		●			●	●

WASTE GENERATION MATRIX

● -- >10% Major
○ -- 1-10%
S -- <1% Minor



WASTE TREATMENT MATRIX

ECONOMICS OF LAND DISPOSAL VS. ON-SITE RESOURCE RECOVERY

Currently the state of Colorado has no hazardous waste disposal facilities available. Hazardous wastes must be transported to nearby states (Kansas, Utah, Idaho, California, Oklahoma) with licensed facilities.

Typical 1982 disposal costs are $70/ton, of which $50/ton is transportation. These costs are higher for less than truckload quantities.

At the present rate of passage of proposed legislation and permitting process, Colorado is unlikely to have land disposal facilities before 1985. In addition, there are proposed state surcharge fees for land disposal of wastes or waste residues that have not been detoxified, stabilized or otherwise treated to render them non-hazardous.

This proposed state surcharge fee is a deliberate attempt at economic incentive for alternative technology to land disposal. The proposed use of these surcharge funds include providing capital to build an off-site detoxifying facility, a trust fund for perpetual care after post-closure, or funds to local government to offset economic and social costs of a land disposal facility.

In 1981 the Office of Alternative Technology in California evaluated alternate technologies to land disposal, and came up with the following estimated costs.

Neutralization/precipitation	$ 30-150/ton
Incineration	$250-500/ton
Cement kiln	$ 50- 70/ton
Aqueous organic waste treatment	$ 30- 60/ton
Stabilization/solidification	$100-120/ton
Oxidation/reduction	$ 50-175/ton

While these figures will vary depending on design size of an alternate facility, they certainly are of the order of the proposed state surcharge, and warrant serious investigation by industry.

Many of these alternates work best on unmixed wastes, and industry should give serious consideration to installing on-site facilities for waste reduction, recycling, treatment or destruction.

HAZARDOUS WASTE GENERATION PATTERNS IN COLORADO

A January, 1980 Colorado Dept. of Health report presented the following survey findings from 961 responses to 1562 survey firms.

855,000 tons/year potentially hazardous wastes

84 million gallons liquids

437,000 tons solid wastes

99.7% of this total from Front Range wastes

86,000 tons/year considered extremely hazardous

The survey gave the following breakdown:

28.2% acidic wastes

15.3% brines

13.4% sludges (heavy metal, oils, treatment)

10.9% wastewaters (rinse and others)

5.8% solvents

26.4% other