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Potential Reuse of Petroleum-Contaminated Soil

A Directory of Permitted Recycling Facilities

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POTENTIAL REUSE OF PETROLEUM-CONTAMINATED SOIL: A DIRECTORY OF PERMITTED RECYCLING FACILITIES

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural resources to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The health impacts associated with uncontrolled releases of petroleum hydrocarbons from underground storage tanks present an area of major concern. The responsible parties, whether large corporations or small businessmen must find an appropriate means of remediating any soil contaminated by such releases. This document will assist them in finding solutions that will not only clean the soil contaminated by such tanks, but also reuse it in an environmentally safe method. It identifies facilities that have, at this date, been approved in the United States as recyclers of petroleum-contaminated soil.

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ABSTRACT

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is one individual small businessman, a group of owners, or a large multinational corporation. They may need a starting point in their search for an appropriate solution, such as recycling.

This report provides initial assistance in two important sections: a clear discussion of the potential recycling technologies and a user-friendly, quick-reference table listing the names and locations of recycling companies in each state that allows such services, supplemented by a detailed directory of specific contacts for further information.

Four types of technologies manufacture marketable products from recycled petroleum-contaminated soil: hot asphalt processes, cold mix asphalt systems, brick (vitrification) techniques, and cement-production.

Table 3, which forms the core of this report, lists recycling facilities alphabetically by location within each state, organized by U.S. Environmental Protection Agency (EPA) Region. The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey (Status: A); that they have temporarily ceased previously approved operations (Status: I); or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations (Status: P).

Table 4 is an alphabetical directory of these companies, providing detailed address, recycling location, telephone number, and contact for the RP who may wish to gather even more specific information.

The scope of the survey project and report concern only fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. This project does not address site-specific remediation facilities. Other EPA documents address such recycling for commercial hazardous waste facilities [1,2].

This report was submitted in fulfillment of Contract Number 68-C9-0033 by Foster Wheeler Enviresponse, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from 1990 to 1991, and work was completed as of February, 1992.

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ABBREVIATIONS AND SYMBOLS

A	Active (recycling facility)
ASTM	American Society for Testing and Materials
BTEX	Benzene, toluene, ethyl benzene, xylene (combined analysis)
COLIS	Computerized On-Line Information System
D	Diesel
dia	Diameter
EPA	U.S. Environmental Protection Agency
G	Gasoline
I	Inactive (recycling facility)
K	Kerosene
lb	Pound (weight)
LUST	Leaking underground storage tank
NA	Not available
P	Permitting (application being processed for the recycling facility)
RP	Responsible Party
RCRA	Resource Conservation and Recovery Act
t/d	Tons per day
t/h	Tons per hour
t/m	Tons per month
t/yr	Tons per year
TCLP	Toxicity characteristic leaching procedure
TPH	Total petroleum hydrocarbons
TSDs	Transportation/storage/disposal facilities (for hazardous waste)
VOC	Volatile organic compounds
UST	Underground storage tank
$/t	Dollars per ton
#2	Number 2 fuel oil
#4	Number 4 fuel oil
#6	Number 6 fuel oil
ADEM	Alabama Department of Environmental Management
DE DNR	Delaware Department of Natural Resources
FL DER	Florida Department of Environmental Regulation
KS DH&E	Kansas Department of Health & Environment
MA DEP	Massachusetts Department of Environmental Protection
ME DEP	Maine Department of Environmental Protection
MDE	Maryland Department of the Environment
MPCA	Minnesota Pollution Control Agency
NC DEM, AQP	North Carolina Division of Environmental Management, Air Quality Permitting
NH ARD	New Hampshire Air Resources Division
NJ DEP	New Jersey Department of Environmental Protection
NY DEC	New York Department of Environmental Conservation

PA DER	Pennsylvania Department of Environmental Resources
RI DEM	Rhode Island Department of Environmental Management
SC GW Div.	South Carolina Ground Water Division
VA DAPC	Virginia Division of Air Pollution Control
WA DE	State of Washington, Department of Ecology
WI DNR	Wisconsin Department of Natural Resources

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SECTION 1
INTRODUCTION

THE PROBLEM OF PETROLEUM-CONTAMINATED SOIL

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is an individual small businessman, a group of owners, or a large multinational corporation. Disposal of such soil is costly, both in terms of money and landfill resources.

Federal legislation makes the generator responsible for soil contaminated by chemical materials, even if the contaminants are virgin products rather than processed waste [40 CFR 261.3(a)(92)]. In the case of a large corporate site, the responsible party may need a starting point for a competent technical team that can explore the appropriate remedies and implement them. At the other extreme, however, for a small businessman, finding an economically feasible remedy may be more difficult. A typical example is the gasoline station owner who has arranged to have an old tank removed/replaced, but is left with a substantial pile of contaminated soil, which has been excavated and covered by a tarpaulin pending cleanup.

Regardless of cleanup volume, the RP should investigate environmentally and financially advantageous recycling options. This report will provide initial assistance in finding an environmentally responsible solution. It contains two key resources: a clear discussion of the potential recycling technologies (Section 2) and a user-friendly, quick-reference table listing the names and locations of recycling companies in each state that allows such services, supplemented by a detailed directory of specific contacts for further information (Section 3).

LEVELS OF REGULATION

Public Law 98:616 (the reauthorization of the Resource Conservation Recovery Act, called RCRA, published in 1984) mandates the development and implementation of an extensive regulatory plan for underground storage tanks (USTs) The U.S. Environmental Protection Agency (EPA) must promulgate the agency regulations that protect human health and the environment. Therefore, EPA must define long-term corrective actions for the treatment of petroleum-contaminated soils at UST sites regulated under RCRA Subtitle I.

Under the federal Resource Conservation and Recovery Act (RCRA), soil contaminated by virgin petroleum product is not considered a hazardous waste. However, the individual states -- and even individual communities -- have the right to legislate standards that are more restrictive than federal statutes. Such regulations, peculiar to a particular state or community, can -- and do -- change rapidly. Past trends indicate that the future may bring even more restrictive statutes on a state-by-state basis, or even on the federal level [42 USC 6901 et seq., RCRA Section 3006(a)]. Therefore, the persons or companies responsible for the disposal or recycling of petroleum-contaminated soil must periodically familiarize themselves with any applicable legislation, and any changes to such legislation, on the national, state, county, and municipal level.

Due to differing statutes and random changes, the concept of a permitted facility cannot be uniform. For the purposes of this report, "permitted" will mean that the facility operates with formal governmental authorization. This may take the form of an air permit, a RCRA permit, certification, or some other vehicle from the appropriate governing body which formally authorizes the facility's operation. In some cases the permitting is required for the manufacturing process, regardless of whether petroleum-contaminated soil is part of the raw material.

This report summarizes information on fixed recycling facilities that are authorized to accept soils contaminated by virgin petroleum products. It does not address facilities that handle hazardous wastes. Similar documents address recycling at commercial hazardous waste facilities [1,2]. Since most states consider petroleum-contaminated soil only a solid waste, these recycling facilities neither require RCRA Part B permitting nor listing in RCRA data bases as TSDs.

SURVEY METHODOLOGY AND REPORT PREPARATION

The project survey contacted authorities and private companies in each state to identify its facilities for recycling petroleum-contaminated soil into a marketable product (e.g., asphalt, bricks, and cement). It progressed in two stages: Stage I, during 1991, established initial parameters and contacts; Stage II refined the scope of the survey, supplemented the listings, and reviewed some of the earlier information.

Stage I

This stage contained four segments:

1. A brief review of some extant listings of treatment facilities, including the EPA COLIS LUST Corrective Action Case Histories Data Base, to determine whether they address the survey requirement,

2. Telephone interviews of selected permit personnel in EPA regional offices to identify region-specific facilities and knowledgeable state contacts,

3. Requests to each state UST and LUST office for information on facilities,

4. A telephone survey of recycling operators to gather basic information about their operations.

The first two segments provided limited information and verified the need for the project. Even sources such as the Asphalt Recycling and Reclaiming Association and the EPA Regional Offices did not have a specific list of facilities that are permitted to recycle petroleum-contaminated soil.

The third segment provided additional information from the following offices and the contacts they provided: state UST Program offices, Air Quality Management Branch, Solid Waste Management Branch, and regional or county counterparts to state offices.

The fourth segment provided the first draft of Table 3, which forms the core of this document.

[__Note:__ **Information provided by the permitted facilities was not verified by site inspection, copy**

of permit, or performance testing. Any reader planning to let contracts for future work must require proof of permit/approval.]

Information from the Stage I survey provided sufficient material for a first draft of the report and its core table. A review of this draft revealed that, while it contained valuable information, it required revision to become a user-friendly document. It also identified needs for a refined definition of recycling facilities and a more comprehensive listing.

The concept of a marketable product (e.g., asphalt, brick, or cement) received added attention because it lowers the recycling cost and increases the environmental value of the selection. Also, the targeted application (i.e., universal assistance to RPs with widely varying volumes of contaminated soil) eliminated the relevance of site-specific remediation facilities. To clarify the scope of the report, the governing definition of "recycling" in the report was limited to the reuse of petroleum-contaminated soil for another purpose. Therefore, it also precluded the listing of on-site "treat and dispose" operations.

Stage II

The Stage II plan evolved from the Stage I review and ensuing discussions. It outlined the preparation of the revised report and the continuation of the survey in 5 areas:

1. A more streamlined table, divided not only by EPA Region, but also by state, would pinpoint for ready access the primary user's first concerns: location and identity. It would then tabulate the capacity, cost, product, and contaminant issues that would help the RP make a "first cut" of potential resources. This streamlined format would also provide a better overview for a researcher seeking a general understanding of recycling opportunities.

2. A detailed directory would follow the table, enabling the user to easily find all the necessary information for follow-up inquiries after initial identification.

3. These better-defined needs would in turn determine the form of a new telephone survey form to elicit information from recyclers. (See Table 1.) This form would be further adapted to fashion the more streamlined table (Table 3).

4. Additional telephone surveying would verify and supplement the original information due to the volatility of the regulatory scene and the rapid emergence of new recyclers.

5. A more thorough discussion of the four targeted products, supplemented with additional illustrations would aid the RP in better understanding the potential of recycling technologies.

TABLE 1. TELEPHONE SURVEY FORM

Recycling Facilities											Acceptable Contaminants						
State	Company	Recycling Location	Status	Capacity t/d	Cost $/t	Hot Asphalt	Cold Asphalt	Cement	Aggregate	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments

SECTION 2
RECYCLING TECHNOLOGIES

TECHNOLOGIES ADDRESSED IN THIS REPORT

Under the scope of this report, four technologies recycle petroleum-contaminated soil into marketable products: hot mix asphalt processes, cold mix asphalt systems, cement-production, and brick manufacturing techniques.

Asphalt is a bituminous material which occurs naturally or derives from the separation of petroleum fractions. It is categorized as asphalt cement or liquid asphalt. Asphalt contains aliphatic, mononuclear aromatic, and polynuclear aromatic hydrocarbons. Asphalt cement is the heaviest fraction. Liquid asphalts are lighter fractions, which are graded by viscosity. Liquid asphalts may also be produced by dissolving asphalt cements in solvent or emulsifying asphalt cements in water [10]. There are two groups of asphalt-producing technologies: hot and cold mix processes.

- **Hot mix asphalt processes** use asphalt cement and can incorporate petroleum-contaminated soils. Aggregate, also marketable, is an intermediate product in this process. It consists of crushed stone, crushed slag, crushed gravel or sand (natural or manufactured) that conforms to the quality and crushed particle requirements of the appropriate ASTM specifications.

- **Cold mix asphalt processes** use liquid asphalts and can incorporate petroleum-contaminated soil. Cold mix plants blend liquid asphalts with aggregate to produce patching material or a lower grade pavement which may be suitable for light duty use.

Unlike asphalt, cement and brick products consist of non-bituminous materials that include clay, shale, and other ingredients, based on their respective product specifications and manufacturing processes.

- **Hydraulic cement** is the basic binding agent in concrete and masonry construction. Portland cement accounts for approximately 95% of the total hydraulic cement production. It is a finely ground mixture of calcium aluminates and silicates, capable of setting and hardening by chemical reaction with water [25].

- **Brick** manufacturing processes blend clay and shale into plasticized mixtures, which are then extruded and molded into green bricks, which are later fired. A typical ASTM-defined-brick is a ceramic product. It is a solid masonry unit of clay or shale, usually formed into a rectangular prism (while plastic) and burned or fired in a kiln [22].

HOT-MIX ASPHALT PLANTS

The hot mix process employs both mixing and heating to make the pavement material. It blends and dries mineral aggregates like sand, gravel, and crushed stone (with a diameter as large as 3/4-in), heating them to 300-350°F. Mixing hot asphalt (5-10% by weight) with the hot aggregate produces paving material.

A hot mix temperature of 300-350°F does not destroy the hydrocarbons vaporizing from the soil. Secondary combustion chambers have modified the process in some hot asphalt plants used for recycling. The recycling of petroleum-contaminated soil takes place in the aggregate preparation process. Exhaust treatment by cloth filters (baghouses) provide a means of controlling particulate emissions. Two plants report high-temperature destruction prior to either a baghouse or a secondary combustion chamber.

Theory

A dryer heats the petroleum-contaminated soil and aggregate prior to mixture with the asphalt. Volatilization and low temperature thermal destruction of the organic compounds occur in the dryer [12]. The process incorporates the remaining heavy-hydrocarbon contaminants into the asphalt/aggregate mix, which may then be utilized for construction purposes such as road building.

Equipment

A typical batch mixing process requires the storage of aggregate material, held in cold bins. An additional cold bin holds the petroleum-contaminated soil. Metered amounts of contaminated soil and aggregate travel by cold elevator to the dryer, where the temperature can range from 500 to 800°F. When the aggregate mix is heated in the dryer for a period up to five minutes, the lighter organic contaminants volatilize. A dust collector and exhaust treatment system, such as a baghouse, treats the gases from the dryer [9].

The mixture leaves the dryer at a temperature of approximately 300°F. A hot elevator conveys it to a screening unit for size separation and subsequent storage in hot bins according to aggregate size . The process formula specifies a measured amount of each size fraction which is weighed and then dropped into the mixing unit containing hot asphalt. After mixing, the process carries the asphalt to heated storage containers or to trucks for immediate use [5,9].

Product

A typical hot asphalt mix contains the following components[11]:

- o 50% coarse aggregate or gravel (size range from 1.5" to U.S. Sieve #4)
- o 40% fine aggregate or sand (size range from <U.S. Sieve #4 to >U.S. Sieve #200)
- o 5% mineral fill, such as crushed stone dust or lime (size <U.S. Sieve #200)

- o 5% asphalt cement

Asphalt cements used in the hot mix technology typically contain high concentrations of aromatics (both mononuclear and polynuclear rings), nitrogen, sulfur, oxygen, and trace amounts of metals or organometallic compounds.

The hot asphalt mix is used in paving roads. To maintain product quality, the recycler adds only a small percentage of petroleum-contaminated soil to the aggregate feed. This also minimizes air emissions resulting from volatilization of organics in the dryer. Asphalt plants limit the clay and silt content in soil feed to 15-20%. However, some plants produce road bedding aggregate and daily landfill cover in addition to asphalt. In addition, the aggregate formed during hot mix asphalt production (described above) is also a marketable product. Some companies produce this intermediate product and, rather than making asphalt, sell it to other enterprises that use it for road base or an asphalt component. Some prepare the recycled aggregate in one location and ship it to another (asphalt-producing) facility.

Application

The feasibility of using asphalt incorporation as a recycling technology depends on the physical and chemical characteristics of the contaminated soil. The soil must be free from large rocks, wood, and debris. Since the strength and durability of the asphalt mix depend on the aggregate size, type, and volume, soil particle size may also influence the application. The contaminated soil particle size must be compatible with the asphalt mix requirements. This usually limits the fine material to a small percentage (normally 2-10%) of the mixture. Weather can potentially limit this application; most asphalt plants do not operate during cold weather.

The lighter contaminant fractions -- fuel oil, kerosene, or gasoline -- that are not burned off in the dryer can act as solvents, softening the final asphalt mix and affecting curing time. The heavier fractions, which are chemically similar to asphalt, will not damage the product.

The cost to retrofit an asphalt batch plant for the incorporation of petroleum-contaminated soil would range from $10,000 to $100,000. The capital costs cover soil storage, feed, conveying, and metering systems. These costs would be offset by the fees paid by RPs.

The average cost of asphalt incorporation has been estimated at $\$80/yd^3$ of soil (Kostecki et al. 1989) exclusive of excavation and transportation costs. Operators contacted in the survey quoted a range of costs from $ 40 to $ 100 per ton, excluding transportation and storage.

Data from tests on asphalt plant and modified asphalt plant efficiency in recycling soil are limited. One study shows increases in hydrocarbon emissions for a feed mixture of clean aggregate and contaminated soil [3]. This particular approach is not recommended since the petroleum volatilizes and leaves the system prior to combustion. (See Figure 1.) Volatile emissions rose from 20 lb/hr to 64 and 67 lb/hr for mixtures of soil contaminated by diesel fuel and gasoline, respectively.

COLD MIX ASPHALT PLANTS

Cold mix plants blend liquid asphalt with aggregate in small open pugmills or revolving drums. It is normally compacted and spread at the job-site where the mixture is at or near ambient temperature. The cold mix asphalt process produces a lower grade pavement which may be suitable for light duty use.

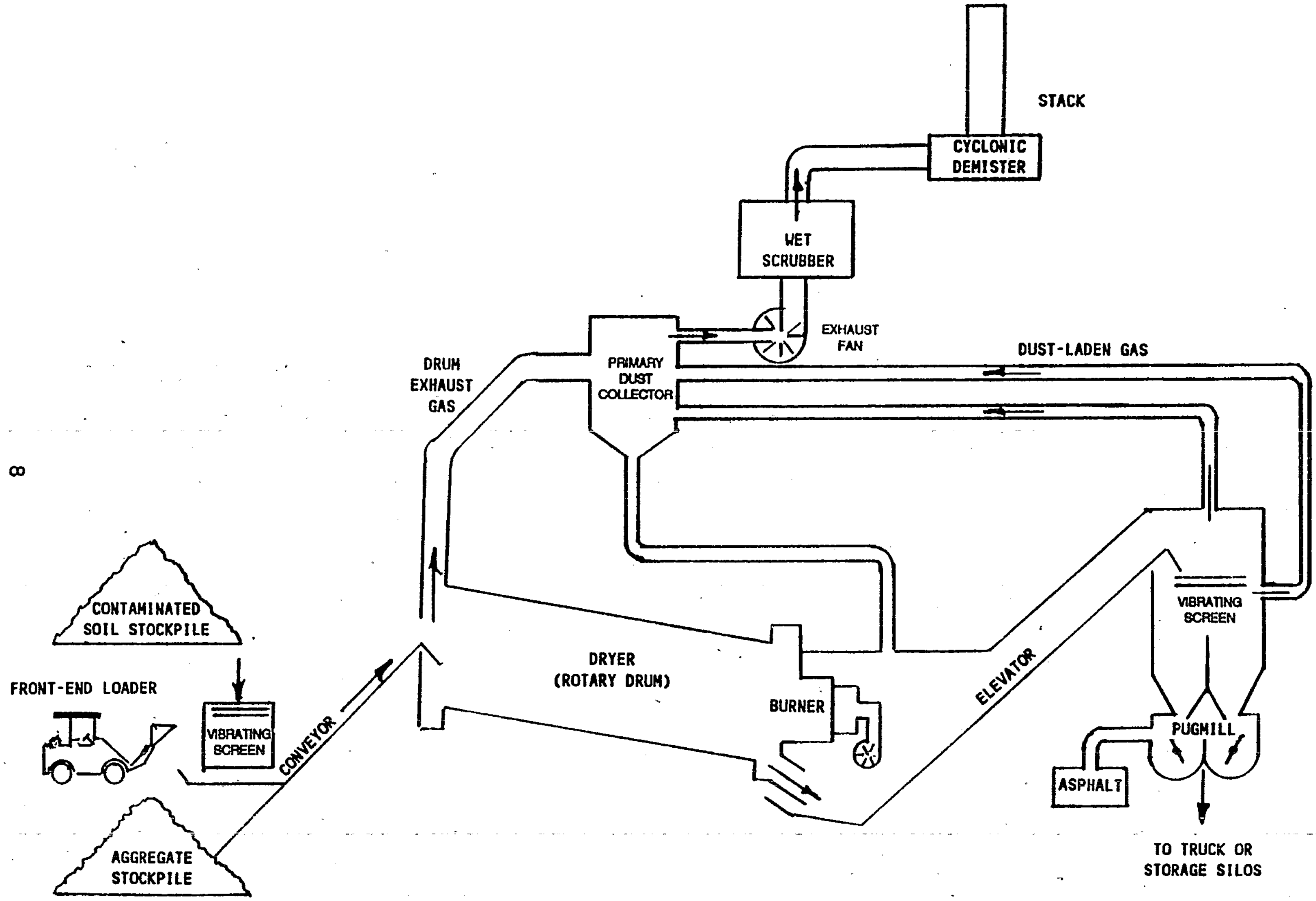


Figure 1. Batch hot-mix asphalt plant.

SOURCE: EPA 1986

Theory

The cold process mixes aggregate and liquid asphalt to form the paving material. It uses surfactant to emulsify asphalt cement in water. Anionic, cationic, and nonpolar asphalt emulsions are available. These materials may contain polynuclear aromatic hydrocarbons, depending on the grade of asphalt cement from which they are derived. The resulting emulsions are relatively nonvolatile [10]. The asphalt particles are suspended in the liquid and separated from each other (and the aggregate) by a film of water. During paving, pressure expels the film of water, bringing the asphalt particles together in contact with the aggregate [9]. (See Figure 2.)

Equipment

The equipment used in the cold process varies from a small open pugmill or revolving drum to a complete plant. The pugmill or drum blends the aggregate, the petroleum-contaminated soil, and the asphalt emulsion. The selected asphalt viscosity controls the viscosity of the asphalt mix, its curing time, and its application.

Product

Asphalt from the cold process is suitable for jobs where a considerable interval of time may elapse between its manufacture and use. The selection of the proper liquid asphalt can adjust the curing time. Therefore, these mixtures can be effective for patching and spreading over small areas. They also provide the surface course of pavements carrying medium or low volume of traffic.

In addition, the aggregate formed during asphalt production (as described in the preceding pages) is also a marketable product. Some companies produce this intermediate product and, rather than making asphalt, sell it to other enterprises that use it for road base or an asphalt component.

Preliminary tests have been conducted on the environmental effects of asphalt paving [26]. These tests confirmed that the petroleum contamination in the soil is combined with the asphalt in the emulsion to produce a mixture that will not separate. The researcher concluded that the incorporation of soils contaminated with petroleum products as aggregate in a cold-mix-emulsion bituminous paving is an environmentally benign method of recycling the contaminated soil.

Application

The cold process is an application suited to the heavier petroleum-contaminated soils, such as those containing Numbers 2 to 6 fuel oil and most lubricating oils. The heavier fractions, chemically similar in nature to asphalt, do not damage the asphalt mix [14]. Soils contaminated with lighter petroleum products, such as kerosene and gasoline, can emit hydrocarbon vapors when they are mixed with asphalt and applied in hot ambient conditions. They have limited application for winter-service cold patch.

The liquid asphalt binder works best when the aggregate has been wetted with asphalt. If a particle has been coated with water or a clay film prior to mixing, the asphalt may not adhere to it. As a result, this technology has limited application for treating petroleum-contaminated soils with high clay fractions and with a high capacity for water retention [10].

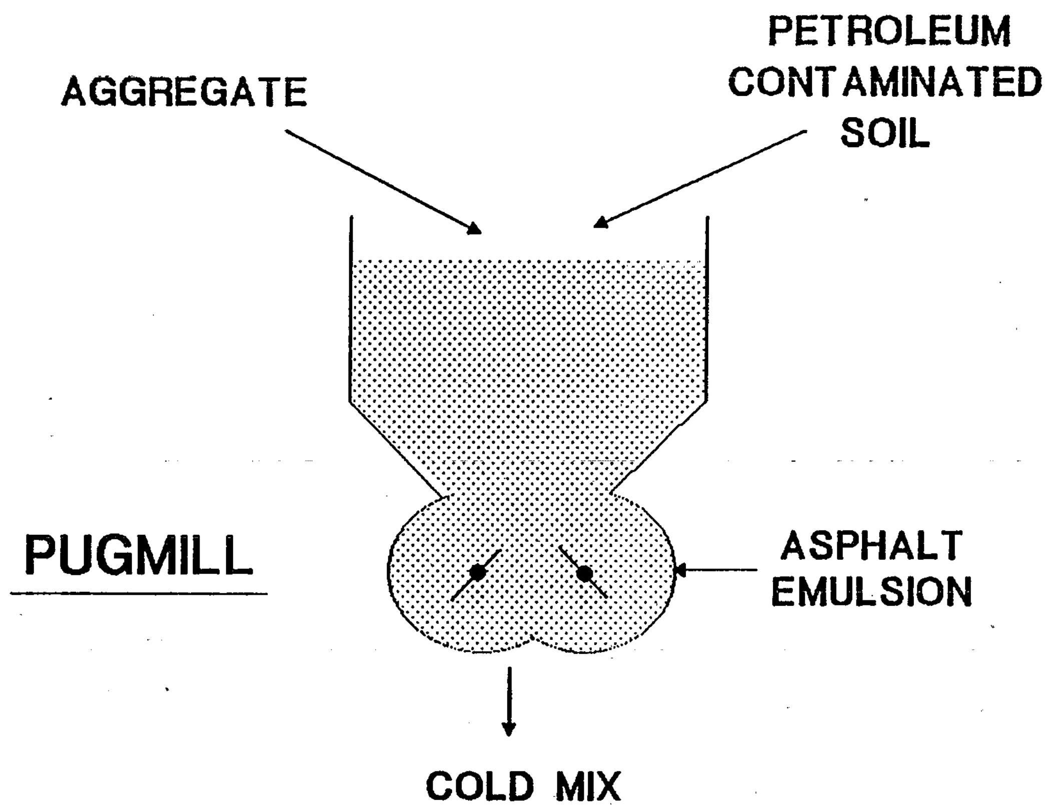


Figure 2. Cold mix asphalt process.

CEMENT MANUFACTURING FACILITIES

Hydraulic cement is the basic binding agent in concrete and masonry construction. Approximately 95% of the cement produced in the United States is Portland cement -- a product of high temperature burning of calcareous material (e.g., limestone, oyster shells), argillaceous material (e.g., clay), and siliceous material (e.g., sand, shale) to produce clinker. Portland cement consists of pulverized clinker blended with water and/or untreated calcium sulfate (gypsum).

Theory

The cement manufacturing process employs raw materials such as limestone, clay, and sand which are usually fed to a rotary kiln. The raw materials enter the raised end of the kiln and travel down the incline to the lower end, which is heated by coal, oil, or gas. Petroleum-contaminated soils may enter the process as part of the raw material or drop into the hot part of the kiln. As the raw materials move through the inclined, rotating kiln, they heat to extremely high temperatures -- up to 2,700°F. These temperatures cause physical and chemical reactions such as evaporation of free water, evolution of combined water, evolution of carbon dioxide from carbonates, and combination of lime with silica, alumina, and iron to form the desired compounds in the clinker. The petroleum-contaminated soil also breaks apart chemically. At extremely high temperatures, the organic compounds burn, producing heat, carbon dioxide, and water vapor. The inorganic components recombine with the raw materials and are incorporated with the clinker. The clinker leaves the kiln in golf-ball-sized lumps. The rapidly cooled clinker, mixed with gypsum and ground to a fine powder, produces Portland cement. (See Figure 3.)

Equipment

There are three major types of cement-manufacturing processes: the wet process, the dry process, and the dry process with preheating and/or precalcining.

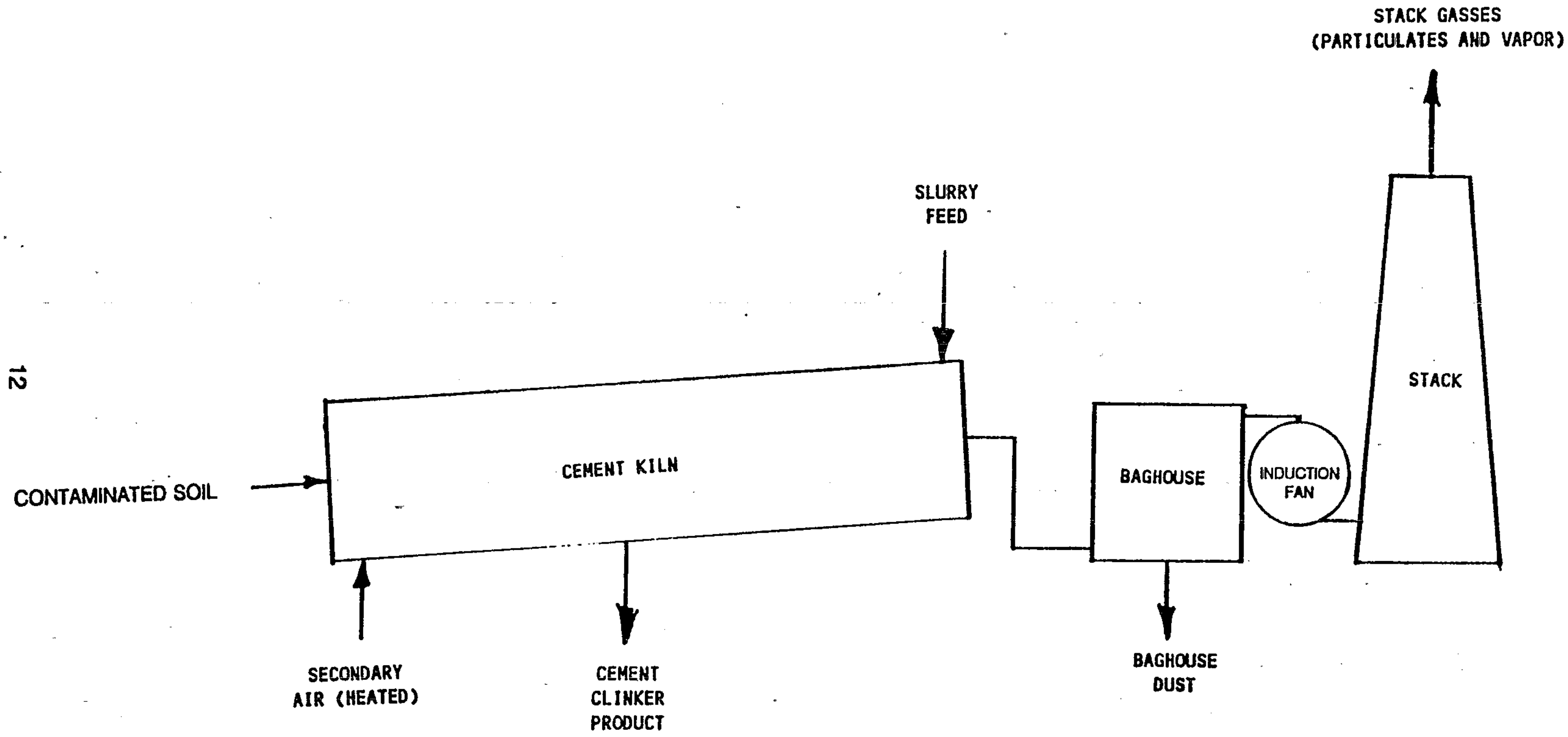
In the wet process, finely ground raw materials, mixed with water, form a slurry feed containing 30 to 40% moisture.

The dry process uses raw materials that are typically quarried and crushed to an approximately 5-in diameter. The materials travel through direct-contact rotary driers to a rotating raw mill where they are ground to approximately 200-mesh. In the preheater, this dry powder passes through a series of heat exchangers before it enters the kiln. The precalcining system uses a secondary firing process within the preheater to increase thermal preparation of the feed.

In each process, the ground and blended raw materials travel through a rotary kiln. The kiln is a large, inclined, rotating cylindrical furnace from 10 to 20 ft in diameter and from 350 to 760 ft long. Raw materials enter the raised end of the kiln and travel down the incline to the other end, which is heated by burning fuel. The retention time in the kiln spans roughly 1 to 4 hours; the temperature at the hot end ranges from 2,500 to 3,500°F.

The kiln produces dark, hard nodules called clinker. The temperature of these 3/4-inch (or smaller) nodules is reduced by air in a clinker cooler. The air from the clinker cooler, along with combustion gases and water vapor, rises through the high (cool) end of the kiln to a dust collection system and out the stack.

An open or closed circuit mill grinds the clinker, adding about 3 to 6% gypsum (calcium sulfate) to retard the cement's setting time. Other additives may include air-entraining, dispersing, and waterproofing



SOURCE: EPA 1986

Figure 3. A basic cement kiln process.

agents. The final product measures about 10 microns in diameter.

The dry process system may use a suspension preheater upstream of the kiln. The preheater consists of a series of cyclones connected by pipes, through which gases from the kiln pass upward and countercurrent to the dry raw material flowing down and around the cyclones. Suspension preheaters transfer the heat from the gas into the raw material feed dust. This leads to roughly 40% calcination of the feed before it enters the kiln. Some new preheater systems use a small direct-fired furnace located between the air suspension preheater and the kiln. This system can calcinate roughly 90% of the raw materials. Such systems can reduce the size of the rotary kiln required or increase the production capacity of an existing kiln.

Product

According to ASTM Specification C150-89, Portland cement is:

> A hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulfate as an interground addition.

The five basic types of Portland cement vary according to their strength and hardening time; they comprise the basic binding agents used in concrete and masonry construction.

Industrial process rotary kilns, which are located throughout the United States, manufacture cement and lime. Based on survey results, the petroleum-contaminated soil treated in these kilns can be used for daily cover in landfills. (See Figure 3.)

Application

Cement kilns can recycle petroleum-contaminated soil as solid material in various ways. Solid material suspended in liquids can be pumped into the hot end of the kiln. In another process, the solids are repackaged and injected into the kiln area where gas temperatures range from 1,800 to 2,150°F. In a third process, preprocessed solids and sludges are dried, ground into powder, and conveyed by air into the hot end of the kiln. Cement manufacturers have a wide choice of raw materials. Lime, silica, and alumina are the most important ingredients. Any materials that will supply these components can be used in cement manufacture, provided that they do not contain excessive amounts of other oxides [25].

The contaminated soils must be characterized and then blended to meet process specifications covering organic makeup, energy value, and compatibility with cement-making. Cement costs vary according to the types of soil and contaminants; producers reported costs from $30 to $100 per ton, exclusive of transportation and storage.

BRICK MANUFACTURING PLANTS

The brick manufacturing process blends clay and shale into a plasticized mixture, which is then extruded and molded into green brick. It dries and fires the green brick in a kiln where temperatures reach approximately 2,000°F during a three-day residence period.

Theory

The brick-making process blends the petroleum-contaminated soil with the clay and shale. It molds this raw material into a green brick. Once the green brick is dried and preheated, the kiln fires it at 1,700 to 2,000°F for approximately 12 hours. The temperature and residence time in the kiln destroy the organics, incorporating the inorganics in the vitrified brick product. (See Figure 4.)

Equipment

The blending of mined clay and shale with contaminated soil occurs in large stockpiles. Grinders reduce this raw material to particles of an acceptable size for brick formation. The raw material, mixed with water in a pugmill, increases in plasticity. The pugmill extrudes a continuous ribbon of clay which is cut into green bricks. These bricks are stacked on rail cars that travel through a tunnel kiln. The green bricks first dry out at a temperature of 600°F. The next temperature stage (1,200 to 1,600°F) preheats them. At the peak temperature of 1,700 to 2,000°F, the kiln fires them for a period of 12 hours. The kiln travel time is approximately 2-1/2 days. After cooling, the bricks are ready for shipment.

Product

In order to provide the strength and durability requirements of a brick product, the manufacturing process must develop a fired bond between the particulate constituents. These requirements will vary, depending on the intended product use and the applicable ASTM specification. The study identified brick-manufacturing facilities in Virginia, North Carolina, and South Carolina. One brick manufacturer has five facilities in North Carolina that recycle petroleum-contaminated soil.

Application

The brick manufacturing process can recycle various petroleum-contaminated soil fractions including silts, sands, loams, and clays. This process can reuse highly plastic clays that are difficult to treat with other methods. Sand reduces firing shrink and improves moisture absorption from mortar (important during brick laying). Some shales and sedimentary rock are also appropriate feedstock. Soils that contain large quantities of debris, concrete, stone, or asphalt require prescreening.

The cost to the RP of sending petroleum-contaminated soil to a brick-manufacturing recycler depends on the contamination level, the blendability of the soil, and the debris content. Cost estimates range from $30 to $45 per ton, exclusive of transportation and storage.

OTHER TECHNOLOGIES

This report contains a summary of information on certain types of facilities that are permitted, where permits are required, to accept soils contaminated by virgin petroleum products. It concerns only fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. There are other technologies that can treat petroleum-contaminated soil at large sites and dispose of the cleaned soil in the areas from which it was excavated or in an on-site landfill. Technologies such as low temperature thermal desorption, incineration, extraction, and bioremediation are the subjects of intensive reports for the RP seeking a large-scale remediation of a site. EPA's Center for Research Information at the Risk Reduction Engineering Laboratory in Cincinnati can provide further information on such documents and lists them in the *Office of Research and Development (ORD) Publications Announcement Quarterly*.

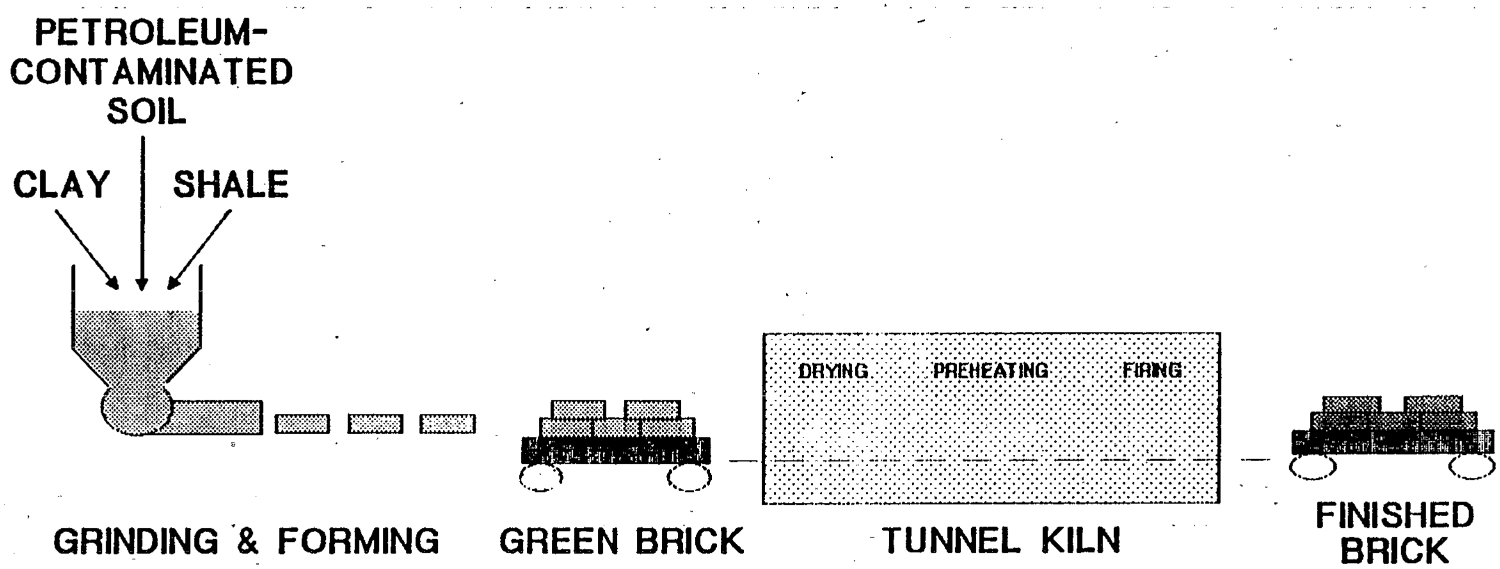


Figure 4. The brick manufacturing process.

SECTION 3
A DIRECTORY OF PERMITTED RECYCLING FACILITIES

USING THE TABLE AND DIRECTORY

Table 3 lists permitted, or otherwise formally state-approved, recycling facilities. It is organized by U.S. EPA Region. (See Table 2 for a list of states in each region.) Within the region, it lists facilities alphabetically by location within each state.

The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey (Status: A); that they have temporarily ceased previously approved operations (Status: I); or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations (Status: P).

Once an RP has selected potential recycling locations from Table 3, they can find all the details necessary to obtain further information in Table 4 -- the Directory of Recycling Facilities. This Directory provides specific address, recycling location, telephone number, and contact for the RP who may wish to follow up with individual queries.

Each facility has its own analytical requirements,. Because these requirements (total hydrocarbons, flashpoint, pH, etc.) respond to the local state regulations as well as an individual permit, they are subject to change. During the follow-up query, the RP should request a written list of requirements that apply at that time from the selected facility.

TABLE 2. U.S. EPA REGIONS

Region	State code	State name	Region	State code	State name
1	CT	Connecticut	6	AR	Arkansas
1	ME	Maine	6	LA	Louisiana
1	MA	Massachusetts	6	NM	New Mexico
1	NH	New Hampshire	6	OK	Oklahoma
1	RI	Rhode Island	6	TX	Texas
1	VT	Vermont	7	IA	Iowa
2	NJ	New Jersey	7	KS	Kansas
2	NY	New York	7	MI	Missouri
3	DE	Delaware	7	NE	Nebraska
3	DC	District of Columbia	8	CO	Colorado
3	MD	Maryland	8	MT	Montana
3	PA	Pennsylvania	8	ND	North Dakota
3	VA	Virginia	8	SD	South Dakota
3	WV	West Virginia	8	UT	Utah
4	AL	Alabama	8	WY	Wyoming
4	FL	Florida	9	AZ	Arizona
4	GA	Georgia	9	CA	California
4	KY	Kentucky	9	HI	Hawaii
4	MS	Mississippi	9	NV	Nevada
4	NC	North Carolina	10	AK	Alaska
4	SC	South Carolina	10	ID	Idaho
4	TN	Tennessee	10	OR	Oregon
5	IL	Illinois	10	WA	Washington
5	IN	Indiana			
5	MI	Michigan			
5	MN	Minnesota			
5	OH	Ohio			
5	WI	Wisconsin			

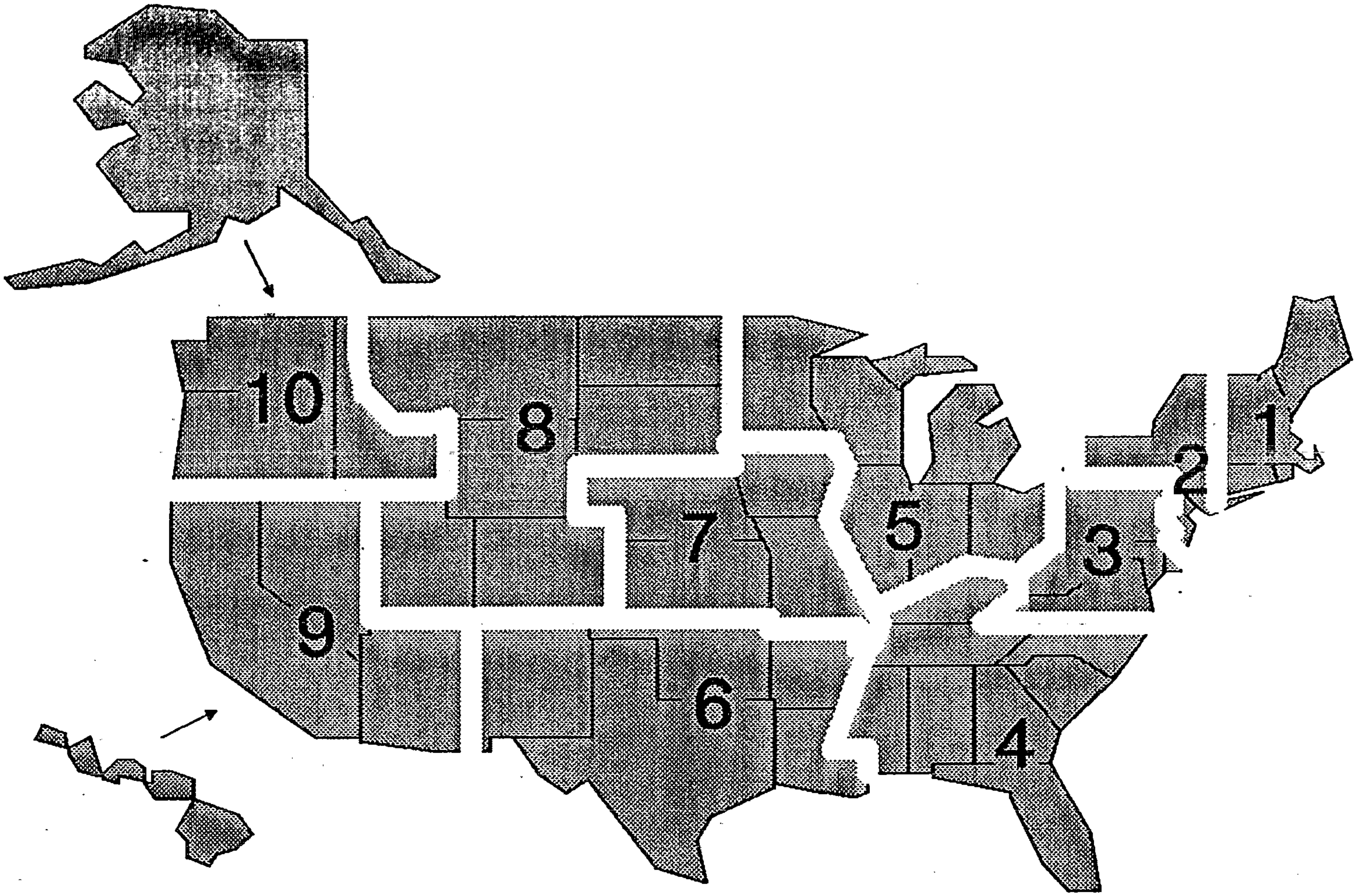


Figure 5. U.S. EPA Regions

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 1

Recycling Facilities				Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Acceptable Contaminants						Comments	Ref.
State	Recycling Location	Company	Status								Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6		
ME	Brunswick	Harry Crooker & Sons, Inc.	I	N/A	N/A	X					X	X	X	X	X	X	No clays or fines	ME DEP
ME	Fairfield	Tilcon Maine, Inc.	A	1,500	25	X					X	X	X	X	X	X		ME DEP
ME	Medway	Tilcon Maine, Inc.	A	800	30	X					X	X	X	X	X	X		ME DEP
ME	Norridgewock	Aggregate Recycling	A	1,000	<50			X			X	X	X	X	X	X	No maximum TPH	MEDEP
ME	Portland	Tilcon Maine, Inc.	A	1,200	35	X					X	X	X	X	X	X	No clay or debris	ME DEP
ME	Washington	Marriners, Inc.	A	100	40			X			X	X	X	X	X	X	No clay or debris	ME DEP
MA	Dracut	Brox Industries	A	180(a) 400(b)	40-50	X (a)	X (b)				X	X	X	X	X	X		MA DEP
MA	Charlton	American Reclamation Corp.	A	1,000	45-50		X				X	X	X	X	X	X	<60,000 ppm TPH	MA DEP
MA	Marlboro	Brox Industries	A	180	40-50	X	X					X	X	X	X	X	<50,000ppm TPH $250.00 minimum	MA DEP
MA	North Adams	Clean Berkshires	A	800	50-60	X					X	X	X	X			<3,000 ppm TPH	MA DEP
MA	Shrewsbury	Bardon Trimount	A	1,000	50	X	X				X	X	X	X	X	X		MA DEP
MA	Stoughton	Bardon Trimount	A	1,000	50	X	X				X	X	X	X	X	X		MA DEP
NH	Bath	AmRec New Hampshire	A	1,000	45-50		X				X	X	X	X	X	X		NH ARD
NH	Chichester	Merrimack Timber Service	A	350	N/A		X				X	X	X	X	X	X	<3,000 ppm TPH	NH ARD
NH	Hudson	Brox Industries	A	180	40-50	X					X	X	X	X	X	X	<30,000 ppm TPH	NH ARD

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 1 (continued)

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
NH	Littleton	Merrimack Timber Service	A	350	N/A	X					X	X	X	X	X	X	<3,000 ppm TPH	NH ARD
NH	Londonderry	Continental Paving	A	400	50-60	X					X	X	X	X	X	X	<30,000 ppm TPH	NH ARD
NH	Loudon	DeCato Sand & Gravel	A	1,200	50-55		X				X	X	X	X	X	X	<20,000 ppm TPH	NH ARD
NH	Plaistow	Beede Waste Oil	A	200	60-65		X				X	X	X	X	X	X	<50,000 ppm TPH <2"diameter particles	NH ARD
RI	Warwick	Cardi Construction Corp.	A	650	50-60	X					X	X	X	X	X	X	No maximum TPH	RI DEM
RI	Warwick	D'Ambra Construction	A	780	N/A	X					X	X	X	X	X	X	<100,000 ppm TPH	RI DEM
VT	Hartland	Merrimack Timber Service	P	N/A	N/A		X				X	X	X	X	X	X	<3,000 ppm TPH	

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 2

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
NJ	Jackson	Earle Asphalt Corp.	P	800	N/A	X		X			X	X	X	X	X	X	<30,000 ppm TPH	NJ DEP
NY	Albany	American Reclamation Corp.	P	1,000	45-50		X				X	X	X	X	X	X		NY DEC
MA	Lanesboro, MA	Clean Berkshires	A	800	50-60	X					X	X	X	X	X	X	Permitted to transport NY soil to MA facility	NY DEC MA DEP

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 3

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
DE	New Castle	Clean Earth of New Castle	A	1,000	55-75			X			X	X	X	X	X	X	<15,000 ppm TPH	DE DNREC
MD	Baltimore	Soil Safe, Inc.	A	5,000	35-45			X			X	X	X	X	X	X	<25, 000 ppm TPH	MDE
MD	Beltsville	Cherokee Sanford	A	2,000	32-45					X	X	X	X	X	X	X		MDE
MD	Chestertown	Recycling Alternatives, Inc.	P	500	40-45					X	X	X	X	X	X	X		MDE
MD	Eden	Kary Asphalt	P	300-500	32-50	X					X	X	X	X	X	X		MDE
MD	Finksburg	Soil Recycling Technologies	A	2,000	55	X	X				X	X	X	X	X	X	<20,000 ppm TPH <14% moisture	MDE
PA	Sinking Springs	Keystone Block Transport	A	500	50-60	X					X	X	X	X	X	X	<21,000 ppm TPH	PA DER
VA	Arvonia Cascade	M&M Chemical & Equipment Co	A	1,000				X			X	X	X	X	X	X		VA DAPC
VA	Exmore	Recycling Alternatives, Inc.	A	500	40-45	X					X	X	X	X	X	X	<20,000 ppm TPH	VA DAPC
VA	Fredericksburg	Envirotech	A	1,000	55-70			X			X	X	X	X	X	X		VA DAPC
VA	Richmond	Recycling Alternatives, Inc.	A	500	40-45					X	X	X	X	X	X	X	<25,000 ppm TPH	VA DAPC

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 4

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
AL	Birmingham	Recycling Alternatives	P	500	40-50	X					X	X	X	X	X	X		ADEM
FL	Green Cove Springs	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		FL DER
FL	Jacksonville	Anderson-Columbia Environmental	A	400	35-50	X					X	X	X	X	X	X	No maximum TPH <2" diameter particles	FL DER
FL	Miami	Rinker Materials Corporation	A	2,000	40-100			X	X	X	X	X	X	X				FL DER
FL	Orlando	C.A. Meyer Paving	A	800	25-35						X	X	X	X	X	X	No maximum TPH	FL DER
FL	Tallahassee	Sonas Systems of Florida, Ltd.	A	1,000	35-65	X					X	X	X	X	X			FL DER
GA	Trenton	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		GA EPD
KY	Brooks	M&M Chemical & Equipment Company	A	1,000	100				X		X	X	X	X	X	X		KY DEP
NC	Gulf	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Moncure	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Norwood	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Norwood	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		NC DEM
NC	Sanford	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM

TABLE 3. LIST OF PERMITTED FACILITIES

REGION 4 (CONTINUED)

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
NC	Sanford	Soil Reclaiming, Inc.	A	2,500	25-40					X	X	X	X	X	X	X		NC DEM
NC	Thomasville	Cunningham Brick Co., Inc.	A	1,000	30-55					X	X	X	X	X	X	X		NC DEM
SC	Charleston	Southeastern Soil Recovery, Incorporated	A	500	55-75	X					X	X	X	X	X	X		SC GW Div
SC	Harleyville	Giant Resources Recovery	A	400	45-100				X	X	X	X	X	X	X			SC GW Div
SC	Harleyville	M&M Chemical Equipment Company	A	1,000	100			X			X	X	X	X	X	X		SC GW Div
SC	Santee	M&M Chemical Equipment Company	A	1,000	100			X			X	X	X	X	X	X		SC GW Div

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 5

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
MN	Maple Grove	McCrossan	A	400	50-70	X		X			X	X	X	X	X	X	<30,000 ppm TPH	MPCA
MN	Rochester	Johnson Blacktop	A	800	N/A	X												MPCA
OH	Lowellville	Gennaro Paving	A	600	30-60	X		X			X	X	X	X	X	X	<20,000 ppm TPH	
WI	Eau Clair	Eau Clair Asphalt Corp.	A	150	40-60	X					X	X	X	X	X	X	No maximum TPH on applications approved by DNR	WI DNR
WI	Green Bay	Payne & Dolan	A	400	35-100	X												WI DNR
WI	Lake Delton	American Asphalt of Wisconsin. Plant #8	A	100	38-50	X												WI DNR
WI	Madison	Payne & Dolan	A	200	35-60													WI DNR
WI	Mosinee	American Asphalt of Wisconsin Plants #2 and #22	A	150 (each)	38-50 (each)	X											<2" particle diameter	WI DNR
WI	Onalaska	Mathy Construction Co.	A	1,600	40-100	X	X				X	X	X	X	X	X	Maximum TPH subject to WI DNR approval	WI DNR
WI	Neillsville	Clark County highway Dept.	A	N/A	N/A	X												WI DNR
WI	Superior	Lakehead Blacktop & Materials	A	430	35-45	X		X										WI DNR
WI	Sussex	Payne & Dolan	A	400	35-100	X												WI DNR
WI	Wausau	American Asphalt of Wisconsin Plant #5	A	150	38-50	X											No maximum TPH	WI DNR

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 6

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
TX	Fort Worth	Recycling Alternatives	P	500	40-50	X					X	X	X	X	X	X		

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 7

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
KS	Independence	Hartland Cement	A	300	30-60				X								No maximum TPH	KS DHE
KS	Witchita	Ritchie Paving Co.	A	350	50-80	X											< 2" diameter, no heavy clays	KS DHE
MO	Hannibal	Riedel Corporation	A	200	400				X		X	X	X	X	X	X	Soil must contain calcium, silica, alumina, or iron	

TABLE 3. LIST OF PERMITTED FACILITIES
REGION 10

Recycling Facilities				Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Acceptable Contaminants						Comments	Ref.
State	Recycling Location	Company	Status								Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6		
AK	Anchorage	Alaska Interstate Construction	A	N/A	N/A			X			X	X	X	X	X	X		ADEC
WA	Everett	Assoc. Sand & Gravel	A	N/A	N/A	X					X	X	X	X	X	X		WA Dept. of Ecology
WA	Kenmore	Sterling Asphalt	A	1,000	75	X					X	X	X	X	X	X	<50 ppm TPH	WA Dept. of Ecology
WA	Port Angeles	Shotwell Precast Co.	A P	650	35-60			X			X	P	X	P	P	P	<30,000 ppm TPH	WA Dept of Ecology
WA	Tacoma	Woodworth & Co.	A	100	56	X											<30,000 ppm TPH	WA Dept. of Ecology

TABLE 4. DIRECTORY OF RECYCLING FACILITIES

Recycling company	Facility location/s	Contact	Telephone
Aggregate Recycling 100 Middle St. Portland, ME 04101	Norridgewock, ME	Bill Mitchell	(207) 634-3652
Alaska Interstate Construction 649 West 54th Avenue Anchorage, AK 99518	Anchorage, AK	Dave Thomas	(907) 562-2792
American Reclamation Corp. P.O. Box 263 Ashland, MA 01721	Charlton, MA Albany, NY (See also AmRec New Hampshire.)	George Camougis Frank Perry	(508) 624-7006
AmRec New Hampshire RFD 1 Box 330 Haverhill, NH 03765	Bath, NH (See also American Reclamation Corp.)	George Camougis	(508) 624-7006
American Asphalt of Wisconsin P.O. Box 1726 Wausau, WI 54402	Lake Delton, WI Mosinee, WI Wausau, WI	Jim Tryba	(715) 693-5200
Anderson-Columbia Environmental P.O. Box 1386 Lake City, FL 32056-1386	Jacksonville, FL	Mike McRae	(904) 752-7585
Bardon Trimount 70 Blanchard Road Burlington, MA 01894	Shrewsbury, MA Stoughton, MA	David Peter	(617) 221-8400
Beede Waste Oil P.O. Box 127 Plaistow, NH 03865	Plaistow, NH	Bob LaFlanne	(603) 382-5761
Brox Industries 85 Greely St. Hudson, NH	Hudson, NH Dracut, MA Marlboro, MA	George Hall Erik Stevenson	(603) 886-8077

* Exclusive agent or broker

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
C.A. Meyer Paving 4978 McLeod Road Orlando, FL 32805	Orlando, FL	Frank Cox	(407) 849-0770
Cardi Construction Corp. 400 Lincoln Ave. Warwick, RI 02888	Warwick, RI	Steve Cardi, Jr.	(401) 739-8300
Cherokee Sanford Group, Inc. 1600 Colon Road Sanford, NC 27330	Beltsville, MD Gulf, NC Moncure, NC Norwood, NC Sanford, NC	Rocky Springer Don Grigg	(919) 775-2121
Clark County Highway Dept. 801 Clay Street Neillsville, WI 54456	Neillsville, WI	Randy Anderson	(715) 743-3680
Clean Berkshires 86 S. Main St. Lanesboro, MA 01237	North Adams, MA (Permitted to transport soil from N.Y. State)	John Anthony	(413) 499-3050
Clean Earth of New Castle P.O. Box 1049 New Castle, DE 19720	New Castle, DE	George Dalphon	(302) 427-6633
Continental Paving 1 Continental Drive Londonderry, NH 03053	Londonderry, NH	Mark Charbonneau	(603) 437-5387
Crooker's	Brunswick, ME	See Harry Crooker & Sons	
Cunningham Brick Co., Inc. Route 2 Thomasville, NC 27360	Thomasville, NC	R. Cunningham	(919) 472-6181

* Exclusive agent or broker

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
D'Ambra Construction 800 Jefferson Blvd. Warwick, RI 02887	Warwick, RI	Jenny Parker	(401) 737-1300
DeCato Sand and Gravel RFD15 Box 52 Concord, NH 03301	Loudon, NH	Roger DeCato	(603) 798-5452
Earle Asphalt Corp. P.O. Box 757 Farmingdale, NJ 07727	Jackson, NJ	Walter Earle, Jr. R. Czarnecki	(908) 657-8551 (908) 938-5038
Eau Clair Asphalt Corp. P.O. Box 326 Eau Clair, WI 54702	Eau Clair, WI	Louie Thune	(715) 835-4858
Envirotech P.O. Drawer 72 Chatham, VA 24531	Fredericksburg, VA	Richard Harris	(804) 432-1901
Gennaro Pavers 1721 Pine St. Warren, OH 44483	Lowellville, OH	David Gennaro Frank Naples	(216) 394-5557 (216) 536-6825
Giant Resources Recovery P.O. Box 352 Harleyville, SC 29448	Harleyville, SC	Al Asaro	(803) 496-7676
Harry Crooker & Sons, Inc. Old Bath Rd. RFD 4 Box 4079 Brunswick, ME 04011	Brunswick, ME	Dick Morgan	(207) 729-3331
Johnson Blacktop 2320 14th Avenue, NW Rochester, MN 55901	Rochester, MN	Royal J. Johnson	(507) 254-1854

*** Exclusive agent or broker**

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Kary Asphalt, Inc. Eden Road Eden, MD 21822	**Eden, MD**	**Steve Lambrose**	**(301) 543-0200**
Keystone Block Transport P.O. Box 9 Temple, PA 19560	**Sinking Springs, PA**	**Laura Lubahn** **Alice Brown**	**(215) 926-6915**
Lakehead Blacktop and Materials of Superior 6327 Tower Avenue Superior, WI 54880	**Superior, WI**	**Joe Kimmes**	**(715) 392-3844**
M&M Chemical & Equipment Co. 1229 Valley Drive Attalla, AL 35954	**Green Cove Springs, FL** **Trenton, GA** **Brooks, KY** **Norwood, NC** **Harleyville, SC** **Santee, SC** **Arvonia, VA** **Cascade, VA**	**D. Burds**	**(205) 538-3800**
Marriners, Inc. P.O. Box 600 Rockport, ME 04856	**Washington, ME**	**David Andrus** **Gilbert Marriner**	**(207) 845-2313**
Mathy Construction 915 Commercial Court Onalaska, WI 54650	**Onalaska, WI**	**Jim Kirschner** **Gail Jensen**	**(608) 783-6411**
McCrossan 7865 Jefferson Highway Maple Grove MN 55369	**Maple Grove, MN**	**Bob Dongoske**	**(612) 425-4167**
Merrimack Timber Service P.O. Box 359 Epsom, NH 03234	**Chichester, NH** **Littleton, NH** **Hartland, VT**	**Jim Langille**	**(603) 798-4557**

*** Exclusive agent or broker**

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Meyer Paving	Orlando, FL	See C.A. Meyer Paving.	
Payne & Dolan P.O. Box 781 Waukesha, WI 53187	Green Bay, WI Madison, WI Sussex, WI	Kurt Bechthold	(414) 524-1769
Recycling Alternatives, Inc.* P.O. Box 1896 Salisbury, MD 21802	Birmingham, AL Chestertown, MD Exmore, VA Richmond, VA Fort Worth, TX	Don Mitchell Jerry Turner	(301) 860-0268
Riedel Industrial Waste Waste Management, Inc. 22 North Euclid, Suite 213 St. Louis, MO 63108	Hannibal, MO	Robert Schreiber	(314) 361-3838
Rinker Materials Corp. P. O. Box 650679 Miami, FL 33265-0679	Miami, FL	Dave Marple	(305) 221-7645
Ritchie Paving Co. P.O. Box 4048 Wichita, KS 67204	Wichita, KS	Jim Jordan	(316) 838-9301
Shotwell Precast Company P.O. Box 2081 Port Angeles, WA 98362	Port Angeles, WA	J. Shotwell	(206) 457-1417
Soil Reclaiming P.O. Box 12248 Sanford, NC 27331-1248	Sanford, NC	W. Wornom	(919) 774-3077
Soil Recycling Technologies, Inc.* 3300 Childs St. Baltimore, MD 21226	Finksburg, MD	Joe Connor	(301) 526-6696

* Exclusive agent or broker

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Soil Recycling Technologies, Inc.* 3300 Childs St. Baltimore, MD 21226	Finksburg, MD	Joe Connor	(301) 526-6696
Soil Safe, Inc. 4600 E. Fayette Baltimore, MD 21224	Baltimore, MD	Walter Kennell	(301) 327-5753
Sonas Systems of Florida P. O. Box 7387 Tallahassee, FL 32314	Tallahassee, FL	George Atkins	(904) 575-8102
Southeastern Soil Recovery, Inc. P.O. Box 70253 Charleston, SC 29415	Charleston Heights, SC	Bob Willms Reid Banks	(803) 566-7065
Sterling Asphalt 6431 NE 175th Kenmore, WA 98028 Tacoma, WA 98421	Kenmore, WA	Sam Johnson	(206) 485-5667
Tilcon Maine, Inc. P.O. Box 209 Fairfield, ME 04937	Fairfield, ME Medway, ME Portland, ME	Rhaeto Pfister Dave Bess Jonathan Oaks	(207) 746-9381 (207) 746-5636 (207) 676-9973
Trimount	Shrewsbury, MA Stoughton, MA	See Bardon Trimount.	
Woodworth & Company 1200 East D. St. Tacoma, WA 98421	Tacoma, WA	Mike Tollkuehn John Woodworth	(206) 383-3585

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SECTION 4
CONCLUSIONS

CONCLUSIONS DRAWN FROM THIS STUDY:

- o This study identified 77 facilities in the U.S. that recycle petroleum-contaminated soil into marketable products. They are not, however, evenly distributed among the 10 EPA regions or the 50 states.

- o More than half of the recycling facilities (41) are located in Region 1 and Region 4 (22 and 19, respectively). Region 5 has thirteen approved facilities; Region 3, eleven; and Region 10, five. The remaining facilities are spread among the other five EPA regions.

- o Most facilities in this study accepted soil with all six typical contaminants (gasoline, kerosene, diesel, fuel oil #2, fuel oil #4, and fuel oil #6).

- o Hot mix asphalt appears to be the most commonly manufactured product at these facilities. Other commonly used technologies are cold mix asphalt, aggregate, hydraulic cement, and brick.

- o Regulations and requirements pertinent to recycling of petroleum-contaminated soil lie almost entirely within the jurisdiction of individual states. They vary significantly among the various states.

- o The cost per ton for recycling petroleum-contaminated soil ranged from a low of $25/ton to a high of $100/ton. The majority of the plants surveyed reported a high of $50/ton.

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TECHNICAL REPORT DATA

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7. AUTHOR(S) J.H. Nash, Chapman, Inc. Atlantic Highlands, NJ 07716 S. Rosenthal, G. Wolf, M. Avery, FW Enviresponse, Inc., Edison, NJ 08837		8. PERFORMING ORGANIZATION REPORT NO.
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Project Officer: Chien T. Chen Comm: (908) 906 -6985

16. ABSTRACT

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is one individual small business owner, a group of owners, or a large multinational corporation. They may need a starting point in their search for an appropriate solution, such as recycling.

This report provides initial assistance in two important areas. First it discusses four potential recycling technologies that manufacture marketable products from recycled petroleum-contaminated soil: the hot mix asphalt process, the cold mix asphalt system, cement production, and brick manufacturing. The report also presents the results of a project survey designed to identify recycling facilities. It lists recycling facilities alphabetically by location within each state, organized by U.S. Environmental Protection Agency (EPA) Region. The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey; that they have temporarily ceased previously approved operations; or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations. The report also includes detailed addresses, recycling locations, telephone numbers, and contacts for these facilities. The scope of the project limits listings to fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. It does not address site-specific or commercial hazardous waste remediation facilities.

17. KEY WORDS AND DOCUMENT ANALYSIS

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