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Earthline Corporation Landfill Evaluation

Introduction

This report is an evaluation of the Earthline Corporation landfill operated by the SCA Services, Inc. at Wilsonville, Illinois to determine if it meets the criteria for chemical waste landfills used for the disposal of polychlorinated biphenyls (PCB) as outlined in the rules proposed by the Environmental Protection Agency under authority of the Toxic Substances Control Act (P.L. 94-469) under Section 6(e) and published in the May 24, 1977 issue of the Federal Register.

Attachment I contains biographical sketches of the individuals involved in the evaluation of the site. The physical site evaluation occurred on June 8, 1977.

Background

Earthline Corporation, a subsidiary of SCA Services, Inc. began operating the landfill in Wilsonville, Illinois on November 15, 1976 after applying for and receiving a permit from the Illinois Environmental Protection Agency (IEPA) to dispose of industrial/hazardous wastes. After the landfill was in operation for approximately 6 months, the citizens of Wilsonville became alarmed to learn that Earthline Corporation was accepting "PCB wastes" and landfilling them at the Wilsonville disposal site. Before opening the site, Earthline Corporation informed the citizens of Wilsonville and the local elected officials by registered letter and/or by an open house at the disposal site that the facility would be treating/storing/disposing of industrial residues (see Attachment II for sample letter and list of recipients of the letter). In addition, a newspaper article printed in the Illinois State Journal, South Edition, approximately one week before the site opened indicated specifically that "hazardous wastes" would be disposed of at the site (see Attachment III). However the citizens of Wilsonville reportedly indicated that they didn't know that these industrial residues included materials such as PCB's (see Attachment IV for news release, Radio T.V Reports, Inc. dated May 28, 1977). Consequently, the City of Wilsonville has brought suit against Earthline Corporation to close the disposal site.

Dr. Leo Eisel, Director of the Illinois EPA, requested by telephone on June 3, 1977 that the U.S. Environmental Protection Agency, through the Regional Office in Chicago, perform a technical evaluation of the site for the disposal of hazardous wastes. As a result, a Technical Evaluation Team (TET) was formed comprised of U.S. EPA personnel. In addition, two representatives of the Illinois State Geological Survey (ISGS) accompanied the TET and served as advisory personnel.

Due to the fact that the U.S. Environmental Protection Agency is in the process of evaluating alternative regulations/guidelines for the treatment/storage/disposal of hazardous wastes under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (P.L.94-580), the TET believes that, at this time, it would be inappropriate to perform an evaluation based on criteria which have been only partially developed by the agency. The only criteria applicable to the Wilsonville site that have been proposed by the Agency are the rules for marking and disposal of polychlorinated biphenyls (PCB). Therefore, this technical report compares and relates the technical aspects of the facility for disposal of PCB's to the EPA proposed regulations. (see Attachment V; proposed regulation 42 Federal Register, (26574), May 24, 1977: Polychlorinated Biphenyls (PCB's) Toxic Substances Control; Annex II).

General Description of the Disposal Site (see Attachment VI for site design drawings)

The Earthline Corporation landfill site is located on a 130 acre tract, approximately 55 miles northeast of St. Louis, Missouri, in Macoupin county. The site is bordered on the east, west and south by undeveloped land (forest/grassy plains area) and on the north by the town of Wilsonville. The waste burial area is located 0.25 miles (buffer zone) from the northern boundary of the site. Current waste management activities are confined to trenches 1, 2, 3, 4, 5, 6, and 7 (trenches measure approximately 15 feet deep, 50 feet wide and 250 to 350 feet long) and an experimental sludge farming operation, as indicated on the drawings.

The general geologic profile of the site, both as observed by the TET at the disposal site and from information supplied by the Illinois EPA, shows a surface layer of about 10 feet of loess, (wind-blown silt and clay material) underlain by 40 to 65 feet of till material that was deposited during the glacial periods. The permeability studies that were conducted during site design measured a permeability of 10^{-8} cm/sec for the till material. In the till material, a thin sand layer is found as reported by the Illinois EPA, ranging in thickness from a few inches to approximately 2 feet depending on where the soil boring was made. The sand layer (located 30 to 40 feet below the surface as indicated by Illinois EPA personnel) contains some water but not all wells driven into the sand layer produce water at the same rate (see boring logs in Illinois EPA files for details). Additionally, the sand layer is reported to be discontinuous, thus, there is no evidence that the sand layer is connected with water bearing formations elsewhere.

The disposal trenches are excavated, as observed by the TET, into this loess material so that the trench bottoms go only about 1 to 2 feet into the glacial till. In addition, the depth of the trenches is restricted to a fixed elevation above sea level (610 feet) as part of the permit conditions, so that there will always be a minimum of 10 feet of this very dense, low permeability glacial till between the bottom of each trench and the sand layer. All trenches dug to date, as reported by the Illinois EPA, have between 10 to 15 feet of till below them.

The site is also located above a former coal mine (approximately 300 feet below the surface) that was opened in the early 1900's and closed in the 1950's. The potential for subsidence of the materials above the abandoned mine operations is an issue. A team of geologists from the ISGS (Messrs. Steve Hunt, Paul DuMontelle and Keros Cartwright) visited the site on May 27, 1977. The opinion of the geologists was that the potential for problems from subsidence is negligible. (see Attachment VII, letter dated July 13, 1977 from Keros Cartwright to Mrs. Granger, for more detailed discussion).

During the mining operation, the process of cleaning the coal extracted at the site generated a large gob pile (coal, shale, and clay) which exists on the 130 acre tract leased by Earthline Corporation on the outskirts of Wilsonville (see drawings for exact location of gob pile). The gob pile is approximately 40 acres in area, and about 100 feet deep at the center. No reclamation procedures had been carried out after the mine was closed and water passing through the gob pile has been converted to acid mine drainage by oxidation of the pyrites in the waste. As a consequence, three surface drainage channels observed by the TET in the middle, eastern, and western side of the site are grossly contaminated with acid mine drainage (red and yellow material with a pH varying from 2 to 2.5).

The hazardous waste disposal site was designed to use the land surrounding the gob pile. The excess soil from the trenches that are filled with industrial residues is to be used gradually to cover the surface of the gob pile. This procedure is expected to retard entrance of water into the waste coal materials and thus reduce the flow of contaminated waste into the surrounding drainage channels. It should be noted that the sand layer has already been contaminated as indicated by analysis of samples drawn from monitoring wells before the site was opened which contained very high concentrations of sulfates and a TDS of about 8000 to 10,000 mg/l and that this contamination has two possible sources. The first being drainage from the gob pile, however, the TET believes that this is very unlikely due to the low permeability of the glacial till. The more likely source of this contamination is from waters that have migrated the vertical shaft of the old mining operation.

Monitoring of the site is performed via 14 monitoring wells (see drawings for exact location of wells) along the perimeter of the property. These wells are screened in the sand layer and are sampled quarterly by a private laboratory (St. Louis Testing Laboratories, 2810 Clark, St. Louis, Missouri). Test results are submitted to the Illinois EPA. (see Illinois EPA files for quarterly analyses reports). Analyses being performed are as follows:

a) Monitoring Wells 1 through 6: Total Dissolved Solids (TDS)
Chemical Oxygen Demand (COD)
Cadmium
Chromium (total)
Zinc
Arsenic, Copper, Cyanide, Mercury, Phenol } One analysis is performed on a rotating basis quarterly

b) Monitoring Wells 7-12 — Same as above. (These wells will not be sampled until waste management activities in this area begin operation).

c) Monitoring Wells 13 and 14 — TDS
COD
Oil
Water level reported

In addition to the monitoring wells, Earthline Corporation collects water samples from surface channels from three monitoring points indicated in the drawings. These analyses are also performed by St. Louis Testing Laboratories and are submitted to the Illinois EPA on a quarterly basis. (see Illinois EPA analyses reports). Analyses being performed are as follows:

a) MP 1 and 2: TDS
COD

b) MP 3: TDS
COD
Oil

Analyses to date indicate no change in the amounts or types of contaminants compared to those measured from samples taken before the site began accepting wastes. This indicates no measurable contamination is taking place (see Attachment VIII for latest analysis of monitoring points).

Operating Procedures

(A) Waste Burial Procedures

Those firms wishing to utilize Earthline Services must provide the company with a description of each waste (including a chemical analysis and the quantity of waste to be managed). Earthline Corporation then submits a supplemental application to the Illinois EPA and requests that the waste be added to the permit. Thus, the Illinois EPA exercises control over which wastes the facility may handle. Up to the present time, Earthline Corporation has received approximately 180 supplemental permits from the Illinois EPA to handle industrial residues. A partial list of such wastes includes: paint sludges, zinc sludge, 2-4-D herbicide, solid cyanides, PCB's and sewage sludge containing hexachlorocyclopentadiene. Earthline Corporation also handles acid and caustic wastes, but requires that these wastes be neutralized by the generator before they can be accepted by the facility.

Approximately ninety-five percent of the industrial/hazardous wastes to date have been received in 55 gallon drums and have been disposed of in the 7 trenches currently in operation. The remaining five percent are received in double-wall paper bags and disposed of on pallets in the trenches. Waste containing drums are lowered into the trench and stacked two high, face to face and then covered at the end of each working day. After each trench has been completely filled, the trench is covered with 2 feet of clay and 1 foot of topsoil which is gently sloped to diminish any rain water infiltration. All PCB wastes disposed of at Earthline have been containerized in 55 gallon drums before they were placed in the trench; in addition, Earthline personnel report that cyanide wastes have been further segregated by enclosing these drums in a clay and lime coated cell constructed within the trench. Also, incompatible wastes are segregated during the disposal operation. It is reported that PCB wastes are not placed in trenches with solvent bearing wastes; PCB wastes have been containerized and buried in trenches containing the materials listed in Attachment IX (see Attachment IX for inventory of wastes placed in each trench). The TET can not make a complete evaluation concerning compatibility from the inventory supplied by Earthline Corporation.

In addition, wastes are routinely checked to determine whether means other than disposal are viable. For example, procedures exist so that if wastes containing 75% or more of organic solvent are received for disposal, Earthline directs the waste to another facility having the capability to distill and recover the solvent or to a facility that can incinerate the waste. To date, wastes received for disposal have contained 50% or less solvent. At the present time, trenches number 2, 3, and 4 are completely filled and covered, 3 trenches are currently being utilized (trenches number 5, 6, and 7) and trench number 1 is empty.

(B) Sludge Farming Operation

The experimental sludge farming operation has not yet been initiated because Earthline has not found a waste suitable for landspreading (i.e., all oily sludges analyzed to date contained PCB's or some other similar material which the company determined to be unsuitable for landspreading). The landspreading process can be described as a biodegradation operation. Wastes earmarked for the sludge farming operation will be spread over 1/4 the site and disked into the soil. Each day a new section of the site will be utilized until all 4 quarters had been "farmed". The soil will be disked each day until the waste is sufficiently degraded (the time for this degradation is unknown). At this point, the company would spread some additional sludge.

(C) On-Site Quality Control

If a waste is accepted and permitted by the Illinois EPA for disposal at Wilsonville, the waste is delivered to Earthline in sealed containers or double-wall paper bags, a requirement of Earthline Corporation. When the waste is first received, an analysis is performed on each shipment to check the composition of the waste with that specified in the permit. If the waste received is different from the permit specifications, Earthline sends the waste back to the generator (no wastes to date, as indicated by Earthline Corporation, have been sent back for this reason). Subsequent wastes that are accepted from a generator under the same Illinois EPA permit are randomly analyzed to "spot check" the composition of the waste.

Most of the analyses are performed at Earthline's own laboratory facility. The laboratory is equipped with an Atomic Absorption Spectrophotometer (AA) unit, a pH meter, a conductivity meter and a visible light spectrophotometer. The laboratory is not equipped with a gas chromatograph (GC) for analyzing organic compounds. All GC work is sent to Chemtrol in Model City, N.Y. for analysis. Chemtrol is a hazardous waste treatment and disposal facility which is also a subsidiary of SCA Services, Inc., Earthline's parent company.

Field Observations

The following information was gathered during the visit by the TET to Earthline Corporation's facility on June 8, 1977 in Wilsonville, Illinois. Three disposal trenches were open; two were excavated to their final depth and the third was excavated only partially into the loess (not into the till material). Of the trenches which had been completely excavated, one had been open for approximately 6 weeks and the other for approximately 3 weeks. In the trench that had been open for 6 weeks, water had collected in one corner, probably due to rainwater or to capillary water oozing out of the clay. The same profile was seen in both of the completed trenches. The loess material extended from the surface to the bottom of the trench at which point the glacial till was exposed. Both the loess and the glacial till were quite dense, had very few pores or root holes, and were essentially massive. In some places, where pieces of the till had been disrupted by a bulldozer, it could be seen that the peds were several feet across. There was a thin layer of soil apparent at the top of the loess. This was the modern soil, approximately one to two feet deep, which had numerous roots and pores and had a definite finer structure. At the intersection of the loess and the till (at the bottom of the trenches) there was a colluvial layer 9 inches to a foot thick. This material contained some larger particles, small stones and gravels, but not much sand. It had some pores, old root holes, and had some structure. It was concluded that this was probably an example of buried soil. There was likely a period of time (after the glaciers had retreated) during which this colluvium was exposed to weathering and biological activity and developed as a soil. These differences in the structure of the till and the colluvium suggest that their permeabilities may be different (as much as an order of magnitude). In the permit application, the permeability for the till was given as 10^{-8} cm/sec. No information is available to the TET on the permeability of the colluvium or of the loess (see additional discussion under Lateral Movement, page 19, for more information).

In the middle, the eastern, and on the western side of the site, there are drainage channels which receive most of the surface runoff from the site. These channels can be classed as intermittent streams. Much of the vegetation in the surface drainage channels around the site has been killed, apparently by the acid mine drainage from the gob pile.

The gob pile, made up of shale, coal, and a little fine earth material has a very large particle size ranging from fine sand to cobbles. Two seeps were identified coming from the pile partway up the sides, on the west side and on the east side. These seeps are a reddish color liquid, typical of acid mine drainage. Since the gob pile is exposed to precipitation and is much more permeable, than the loess on which it rests, it is likely that there is a groundwater mound (a water table perched on top of the loess) built up into the gob pile since the TET observed several seeps flowing from the sides of the mound. Accordingly, there is a possibility that the small amount of water observed in one of the trenches might be a local raising of the water table due to the influence of this groundwater mound under the gob pile. The surface drainage and the groundwater drainage from the site are to the south away from the town of Wilsonville. Additionally, it should be noted that the City of Wilsonville's water supply is pumped from 5 miles north.

Much of the earth material that has been excavated to construct the trenches has already been placed around the edges of the gob pile. This reclamation treatment will eventually reduce the entrance of water into the gob pile and should reduce the acid mine drainage.

The present trenches are located about 60 feet from the nearest drainage channel and approximately one hundred feet from the boundary of the property. For full site development, the company plans, if permitted by the Illinois EPA, to establish trenches so as to maintain a buffer of 50 feet between a trench and the boundary of the property. The site, at the time of the visit, was in good order and the site housekeeping procedures appear adequate.

DATA INTERPRETATION

The time required for water to move downward through the soil from the bottom of a disposal trench to the top of any water-bearing layer under the trench is called the travel time or containment time. This is a commonly used criterion for judging the suitability of soils for a disposal site. The presumption is that soils with long travel times are best for disposal activities. Although it is true that a soil with a longer travel time would be better than one with a shorter travel time, it does not follow that a soil with a short travel time is automatically unsuitable. Several items that affect the significance of travel time are discussed below.

First, there are two rates of movement, the Darcian velocity and the pore water velocity, that may be used to calculate a travel time for fluids through a soil. Travel times calculated with the Darcian velocity will appear to be longer than travel times calculated with the pore water velocity. However, when these different travel times are used to calculate the time required for a specific quantity of liquid (e.g. quart, gallon, liter) to pass through the soil, the answer will be the same regardless of which travel time is used. The method of calculating travel times and of using them to determine what volume of liquid will pass through the soil in a given time are described in Attachment X.

Thus, one problem with the use of travel time (calculated from either rate of movement) as the primary basis for judging a soil's suitability is that it provides no direct information about the quantity of fluid transported in a given period of time nor does it provide any information about how much contaminated fluid must reach the underlying waters before changes in water quality will be detectable or before the water will become unsuitable for use.

Another problem with using travel time as the basis for judging the safety of a particular location is that travel times are calculated assuming the soil is entirely saturated. This is not usually the case at the time the disposal trench is closed. The rate at which water moves through unsaturated soil is much less than the rate of movement in a saturated soil. It is difficult to calculate how long it will take for the soil under the disposal trenches to reach saturation but it can be said with certainty that, because of the time for wetting the soil and the lower rate of water movement in unsaturated soil, the time required for the first liquid from the trenches to reach the underlying sand layer will be longer than the calculated travel time.

Finally, the travel time is only the time for liquids to move; as discussed below, solutes move more slowly through soil than the liquids in which they are dissolved. Solutes interact more strongly with fine textured (clay and silt) soils than with coarse textured (sandy) soils. Hence, a short travel time would be more significant in a sandy soil than in a finer textured one.

The Illinois EPA has calculated the travel time from the bottom of the trenches to the underlying sand layer to be 600 years using the Darcian flow velocity. Data on the porosity of the soil underlying the site is not available so the travel time based on pore water velocity cannot be calculated.

A porosity of 0.25 would be within the range of porosities seen in similar soil materials elsewhere. Assuming this value, the pore water velocity would be about 4 times greater than the Darcian velocity and the travel time would be 150 years. Using either travel time (150 or 600 years) the amount of liquid passing out of a trench in a year would equal a layer 0.3 inches deep. See Attachment X for a description of how this calculation is performed. This 0.3 inch deep layer of fluid would be passing into the 24 inch deep sand layer containing water already heavily contaminated by acid mine drainage.

In connection with this discussion of vertical travel times, two points are noted. First, the Illinois EPA has assumed a worst case condition (trenches full of water) in making their calculation and, second, soluble contaminants will take longer to travel a given distance than will the fluid in which they are dissolved.

The worst case condition (trenches full of liquid) assumes a maximum driving force (hydraulic gradient) for downward water movement through the soil and gives a minimum travel time. In the files, the soils data for the site shows the pieziometric surface ranging from a few feet above the bottom of the trenches to a few feet below the bottom of the trenches. This indicates that the water in the sand layer is under pressure and this pressure will tend to counteract the downward movement of fluids from the trenches. If there were only a foot or two of fluid in the trench instead of the 15 feet assumed by Illinois EPA calculations, the driving force for water movement would be decreased and the travel time longer. Site design and operation (surface water diversion, capping and grading of trenches) are aimed at keeping the trenches dry and it is the opinion of the TET that these measures, if properly executed, will greatly reduce the amount of water entering the trenches. To the extent that these procedures keep the trenches from completely filling with liquid, the actual liquid travel time will be longer than the travel time calculated by the Illinois EPA.

To demonstrate the magnitude of the effect, if the pieziometric surface were down at the sand layer (no pressure on the water in the sand layer) instead of near the surface and if the trench were assumed to have no liquid in it instead of the 15 feet in the Illinois EPA calculations, then the driving force would be reduced by 50% and the travel time (Darcian) would be increased to 1200 years. Since the pieziometric surface is near the soil surface, the percentage decrease in the driving force resulting from an empty trench would be much greater than 50% and the resulting Darcian travel time will likely be much greater than 1200 years.

Because solutes interact with soil, they travel through soil at a lesser rate than the fluid in which they are dissolved. Even very mobile contaminants such as sodium, selenium, and cyanide travel at only 1/2 to 3/4 the rate of the fluid while the heavy metal contaminants such as lead, zinc, and cadmium travel 1/10 to 1/15 or less of the fluid travel rate. Thus, compared to movement of water alone, mobile contaminants will take 1 1/3 to 2 times longer to travel a given distance and other contaminants will take 10 to 15 times longer to travel a given distance.

Since the contaminant travel factors in the previous paragraph were estimated from the number of pore volumes of water that passed through a soil column before the contaminants appeared in the column effluent, travel time for the contaminant from it should be based on the pore water veolcity. To estimate the time for the first arrival of contaminated water at the sand layer, multiply the pore water travel time by the factor, from the previous paragraph, for the type of contaminant under consideration. The travel time of mobile contaminants would be 200 to 600 years, depending on the contaminant and on the depth of water in the trench, and 1500 to 4500 years for the less mobile contaminants, depending again on the contaminant and of course, on the depth of water in the trench (see Attachment XI). The smaller of each pair of figures assumes the trench full of water; the larger of each pair of figures assumes no water in the trench and the pieziometric surface at the sand layer. The closer the pieziometric surface is to the soil surface, the less will be the driving force and the greater will be the upper limits for these travel times.

The first arrival of contaminated water at the sand layer will not be the same as the beginning of detectable contamination. In laboratory studies with similar soil materials, the concentration of contaminants in the first effluents from soil columns was quite low because the solutes have been largely held by the soil. The concentration gradually increases over a period of time, finally reaching the same concentration as in the fluid being applied to the column. Similarly, in the field, the first contaminants reaching the sand layer will be in very low concentrations and, because of the low permeability of the till, the amount of fluid in a given time will be small. The figure of 0.3 inches/year, calculated earlier, was based on the assumption that the trenches were full of water. If the trenches are empty, this figure will be reduced at least to 0.15 inches per year and could be much less if the pieziometric surface is near the soil surface. Thus, it will require some time more than the travel time (data is not available to calculate how long) for enough contaminants to be transported into the sand layer to raise the concentration in the sand layer to detectable levels.

Data to support this opinion are found in papers by Griffin et al. - "Attenuation of Pollutants by Clay Minerals" Environmental Geology Notes No. 78 and 79, Illinois State Geological Survey, 1976 and 1977. See also a draft final report by J. Gibb et al. from the Illinois State Water Survey for Grant R803216 from the U.S. EPA Municipal Environmental Research Laboratory in Cincinnati, Ohio, entitled "Field Verification of Hazardous Waste Migration from Disposal Sites." This latter study found that over a period of 100 years and for contaminants from very concentrated sources, movement through soil materials similar to those at Wilsonville was slight.

(B) PCB Migration

If PCB's continue to be segregated from solvents, the PCB's will be nearly immobile. PCB travel times will be at least 10 to 100 times longer than even the least mobile heavy metals. Work by Griffin et al. has shown that PCB's are so strongly sorbed by soil materials that they are immobile, even in coarse sand, when leached with water or with municipal landfill leachate. Solvents however, such as carbon tetrachloride, methylene chloride, methanol or acetone cause PCB's to be highly mobile in any soil material (see Attachment XII, letter dated June 10, 1977 from R.A. Griffin to M.A. Straus and the report entitled "Attenuation of PCB's by Soil Materials and Char Wastes" by Griffin et al.).

(C) Lateral Movement

No data were available for the permeability of the loess or the colluvium. Based on experience with similar soil materials elsewhere in Illinois, Griffin and Lindorff estimate the permeability of the loess at 10^{-7} to 10^{-8} cm/sec and the permeability of the collumium in the range of 10^{-6} to 10^{-8} cm/sec. The fact that the permeabilities of the colluvium and the loess could be less than the till underlying the site suggests the possibility of lateral movement. Liquids from the trenches could possibly move laterally to the surface drainage channels. However, the distance from the trenches to the nearest drainage channel is greater than 4 times the distance from the bottom of the trench to the sand layer suggesting that lateral travel times would be comparable to the vertical travel times even if there were permeability differences. Note also that the material of potentially highest permeability (the colluvium) occupies a very small amount of the interior surface area of the trench. To illustrate this, assume that a trench is 15 feet deep, 50 feet wide and 300 feet long. The geologic profile at this location shows loess extending from the surface down to 11 feet, colluvium from 11 feet to 13.5 feet, and glacial till below 13.5 feet. Of this surface area, 16,750 square feet are glacial till, 7,700 square feet are loess and 1,050 square feet are colluvium. Thus, the amount of fluid that could flow through the colluvium, even if it has a greater permeability, would be likely to be small in comparison to the amount of fluid passing into the other two materials, the loess and the glacial till, with their much greater exposure of surface area.

If fluids did move laterally from the trenches, the surface drainage channels would be the areas affected. The surface drainage channels are already heavily polluted by acid mine drainage from the gob pile and the vegetation on both sides has been killed. Continuous sampling of the drainage channels will identify if lateral movement occurs.

The interceptor drains around the gob pile appear to be catching most of the surface runoff and internal drainage from the gob pile. There may be some interaction between the groundwater mound if present in the gob pile and the water level in the trenches but not enough information is available at present to adequately assess this possibility.

Comparison of the Wilsonville Site With the Requirements of the Proposed Regulations for PCB Disposal

The comparison of the disposal site characteristics with those specified for chemical waste landfills in the proposed regulations for PCB disposal is listed below using the numbering system in paragraph (b) of Section 761.41 of the proposed regulations. It must be kept firmly in mind that the subject regulations are only in a state of proposal and are therefore subject to change based on new information. A detailed analysis of the significance of the differences between the Wilsonville site characteristics and characteristics required by the proposed regulations is discussed at the end of this section.

(1) Soils

(i) In-place soil thickness is required to be 4 feet or a compacted soil liner thickness of 3 feet:

All the trenches excavated to date have at least 10 to 15 feet of in-place soil below them. The Illinois EPA operating permit requires a minimum of 10 feet of in-place soil.

(ii) The permeability is required to be 10^{-7} cm/sec or less; The permeability values measured in the till and reported in the permit application at the site were in the range 3×10^{-8} to 8×10^{-8} cm/sec. Permeabilities of the loess and colluvium, through which the trenches are excavated are not known. The loess is estimated to be 10^{-7} or less while there is a possibility that the colluvium could have a permeability greater than 10^{-7} (see discussion on Lateral Movement, page 19).

(iii) The percent of soil passing a No. 200 sieve shall be greater than or equal to 30: The percentages for soil samples taken from the site were greater than 45 as reported in the permit application.

(iv) The liquid limit shall be greater than or equal to 30: Liquid limit was not measured for soils at the site.

(v) Plasticity index shall be greater than or equal to 15: Plasticity index was not measured for soils at the site.

(vi) Artificial liner thickness: Not applicable.

(2) Hydrology

Above the historical high groundwater table: Data were not available on the historical groundwater table elevations in the area. The bottom of the landfill is above the current groundwater table.

Floodplains, shorelands, and groundwater recharge areas shall be avoided: There are none in the area.

There shall be no hydraulic connection between the site and standing or flowing surface water: The TET found no evidence of a hydraulic connection between the site and standing or flowing surface water.

The site shall have monitoring wells, leachate collection and shall be 50 feet from the nearest groundwater: There are 14 monitoring wells installed at the site and no leachate collection system. The sand layer, 30 to 40 feet below the site contains some water.

(3) Flood Protection

No data were available but it is the opinion of the TET that the site is well above the 100 year floodwater elevation. Hence, subparagraph (ii) applies.

(ii) Structures capable of diverting all of the surface water runoff from a 24 hour, 25 year storm shall be provided: The only diversion structures on the site are the interceptor drainage channels around the gob pile. The design capacity of these structures are not known, however, they are placed so as to intercept all surface water that might drain toward the trenches. It was also indicated that both the general disposal area and each individual trench have been bermed so as to divert any surface water runoff.

(4) Topography

The landfill site shall be located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping: The landfill is located in an area of low relief. The loess, into which the trenches are excavated is quite stable. Cuts for road and railroad right-of-ways in the area remain stable for long periods of time without any control measures. During the short period that each trench will remain open no slumping or erosion is likely; the land surface around the site shows no evidence of erosion.

(5) Monitoring Systems

(i) Water Sampling

(a) The ground and surface water from the disposal site area shall be sampled for use as baseline operations:
Samples were taken and analyzed from the surface drainage channels and the 14 monitoring wells around the site before it was opened.

(b) and (c) Defined water sources shall be sampled monthly during operation and at six month intervals after closure:
Neither the surface water nor the groundwater is used on the site in Wilsonville. Wilsonville receives their water supply from a resevoir 5 miles north. Monitoring wells and surface streams are analyzed quarterly by a private laboratory. The Illinois EPA also reported that they will randomly take samples and analyze the monitoring wells approximately twice a year. Requirements for post-closure sampling include a quarterly analysis by Earthline Corporation for 3 years after site closure. After this time, the State may monitor the site periodically.

(ii) Groundwater monitoring wells

(a) If underlaying earth materials are homogenous, impermeable and uniformly sloping in one direction, only three sampling points shall be necessary, on a line through the center of the site parallel to the direction of the groundwater gradient: The proposed rules do not specify the number of sampling points required if the earth materials do not meet the requirements of the rules. The TET considers that the 14 groundwater and the 3 surface water sampling points around the site are sufficient to detect any contamination of the sand layer or of the surface drainage channels. Additional groundwater sampling points screened in the colluvium would be desirable as an added precaution.

(b) Monitoring wells shall be cased, the annular space backfilled with Portland cement, and the well opening at the surface covered with a removable cap: The monitoring wells at the site meet all these requirements as reported by Illinois EPA personnel (the wells are slotted to receive water samples in the sand lense).

One well volume shall be pumped out before sampling and the discharge treated or recycled to the landfill: The wells are sampled with a bailer; no provisions are made for treating or recycling the discharge.

(iii) Water Analysis

Water analysis and sampling procedures shall be as specified in 40 CFR Part 136 as amended in 41 FR

52779 of December 1, 1976 and records shall be maintained as specified in Annex VI of the proposed rules for PCB disposal: Illinois EPA requires that sampling and analysis be conducted in accordance with ASTM standard procedures. These procedures are essentially the same as those required by the proposed rules. Records are not being maintained as specified in Annex VI. However, the TET is of the opinion that the record maintenance requirements imposed by the Illinois EPA are among the most advanced in the United States and that these records will make it possible, at some time in the future, to determine the type of PCB waste, the generator, and the location of the wastes in the trench. The containerization of the wastes and recording of their location in the trenches is done so that it will be possible to retrieve any waste if it becomes feasible to recover or re-use. Thus, it would be possible to retrieve wastes if it was later determined that they have been placed with incompatible wastes or that more stringent disposal protection was required.

The proposed rules under Annex II specify analysis for the following parameters:

(a) PCB's

(b) pH

(c) Specific conductance

(d) Chlorinated organics

These parameters are not included among the many for which water samples from the site are analyzed. TDS is one of the analyses required by the Illinois EPA. Although this is not the same as specific conductance analysis required by the proposed rules, it does provide related information (see the general description of the site and monitoring requirements earlier in this report).

(6) *Leachate Collection*

A leachate collection monitoring system shall be installed beneath the chemical waste landfill: No leachate collection system is required by the Illinois EPA for the site and none is installed.

(7) Chemical Waste Landfill Operations

(i) PCB's shall be placed in the landfill in a manner that will prevent damage to containers or articles and shall be segregated from incompatible wastes during handling and disposal: At the site, containers are lifted into the trenches as reported by Earthline personnel by a special set of hooks that hold 4 drums, upright, at one time. It is the opinion of the TET that this arrangement prevents damage during lifting and stacking of the drums. The waste segregation practices at the site appear to be satisfactory, based on current information about the migration behavior of PCB's (additional information concerning the composition and form of the waste is needed before a complete compatibility analysis is performed).

(ii) An operations plan shall be developed and submitted...: An operations plan for the site is part of the permit issued by the Illinois EPA. The plan covers the topics required by this subparagraph of the proposed rules.

(iii) Records maintained for PCB disposal shall include the 3-dimensional burial coordinates and other details as specified in Annex VI of the proposed rules: The location of the PCB wastes in each trench is recorded. For comments on the Annex VI requirements, see the discussion, in this report, of subparagraph (5) (iii) - Water Analysis.

(8) Supporting Facilities

(i) A six foot fence, wall, or similar device shall be provided around the site: The site has a seven foot cyclone chain link fence topped by a 3-strand, inclined section of barbed wire as observed by the TET.

(ii) Roads shall be maintained to and on the site which are adequate to operate and maintain the site without causing safety or nuisance problems or hazardous conditions: The TET is of the opinion that the roads on the site meet this requirement. Because all wastes are brought to the site in sealed containers, the TET is of the opinion that hazardous conditions are not created to the residents of Wilsonville. It is noted that the route to the gate of the site passes down the main street (Wilson Ave.) of Wilsonville. Mr. Pete Dunlop, President of Earthline Corporation indicated that an informal agreement was reached with the former mayor to cooperate with the Village of Wilsonville in the maintenance of Wilson Ave. However, it seems clear to the TET and Earthline Corporation that the potential for problems, if any, would be decreased by a different routing of the access road to the site. Earthline Corporation is reportedly planning to build another access road around the Village of Wilsonville within 8 to 12 months.

(iii) The site shall be operated and maintained in a manner to prevent safety problems or hazardous conditions resulting from spilled liquids and windblown materials: The TET is of the opinion that the site operation procedures meet this requirement.

Summary

The paragraphs of the proposed PCB rules for which the Wilsonville site is in conflict or for which there is insufficient information to determine whether it complies are as follows:

(1) (ii) Permeability of loess and colluvium not known

(1) (iv) Liquid limit of soils not known

(1)(v) Plasiticity index of soils not known

(2) Depth of groundwater

(3) (ii) Design capacity of the interceptor drain around the gob pile not known

(5)(ii)(b) Sampling procedures for monitoring wells

(5)(iii) Record maintenance as per Annex VI

Parameters to be analyzed in water samples

(6) Leachate collection system

As discussed previously in this report:

1) The possibility that the loess and the colluvium may have permeabilities greater than the till is offset by the much greater distance that the liquids must travel laterally through these materials before reaching waters that could be impacted.

2) The liquid limit and plasticity index are measures of the physical properties of soils. Field observations by the TET and discussions with other people knowledgeable about soil physical properties (Mr. Norbert Schomaker, Municipal Environmental Research Laboratory, U.S. EPA) suggest that the liquid limit and plasticity index for the Wilsonville soils will be satisfactory and that the physical properties of the soils at the site are suitable for the practices employed.

3) The site does not meet the requirement with respect to the proposed PCB regulations that ground water be greater than 50 feet below the site. However, the TET notes that the sand layer, 30 to 40 feet below the site contains only a small amount of water, this water is already polluted with acid mine drainage, and there is no evidence that this sand layer is connected with water bearing formations elsewhere. Additionally, the 10 to 15 feet of soil material between the bottom of the trenches and the sand layer is fine textured and has a very low permeability.

4) It is the opinion of the TET that the drainage channel around the gob pile will prevent surface water movement into the trenches; if the design capacity does not meet the proposed rules, the interceptor can readily be modified.

5) The TET is of the opinion that the well sampling procedures, though not fully in accordance with the proposed rules, can be easily modified to comply with the proposed rules described in the PCB disposal regulations.

6) Due to the small volumes of water withdrawn from the monitoring wells and the fact that there are no differences from background water quality, the requirement, in the proposed rules for treatment or recycling of discharge from the wells can be modified so as to place the water back in one of the trenches.

7) Although the site records are not maintained as per Annex VI of the proposed PCB regulations, the record maintenance requirements of the Illinois EPA appear to satisfy the intent, if not the specifications, of Annex VI.

8) The TET is of the opinion that monitoring samples from the site should be analyzed for major contaminants (i.e., PCBs, pH, specific conductance and chlorinated organics) in the wastes deposited at the site.

9) The combination of soil thickness and permeability at the Wilsonville site offers considerably more protection than the combination of soil thickness and permeability specified in the proposed PCB regulations. Consequently, the TET is of the opinion that the absence of a leachate collection system does not make the site unsafe for disposal of PCBs.

Conclusion

In evaluating Earthline Corporation's landfill in Wilsonville, Illinois for the disposal of polychlorinated biphenyls (PCBs), it is the opinion of the TET after considering the design and operational information on the Wilsonville site that it is a well-designed, secure landfill which provides disposal by environmentally acceptable methods and consequently, believe that the facility is capable of managing PCBs. More specifically, the following points are noted:

1) The glacial till which lies under the site is quite dense and essentially massive (permeability 10^{-8} cm/sec).

2) The potential for mine subsidence under the site as reported by the ISGS is negligible.

3) The 14 ground water and the 3 surface water sampling points around the site are sufficient to detect any contamination of the sand

layer or of the surface drainage channels (analyses to date indicate no change in the amounts or types of contaminants compared to those measured from samples taken before the site began accepting waste).

4) The operation of the site, as demonstrated to the TET considers those precautions necessary to assure that both the public and the environment are protected.

5) The site, at the time of the visit, was in good order and the site housekeeping procedures appear adequate.

6) The segregation of PCBs from solvents as practiced by Earthline Corporation will cause the PCBs to be nearly immobile (PCB travel times will be at least 10 to 100 times longer than even the least mobile heavy metals).

In addition, Earthline Corporation in the operation of the site is alleviating the acid mine drainage problem which has already polluted the surrounding streams. Much of the earth material that has been excavated to construct the trenches has already been placed around the edges of the gob pile. This reclamation treatment will eventually reduce the entrance of water into the gob pile and reduce the acid mine drainage.

Attachment I

Biographical Sketches

Karl Klepitsch, Chief, Waste Management Branch, Air and Hazardous Materials Division, EPA Region V has a B.S. in Civil Engineering from the University of Illinois and was designated as the lead for the technical evaluation team (TET).

Matthew A. Straus, an engineer with the Hazardous Waste Management Division, Office of Solid Waste, U.S. Environmental Protection Agency has a B.S. in Civil Engineering from the University of Maryland and for approximately 1.5 years has provided technical assistance to the States and industries on the management of hazardous wastes.

Jack Turer, a chemist with the Office of Toxic Substances, U.S. Environmental Protection Agency has an M.S. in chemistry from Fairleigh Dickinson College and is currently responsible for the PCB disposal regulations. Mr. Turer has spent the last 32 years in private industry dealing with environmental matters and prior to that was a research chemist in soils.

Mike Roulier, a soil scientist with the U.S. EPA Municipal Environmental Research Laboratory, in Cincinnati, Ohio, has a Ph.D. in soil physics and has served for approximately 3-1/2 years in Cincinnati as a project officer managing extramural research projects on the fate and transport of hazardous materials in soils from the disposal on land of municipal and industrial wastes.

Robert Griffin, an associate geochemist with the Illinois State Geological Survey in Urbana, Illinois has a Ph.D. in soil chemistry and during the past several years has worked partially on grants and contracts for the Municipal Environmental Research Laboratory, studying the fate and transport of pollutants in soils and earth materials. He is currently studying the absorption and degradation of PCB in soils.

David Lindorff, an assistant geologist with the Illinois State Geological Survey at Urbana, Illinois, has an M.S. in geology and is involved with the selection and evaluation of municipal and hazardous waste disposal sites and the evaluation of ground water resources. His most recent pertinent experience has been with an EPA sponsored field study of the migration of hazardous wastes from land disposal sites (Grant R803216) in a geologic setting quite similar to the one in which the Wilsonville landfill is located.

ATTACHMENT II

EARTHLINE CORPORATION
WILSONVILLE RESEARCH DIVISION
1013 West Laurel Avenue
Springfield, Illinois 62704
Telephone: (217) 787-4554

February 11, 1976

For more than twenty years the property formerly comprising the Superior Coal Company Mine 4 near the Village of Wilsonville in Macoupin County has been lying unused and virtually unattended. Our company has recently contracted for purchase of approximately one hundred, thirty acres of this property described as follows:

> NW 1/4, SE 1/4 Section 10; NE 1/4, SE 1/4 Section 10; SW 1/4, SE 1/4 Section 10; and a portion of SE 1/4, SW 1/4, NE 1/4 Section 10; T.7N, R.7W of the 3rd P.M., Macoupin County

We solicit the cooperation and support of all the citizens of Macoupin County in our intent to develop and operate a unique and much-needed industry for the recovery, treatment, storage and containment of industrial residues at this location. In the interest of conserving our precious resources and protecting our environment, it is essential that facilities such as Earthline will soon be constructing for its Wilsonvil Research Division be encouraged.

Within the next few months work will begin at our Wilsonville facility. It is our hope that the people of the area will seek employment with our company and that we will become good neighbors in the community.

We expect to utilize a substantial part of the mine spoil in our operati and to grade and revegetate the remaining portion. Working together, we can convert a useless area of unproductive mine spoil into a valuable community asset and an attractive, well-groomed landscape.

When our field office is opened at the Wilsonville site we hope you wil find the time to visit us so that we can completely acquaint you with o plans.

Sincerely,

David L. Beck
Wilsonville Research Division
Earthline Corporation

8. Notice of the intent to develop and operate the subject facility has been provided to the appropriate officials. and to all adjacent landowners. An example of the notification letter is attached. Notification has been provided to the following:

Village President and
Board of Trustees
Village of Wilsonville
Wilsonville, Illinois 62093

Macoupin County Board
of Supervisors
Macoupin County Courthouse
Carlinville, Illinois 62626

Macoupin County Regional
Planning Commission
c/o Clerk of Macoupin County
Macoupin County Courthouse
Carlinville, Illinois 62626

Honorable Vince Demuzio
Illinois State Senate
Four Valley Lane
Carlinville, Illinois 62626

Honorable Kenneth R. Boyle
Illinois House of Representatives
Post Office Box 480
130 East First Street
Carlinville, Illinois 62626

Honorable John F. Sharp
Illinois House of Representatives
11 North Wood River Avenue
Wood River, Illinois 62095

Honorable Thomas C. Rose
Illinois House of Representatives
307 West State Street
Jacksonville, Illinois 62650

Mr. Orville Thede, Supervisor
Dorchester Township
Dorchester, Illinois 62020

Ms. Dorine Hoffstetter
Rural Route One
Staunton, Illinois 62088

American Telephone and Telegraph
Five World Grain Center
New York, New York 10048

Mr. William Heyen
Rural Route Two
Box 139 B
Gillespie, Illinois 62033

Mr. Leo Termine

Eagerville, Illinois

Mr. Kenneth Hartbarger
601 E. Chain-of-Rocks Road
Granite City, Illinois 62040

Mr. Hiram Turner

Wilsonville, Illinois 62093

Mr. Oliver White
Post Office Box 497
Bunker Hill, Illinois 62014

Mr. Morrie Giandrone

Wilsonville, Illinois 62093

Mr. Jack Mussatto

Wilsonville, Illinois 62093

Mr. James Mussato

Wilsonville, Illinois 62093

Mr. John Nessl
409 Park Avenue
Gillespie, Illinois 62033

Treasurer of Macoupin County
Macoupin County Courthouse
Carlinville, Illinois 62626

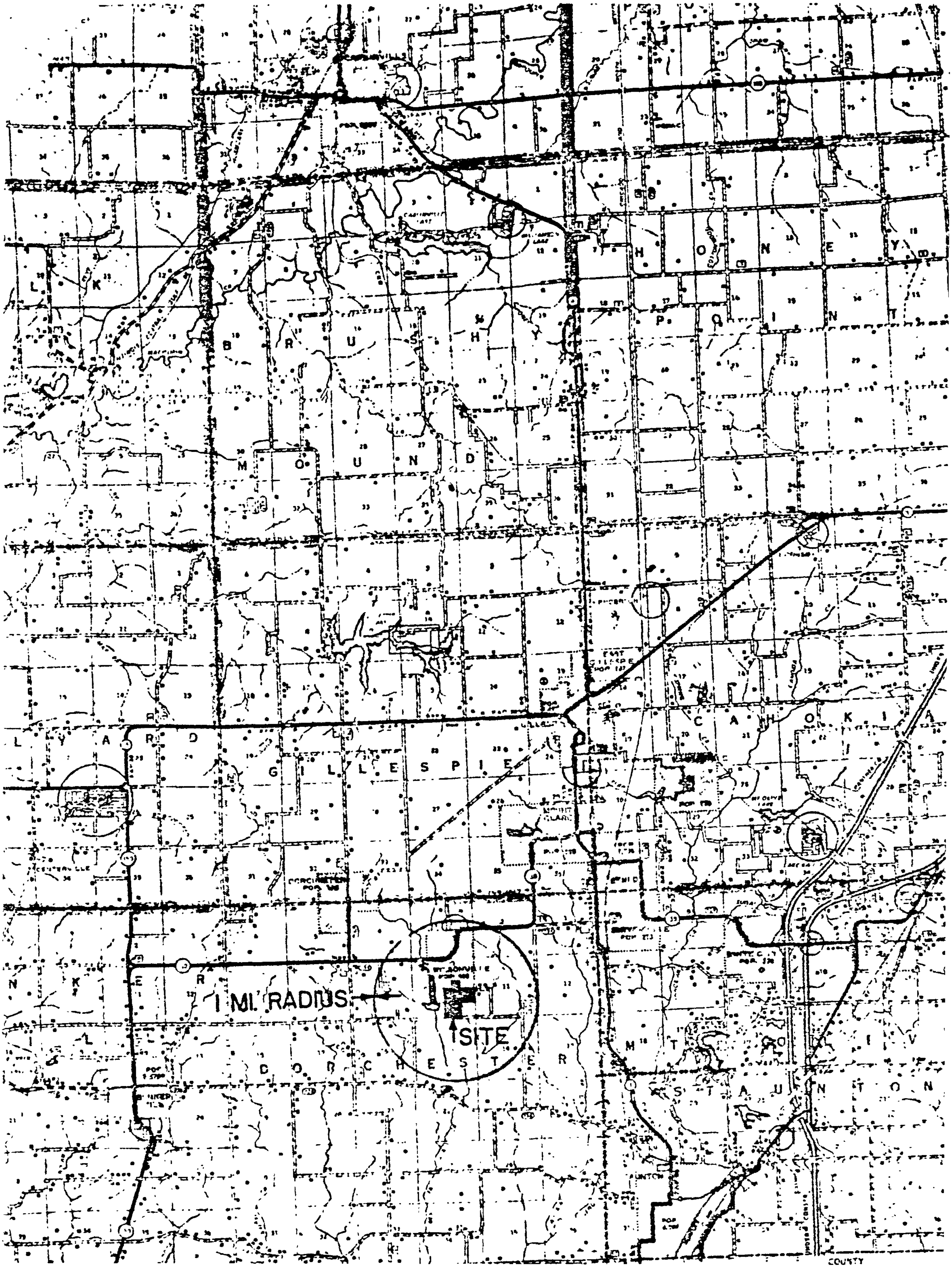
Draghi and Batuello

Wilsonville, Illinois 62093

Chicago and Northwestern Transportation Co.
400 West Madison Street
Chicago, Illinois 60606

Ms. Mary Rose Vassia
51 Portland Place
St. Louis, Missouri 63108

Mr. Carline Wilson
Rural Route Fourt
Box 25
Staunton, Illinois 62088



1 MI. RADIUS
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S T A U N T O N

ATTACHMENT III

Hazardous waste dump in Wilsonville

Abandoned mine site now a landfill

by Mary Odorizzi

WILSONVILLE — An abandoned Wilsonville mine site has been converted into Macoupin County's first hazardous waste landfill, which will be used by industries to dump materials such as chemicals and pathological waste.

Earthline Corporation of Springfield will use the 130-acre site to dispose of industrial refuse from the greater St. Louis area, following the recent approval by the state Environmental Agency (EPA).

The landfill is expected to begin operation this week, according to Douglas Andrews, consulting engineer for Earthline Corporation.

Andrews said some of the waste materials generated from industries in Alton, Wood River, Granite City and St. Louis also will be recycled and sold for industrial use.

HAZARDOUS WASTE is described in the Environmental Protection Act as "refuse with inherent properties which make such refuse difficult or dangerous to manage by normal means including chemicals, explosives, pathological wastes and wastes likely to cause fire."

Earthline's operating permit, granted by the state EPA Sept. 28, prohibits the corporation from accepting radioactive and explosive waste material.

Under the agency's Solid Waste Rules and Regulations, Eathline is required to obtain a permit for each special waste products disposed of in the landfill, according to Michael Rapps, environmental engineer for the EPA's Division of Land Pollution Control.

"A landfill desiring to dispose of 10 different types of waste would need 10 different permits," Rapps said.

Rapps said examples of hazardous waste include spent acids, oils, chemical process effluents and pesticides.

THE MINE was abandoned in 1951 by the Superior Coal Co. Andrews said the property, owned previously by two other companies, had been used as a general dump for a number of years.

Earthline is a subsidiary of SCA Services Inc. of Boston, Mass., which specializes in commercial, industrial, municipal and residential waste services throughout the nation.

Wilsonvile Mine No. 4 is one of 20 abandoned mines in southern Macoupin and northern Madison counties that presently pollute the Cahokia Creek basin.

A Staunton mine about five miles northwest of the Wilsonville site is currently being reclaimed for recreational use under a $492,000 project funded by the state's Abandoned Mined Land Reclamation Council. The Staunton project is the first state-funded, shaft mine reclamation in the nation.

PLANS TO DEVELOP the basin into a large reservoir serving 18 communities were halted six years ago after a feasibility study said acid runoffs from the mine's slag piles present a pollution problem.

Rapps said the landfill, which is estimated to be in operation for a minimum of 25 years, will not further pollute the creek's watershed.

"The water presently flowing from the mine area could be considered a hazardous discharge," Rapp said. "If anything, the situation will be improved."

As a pollution control measure, he said excess dirt from the landfill trenches would be placed over the slag piles to reduce acid runoff.

JAMES HALLBAUER, chairman of the Macoupin County Board's Planning and Zoning Committee, said he is pe
sonally opposed to the landfill.

"I just don't like the idea of oth
people's waste being dumped in o
county," Hallbauer said.

The landfill plans had been discuss
by both the Commission and the Boar
The corporation has never presented
plans to either, Hallbauer said.

"Its operation is really something d
ficult to understand at this point," Ha
lbauer said. "We don't know what cou
happen and then again it could prove
be a real asset to the county."

HALLBAUER SAID the coun
presently does not have ordinances re
ulating landfills.

"There are mixed feelings on t
Board concerning the landfill but there
not much we can do about it," said Ha
lbauer in reference to the EPA's a
proval of Earthline's operating permi

All state landfills are regulated by t
emission and discharge standards a
ministered by the Division of Air a
Water Pollution Control. In addition, t
sites are subject to the Solid Was
Rules and Regulations of the Division
Land Pollution Control.

Rapp said a recent Supreme Court d
cision placed the responsibility of lan
fill zoning on the EPA. Before t
court's ruling, Rapps said the landf
zoning procedures had been left up
individual communities.

WILSONVILLE'S ACTING MAYO
Dino Filippini said the village of 7
residents has not been disturbed by t
landfill, which is enclosed by a seve
foot cyclone fence and borders the yar
of many residents.

"If there are any, they sure haven
been presented to the Board," Filippi
said.

Results of a door-to-door survey la
week indicated many Wilsonville res
dents knew little about the landfill
function.

Filippini said the corporation h
been in contact with the Village Boa
to explain the disposal facility.

THE BOARD recently agreed to
fire protection to the landfill, Fillip
said.

Rapps said the site would be sub
to monthly inspections by the EPA.
Earthline's operating permit requir
quarterly monitoring of 14 ground w
located on the site.

Because Earthline plans to exp
ment with new disposal techniq
Rapps described the Wilsonville sit
unique.

"It could be a model landfill sit
the state," Rapps said.

An ominous warning backed up by barbed wire alerts Macoupin County residents that the Wilsonville mine site is a special landfill—one that handles hazardous waste (Photo by Rick Stankoven).

FOR ENVIRONMENTAL PROTECTION AGENCY

PROGRAM CBS Saturday Evening News STATION WTOP TV CBS Network

DATE May 28, 1977 6:30 PM CITY Washington, D.C.

SUBJECT Hazardous Wastes

BOB SCHIEFFER: American industry produces upwards of 24 million tons a year of dry industrial waste officially considered hazardous. The poisonous residues of an increasingly plastic, chemicalized society.

Eventually all of it has to be dumped someplace, and the people in those places don't like it at all, as Chris Kelly reports from Wilsonville, Illinois.

CHRIS KELLY: There's not much to Wilsonville. Only about 700 people live here, the descendents of Italian and Polish immigrants who came to work in the coal mine that's been closed more than 20 years now.

To the outisder the town seems quiet, very quiet, until you take a closer look at the flags along Wilson Avenue. They fly upside down, a sign of distress, and simmering anger over what's called the Earthline Corporation's Wilsonville Research Center. Actually, it's one of the few burial grounds in the nation for toxic wastes, a 130-acre site atop the old abandoned mine.

Since the Center opened last November, trucks have been hauling in waste material from nearby states to be stored here under supervision of the Illinois Environmental Protection Agency.

LOUIS PELLIGRINI: A lot of the oldtimers that's living in this town, they don't like to live with the thought that they're going to bring toxic materials in here. Some of them are afraid that the place is going to blow up.

KELLY: Well, why are you so afraid of it?

PELLIGRININ: Well, they don't know what's buried there.

[KELLY: Before setting up it's dump, the Earthline Corporation told Wilsonville that the facility would treat and bury what the company called industrial residues. But the people here say they didn't know that meant things like 24D herbicide, solid cyanides, MPT sludge, and polychlorinated biphenal, better known as PCB.]

Five thousand barrels of PCB-contaminated soil that was illegally dumped in Missouri is being deposited here along with six tons of highly toxic sludge from a sewage treatment plant in Louisville. Earthline officials insist there is no danger, that if the mine 300 feet below should collapse, any shift at the surface would be minimal, that the site has a deep clay bed so the poisons, sealed in special containers, would take 500 years to seep out if the monitoring system failed to detect an unexpected leak.

Douglas Andrews designed this site.

DOUGLAS ANDREWS: I'd describe it as being almost as completely failsafe as any facility of its type in the world.

KELLY: If you happened to reside in this community, would you feel comfortable living here, shall we say right on the boundary line of this depository?

ANDREWS: I know enough about the site to feel comfortable living on the boundary of it, yes.

KELLY: But Wilsonville is not comfortable. It's heading to court to close down the dump, and when word came out re-vcently that 1600 tons of PCB-contaminated sludge might be shipped here from Indiana, Illinois Attorney General William Scott filed suit to ban any further dumping of PCB. Publicizing the issue, Scott visited the site this week.

WILLIAM SCOTT: I don't see why Illinois has to be the dumping ground for the nation. I think that's absolutely incredible to say that in a nation that has areas that are in desert that aren't anywhere near any population at all that we have to pick one of the most populated states in the nation.

KELLY: But Scott's action contradicts state EPA policy and underlines the dilemma posed by the Wilsonville controversy, whether at least to control toxic waste disposal or take a chance on losing track of what happens to it at all.

LEO EISEL: We really don't have the choice of are we going to put PCB's in at the Wilsonville site or are we not going to put PCB's into the state at all. But the choice we have is are we going to find safe sites to dispose of chemicals such as this down manholes during the middle of the night.

KELLY: It's estimated as much as 24 million tons of toxic waste is generated in this country annually. By next year the federal government is supposed to put into effect regulations that cover the disposal of all solid wastes.

Americans will have to get used to a new idea in pollution control. Not air or water pollution, but land pollution. In Washington, CBS News correspondent Bill Plante spoke with Sheldon Myers of the EPA.

SHELDON MYERS: Over time, the American public will accept that it's going to mean changes in lifestyle. We've been accustomed to using things and throwing them away. Now their garbage gets picked up, and nobody really cares where it gets put down, but it's got to be put down someplace.

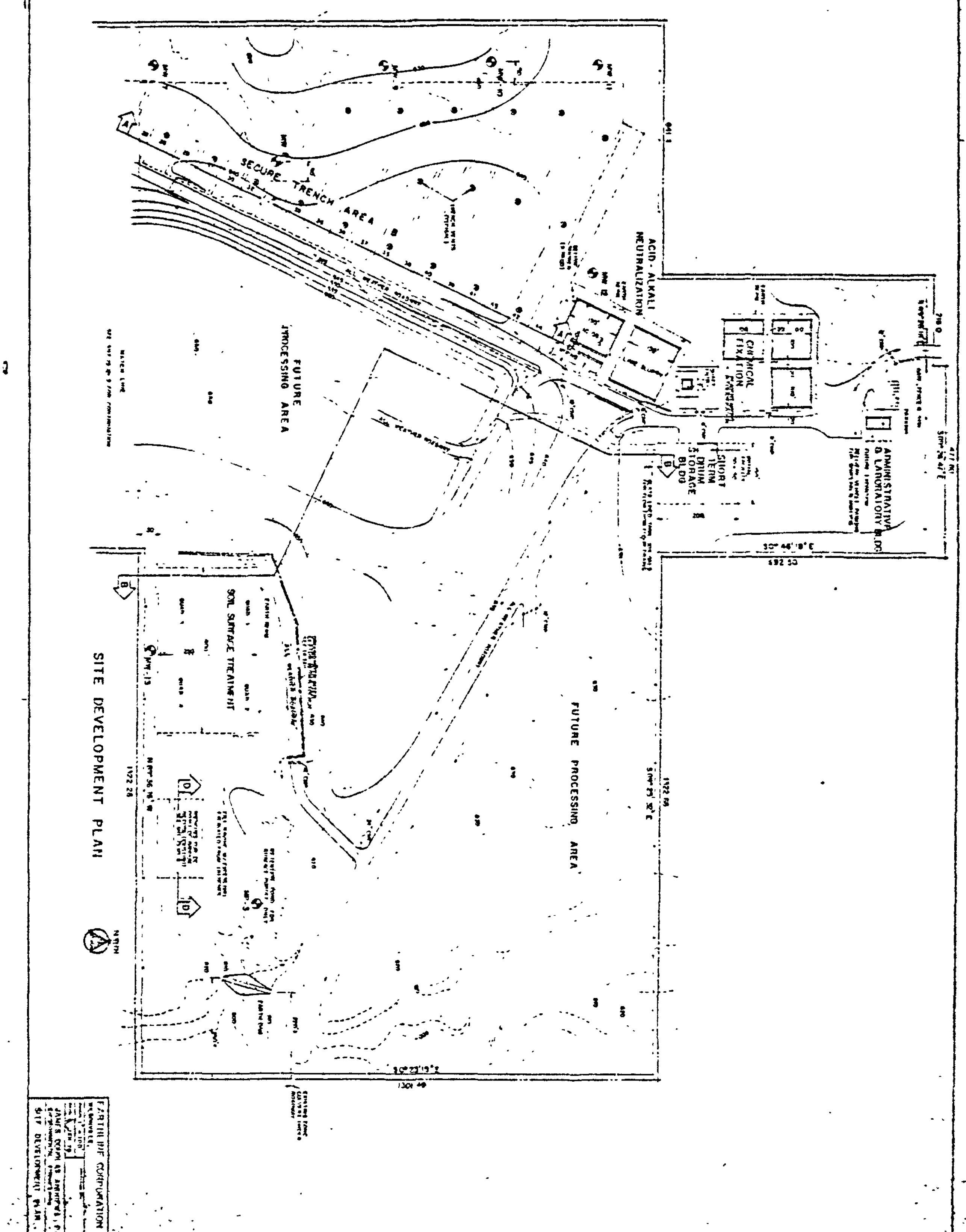
KELLY: Both the Earthline Corporation and Illinois environmental officials say the Wilsonville site is ideal, the best of what is happening in the growing new disposal industry. But what is happening here is also about to enter the legal arena, and soon it is likely that the questions being raised here will be asked in other communities in the country.

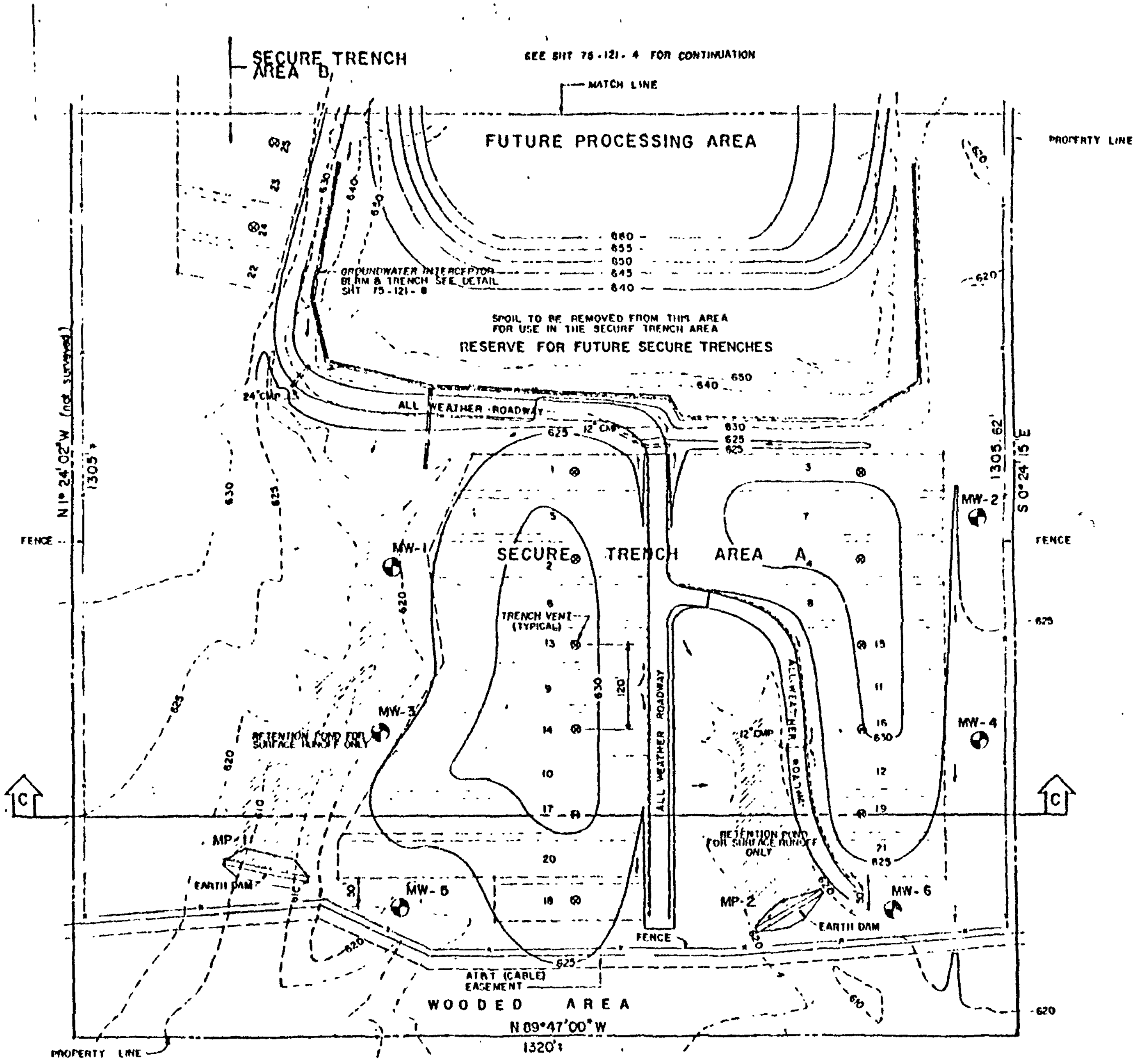
PELLIGRINI: You wouldn't want something like this in your backyard, would you?

KELLY: Chris Kelly, Wilsonville, Illinois.

SCHIEFFER: And a footnote: today Illinois Governor James Thompson announced a 45-day moratorium on the dumping of other states' toxic wastes in Illinois.

ATTACHMENT VI





SITE DEVELOPMENT PLAN

ATTACHMENT VII

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
JOHN C. ANDERSON
DIRECTOR, SPRINGFIELD
BOARD OF NATURAL RESOURCES AND CONSERVATION

ILLINOIS STATE GEOLOGICAL SURVEY

NATURAL RESOURCES BUILDING, URBANA, ILLINOIS 61801 TELEPHONE 217 344-1481

Jack A. Simon, CHIEF

RECEIVED

JUL 18 1977

EPA REGION 5
OFFICE OF REGIONAL
ADMINISTRATOR

July 13, 1977

Mrs. Clarence Granger
R. R. #2, Box 24
Gillespie, IL 62033

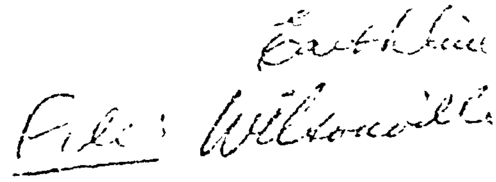
Dear Mrs. Granger:

Mr. Valdas V. Adamkus of the U. S. Environmental Protection Agency forwarded to me a copy of your letter dated June 1, 1977, to President Carter concerning the Earthline disposal site at Wilsonville, Illinois. We have supplied basic geologic information to a number of individuals and agencies concerned with the Earthline site.

The wastes are being buried in shallow trenches and are not being placed in the Superior Mine. The trenches are dug in the glacial drift which forms the land surface and overlies the bedrock at the site. The glacial drift, which consists mostly of pebbly clay till, ranges from 30 to more than 100 feet thick in the region. At the disposal site itself, the drift is about 75 to 85 feet thick. The glacial drift overlies shale bedrock. The Pennsylvanian-age bedrock consists mostly of shale with some limestone, sandstone and coal.

The area was mined for coal prior to 1954. The depth of the workings at Wilsonville was approximately 300 feet. Both the glacial till and the shale and limestone of the bedrock have very low hydraulic conductivities (commonly referred to as permeability); that is, they do not readily permit water to move through them.

There is no evidence of connection of near-surface ground water and the mines. Studies elsewhere in Illinois have shown that most abandoned and sealed mines still contain air, and that the ground water enters the mine very slowly, if at all. While many mines are connected underground as you state in your letter, the abandoned workings are generally "sealed off" as mining progresses. Only a few passages may remain open. The fact that the passages still contain air indicates that there is little leakage of water down from the surface.



The geologic materials in this region are well suited for waste disposal; they are "tight" and capture pollutants that may be released by buried waste. Furthermore, they are not favorable sources of water in wells. This offers protection of the water resources. However, any site must be drilled and tested to determine the exact character of the geologic materials present on the property. I know the Illinois Environmental Protection Agency (IEPA) required such testing, and I assume that the testing showed there to be no environmental hazards before they issued the permit. I suggest you contact the IEPA concerning their guideline for disposal sites.

If you have any further questions regarding the geology of the region, please feel free to contact me.

Very truly yours,

Keros Cartwright
Geologist and Head
Hydrogeology and Geophysics Section

cc: -President Carter
-Leo Eisel, Illinois EPA
-V. V. Adamkus, U. S. EPA

cc: A & H M

MAY 2 3 1977

ATTACHMENT VIII

105 ...

SOLID WASTE MANAGEMENT
RESOURCE RECOVERY SYSTEMS

1320 S. Fifth Street
Springfield, Ill. 62703
Phone (217) ...

JAMES DOUGLAS ANDREWS, P.E.
ENVIRONMENTAL ENGINEERING

May 19, 1977

Mr. Monte Nienkerk
Water Monitoring Coordinator
Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

SUBJECT: Macoupin County
Wilsonville/Earthline Corporation
Permit No. 1976-20-OP

Dear Mr. Nienkerk:

Enclosed are water monitoring results from monitoring points at the subject site. Monitoring points MP-2 and MP-3 could not be sampled due to an insufficient flow of water.

Please contact the undersigned if you have any questions concerning these results.

Sincerely,

James Douglas Andrews, P.E.
Environmental Engineer

JDA:jr

cc: Sal Campagna

MADE WITH RECYCLED FIBER

IAY 2 3 1977

C. D. TROWBRIDGE, Director

[illegible]10 CLARK AVENUE • ST. LOUIS, MO. 63103
531-8080 Code 314

Chemical, Metallurgical, Physical, Non-Destructive, Spectrographic, Agricultural Testing and Analyses
Investigations, Research and Development, Inspection, Field Services

May 6, 1977
Report No. 77-02550
Lab No. 5997

Earthline Division
PO Box 38
Wilsonville, Ill. 62093

Attention: Mr. Thomas Stanczyk

REPORT OF TESTS

MATERIAL: Nine (9) samples identified below for chemical testing

RESULTS:

	MW1	MW2	MW3	MW4
T.D.S., mg/l ----	8426	6298	992	2591
COD, mg/l -------	35	10	40	65
Chromium, mg/l --	<.05	<.05	<.05	<.05
Cadmium, mg/l ---	0.04	0.04	<.01	0.02
Zinc, mg/l ------	0.05	0.03	0.05	0.05
Mercury, mg/l ---	<.0005	<.0005	<.0005	<.0005

	MW5	MW6	MP1
T.D.S., mg/l ----	3864	1248	7106
COD, mg/l -------	34	65	16
Chromium, mg/l --	<.05	<.05	
Cadmium, mg/l ---	0.02	<.01	
Zinc, mg/l ------	0.04	0.05	
Mercury, mg/l ---	<.0005	<.0005	

Testing Laboratories

314/531-8080

Earthline Division
Report No. 77-02550
Page 2

MW14	TDS, mg/l	909
	COD, mg/l	103
	Oil, mg/l	16

MW13

TDS, mg/l	3925	Lead, mg/l	.40
COD, mg/l	131	Magnesium, mg/l	283
Chromium, mg/l	.06	Manganese, mg/l	.88
Cadmium, mg/l	.02	Nickel, mg/l	.41
Zinc, mg/l	.26	Potassium, mg/l	8
Mercury, mg/l	<.0005	Sodium, mg/l	296
Oil, mg/l	34	Arsenic, mg/l	.08
Calcium, mg/l	457	Barium, mg/l	.6
Copper, mg/l	.11	Phenol, mg/l	<.01
Iron, mg/l	30	Cyanide, mg/l	<.05

Respectfully submitted,

W. Dee Trowbridge
Assistant Director

WDT/kv

ATTACHMENT IX

EARTHLINE DIVISION SCA SERVICES, INC.
P. O. BOX 38
WILSONVILLE, ILL. 62093

RECEIV... JUN 1 Denby, Do

SCA SERVICES INC. SUBSIDIARY

RECEIVED JUN 1 8 1977 Denby, Dobbs & Meno

TO: Matt Straus

FROM: Tom Stanczyk

RE: Chemical Breakdown of Trench Areas

Trench #1

empty, dry, has not been used.

Trench #2(filled and completed)

granular (Solo) herbicide
grit contaminated w/C-5,6
Paint sludge
paint wastes (included liquid paint wastes, latex, urethanes, resin)
oil wastes
para-nitroaniline sludge

Trench #3 (filled and completed)

oil wastes
paint sludge
paint liquid
ink residue
waste perchlor
inorganic zinc sludge
chlorinated solvent
packaged lab chemicals
phenol zinc sulfonate

Trench #4 (filled and completed

dirt contaminated w/PCB
liquid PCB and sludge
Scott fertilizer and weed killer
solid cyanide
mercury sulfide, floor sweepings
paranitroaniline
pesticides: floor sweepings, rags, DDT, chlordane, diazinon, endrin heptachlor, lindane malathion, methoxychlor, toxaphene, zineb

Trench #5 (filled)

methyl mathacrylate polymer (5-10%)
paint wastes
paint sludge
paint thinner

EARTHLINE DIVISION SCA SERVICES, INC.
P. O. BOX 38
WILSONVILLE, ILL. 62093

SCA SERVICES INC. SUBSIDIARY

Trench #5 (filled) - cont.

grit w/C-5,6
C-56 bottoms (tar-like)
paranitroaniline

Trench #6 (presently working on)

grit contaminated w/C-5,6
paranitroaniline
C-56 bottoms

Trench #7 (presently working on)

dirt w/PCB
pesticides
demolition building contaminated w/Hg

Attachment X

Flow Velocities and Travel Times

This describes how the Darcian and Pore Water velocities are calculated, how they are, in turn, used to calculate travel time or containment time, and how the amount of liquid passing through a soil in a given time is calculated.

Assume that a column of soil is set up in the laboratory and water is being applied to the top of it just fast enough so that all the soil in this column is always saturated but only a very thin film of water is standing on the top surface of the column. In a period of time, a quantity of water Q come out of the bottom of the soil column. The velocity or rate that water is moving down through this column is calculated from:

$$V = \frac{Q}{A \times t} \quad (1)$$

Where V is the velocity (cm/sec, ft/hr, etc.), A is the cross sectional area of the column (cm^2, in^2, ft^2, etc.) and t is the time (minutes, hrs., etc.) that it will take for the quantity Q (quarts, liters, gallons) to flow out of the column.

The difference in the Darcian and Pore Water velocities is in the size of the cross sectional area A. For the Darcian velocity, it is assumed that the water flows through the whole cross section, A of the column as if the soil was not there at all. For the pore water velocity, it is assumed that the water flows only in the pore spaces between the soil particles. If E% of the total volume of the soil column is pore space, then it is assumed that in any cross section of the soil column, only E% of the area is open to water flow and the A in equation (1) is replaced by E X A to calculate the pore water velocity. If, for example, the soil had 25% pore space, the A would be replaced by 0.25A in (1) to calculate pore water velocity.

Pore water velocity is always faster than the Darcian velocity and the pore water velocity is likely a better estimate of how fast water is actually moving in the spaces within the soil. The Darcian velocity, nevertheless, is a useful parameter because it makes it easier to calculate the amount (Q) of water that will pass through a given area of soil.

The permeability of a soil is calculated by the Darcy equation:

$$V = k \times i \quad (2)$$

Where k is the permeability of saturated soil measured in cm/sec., ft/day, etc., i is the hydraulic gradient in ft/ft or cm/cm, and V is the Darcian flow velocity in cm/sec., ft/day, etc. The hydraulic gradient is a measure of the driving force that causes water to move. For the soil column described above, the conditions have been chosen so that i = 1.0 to simplify this discussion.

To calculate the travel time or containment time for the soil column in this example, use the distance formula:

$$D = R \times T \quad (3)$$

Where D is the distance in ft., cm., etc (in this example, the length of the soil column), T is the travel time in hrs., days, etc., and R is the rate of water movement (either the Darcian velocity or the pore water velocity).

In field situation, when the permeability (k) and the hydraulic gradient (i) have been measured at a location, the Darcian travel time is calculated by substituting equation (2) into equation (3) and rearranging the terms.

$$T = \frac{D}{R} = \frac{D}{v} = \frac{D}{k \times i} \quad (4)$$

To calculate the pore water velocity, it is necessary to account for the area through which water is flowing.

In equation (1) it can be seen that when pore water velocity is to be calculated, A is replaced by E x A and the pore water velocity is 1/t times greater than the Darcian velocity. (Recall that E, the soil porosity is always less than 1.0). As the V in equation (4) becomes larger, the T becomes smaller. Therefore, the equation relating the Darcian travel time to the pore water travel time is:

$$Tpw = E \times Td \quad (5)$$

Where Tpw is the travel time calculated on the basis of pore water velocity, E is the fraction of the soil volume occupied by pore space, and Td is the travel time calculated on the basis of the Darcian velocity.

This explanation is simplified to illustrate the basic principle. Precise estimation of travel times must also take into account the amount of the pore space (E) that is "dead end" so water does not flow through it and also the time required to wet the soil when it is not completely saturated.

One way to determine what quantity of water will pass through a soil in a given time is to go back to equation (4) and rearrange it.

$$V = \frac{D}{T} \quad (5)$$

If T is the Darcian travel time (Td) in years, and D is the depth of soil in feet, then v will be in feet per year, the depth of water that will pass through a given area of soil in a year. As an example, if the Darcian travel time is 600 years and the depth of soil is 15 feet, then:

$$V = 15/600 = 2.5 \times 10^{-2} \text{ ft/yr} = 0.3 \text{ inch/yr}$$

To get the volume per year, the 0.3 in/yr would be multiplied by the area of the soil column or, in the field, by the area of the trench or lagoon.

If this soil had a porosity of 25%, then E = 0.25 and using equation (5), the Pore Water travel time would be:

$$Tpw = E \times Td = 600 \text{ yrs.} \times 0.25 = 150 \text{ years}$$

To determine the quantity of water using the pore water travel time, start with equation (6):

$$V = 15/150 = 0.1 \text{ ft/yr} = 1.2 \text{ in/yr}$$

However, because pore water travel time is calculated assuming the water flows only in the soil pores, the 1.2 inches/year is likewise moving down only through part of the total area of the soil. Since the porosity, E, was assumed to be 0.25, this 1.2 in/yr is passing through only 1/4 of the area. If the same amount of water is spread over the whole area of soil, the amount will be only 1/4 as much.

$$1.2 \text{ in/yr} \times 1/4 = 0.3 \text{ in/yr}$$

This is the same as was calculated with the Darcian travel time.

Attachment XI

Contaminant Travel Times (years)[1]

	Rate of Contaminant Movement Relative to Fluid Movement			
	3/4	1/2	1/10	1/15
Trenches full of water	200	300	1500	2250
Trenches empty[2]	400	600	3000	4500

1) Using 150 year travel time for liquids

2) Pieziometric surface at sand layer, hydraulic gradient 1/2 of gradient when trench is full

ILLINOIS STATE GEOLOGICAL SURVEY
NATURAL RESOURCES BUILDING, URBANA, ILLINOIS 61801   TELEPHONE 217 344-1481
Jack A. Simon, CHIEF

June 10, 1977

Mr. Matthew A. Straus
Hazardous Waste Management Division
Office of Solid Waste (AW-465)
401 M Street S.W.
U. S. Environmental Protection Agency
Washington, D. C. 20460

Dear Matt:

Please find enclosed a copy of the research report "ATTENUATION OF PCB's BY SOIL MATERIALS AND CHAR WASTES" that you requested during our recent inspection of the Earthline hazardous waste disposal facility in Wilsonville, Illinois.

The results of the research report indicate that PCB's are immobile in soil materials, including pure sand, when leached with water. It should be noted that the Ava silty clay soil (Table 1) represents a soil with characteristics similar to the soil materials examined at the Wilsonville site. The results of more recent studies conducted in our laboratory with other aqueous solutions such as landfill leachates confirm the results presented in the March 1977 report. However, when the mobility of PCB's were tested using organic solvents (e.g. carbon tetrachloride, methylene chloride, methanol, and acetone), using the same experimental conditions as in the aqueous solvent tests, the PCB's were found to be highly mobile.

Therefore, based on my laboratory studies and my inspection of the Wilsonville site, it is my best scientific judgement that the possibility of pollution of water resources due to the migration of PCB's in aqueous form from the site is essentially nil. I strongly recommend that organic compounds that might solubilize PCB's not be disposed of in the same trenches with PCB wastes since these organic solvents greatly increase the mobility of PCB's through soil materials.

If I may be of further assistance in your evaluation of the Wilsonville site, please don't hesitate to contact me.

Sincerely,

R. A. Griffin
Associate Geochemist
Section of Geochemistry

cc: Jack Simon
Michael Roulier
Keros Cartwright
Howard Chinn

Enclosure

ATTENUATION OF PCB's BY SOIL MATERIALS AND CHAR WASTES

by

R. A. Griffin,[1] F. B. DeWalle,[2] E. S. K. Chian,[2] J. H. Kim,[2] and A. K. Au[1]

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Department of Civil Engineering
University of Missouri - Columbia

and

Environmental Protection Agency
Cincinnati, Ohio

March 1977

ATTENUATION OF PCB's BY SOIL MATERIALS AND CHAR WASTES

by

R. A. Griffin, F. B. DeWalle, E. S. K. Chian, J. H. Kim, and A. K. Au

ABSTRACT

Adsorption of polychlorinated biphenyl (PCB) isomeric mixtures containing 42 and 54 percent chlorine by montmorillonite clay and soil and the relative mobility of these compounds through soil media were determined by both gas chromatography and ^{14}C labeling techniques. Adsorption by these earth materials was found to be strong with more than 90 percent removal from solution at concentrations approaching the water solubility of the compounds tested.

PCB's were found to be immobile in earth materials when measured by the soil thin-layer chromatography technique. R_f values for PCB's were found to be zero to 0.02 for all amounts of PCB's tested (42-206 ng). Dicamba, a pesticide with high mobility, was used as an internal standard and yielded R_f values of 0.80 to 1.00.

Gas chromatographic analytical procedures that allowed improved quantitative measurement of PCB's in aqueous solutions were developed. The overall perchlorination procedure for conversion of isomeric mixtures of PCB's to the fully chlorinated biphenyl by digestion with $SbCl_5$ was successfully reduced from approximately 20 steps to about 10 steps. The speed of the analyses was improved and interference from bromine was removed. Reproducibility of the overall perchlorination with 80 ng biphenyl in sealed glass tubes was determined to be 0.52 percent relative standard deviation.

INTRODUCTION

Polychlorinated biphenyls (PCB's) are used in a wide range of industrial applications such as electrical insulation, fire-resistant and heat transfer fluids, hydraulic fluids, high temperature and pressure lubricants, sealants, expansion media, adhesives, plasticized paints, lacquers, varnishes, pigments, paper coatings, waxes, and as constituents in elastomers. They were largely ignored as environmental contaminants until Jensen (1) and Widmark (2) identified them in 1966. PCB's did not attract much concern as hazardous chemicals until the incidents of contaminated cooking oil in Japan in 1968 and of contaminated chicken feed in the United States in 1971 (3). Laboratory studies with animals have shown that PCB's can cause enlargement of the liver, induction of hepatic microsomal enzymes, reproductive failures, gastric disorders, skin lesions, and tumors in birds and mammals (3). The 2000 afflicted Japanese people in the "Yusho" incident of 1968 experienced lesions of the skin, facial swelling, and neurological disorders that were similar to the results reported in the animal studies (4).

Fish and other aquatic organisms tend to accumulate PCB's in lipid-rich tissues and organs. Predators at the top of the food chain may accumulate PCB's to levels of more than 10^7 times that of the ambient water (4). Man usually resides at the top of the various food chains and, due to the biological magnification, may ingest large amounts of PCB's even though only trace amounts are present in the ambient waters.

PCB's have, therefore, been considered as a significant hazard to human health as well as the environment.

PCB's have been manufactured in the United States since 1929; it has been estimated that more than 400,000 tons have been produced since that time. The sole U.S. manufacturer of PCB's is the Monsanto Company located near East St. Louis, Illinois. Since 1971, Monsanto voluntarily has restricted its sales of PCB's to only "closed" systems, such as PCB-containing insulating fluids used in electrical transformers and capacitors. These two applications account for essentially all the current use of PCB's in the United States (5). On October 5, 1976, Monsanto announced that it would cease to manufacture and distribute PCB's by October 31, 1977. A timetable set by the U.S.-EPA has called for a gradual phasing out of PCB manufacturing by January 1, 1979, and a ban on all PCB processing or distribution in commerce by July 1, 1979 (6). These steps have significantly reduced the introduction of PCB's into the environment.

Unfortunately, approximately one-half million pounds of PCB's are still imported into the U.S. each year from foreign manufacturers and millions of pounds of PCB's still exist causing the environmental levels to remain quite high. For example, two tributaries of Lake Michigan have PCB levels that consistently exceed 100 ppt. This has contributed to PCB levels between 4 and 10 ppt in certain parts of the lake. The present U.S.-EPA recommended water quality criteria is less than 1 ppt and the high PCB levels have caused great concern to the residents of Chicago, who draw their drinking water from the lake (4).

Many companies discard their old electrical equipment in unapproved places and thus discharge the PCB's into the atmosphere and waterways. One problem of disposal involves the high costs and fees for transporting PCB wastes to regional incinerators or approved landfills vs. simply discarding the wastes. Incineration is considered the safest method for disposal of PCB wastes. However, this method is extremely costly and has some operating difficulties. PCB's do not burn readily and, under improper operating conditions, can be vaporized during incineration. Thus, incineration may turn out to be the major source of PCB's reentering the environment. In addition, large electrical transformers and capacitors, the major source of waste PCB's, cannot be satisfactorily incinerated.

Thus, land disposal is the only reasonable alternative for waste PCB's. Although landfill disposal appears to be the most acceptable alternative, little information is presently available concerning the possibility of ground-water contamination by leaching PCB's from landfills. Lidgett and Vodden (7) analyzed waters around a sanitary landfill for PCB's and found the contamination levels to be below their detection limit of 4 ppb. Similarly, Robertson and Li (8) failed to detect PCB's in ground water using GC/Mass Spectrometry techniques. Tucker, Litschgi, and Mess (9) studied the leaching of Aroclor 1016 from various types of soils and concluded that PCB's are not readily leached from soil by percolating water.

The paucity of information available shows no evidence that ground waters have become contaminated by PCB's. However, many surface waters do contain PCB's and the mechanism of transport in the biosphere and the mechanism of attenuation in soil are still unknown. Data on the factors affecting PCB attenuation by earth materials would provide a rational basis for future disposal site selection and design.

BACKGROUND

The research reported here is supported in part by Grant R-804684-01, from the U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, Solid and Hazardous Waste Research Division, Cincinnati, OH 45268.

The purposes of the present project are:
a) To conduct an extensive literature review of pertinent information on the adsorption of hazardous organic compounds;
b) To measure the adsorption capacity of selected earth materials for pure PCB's and PCB wastes;
c) To quantitatively evaluate the effects of pH, biological degradation, photodecomposition, volatilization, time, and adsorbent structure on adsorption of PCB's;
d) To use this data to develop a mathematical model that will allow prediction of PCB adsorption and mobility; and
e) To further develop analytical procedures that will allow improved quantitative measurement of PCB's contained in aqueous solutions.

PCB Materials

Polychlorinated biphenyls (PCB's) is a generic term applied to certain mixtures of synthetic organic compounds. These compounds are mixtures of very closely related isomers and homologs that contain two phenyl rings with 10 possible chlorine attachments. The biphenyl structure is shown in Figure 1. PCB's are made by substituting chlorine atoms for one or more of the hydrogen atoms at the numbered positions of the biphenyl structure. These compounds are chemically and thermally stable, very resistant to microbial degradation, and are highly persistent in the environment.

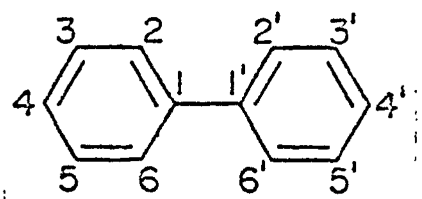

Fig. 1. BIPHENYL STRUCTURE: Positions 2 to 6 and 2' to 6' indicate ten possible positions for chlorine substitution. Different amounts of chlorine substitution form the various PCB's.

The PCB materials chosen for study were the pure Aroclors 1242 and 1254 (42 and 54% substituted chlorine, respectively) supplied by the Monsanto Company, and the ^{14}C labeled compounds were prepared by New England Nuclear Corporation. Gas chromatographic traces of the ^{14}C labeled compounds were identical to those of the pure Aroclors 1242 and 1254, respectively. Therefore, it was assumed that there were no significant differences in the respective compounds and that the ^{14}C labeled and pure Aroclors would behave similarly in studies of adsorption, mobility, and microbial degradation.

A used capacitor fluid was also obtained for study. The fluid was drained from a burned out 50 KVA capacitor manufactured by Westinghouse in 1966 and originally contained Aroclor 1242. This capacitor was supplied by Illinois Power Company and was scheduled to be landfilled. We believe this fluid is representative of the type of PCB wastes that are normally disposed of in landfills.

Adsorbents

Earth materials, representing a wide range in characteristics, have been selected as adsorbents. The materials being studied are: Ottawa silica sand; Panther Creek southern bentonite clay; the soils, namely Bloomfield ls, Ava sic, Cisne sil, Flanagan sil, Catlin sil, Drummer sicl, Weir sic, a calcareous loam till; and two coal chars. The chars were selected because of their high adsorption capacity for organic compounds. They are a waste product of many coal conversion processes and thus have potential use as a liner material for disposal sites accepting organic wastes.

Analytical Development

In general, PCB's are determined quantitatively by comparing gas chromatographic (GC) response patterns of a multicomponent environmental sample with commercial PCB's (Aroclors) or a mixture of Aroclors. This technique is limited by the sensitivity and reproducibility of comparisons of the large number of peaks produced by the various PCB isomers. The procedure is further complicated because the various components of water soluble PCB's contained in environmental samples are not likely to have the same composition as those in the original Aroclor used as a reference compound. For practical reasons, the quantitation is usually done by integration of the major peaks while ignoring the minor peaks. This can cause some error, depending on how well the mixture of isomers in an unknown sample compares to a standard.

Because of these problems, we have developed procedures that allow improved quantitative measurement of PCB's in aqueous samples. The main thrust of our studies have been to improve previous procedures whereby isomeric mixtures of PCB's were converted to the fully chlorinated biphenyl, decachlorobiphenyl (DCB), by digestion with $SbCl_5$. This procedure has the advantage of converting all the PCB's to a single peak for improved quantitation. The electron capture GC detector is many times more sensitive to DCB than it is to PCB's; thus, the conversion to DCB improves the sensitivity and lowers the detection limit for PCB's.

CURRENT STUDIES OF PCB ATTENUATION AND ANALYTICAL DEVELOPMENT

PCB Mobility

The technique of determining pesticide mobility in soils by soil thin-layer chromatography was introduced in 1968 by Helling and Turner (10). Since the introduction of the technique, the mobility of a large number of pesticides in a variety of soils has been tested (11, 12, 13). Soil thin-layer chromatography, or soil TLC, is a laboratory method that uses soil as the adsorbent phase and water as the developing solvent in a TLC system. The system is relatively simple and yields quantitative data on the mobility of organic compounds in soils that appear to correlate well with trends noted in the literature (10). The results reported here are mobility data for Aroclor 1242 and 1254 on TLC plates made from sand, clay, three soils, and a coal char. Dicamba, a pesticide of known high mobility, was used as an internal standard.

The soil sample was slurried with water until moderately fluid, and then was applied with a spreader to clean glass plates 20 cm by 20 cm square. The soil was spread to a thickness of 0.5 mm and then air dried. A horizontal line was scribed 12 cm above the base to stop water movement; vertical lines were scribed 2 cm apart to separate the various treatments. The compounds were spotted 2 cm from the base and leached 10 cm with water. The activity of the ^{14}C labeled compound varied between 11,000 and 44,000 dpm. The plates were immersed in 0.5 cm of water in a closed glass chamber and were removed when the wetting front reached the horizontal line. Leaching was thus ascending chromatography. The soil plate was then removed and air dried. A piece of 8 × 10 inch medical X-ray film was placed in direct contact with the soil plate for approximately one week. The resultant autoradiograph indicated the relative movement of the compound, which was measured as the frontal R_f of the spot or streak.

Figure 2 shows the results of PCB and Dicamba mobility on Catlin soil plates. The figure is a composite of data from two plates illustrating the low mobility of the two PCB's at four concentrations and the excellent replication of the Dicamba mobility. The amounts of PCB spotted in each lane is labeled on the figure and ranged from 42 to 206 ng. It is clear that at all four amounts PCB's remained at the origin, were immobile in Catlin soil, and the Dicamba had an R_f of between 0.85 and 0.90. The R_f is defined as the distance the compound moved relative to the distance the water front moved, that is, the Dicamba moved 85 to 90 percent of the distance the water front moved on the plate. The two PCB's had R_f values of zero.

The R_f values obtained for Aroclor 1242 and 1254, and for Dicamba on TLC plates made with several earth materials are presented in Table 1. The results clearly indicate that the two PCB's tested are highly immobile in these test systems. R_f values of zero to 0.02 were obtained for all the materials tested, even the pure silica sand. Dicamba was shown to be highly mobile in these tests with R_f values ranging from 0.80 in the char to 1.00 in the sandy materials.

Adsorption Studies

Equilibrium adsorption studies were carried out by shaking known volumes of PCB solutions with varying weights of earth materials at a constant temperature of 25°C. Figure 3 shows representative results for adsorption of Aroclor 1242 and 1254 by montmorillonite clay. Weights of clay varied from 0.01 to 0.5 g per 10 ml of solution. Blanks containing no clay were carried through the experiment. The data in Figure 3 indicates that more than 50 percent of the PCB's were removed in the blanks (no clay). The reaction was carried out in sealed centrifuge bottles so that volatilization and losses during separation of the solid from the liquid phase were minimized. Since PCB's are highly resistant to microbial degradation, the results are interpreted as adsorption of the PCB's onto the glass walls of the centrifuge bottle. This strong adsorption by the glass container is consistent with the observation that PCB's were immobile on the silica sand TLC plates described above. Adsorption by 0.5 g of clay is nearly complete with less than 1 ppb remaining in solution. It was concluded that PCB's are strongly adsorbed by earth materials. This conclusion is consistent with the high degree of immobility observed in the soil TLC study.

Analytical Procedure Development

Little effort has been made to derivatize

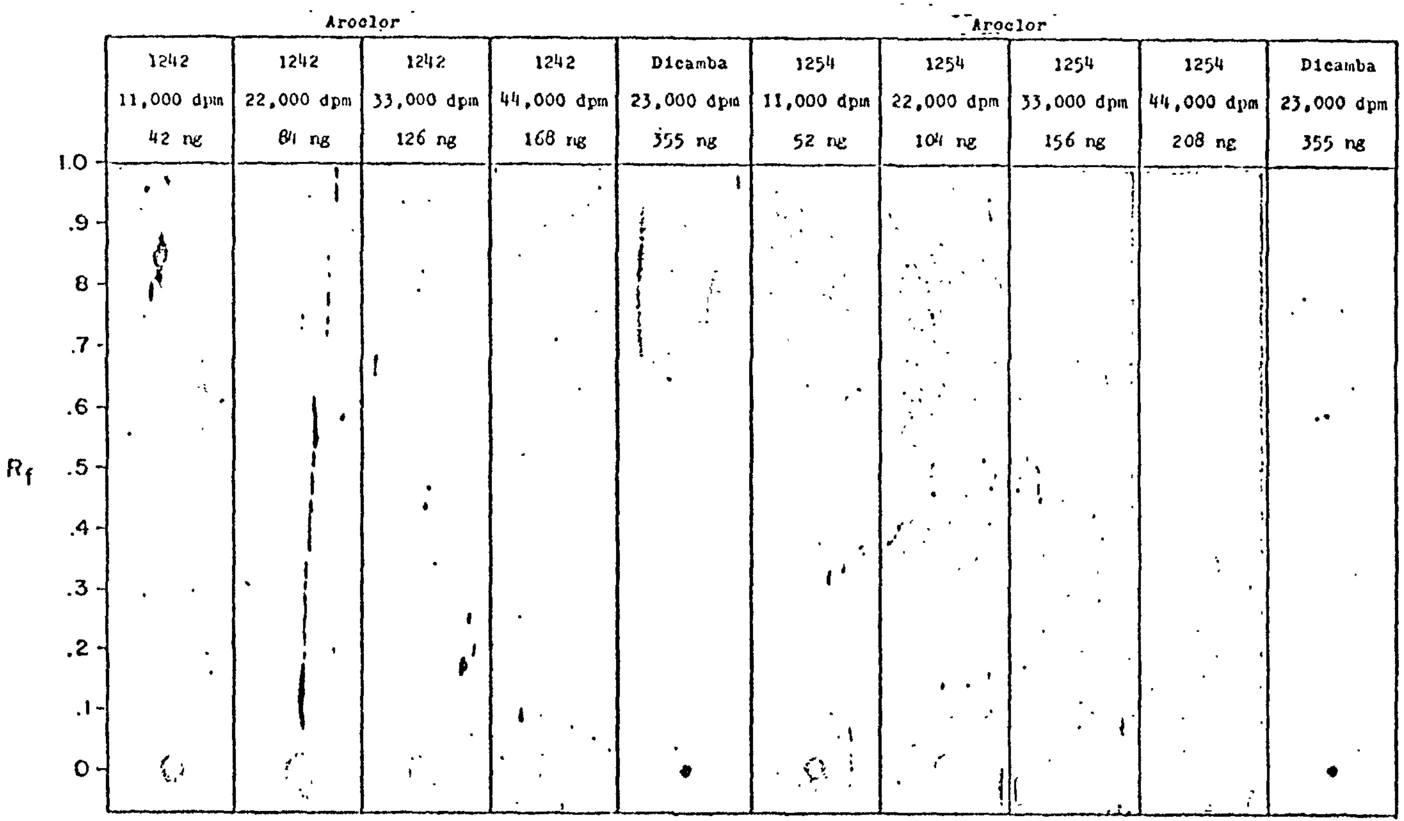

Fig. 2. PCB and Dicamba mobility in water on Catlin sil soil thin-layer chromatography plates.

Table 1: Mobility of Aroclors 1242 and 1254 and Dicamba in Earth Materials as Measured by Soil Thin-Layer Chromatography.

Earth Material	Compound		
	Aroclor 1242	Aroclor 1254	Dicamba
	R_f		
Silica sand	.02	.02	1.00
Bloomfield ls	.01	.01	1.00
Ava sic	.00	.00	1.00
Catlin sil	.00	.00	.88
Montmorillonite	.00	.00	1.00
Coal Char (1200°F)	.00	.00	.80

the PCB residue to a single compound for quantification. The attempted derivatives were biphenyl and decachlorobiphenyl (DCB). The former derivative could be obtained by catalytic hydrogenation of PCB's (14, 15). The main disadvantage of this approach is that the derivative, biphenyl, is determined with flame ionization detector (FID) on GC, which decreases the sensitivity of the detection system.

Procedures have been established to convert PCB's to perchlorinated PCB, DCB, by Armour (16). In brief, an extracted PCB residue with 0.2 to 0.5 ml antimony pentachloride in ~0.1 ml chloroform was subjected to heating at 170° for 4 to 15 hours. The reaction vessel used was 10 OD mm × 150 mm (internal volume ~7.5 ml) resealable glass tubes; heat was applied to one third of the tube length during the reaction. At the end of the heating the excess $SbCl_5$ was decomposed with 6N HCl, followed by hexane extraction of DCB for GC analysis. Overall perchlorination reaction requires approximately 20 steps.

The procedure has been subjected to further study by Trotter (17) and the limitations on the use of $SbCl_5$ for perchlorination of PCB's were discussed. Commercially available $SbCl_5$ is contaminated with traces of Br, likely as antimonybromotetrachloride. The presence of the Br contaminants is believed to be the source of bromonanochlorobiphenyl (BNCB), which was a likely competing product with DCB during perchlorination.

Based on the above information, our efforts have been directed toward modification of the perchlorination procedure by:
1) Increasing the amount of solvent used during perchlorination,
2) Removing the Br interference,
3) Reducing the overall number of reaction steps.

The gas chromatographic column used in this study consisted of a 2 mm ID × 1.83 m glass column packed with 4% SE 30/6% OV-210 on 80/100 mesh chromosorb WHP. The column temperature was held isothermally at 260°C. The detector used was a Hewlett Packard linear ^{63}Ni electron capture (ECD) with nitrogen as a carrier gas. The attenuation of the gas chromatograph was set at 1 × 4 with which full-scale recorder deflection was observed with 100 ng DCB.

For the gas chromatographic quantification, Mirex was used as an internal standard. Reproducibility of gas chromatographic quantitation of DCB with Mirex as an internal standard will be discussed in the later part of this section.

By increasing the amount of perchlorination solvent, loss of extracted PCB's can be avoided during concentration of the extracts (18). Also, a larger volume of solvent will maintain reflexing inside the reaction vessel resulting in complete mixing of PCB's and the perchlorinating reagent, $SbCl_5$.

When 2 ml of a mixture containing equal amounts of $CHCl_3$ and $SbCl_5$ was heated overnight at a heating block temperature of 220°C, interfering gas chromatographic peaks were observed. The interfering GC peaks may result from a reaction between the $SbCl_5$ and the $CHCl_3$, or between $SbCl_5$

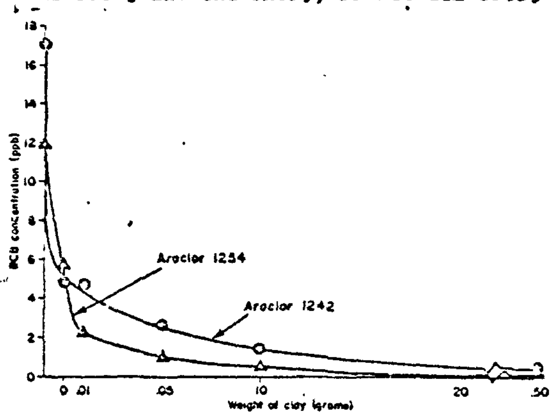

Fig. 3. Adsorption of Aroclor 1242 and 1254 by montmorillonita at 25°C.

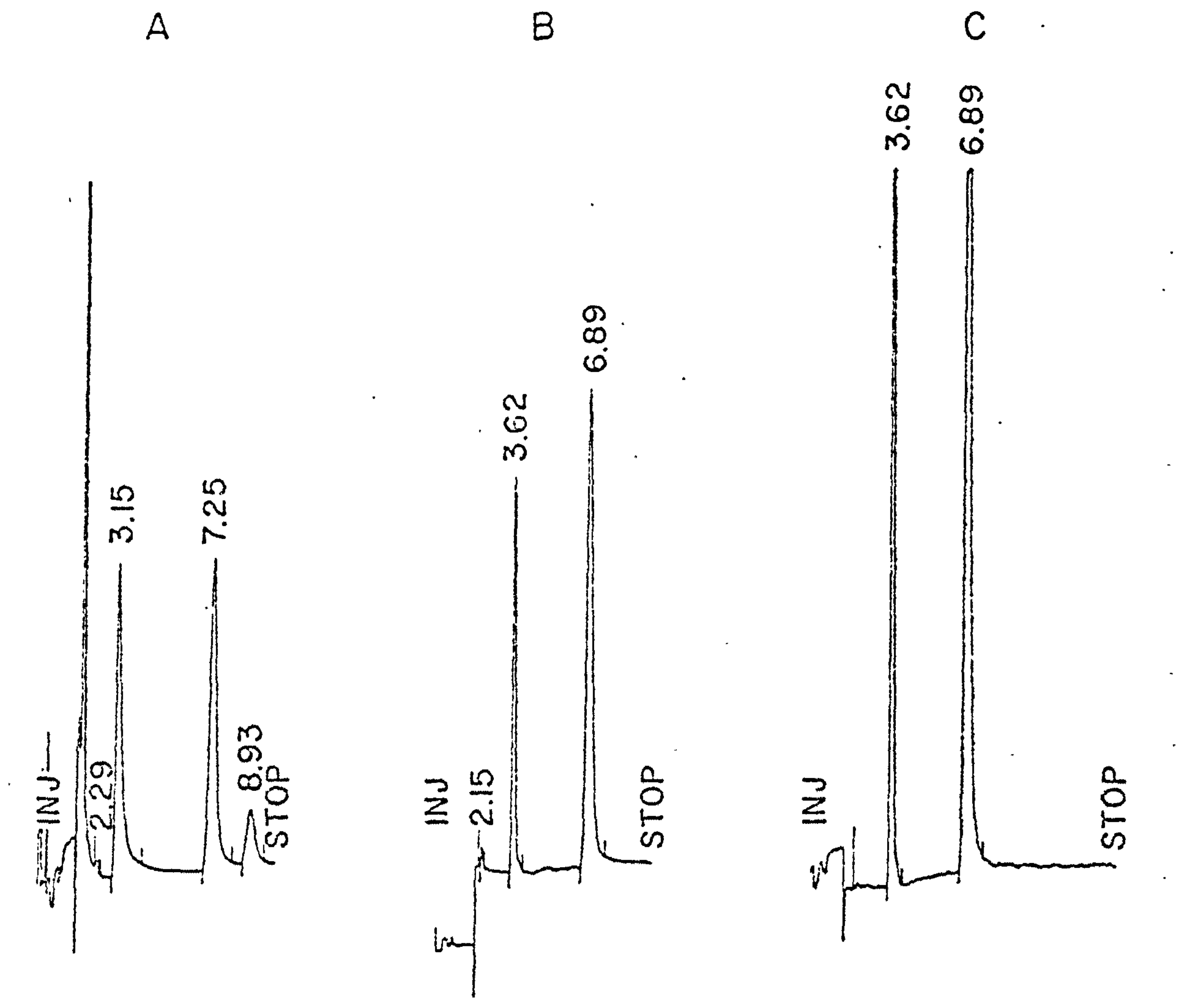

Fig. 4. Gas chromatography traces for PCB analysis. A) Interference caused by Br and incomplete perchlorination. B) Complete perchlorination showing disappearance of Br interference. C) Analysis of actual water sample using perchlorination procedure.

and the C_2H_5OH that is present in $CHCl_3$ as a preservative. Further, the use of CH_2Cl_2 gave a similar result. However, CCl_4 did not react with $SbCl_5$ under the given reaction conditions.

A close examination of the distributions of the reaction products DCB and BNCB reveals that the halogenation steps are reversible. When a mixture of 0.5 ml of $SbCl_5$ and 80 ng of biphenyl in 1 ml of CCl_4 was reacted at 220°C for different periods of time, the distribution of these products also changes. BNCB is believed to be formed from the reaction between biphenyl and $SbBrCl_4$, which is present as an impurity in $SbCl_5$. The ratios of DCB and BNCB vs. reaction times are given in Table 2.

Table 2: Effect of Reaction Time on Formation of DCB and BNCB.

Reaction time	% of DCB Formed	% of BNCB Formed
4 hours	83	17
8 hours	.93	7
25 hours	96	4

It is clear that a longer reaction time favors the formation of DCB over BNCB and indicates that the initial formation of BNCB is a kinetically controlled reaction. Further reaction time shifts the unstable BNCB to the more stable compound DCB—that is, it is a thermodynamically controlled reaction. Figure 4A shows that when the reaction is incomplete the BNCB peak appears at 8.6 on the GC trace. When the reaction is complete, BNCB does not appear on the GC trace (Fig. 4B). Thus interference from Br can be eliminated by complete reaction in the perchlorination step. Furthermore, the appearance of the BNCB peak indicates that complete perchlorination is not achieved in the particular sample.

The overall perchlorination procedure of PCB's was successfully reduced to approximately 10 steps by modifying the usual methods of liquid-liquid extraction and evaporation of the solvent. This new technique now only requires 15 to 20 minutes to prepare a finished sample after perchlorination of PCB's. The detailed procedure is shown in Figure 5. It was found that the sample reaction temperature must be at least 180°C for more than 16 hours to achieve complete reaction and destruction of BNCB. In our studies, this procedure required a heating block temperature of 240°C. Figure 4C shows a typical GC trace for a water sample processed by the procedure shown in Figure 5.

PCB ANALYTICAL PROCEDURE

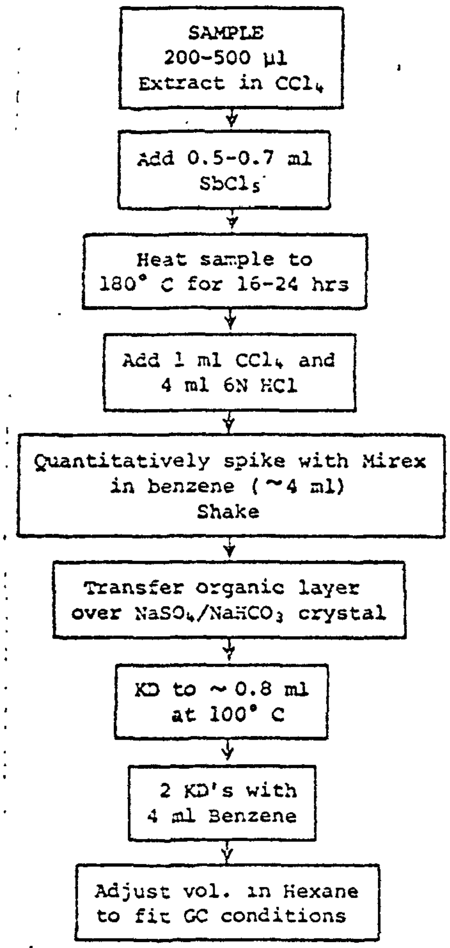

Fig. 5. Schematic block diagram of procedures used in PCB analysis by perchlorination with $SbCl_5$.

The reaction step was initially carried out in glass sealed tubes and excellent reproducibility was obtained. Table 3 shows representative results from four runs where a relative standard deviation of 0.52 percent was obtained. However, the glass sealed tubes were subject to explosion and created a safety hazard to workers in the laboratory. Therefore, the glass tubes were replaced with the teflon plugged reaction tubes shown in Figure 6; the teflon plugged tubes were more convenient and safer to use. However, Table 3 shows that

Table 3: Perchlorination of Biphenyl to DCB.

Sample	Glass Sealed	Teflon Sealed
1	58.7	69.1
2	58.8	72.8
3	59.0	74.8
4	59.4	66.8
	RSD = 0.52%	RSD = 5.0%

much more variability in the data was obtained. The relative standard deviation from replicate samples is 5 percent. This accuracy is satisfactory for most routine analysis, but we are working to find ways to improve this procedure further.

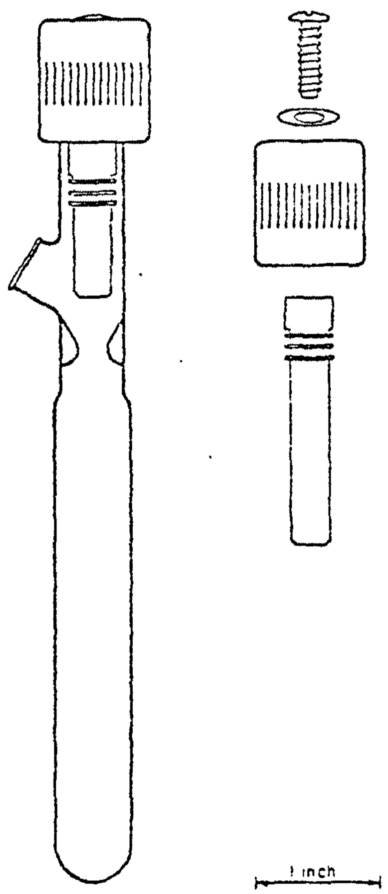

Fig. 6. Teflon plugged reaction vessel used in perchlorination reaction.

REFERENCES

1. Jensen, S., A New Chemical Hazard: New Sci. 32:612. (1966).

2. Widmark, G., Possible Interference by Chlorinated Biphenyls: J. Assoc. Offic. Anal. Chem. 50:1069. (1967).

3. Nelson, N., Panel on Hazardous Trace Substances, Polychlorinated Biphenyls - Environmental Impact: Env. Res. 5:249. (1972).

4. Illinois Institute for Environmental Quality, Polychlorinated Biphenyls (PCBs): Health Effects and Recommendations: Env. Health Resource Center News No. 20, May 1976.

5. American National Standards Committee, Askarel Committee Responds to PCB Peril: ANSI Reporter 10:3. (1976).

6. Outlook, Legislation: The Toxic Substances Control Act is Effective This Month: Env. Sci. and Tech. 11:28. (1977).

7. Lidgett, R. A., and H. A. Vodden, PCB - The Environmental Problem, in PCB Conferences, Wenner-Gren Center: National Environmental Protection Board, Stockholm: Sept. 29, 1970, p. 88-96.

8. Robertson, J. M., and E. C. C. Li, Organic Leachate Threatens Ground-water Quality: Water and Sewage Works, Feb. 1976, p. 58-59.

9. Tucker, E. S., W. J. Litschgi, and W. M. Mess, Migration of Polychlorinated Biphenyls in Soil Induced by Percolating Water: Bull. Environ. Contam. and Toxicol. 13:86-93. (1975).

10. Helling, C. S., and B. C. Turner, Pesticide Mobility: Determination by Soil Thin-Layer Chromatography: Science 162: 562-563. (1968).

11. Helling, C. S., Pesticide Mobility in Soils I. Parameters of Thin-Layer Chromatography: Soil Sci. Soc. Am. Proc. 35:732-737. (1971).

12. Helling, C. S., Pesticide Mobility in Soils II. Applications of Soil Thin-Layer Chromatography: Soil Sci. Soc. Am. Proc. 35:737-743. (1971).

13. Helling, C. S., Pesticide Mobility in Soils III. Influence of Soil Properties: Soil Sci. Soc. Am. Proc. 35:743-747. (1971).

14. Asai, R., et al., J. Agri. Food Chem. 19:396-398. (1971).

15. Berg, O. W., et al., Bull. Environ. Contam. Toxicol. 7:338-347. (1972).

16. Armour, J. A., J. AOAC 56:987-993. (1973).

17. Trotter, W. J., J. AOAC 58:466-468. (1975).

18. Webb, R. G., Isolating Organic Water Pollutants: EPA Publication EPA-660/4-75-003, June 1975, p. 11-17.

Glossary of Technical Terms and Abbreviations

CLAY - A plastic material consisting of rock or mineral fragments. In engineering use, such material is included in the classification "fines" having a diameter less than 74 microns; In geology the term is applied to fragments having a diameter less than 4 microns; In soil science, less than 2 microns.

COLLUVIUM - A general term applied to any loose, heterogenous, and incoherent mass of soil material or rock fragments deposited by unconcentrated surface runoff or sheet erosion, usually at the base of a slope. In this case, material on top of the glacier that was deposited in place when the glacier melted.

DRAINAGE CHANNEL - A channel or course along which water moves in draining an area.

FINE TEXTURED - Containing more clay and silt than sand.

GLACIAL TILL, TILL - Unsorted and unstratified drift, generally unconsolidated deposited directly by and underneath a glacier without subsequent reworking by water from the glacier, and consisting of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape.

GOB PILE - A mixture of coal, shale, and earth materials remaining from the coal cleaning process during the mining operation.

GROUNDWATER GRADIENT - The slope of the potentiometric surface.

GROUNDWATER MOUND - A rounded, mound-shaped elevation in a water table or other potentiometric surface that builds up as a result of the downward percolation of water through the overlying earth materials.

HYDRAULIC GRADIENT - The rate of change of hydraulic head, per unit distance.

HYDRAULIC HEAD - The height to which water would stand in an open pipe when connected to a specific location in the soil.

LIQUID LIMIT - The water content at which a soil material changes from the plastic to the semiliquid state. One of the Atterberg Limits, measures of how soil material physical properties are affected by changes in water content.

LOESS - A widespread, homogenous, commonly nonstratified, porous, friable, unconsolidated but slightly coherent, usually highly calcareous, fine-grained, blanket deposit of marl or loam, consisting predominantly of silt with subordinate grain sizes ranging from clay to fine sand. Although source and origin is still a controversial question, loess is now generally believed to be windblown dust of Pleistocene age carried from desert surfaces, alluvial valleys, and outwash plains lying south of the limits of the ice sheets, or from unconsolidated glacial or glaciofluvial deposits uncovered by successive glacial recessions but prior to invasion by a vegetation mat.

MP - Monitoring point, location where surface water is sampled, in drainageways, streams, etc.

POLYCHLORINATED BIPHENYLS (PCB) - Mixtures of the chemical compounds formed by the chemical bond of two benzene molecules into a biphenyl molecule with varying numbers of chlorine atoms attached to the biphenyl molecule. PCBs are among the most stable organic compounds known and exhibit other properties that render them useful as dielectric and heat transfer fluids. Although PBCs have long been known to be toxic and bioaccumulative, only in recent years have they been acknowledged to be a general threat to the environment.

PED - An individual soil aggregate, an aggregation of primary soil particles into compound particles, or clusters of primary particles which are separated from adjoining aggregates by surfaces of weakness. This is contrasted to a clod caused by disturbance such as plowing, a fragment caused by the rupture of the soil mass across natural surfaces of weakness, or a concretion caused by local concentrations of compounds that irreversibly cement the soil grains together.

PERMEABILITY - The property or capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

PIEZIOMETRIC SURFACE, POTENTIOMETRIC SURFACE - An imaginary surface representing the static head of ground water and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

PLASTICITY INDEX - The water content range of a soil at which it is plastic, defined numerically as the liquid limit minus the plastic limit.

POROSITY - The property of a rock, soil, or other material of containing interstices. It is commonly expressed as a percentage of the bulk volume of material occupied by interstices, whether isolated or connected.

SAND - A coarse material consisting of rock or mineral fragments. In engineering use the term is applied to fragments having a diameter in the range 74 microns to 4,760 microns; In geology, in the range 62 microns to 2,000 microns; In soil science, in the range 50 microns to 2,000 microns.

SILT - A moderately coarse, floury material consisting of rock or mineral; In engineering use, such material is included in the classification "fines" having a diameter less than 74 microns; In geology the term is applied to fragments having a diameter in the range 4 microns to 62 microns, In soil science, in the range 2 microns to 50 microns.

SOLUTES - A substance dissolved in a solution. When dissolved in water common table salt is a solute.

STABILITY, SOIL - The quality of permanance or resistance of a structure, slope, embankment, or other foundation to failure by sliding, overturning, collapsing or other prevailing condition of stress.

TDS - Total Dissolved Solids. The weight of solutes in a sample of water is determined by evaporating the water and weighing the remaining solids.

UNSATURATED - A condition in which the interstices of a material are not completely filled with a liquid, usually water. The interstices not filled with liquid are filled with gases more or less similar to those existing in the atmosphere above the soil surface.