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Office of Emergency and Remedial Response

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Superfund Record of Decision:

Delaware City PVC, DE

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT

The Delaware City PVC site is located two miles northwest of Delaware City, New Castle County, Delaware. In 1966 Stauffer Chemical Company (SCC) of Westport, Connecticut, founded the Delaware City PVC Plant, which is used for the manufacturing of polyvinylchloride resin (PVC), polyvinyl acetate and other polymers. From 1971 to 1974 off-grade PVC resin, sludge from the wastewater treatment system and residue from the stripping process were disposed of in two onsite pits. These "buried sludge pits" were closed and covered in 1979. Off-grade PVC resin was disposed of in a third pit. This material was removed and the pits backfilled in 1974. In May 1981 Formosa acquired the PVC manufacturing and processing facility and has continued operations to present. The two buried sludge pits and the third disposal pit were retained by SCC as part of its Carbon Disulfide Plant, located adjacent to the PVC Plant property. An EPA conducted inspection in May 1982 indicated serious contamination of the shallow ground water. Currently, ground water, surface water, and soils are contaminated with PVC, benzyl chloride monomer (VCM), TCE, and 1,2-dichloroethane (EDC).

The description of the selected remedial action for each area of this site is provided below. Off-Grade Batch Pits: excavate and remove existing PVC sludge and contaminated soils; install a double synthetic liner; install monitoring wells and perform quarterly sample analysis for TCE, EDC, VCM. The excavated material will be (See attached sheet)

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Superfund Record of Decision Delaware City PVC, DE Contaminated Media: gw, sw, soil Key contaminants:TCE, PVC, EDC, VCM		

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16. ABSTRACT (continued)

processed and recovered (estimated at 80-85%) as a saleable finished product to the maximum extent possible. Non-recoverable material will be disposed of offsite at an approved RCRA facility. Stormwater Reservoir: The same remedy as described for the above off-grade batch pits. Unlined Ditches: excavate and remove PVC sludge and dispose of at an approved RCRA facility; install a single synthetic liner. Aerated Lagoons: excavate and remove PVC sludge; clean and repair lagoons as necessary; install a double synthetic liner; install monitoring wells and perform quarterly sampling analysis for TCE, EDC and VCM. The excavated material will be recovered to the maximum extent possible (estimated to be 80-85%) and non-recoverable material will be disposed of offsite at an approved RCRA facility. Closed Buried Sludge Pits: place a drainage layer on top of the existing synthetic cap; cover with a second synthetic cap and topsoil and revegetate. Former PVC Storage Area: cover and cap the entire area with a double synthetic cap. Ground Water: install a line of six ground water recovery wells at the northern edge of the contaminant plume, and another six wells at the southern edge. Reuse the collected ground water in Formosa's plant operations. During periods of low water demand in the plant, treat the ground water in the existing waste water treatment plant. Install two monitoring wells at the southern edge of the plume. Provide an alternate water supply for existing contaminated wells. Operation and Maintenance: as a minimum, regular inspections and, as necessary, repairs to the liners and caps. The ground water recovery system will be routinely monitored to assure that it is capturing the contaminated plume. The estimated capital cost for the remedy is $1,904,000 with annual O&M costs of $43,000.

RECORD OF DECISION

REMEDIAL ALTERNATIVE SELECTION

Site: Delaware City PVC Site, New Castle County, Delaware

Documents Reviewed:

I am basing my decision principally on the following documents describing the analysis of cost effectiveness and feasibility of remedial alternatives for the Delaware City PVC Site:

- "Remedial Action Feasibility Study": Delaware City PVC Site, New Castle County (Malcolm Pirnie, Roux Associates, June 1986).
- "Hydrogeology and Groundwater Conditions": Delaware City PVC Site, New Castle County (Roux Associates, February 4, 1983).
- "Interim Report, Groundwater Conditions": Delaware City PVC Site, New Castle County (Roux Associates, June 1982).
- "A Site Inspection Report": Delaware City PVC Site, New Castle County (Ecology & Environment, Inc., June 28, 1982).
- "Hydrogeologic Review": Delaware City PVC Site, New Castle County (Ecology and Environment, Inc., June 3, 1982).
- Staff summaries and Recommendations.
- Recommendation by the Delaware Department of Natural Resources and Environmental Control.

Description of the Selected Remedy:

1. Off-grade Batch Pits - Excavate and remove existing polyvinyl chloride (PVC) sludge and contaminated soils to the levels to be determined at the design stage; install a double synthetic liner, install monitoring wells and perform quarterly sample analysis for trichloroethylene (TCE), 1,2, dichloroethane (EDC) and vinyl chloride monomer (VCM), the contaminants of concern at the site. The excavated material will be directly processed and recovered (estimated by the companies to be 80-85%) as a saleable finished product to the maximum extent possible. Non-recoverable material will be disposed of off-site at an approved RCRA facility (est. 1 year).

2. Stormwater Reservoir (RV Pond) - The same remedy as described for the above off-grade batch pits (est. 1 year).

3. Unlined Ditches - Excavate and remove PVC sludge, install a single synthetic liner. The excavated material will be disposed of off-site at an approved RCRA facility (est. 8 months).

4. Aerated Lagoons - Excavate and remove PVC sludge, clean and repair lagoons

as necessary, install a double synthetic liner, install monitoring wells and perform quarterly sampling analysis for TCE, EDC and VCM. The excavated material will be recovered to the maximum extent possible (estimated by the companies to be 80-85%) and non-recoverable material will be disposed of off-site at an approved RCRA facility (est. 18 months).

5. Closed Buried Sludge Pits - Place a drainage layer on top of the existing synthetic cap, and cover with a second synthetic cap (or comparable substitute in compliance with the requirements of RCRA) and topsoil and then revegetate (est. 1 year).

6. Former PVC Storage Area - Cover and cap the entire area with a double synthetic cap (or comparable substitute in compliance with the requirements of RCRA) and then revegetate (est. 6 months).

7. Groundwater - Install a line of six groundwater recovery wells at the northern edge of the contaminant plume, and another six wells at the southern edge. Reuse the collected groundwater in Formosa's plant operations. During periods of low water demand in the plant, treat the groundwater in the existing waste water treatment plant. Install two monitoring wells at the southern edge of the plume. Provide an alternate water supply for existing contaminated wells.

8. Operation and maintenance (O&M) for the remedy will include as a minimum regular inspections and as necessary repairs to the liners and caps. The groundwater recovery system will be routinely monitored to assure that it is capturing the contaminated plume.

Declarations

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. § 9601-9657) and the National Contingency Plan (40 CF R Part 300), I have determined that the remedial action described above, together with proper operation and maintenance constitutes a cost-effective remedy which mitigates and minimizes damage to public health, welfare, and the environment. The remedial action does not affect or violate any floodplain or wetland area. The State of Delaware has been consulted and agrees with the approved remedy. In addition, the action will require future operation and maintenance activities to ensure the continued effectiveness of the remedies. These activities will be considered part of the approved action and eligible for Trust Fund monies for a period of six months following completion of construction.

In addition, the off-site disposal of contaminated soil to a secure hazardous waste facility is necessary to protect public health, welfare and the environment.

I have determined that the action being taken is appropriate when balanced against the availability of Trust Fund monies for use at other sites.

9/30/86
DATE

James M. Seif
REGIONAL ADMINISTRATOR

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

DELAWARE CITY PVC SUPERFUND SITE

SITE DESCRIPTION

The Delaware City PVC Site is located approximately 2 miles northwest of Delaware City at latitude 39°35'16"N and longitude 75°38'50"W in New Castle County, Delaware. The site is situated on State Route 13 just west of the Getty Refining and Marketing Company between Red Lion Creek to the north, and Dragon Creek to the south. The area of the study site is approximately 260 acres. (See Figure #1)

The Delaware City PVC Site consists of a Polyvinyl Chloride (PVC) manufacturing facility owned and operated by Formosa Plastics Corporation (Formosa). From 1966 until May, 1981, Stauffer Chemical Company (Stauffer) manufactured PVC resin and processed vinyl chloride monomer at the facility. In May 1981, Formosa acquired the PVC manufacturing and processing facility and has continued operations to present. Stauffer has retained ownership of an existing carbon disulfide plant adjacent to Formosa's property. In April, 1982, one of the domestic supply wells on Stauffer's property became contaminated with 1,2 dichloroethane (EDC), vinylchloride monomer (VCM) and trichloroethylene (TCE). This occurence prompted Formosa and Stauffer to perform a hydrogeologic investigation, conducted by Roux Associates, which identified the sources of ground water contamination (See Figure #2). The following sources were identified at the site:

1. Off-grade Batch Pits - unlined earthen lagoons which receive wastewater from the S-1 and S-2 production areas, when the wastewater sumps in these areas overflow. These lagoons also serve as surge reservoirs during periods when the wastewater effluent cannot be discharged to the Delaware River. PVC solids contaminated with EDC, VCM and TCE are also deposited in these lagoons. This sludge-like material must be periodically excavated and disposed of off-site.

2. Stormwater Reservoir (RV Pond) - an unlined earthern basin used primarily for storm water collection. This pond occasionally receives process wastewater and PVC solids from the production area (E-2) when the wastewater sump overflows.

3. Unlined Ditches - these ditches conduct stormwater runoff from the plant site to the off-grade batch pits and the RV pond. Process wastewater is also discharged to these ditches when the production area sumps overflow. PVC solids have been deposited at several locations in the ditches.

4. Aerated lagoons - concrete lined lagoons which receive wastewater and PVC solids for treatment. The potential for leakage from the aerated lagoons exists through cracks in the concrete liner.

5. Closed Buried Sludge Pits (Burial Pits) - unlined pits which were used to dispose of PVC solids and sludge from the aeration lagoon. In 1979, Stauffer closed out the pits with a synthetic cap made from PVC and designed to prevent percolation. The cap was then covered with soil and revegetated.

6. Former PVC Resin Storage Area - A former PVC resin storage area was excavated and regraded in 1974 by Stauffer. Recent sampling has indicated the presence of resin residue with EDC, VCM and TCE concentrations at levels of concern.

The Closed Buried Sludge Pits and the Former PVC Resin Storage Area are located on the Carbon Disulfide Plant property owned by Stauffer Chemical Company and are no longer in use. The remaining sources are part of the active manufacturing process at the Formosa Plastics Plant.

The hydrogeologic investigation identified a plume of contamination consisting of EDC, VCM and TCE in the lower portion of Columbia aquifer. High concentrations of EDC, VCM and TCE are present in the ground water in an area adjacent to, and west of the PVC plant. The Roux report recommended evaluating remedial actions to eliminate the major sources of EDC, VCM and TCE on the property and eliminating the ground water pollution.

SITE GEOLOGY

The site is located within the Atlantic Coastal Plan Geologic Province and is underlain by southeasterly dipping, unconsolidated sedimentary strata of Cretaceous age.

The Cretaceous deposits mantle the irregular surface of the crystalline bedrock and have been locally divided into three formations. The oldest or deepest deposits are called the Potomac Formation. The Potomac consists of silt and clay beds with sandy layers or lenses that serve locally as aquifers. The sand lenses encountered between clay layers are generally thinner than the clays. The sand layers divide the Potomac Formation into three zones, the Upper, Middle, and Lower. The Potomac Formation is an important municipal and industrial water supply source in the area. (See Figure #3)

Stratigraphically overlying the Potomac Formation within a portion of the area of investigation, is a layer of white, "sugery", fine-grained sand known as the Magothy formation.

Above the Potomac and Magothy formations in the study area, is the Merchantville Formation which belongs to the Matawan Group of Upper Cretaceous Age.

The Merchantville Formation consists of greenish-grey clayey silt with clay, which is locally abundant as the in filling of burrows of benthic organisms. The Merchantville Formation has a low permeability and thus serves as an aquitard which hydraulically separates the sand of the Magothy and Potomac Formations from the overlying Columbia aquifer. Where the Merchantville is absent, clays of the Upper Potomac are present directly below the Columbia and serve the same purpose. All evidence from this investigation indicates that the Columbia is continuously underlain by an aquitard.

Overlying the irregular topography of the Merchantville is the Columbia Formation which is Pleistocene in age. The Columbia Formation in Northern Delaware consists of quart & sand with minor interbeds and lenses of gravel, silt and clay. The Columbia aquifer is a water supply source for many residents of this area.

HYDROGEOLOGY OF COLUMBIA AQUIFER

The drilling and sampling program performed during the RI has concentrated on the Columbia Formation, because this is the aquifer that was found to contain EDC, VCM and TCE. The resistivity survey that was also performed during the investigation has helped to confirm the continuity of the Merchantville and/or Potomac clay under the entire study area. It has also demonstrated that the Potomac clay layer is continuous under the Magothy sand layer which is present in the western portion of the site. Due to the presence of the Potomac clay present in the area it can be concluded that the Potomac formation is not threatened by contamination at the present time.

Water table maps prepared during the RI report show indications of a "mound" in the water table under the western portion of the PVC plant property. The highest water level in this mound was recorded at Observation Well OW-11, east of the identified sources. This mound is probably caused by water losses at the plant (fire water ponds, cooling water towers) upgradient of the identified source area. Ground water flows from the area of this mound under the sources to the northwest, west and southwest toward U.S. Route 13. Ground water to the west of Route 13 flows east to converge with the flow from the plant. Thus, ground water flowing to the northwest, toward OW-5, turns in a northerly direction (roughly parallel to Route 13) and flows toward Red Lion Creek. Ground water flowing from the PVC plant toward OW-16 turns in a southerly direction and flows to Dragon Run. (See Fig. 4)

Within the Columbia aquifer on the Stauffer property, there is a downward component of groundwater flow typical of a recharge area. The underlying Merchantville formation will restrict further movement of ground water into the deeper aquifer. This explains why EDC, VCM and TCE can be found in only the lower portions of the Columbia Aquifer.

Site History

In 1966 Stauffer Chemical Company of Westport, Connecticut, founded the

Delaware City PVC Plant, which is used for the manufacturing of polyvinylchloride resin (PVC), polyvinyl acetate and other polymers. From 1971 to 1974 off-grade PVC resin, sludge from the wastewater treatment system and residue from the stripping process were disposed of in two on-site pits. These "buried sludge pits" were closed and covered in 1979. Off-grade PVC resin was disposed of in a third pit. This material was removed and the pits backfilled in 1974. These three pits constitute the areas onsite where disposal of waste occurred.

In May 1981, Stauffer Chemical Company sold the PVC Plant to Formosa Plastics Corporation, who currently operates the facility. The sale did not include the property on which the two buried sludge pits are located and on which the third disposal pit, now backfilled, was also located. This property was retained as part of the Stauffer Chemical Company Carbon Disulfide Plant, which is located adjacent to the PVC Plant property.

On March 9 and 10, 1982, EPA conducted an inspection and sampling of the Delaware City PVC Plant. A total of 20 samples were obtained, including 8 surface water, 9 monitoring well, 2 industrial well, 2 residential well, 3 soil, and 1 waste sample. Sample results from this inspection have indicated that serious contamination of the shallow groundwater in the Columbia Formation exists under the site. In particular, high levels of VCM, TCE, and EDC were found in ground water samples from monitoring wells located in the vicinity of the lagoons and buried sludge pits.

Subsequent to this inspection, Stauffer Chemical Company and EPA conducted sampling of the residential wells located northwest of the sources in the shallow (Columbia) aquifer. The results showed significant contamination of the wells with EDC and VCM. The impacted domestic wells (3 wells) were immediately replaced with an alternative water supply (tank truck and bottled water).

The residential well contamination prompted Stauffer to conduct a hydrogeologic investigation. This detailed hydrogeologic investigation included: the installation of 32 monitoring wells, a sensitivity survey, and well sampling. The results are described in the Roux Associates, Inc. report dated February 4, 1983. The findings and conclusions from the Roux report are outlined below:

1. "The shallow geology in the area of investigation, from the land surface downward, includes: layers of sand (Columbia Formation); a clayey silt aquitard (Merchantville Formation); a sand layer (Magothy Formation); and a thick clay layer of the Potomac Formation.

2. The Merchantville Formation and upper clay layer of the Potomac Formation are apparently continuous beneath the site and hydraulically separate the Columbia aquifer from deeper Potomac aquifers.

3. High concentrations of EDC and VCM are present in ground water in the Columbia aquifer in the area adjacent to, and west of, the PVC plant.

4. The extent of EDC and VCM in the Columbia aquifer has been determined to be limited to an area of the Stauffer and Formosa properties west of the PVC plant and possibly a small portion of Getty property west of Route 13. Also, EDC and VCM is limited to the lower portion of this aquifer.

5. Ground water flow in the Columbia aquifer from the western portion of the PVC plant property is apparently in all directions. Observation wells in the Columbia aquifer to the north, south, and east of the plant do not contain detectable concentrations of EDC or VCM. Observation wells to the west of the plant do contain these compounds. Therefore, based on the distribution of EDC and VCM in the Columbia, the flow of ground water containing these compounds is to the west.

6. Based on the observed ground water flow directions and the concentrations of EDC and VCM in ground water samples from observation wells, it appears that the source(s) of EDC and VCM are the surface impoundments in the western portion of the PVC plant property. Based on the construction of these impoundments, it is logical to assume that the off-grade batch pits, which are unlined, are the principal source.

7. Flow of ground water in the Columbia aquifer to the west of the PVC plant is apparently controlled by the slope of the upper surface of the Merchantville, the presence of more permeable sediment in the deeper portion of the Columbia, and a ground water mound in the western portion of the PVC plant property.

8. The rate of ground water flow in the Columbia aquifer is estimated to range between 0.3 and 1 foot per day (approximately 100 to 300 feet per year).

9. The total volume of ground water flowing past the boundary of Stauffer's property to the west (beneath Route 13) is estimated to be 100,000 gallons per day (70 gallons per minute). Only the deeper portion of this flow contains EDC and VCM.

10. The Columbia aquifer is used locally for individual domestic supply. The deep Potomac aquifer is used locally by Getty for industrial water supply.

11. No water supply well within the area of investigation, domestic or industrial, (except for one on-site Stauffer residence) contains detectable concentrations of EDC or VCM. The one exception (in addition to the Stauffer domestic well) is a single finding in 1982 of 6.1 ppb EDC in a supply well for an Stapleford Chevrolet Dealer on Route 13, south of Wrangle Hill Road. However, this value was questioned in the Roux Report since the concentration was near the detection limit.

12. Discharge from the Columbia aquifer appears to be to local streams, primarily Dragon Run.

13. None of the stream samples collected in the study area contained detectable concentrations of EDC or VCM."

In May 1984, EPA and the Department of Natural Resources and Environmental Control (DNREC) entered into a Consent Order with Stauffer and Formosa to perform a Feasibility Study (FS) for the site and to implement an approved remedial action. The final FS was submitted to EPA in June 1986 and was released for public comment on July 25, 1986.

CURRENT SITE STATUS

After the submittal of the Roux Associates report, Stauffer and Formosa continued ground water monitoring in order to track the migration of the ground water plume. During one of these sampling efforts in 1983, EDC and VCM were detected in the Foraker Getty Service Station and Stapleford Chevrolet dealer wells south of the previously mapped plume area. Stauffer provided an alternate water supply (tank truck and bottled water) to the owners of these two wells. This sampling confirmed the contamination of the auto dealer's well questioned by Roux in 1983.

In August 1985, Stauffer provided city water from their plant to the three residences on their property. In 1986, the telephone company relay station well located south of the Foraker Getty and Stapleford Chevrolet wells, also became contaminated with EDC, VCM and TCE. The owner of the well was also provided with a temporary water supply by Stauffer and Formosa.

A permanent solution for the Foraker Getty, Stapleford Chevrolet and telephone company relay station wells will be specifically addressed during the recommended remedial action.

ADDITIONAL REMEDIAL INVESTIGATION ACTIVITIES

In accordance with the Consent Agreement, Stauffer and Formosa performed an additional remedial investigation (RI) at the site. This additional RI work included the installation of monitoring wells , pump testing, and soil testing. With regard to monitoring, four (4) additional monitoring wells were installed to identify the extent of the plume migration. Two monitoring wells OW-30 and OW-31 were installed to define the southern limit of the plume and two monitoring wells OW-32 and OW-33 were installed to determine the northern limit of the plume. These monitoring wells, including other selected wells, were sampled during the August and December 1984 sampling efforts (see Tables 1 and 2).

The results of the August and December 1984 sampling were compared with the limits of the plume identified in the Roux Associates report dated February 4, 1983. A comparison of the previous sampling results and the later results indicated:

1. The ground-water sample collected in August 1984 from OW-30 shows levels of 1,100 ppb EDC and 50 ppb VCM (Table 1). This finding is consistent with the ground-water flow directions mapped for the area and more significantly, this well showed no EDC or VCM the first time it was sampled.

2. It appears that the plume has stabilized in the northerly direction. Despite findings of EDC and VCM in OW-5 from the inception of the project, OW-33, and OW-32 have never shown EDC or VCM. This situation is the result of this area of the Columbia aquifer being significantly less permeable with a lower gradient than those to the south.

3. Neither EDC or VCM were detected in the wells west of Route 13 (OW-33, OW-29, OW-28).

A pump test program was conducted to determine the aquifer hydraulic parameters necessary for the design of a potential groundwater intercept system. It was determined that recovery wells could be pumped between 10 and 15 gallons per minute (gpm) over an extended period of time.

A total of ten test pits in the former PVC resin storage area (TP 9-18) were excavated on October 23, 1984 under the supervision of a geologist from Roux Associates. The purpose of excavating these pits was to investigate this potential source area and to determine its significance with regard to local groundwater contamination. Samples were collected, logged, and delivered to Stauffer's Eastern Research Center for VCM, EDC, and TCE analysis. A minimum of two samples were collected from each test pit, with at least one sample normally being collected from natural sediments underlying any fill or resin. The locations of the test pits are shown on Figure 5 and analysis results are given in Tables 3 & 4. Four additional test pits (TP19-22) were excavated on November 29, 1984. The purpose of these pits was to further define the extent of the PVC resin. Analytical results for these resin/soil samples are given in Table 2. Overall the concentrations of EDC in the soil ranged from non-detectable (ND) to 120 parts per million (ppm) and the concentrations of TCE ranged from ND-210 ppm. Note: the detection limit in soil is 4 ppm.

ENDANGERMENT ASSESSMENT

The Feasibility Study performed by Malcolm Pirnie provided an analysis of the potential environmental and health-related impacts represented by the contaminants VCM, EDC, and TCE. The analysis used available physiochemical, toxicological and fate assessment data, relative to the above contaminants, in order to screen and evaluate potential pathways of exposure, receptors and associated health and environmental risks.

For any of the above mentioned compounds to represent a potential threat to environmental or human receptors, an exposure pathway from these source areas to the receptors must exist. The significance of air, surface water, soil and ground water as potential exposure pathways was considered and evaluated:

Air - The small amount of volatilization of EDC, VCM and TCE from the unlined ditches, batch pits, RV pond and aeration lagoons is the primary release mechanism to air from the identified sources. It is estimated that total VCM emissions from the unlined ditches, batch pits, RV pond and aeration lagoons amount to 0.33 lb/day. Relative to releases controlled under the Clean Air Act from the active operation ,the release of VCM, EDC, and TCE represents an insignificant exposure pathway.

Soil - Two types of exposure pathways, direct and indirect dermal contact, are considered in the evaluation of on-site soils. The most significant pathway is direct dermal contact with PVC sludges containing VCM, EDC or TCE, during their removal or by unauthorized persons entering the site. Direct dermal contact is highly unlikely. During periods of excavation and removal, specific worker protective controls will be employed and, in addition, plant security measures are more than sufficient to ensure that unauthorized site access will not occur.

The second pathway is indirect contact and involves the contamination of ground water through leaching of the VCM, EDC and TCE from overlying PVC sludges. The Remedial Investigation Study concluded that ground water contamination by indirect contact with on-site PVC sludges constitutes the greatest environmental and human health threat. The proposed remedial alternative measures will eliminate contaminated PVC sludges as an indirect exposure pathway to environmental and human receptors.

Surface Water - Ground water containing VCM, EDC and TCE is migrating northerly toward Red Lion Creek and southerly toward Dragon Run. Serving as a discharge point for the contaminated ground water plume, these surface waters represent a potential exposure pathway for aquatic biota and humans. Available data from the literature, however, indicates that the rapid volatilization rates for VCM, EDC and TCE under the turbulent stream conditions found in typical surface waters will significantly reduce these contaminant levels. Red Lion Creek and Dragon Run may not be turbulent to the point of producing volatilzation rates comparable to the literature. Nevertheless, the potential impacts of the contaminants reaching the surface water must be addressed.

Ground Water- A detailed hydrogeologic investigation has confirmed the presence of the contaminants VCM, EDC and TCE in the Columbia aquifer. This aquifer serves as a drinking water supply for residents in the surrounding area and, therefore, represents a significant potential threat for direct human exposure via ingestion, inhalation and dermal contact. Consumption of contaminated ground water by local residents represents the most significant site-related exposure pathway and health risk threat.

Potential human and environmental receptors at this site are described below:

Human Receptors - As discussed earlier, the most significant potential exposure pathway is via the ground water. A concern exists that residents could potentially be exposed to the contaminants via ingestion of the ground water or via inhalation of vapors or dermal contact during cooking, bathing, and other domestic uses. Samples collected from monitoring wells as part of the Remedial Investigation Study indicate the presence of VCM, EDC, and TCE. The use of the three wells on Stauffer property serving residences has been discontinued due to contamination in one well by VCM and EDC.

Hydrogeologic investigations indicate that the ground water plume is moving away from the site in a northerly direction, towards Red Lion Creek, and in a southerly direction towards Dragon Run. An estimated 25-30 residences that utilize ground water are located downgradient of the northerly and southerly paths of the plume. These residences are located along Route 13 north of its intersection with Route 7, in the vicinity of the intersection of Route 13 and Wrangle Hill Road, and further to the south along Route 13. Only one of these residential wells may be tapping deeper, protected aquifers.

A hydraulic connection, between the ground water and Red Lion Creek and Dragon Run, represents a potential exposure pathway via surface water, since these creeks are used for recreational or drinking water purposes.

Off-site exposure of humans to VCM, EDC, and TCE via air or soil is not likely since the release of contaminants from source areas to air is insignificant and soil dermal contact is virtually non-existent.

Environmental Receptors - Future potential environmental receptors of the contaminants VCM, EDC and TCE include the aquatic and terrestrial biota of the surrounding area, however, there is very little information on the actual biotic communities present. The area is largely rural with some commercial/industrial development. The primary pathway for exposure of biota is through surface waters potentially contaminated by groundwater. The persistence of these contaminants in surface waters would be limited, as discussed previously. In addition, data on VCM, EDC and TCE in the literature indicates that none of these three substances has a high potential for bioaccumulation or biomagnification in aquatic or terrestrial biota.

ALTERNATIVE EVALUATION

The major objectives for the remedial action to be taken at the Delaware City PVC site are to abate the sources of contamination and to mitigate the existing plume of contaminated ground water. This would involve preventing and/or reducing: a) infiltration through the sources; b) further migration of the existing contaminated shallow ground water; c) direct contact of the soil with the PVC resin; d) future contamination of the Potomac Formation, and e) the degradation of surface waters. The requirements of CERCLA Section 104, EPA's mandate to protect the public health and welfare and the environment, determine the goals and level of response for the site.

In an effort to determine remedial alternatives for the subject site, feasible technologies were identified. These technologies were then screened to eliminate all but the most practicable and implementable ones. This screening considered: technical, public health, environmental, institutional, and cost considerations. Those technologies that passed the technology screening process were used to form remedial alternatives.

The remedial alternatives were developed using best engineering judgement to select a technology or group of technologies that best addresses the problems existing at the site to protect public health, welfare, and the environment. In an effort to provide a degree of flexibility in the final selection of a remedial action, alternatives covering a range of remedial action categories have been developed.

These categories are described below:

a) No action

b) Alternatives for treatment or disposal in an off-site facility.

c) Alternatives which attain public health and environmental standards as defined by CERCLA.

d) Alternatives which exceed public health and environmental standards as defined by CERCLA .

e) Alternatives which do not attain public health or environmental standards but will reduce the likelihood of present or future threat.

In order to establish a means of evaluating the developed remedial alternatives, Section 300.68(h) of the National Contingency Plan (NCP) was reviewed. In accordance with the NCP, criteria were selected by Malcolm Pirnie to evaluate the developed alternatives. With the exception of public acceptance, the selected criteria presented below are consistent with the EPA Final Draft Guidance Document for the preparation of Remedial Action Feasibility Studies under CERCLA dated October 18, 1984 (Draft Guidance Document) and are defined as follows:

Criterion	Definition
Environmental Effectiveness	Environmental effectiveness is defined as the ability of a particular remedial alternative to provide mitigation of future ground water and surface water contamination.
Reliability	Reliability is defined as the level and difficulty of operation and maintenance (O&M) requirements for a demonstrated technology to reach and maintain the desired performance.

Public Acceptance	Public acceptance is defined as the reaction most likely to be expressed by the neighboring communities to the potential health effects of a particular remedial alternative. Community opposition can prevent viable plans from being implemented.
Constructibility	Constructibility is defined as the labor effort and degree of construction difficulty necessary to implement a particular remedial alternative considering the physical characteristics of the site and external factors such as construction equipment and materials availability.
Time Frame	Time frame is defined as the length of time it takes to complete the construction of a particular remedial alternative.
Safety	Safety is defined as the amount of precaution necessary to prevent accidental exposure from occurring to either on-site workers or nearby residents during the actual implementation of a particular remedial alternative or for disposal off site.

The developed remedial alternatives were ranked (using the matrix approach as described in Chapter 3 of the Draft Guidance Document) with the six criteria defined above. Weighing factors for each criterion, which vary from 0.5 to 1.2, were also developed and used in the evaluation process. The weighing factors used by Malcolm Pirnie were based on prior Remedial Investigation/Feasibility Study (RI/FS) documents and attempt to reflect the relative importance of the individual criteria.

A rank ordering technique was used as an effective method to eliminate inappropriate alternatives from further detailed consideration.

ANALYSIS OF REMEDIAL ALTERNATIVES

Note: Tables 5 & 6 contain costs for all alternatives.

Elements common to alternatives below:

- Offsite Disposal - The FS prepared by Malcolm Pirnie discusses three options for the excavation and disposal of the PVC sludge from the impoundments. These options are: excavation and disposal of the PVC sludge in a municipal landfill, excavation and disposal of the PVC sludge in a RCRA Hazardous Waste Management Facility (HWMF) and the recovery of the PVC sludge to the maximum extent possible as a saleable finished product and disposal of the non-recoverable soil/PVC mixture in a RCRA HWMF.

The disposal of the PVC sludges in the municipal landfill does not comply with the Agency's policy regarding the off-site disposal of Superfund waste. The Off-Site Disposal Policy requires all of the waste from a Superfund site to be taken to a RCRA HWMF. Therefore, this alternative was determined to be unacceptable by EPA.

The disposal of the PVC sludge at a RCRA HWMF while complying with the Agency's Off-Site Policy is an expensive alternative (approximately 2-3 times cost of disposal at a municipal facility) and does not necessarily provide a permanent remedy. The recovery of the sludge and disposal of the excess waste in a RCRA facility is cost effective and environmentally effective, because it reduces the amount of waste to be taken off-site, provides a permanent remedy for a significant percentage of the existing PVC sludge, is less expensive than disposal of all the PVC sludge in a RCRA facility and is comparable in cost to the disposal of all the PVC sludge in the municipal landfill. It also attains all environmental and public health standards under CERCLA.

The recovery of the PVC sludges to the maximum extent possible (estimated by the companies to be 80-85%) as a saleable finished product and disposal of the non-recoverable soil/PVC mixture in a RCRA Hazardous Waste Management Facility (HWMF) will be used in the source control alternatives.

- Use of RCRA controls - Most of the alternatives listed below include the installation of some type of liner or cap to prevent or minimize the continuing leaching of contaminants into the groundwater at the site. The Malcolm Pirnie study discusses the use of clay, single synthetic and double synthetic liners, concrete lining for the trenches and single and double synthetic caps.

The National Contingency Plan (Section 300.68(j), 47 Fed. Reg., 31180 [July 16, 1982]) states that the remedial alternative selected will be the one the Agency determines is cost effective (i.e. the lowest cost alternative that is technically feasible, reliable, and which will effectively mitigate or minimize damage to human health, welfare and the environment.) In addition, in selecting a remedial action for this site, the EPA must also consider all other applicable environmental laws including RCRA.

Vinyl chloride is a RCRA listed waste in pure form, but when mixed with byproducts of manufacturing, the waste mixture is exempt. EPA examined the technical alternatives presented and available to minimize migration of contaminants. The relevant standards for caps and liners, outlined in RCRA for control of migration of hazardous wastes, were seen to provide the control that is required. Therefore, the alternatives were evaluated in this light to insure that they meet the requirements of CERCLA and the NCP and are essentially those that would be required under RCRA.

The design requirements for multi-media or multiple caps and liners outlined in RCRA are suitable for storage areas and treatment units because they allow better environmental protection than single liners and enable monitoring of the upper cap or liner to identify failures before serious leakage results.

ANALYSIS OF REMEDIAL ALTERNATIVES (cont)

A. Off-grade Batch Pits and RV Pond Remedial Alternatives

These two sources have been considered together since the same remedial actions apply to both. In developing remedial alternatives, it was determined that Formosa would continue to keep both the offgrade batch pits and the RV Pond in service due to their importance in the continued operation of the Plant. Hence, any alternatives in which these impoundments are taken out of service were initially screened out.

Alternative No. 1 - No Action

This alternative involves no remedial action and leaves the sources in their existing state. Both off-grade batch pits and RV pond are of earthen construction which is not suitable for retaining wastewater. At the present time, the PVC sludges placed in these basins are in direct contact with the soil and cause groundwater contamination through leaching of the VCM, EDC, and TCE. The groundwater contamination through direct contact with on-site PVC sludges constitutes the greatest environmental and human health threat. A no action alternative would provide no additional protection to the public health or environment and the contamination of soil and groundwater would continue.

Alternative No. 2 - Recovery of the PVC Sludges and Installation of a Clay Liner

This alternative includes excavation of the PVC sludges and contaminated soil to levels to be determined at the design stage and recovery of PVC to the maximum extent possible. Disposal of non-recoverable material will be at an off-site RCRA HWMF. This alternative also includes installation of a three foot clay liner compacted to a permeability of 10^{-7} cm/sec.

Since this alternative involves excavation and recovery of contaminated sludges, the risk of further groundwater contamination from these sludges will be eliminated. The clay liner will prevent the leaching of VCM, EDC, and TCE into the groundwater. The clay liner, however, may not be completely reliable due to the potential for cracking, thus jeopardizing the integrity of the liner. This alternative does not attain public health and environmental standards as defined by CERCLA.

Alternative No. 3 - Recovery of the PVC Sludges and Installation of a Single Synthetic Liner

This alternative includes excavation of the PVC sludges and contaminated soil to levels to be determined at the design stage, and recovery of PVC to the maximum extent possible. Disposal of non-recoverable material will be at an off-site RCRA HWMF. This alternative also includes installation of a single synthetic liner. Prior to installation of a synthetic liner, the site will be carefully graded to remove rocks and other materials that may puncture the liner and a layer of clay or geotextile material may be placed as a sub-base. A one foot thick layer of clay will be placed on top of the synthetic liner to protect against weathering. Three downgradient monitoring wells will be installed to monitor any potential contaminant migration from the pits and the pond. The wells will be initially sampled on a quarterly basis for PH, TOC, TOX, conductivity, VCM, TCE and EDC. If sampling results from two consecutive quarters are found to be consistent and acceptable, further sampling may be extended to semi-annually. In addition, a Hazardous Substance List (HSL) analysis will be conducted once a year.

Since this alternative involves recovery of contaminated sludges, the risk of ground water contamination from these sludges will be eliminated. The single synthetic liner is more environmentally effective than a clay liner, but single liners do not attain public health and environmental standards as defined by CERCLA.

Alternative No. 4 - Recovery of the PVC Sludges and Installation of a Double Synthetic Liner

Under this alternative, the contaminated sludges and soil will be excavated to levels to be determined at the design stage and will be recovered to the maximum extent possible. Non-recoverable material will be disposed of off-site in a RCRA HWMF. The risk of groundwater contamination from direct contact of these sludges with the soil will be eliminated. This alternative also includes installation of a double synthetic liner. Prior to installation of the lower (secondary) liner, the site will be carefully graded to remove rocks and other materials that may puncture the liner. Then a layer of clay will be placed as a sub-base on the graded site. After the secondary liner is placed, a loose fill material (sand/gravel) will be installed on top. This fill material will provide drainage to a leak detection system which will also be installed at that time. The leak detection system is generally a slotted pipe that is pitched to a sump located outside of the impoundment. Due to the slope of the pits and the RV pond, a loose fill would not remain on the side slopes. A geotextile fabric will, therefore, be placed between the synthetic liners along the side slopes. Above the drainage layer an upper synthetic liner will be installed and a one-foot thick clay layer will be placed on top of the upper synthetic liner to protect it against weathering and erosion. The liner and geotextile fabric will be tied into the berm around the impoundment with the top clay cover extended to cover the tie-in. The monitoring requirements for this alternative would be the same as for the single liner alternative described earlier.

The double liner alternative will provide the most protection against groundwater contamination. Any wastewater that possibly penetrates through the first liner should be retained by the second and detected by the detection system. Hence, the environmental effectiveness of the double liner is considered to be excellent.

Reliability of the double liner is judged to be excellent due to low operation and maintenance requirements once the system is installed. In addition, double synthetic liner systems with leak detection systems have demonstrated their reliability and applicability at similar sites. In particular, the double liner is more reliable in preventing leakage than the clay or single synthetic liner over time and represents a small increase in cost.

The double liner alternative meets all public health and environmental standards as defined by CERCLA.

B. Unlined Ditches Remedial Alternatives

In developing remedial alternatives for the unlined ditches it was determined that Formosa would continue to operate the ditches as part of their wastewater treatment plant. It was also determined that the PVC sludges within the unlined ditches cannot be recovered due to contamination with soil in the ditches and, therefore, approximately 100 cubic yards (cy) of solids will be removed and disposed of in a RCRA HWMF. The amount of solid material to be removed is based on a one foot deep excavation along an estimated twenty five percent of the total length of the unlined ditches. The actual areas which require excavation were visually noted during a 1985 site visit, based on the presence of the white PVC residue.

Alternative No. 1 - No Action

This alternative involves no remedial action and leaves the source in its existing state. The unlined ditches are of earthen construction and do not prevent leaching of VCM, TCE, and EDC from the PVC solids into the groundwater. The groundwater contamination through contact with on-site PVC sludges constitutes the greatest environmental and human health threat. A no action alternative would provide no additional protection to the public health and the environment and the contamination of soil and groundwater would be expected to continue.

Alternative No. 2 - Installation of Concrete Trench

In this alternative no contamination would be removed and a pre-cast 4-inch thick concrete liner would be placed in the ditches (see Fig. 7). The concrete trench would be susceptible to erosion and cracking during its operation. If cracking does occur, it could cause further ground water contamination due to leaching of the VCM, EDC, and TCE from the PVC sludges that are left in the ditches. This alternative does not attain public health and environmental standards as defined by CERCLA.

Alternative No. 3 - PVC Sludge Excavation and Installation of Single Synthetic Liner

In this alternative, contaminated sludges will be removed and disposed of off-site in a RCRA HWMF. The risk of groundwater contamination due to direct contact of the sludges with the soil will be eliminated. This alternative also involves installation of a single synthetic liner (see Fig. 7). These ditches convey waste to storage areas and are not storage areas themselves. Single liners are believed to provide an adequate barrier and effective protection of the groundwater. Prior to installation of the synthetic liner, the site will be carefully graded to remove rocks and other materials that may puncture the liner. A geotextile fabric will be used as the sub-base material to protect the liner from puncturing. The geotextile fabric will also help to keep the side slopes from eroding.

The PVC sludge excavation and lining of the ditches with an impermeable synthetic liner will significantly reduce the potential for leakage into the groundwater. The environmental effectiveness of the synthetic liner was judged to be excellent compared to that of a concrete trench. There are concerns regarding the stability of the synthetic liner with the eroding side slopes, however, the geotextile fabric will be helpful in controlling this factor.

This alternative attains public health and environmental standards as defined by CERCLA.

Alternative No. 4 - PVC Sludge Excavation and Installation of Concrete Trench

In this alternative, contaminated sludges will be removed and disposed of off-site in a RCRA HWMF. The risk of groundwater contamination due to direct contact of sludges with the soil will be eliminated. This alternative also includes installation of a pre-cast 4-inch thick concrete liner. The concrete trench will be susceptible to erosion and cracking during its operation. If cracking does occur, it could cause further groundwater contamination due to leaching of the VCM, EDC, and TCE from the PVC sludges that are contained in the ditches due to the active operations. This alternative does not attain public health and environmental standards as defined by CERCLA.

C. Aerated Lagoons - Remedial Alternatives

In developing remedial actions/alternatives for the aerated lagoons it was determined that Formosa would continue to operate the lagoons as part of their wastewater treatment plant. Therefore, any alternatives in which these impoundments are taken out of service have not been considered. Additionally, the recovery of the PVC sludges to the maximum extent possible as a saleable finished product and disposal of the non-recoverable soil/PVC mixture in a RCRA HWMF will be used in all of the source control alternatives.

Alternative No. 1 - No Action

This alternative involves no remedial action and leaves the source in its existing state. The lagoons are constructed with a reinforced concrete liner, which has eroded in different areas. At the present time, these lagoons are not effective in retaining wastewater. The VCM, TCE and EDC found in the PVC sludges, move through cracks in the concrete liner and cause groundwater contamination. The groundwater contamination at the site constitutes a great environmental and human health threat. A no action alternative would provide no additional protection to the public health or environment and the contamination of soil and groundwater could be expected to continue.

Alternative No. 2 - PVC Sludge Recovery and Repair of a Concrete Liner

This alternative includes excavation of the PVC sludges and recovery of PVC to the maximum extent possible. Disposal of non-recoverable material will be in an off-site RCRA HWMF. The risk of groundwater contamination due to leaching of the VCM, EDC and TCE through cracks in the existing concrete liner will be eliminated. This alternative also includes the repair of the existing concrete liner. After the liner is repaired, it will still be sensitive to erosion and cracking during its operation. If cracking does occur, it could cause further groundwater contamination due to leaching of the VCM, EDC and TCE from the PVC sludges. This alternative does not attain all public health and environmental standards as defined by CERCLA.

Alternative No. 3 - PVC Sludge Recovery and Installation of a Single Synthetic Liner

This alternative includes excavation of the PVC sludges and recovery of PVC to the maximum extent possible. Disposal of non-recoverable material would be in an off-site RCRA HWMF.

This alternative also includes repair of the existing concrete liner and installation of a single synthetic liner over the existing liner. The risk of groundwater contamination due to leaching of the VCM, EDC and TCE through the cracks in the existing concrete liner would be eliminated.

After excavation of the accumulated PVC solids and crack repair, geotextile fabric will be placed over the existing concrete to protect the synthetic liner from wear and puncture. Monitoring wells will be installed and sampled to verify the containment (as described for the offgrade batch pits and RV pond). The single liner system placed over the cleaned and repaired existing liner would provide more protection against leakage of the contaminants to groundwater than the repaired concrete liner. However, a single synthetic liner system does not attain all public health and environmental standards as defined by CERCLA.

Alternative No. 4 - PVC Recovery and Installation of a Double Synthetic Liner

Under this alternative, the contaminated sludges will be recovered to the maximum extent possible and non-recoverable material will be disposed of off-site in a RCRA HWMF. The risk of groundwater contamination due to leaching of the VCM, EDC and TCE through the cracks in the existing concrete liner will be eliminated.

This alternative also includes repair of the existing concrete liner and installation of a double synthetic liner over the existing liner. The double liner system has been described previously: clay sub-base, secondary synthetic liner, leak detection system, geotextile fabric, primary synthetic liner, and clay cover. Monitoring wells will be installed and sampled to verify containment (as described for offgrade batch pits and RV pond).

The double liner alternative will provide the greatest protection against groundwater contamination. Any wastewater that could possibly penetrate through the first liner should be retained by the second and detected by the leak detection system. Hence, the environmental effectiveness of the double liner is considered to be excellent.

Reliability of the double liner is judged to be excellent due to low operation and maintenance requirements once the system is installed. In addition, double synthetic liner systems with leak detection systems have demonstrated their availability and applicability at similar sites.

The double liner is more reliable in preventing leakage than the concrete or single synthetic liner over time and represents a small increase in cost.

The double liner alternative meets all public health and environmental standards as defined by CERCLA.

D. Closed Buried Sludge Pits - Remedial Alternatives

The unlined closed buried sludge pits (approximately 30,000 ft^2 in area) were used to dispose of PVC solids and sludge from aeration lagoons. In 1979, these pits were closed out with a single 20 mil PVC cap, covered with topsoil and revegetated. The capped area was graded to promote stormwater runoff to a collection ditch which runs along the perimeter of the area. The synthetic cap is tied into the ground beyond the extent of the contaminated sludges and soils. It should be noted that direct contact of the buried sludges with the underlying groundwater is not anticipated to be a problem, since the water table lies below the deepest area of contamination.

Alternative No. 1 - No Action

In this alternative the existing cap would be periodically inspected for signs of erosion, puncture, infiltration and repaired as necessary. An inspection of the PVC liner conducted in July 1985 by Stauffer, indicated minimal to no reduction of integrity of the cap system. The topsoil was uncovered at two locations to sample the integrity of the PVC cap. These samples exhibited no cracks, tears or perforations caused during six years of service.

The existing synthetic cap appears to prevent percolation of stormwater since it promotes stormwater runoff to a collection ditch running along the perimeter of the pits. However, if the cap is not maintained properly, there is a potential for cracks, tears or perforations to occur which would contribute to groundwater contamination through leaching of the VCM, EDC and TCE. This alternative does not attain public health and environmental standards as defined by CERCLA.

Alternative No. 2 - Recapping

This alternative involves placing 18" - 24" of loose material (sand/gravel) to serve as a drainage layer on top of the existing synthetic liner and providing an additional synthetic cap over the drainage layer. This new liner would then be covered with topsoil and revegetated. The new liner would extend 10 feet beyond existing liner.

This double cap alternative will provide more protection against groundwater contamination than a single synthetic cap. Any percolation that could possibly penetrate through the first liner should be retained by the drainage system and the second liner. The double cap is more reliable in preventing leakage than the single cap over time and represents a small increase in cost. This alternative meets all public health and environmental standards as defined by CERCLA.

Alternative No. 3 - Excavation and Removal

This alternative involves excavation and removal of all contaminated material and disposal in a RCRA HWMF. Removing the contaminated soil and sludges would entail excavating approximately 25,000 cubic yards. The area would be regraded upon the removal of the contaminated material.

This alternative would eliminate the source of contamination and therefore protect the groundwater from further contamination.

This alternative meets all public health and environmental standards as defined by CERCLA.

E. Former PVC Resin Storage Area - Remedial Alternatives

The former PVC storage area (approximately 12,000 ft^2 in area) had been excavated and regraded in 1974 by Stauffer. During the performance of the FS, fourteen test pits were excavated under the supervision of a geologist from Roux Associates in order to determine the extent of contamination in this source area. The concentrations of EDC in the soil ranged from ND to 120 ppm and the concentrations of TCE ranged from ND to 210 ppm. ND indicated concentrations less than the 4 ppm detection limit.

The remedial actions for the former PVC resin storage area involve preventing the stormwater from contacting the PVC resin and contaminated soil that are present on-site. The remedial alternatives, therefore, involve either removal of all the contaminated material or capping to prevent stormwater percolation. Direct contact of the contaminated material with the underlying groundwater is not anticipated to be a problem since the water table lies below the area of contamination.

Alternative No. 1 - No Action

This alternative involves no remedial action and leaves the source in its existing state. At the present time, the stormwater percolates through the PVC resin and the contaminated soils and contaminates the groundwater through leaching of the VCM, EDC and TCE. The groundwater contamination through stormwater percolation constitutes an environmental and human health threat. The no action alternative would provide no additional protection to the public health and environment and the contamination of groundwater would be expected to continue.

Alternative No. 2 - Excavation and Removal

Under this alternative, the areas of highest contamination will be excavated and disposed of in a RCRA HWMF. Based on the analytical results from test pit excavation and sampling, it was determined by Malcolm Pirnie, that test pit (TP) 12 and TP-14 should be excavated. TP-12 contained 210 ppm of TCE at a depth of 24" and TP-14 contained 120 ppm of EDC and 50 ppm of TCE at a depth of 42". The total amount of material removed will be 615 cubic yards. The highest concentration of any contaminant to remain in the soil would be 27 ppm of EDC located at a depth of 5'5" in TP-9.

This alternative would not provide protection against groundwater contamination, because the leachate generated from the soil left on-site would cause concentrations of contaminants in groundwater greater than the 10^{-6} Unit Cancer Risk (UCR). This alternative does not meet all public health and environmental standards as defined by CERCLA.

Alternative No. 3 - Capping the Areas of Highest Contamination with Single Synthetic Liner

Under this alternative the material would be left in place and the areas of highest contamination will be capped with a synthetic cap. The cap would be installed over a 2,700 square foot area around both TP-12 and TP-14. Prior to cap installation, additional tests would be performed around TP-12 and TP-14 to confirm that significant levels of PVC sludges exist and warrant capping.

This alternative would not provide protection against ground water contamination, because the leachate generated from the soil left uncovered would cause concentrations of contaminants in the groundwater greater than the 10^{-6} UCR. Also, the areas that will be capped may develop cracks, tears or perforations if they are not properly maintained. This could contribute to groundwater contamination through leaching of the VCM, EDC and TCE.

This alternative does not attain public health and environmental standards as defined by CERCLA.

Alternative No. 4 - Capping the Entire Area with a Single Synthetic Cap

This alternative involves installation of a synthetic cap over the entire area. The installation of the synthetic membrane would involve sub-base grading, placement of a sand layer, installation of a membrane, topsoil placement and vegetation of topsoil. The synthetic liner would also extend approximately 10 feet beyond the area of contamination.

This alternative does not attain public health and environmental standards as defined by CERCLA.

Alternative No. 5 - Capping the Entire Area with a Double Synthetic Cap

This alternative involves installation of a double synthetic cap over the entire area. The installation of a double synthetic liner would involve grading the site, placement of a sand layer, installation of a lower membrane, installation of a drainage layer, placement of an upper membrane, topsoil placement and vegetation of topsoil.

The double cap alternative will provide more protection against groundwater contamination than a single synthetic cap. Any percolation that could possibly penetrate through the first cap would be retained by the drainage layer and the second cap.

The double cap alternative is more reliable in preventing leakage than a single cap and represents a small increase in cost.

The double cap alternative meets all public health and environmental standards as defined by CERCLA.

F. Groundwater - Remedial Alternatives

At the present time, groundwater containing EDC, VCM nd TCE is flowing west from the area of the identified sources. Groundwater flowing to the northwest toward OW-5 turns in a northerly direction (roughly parallel to Route 13) and flows towards Red Lion Creek. Groundwater flowing toward OW-16 turns in a southerly direction and flows towards Dragon Run. The alternatives to be discussed below involve either plume remediation or plume management. For the alternatives that involve plume remediation, the recovered water will be used in Formosa's PVC plant operations. During any low water demand period at the plant, the recovered water will be discharged to Formosa's wastewater treatment plant. The discharge of the treated groundwater will be in compliance with NPDES standards.

Alternative technologies considered for groundwater remediation included biological, physical and chemical treatment. Due to low concentrations of contaminants in the groundwater, most alternatives were eliminated on both a technical and cost basis. Air stripping remained after initial screening but was not chosen because reuse of the water in the plant was more cost-effective.

Alternative No. 1 - No Action

This alternative involves no remedial action and leaves the site in its existing state. A detailed hydrogeologic investigation has confirmed the presence of the contaminants VCM, EDC and TCE in the Columbia aquifer. The aquifer serves as a drinking water supply to residents in the surrounding area. Without groundwater controls, the contaminant plume will continue to migrate in the northerly and southerly directions and will impact the residential wells located downgradient. At the present, an estimated 25-30 residences are located downgradient of the northerly and southerly paths of plume. The migration of the contaminated plume represents a significant potential threat to those citizens who are currently using the aquifer through direct exposure via ingestion, inhalation and dermal contact.

The contaminated groundwater, if not recovered, will eventually discharge into Red Lion Creek and Dragon Run. Additionally, is has been calculated that EDC and VCM will be present in the groundwater at the discharge point in concentrations greater than allowed by EPA Water Quality Criteria. Aquatic and terrestrial biota may be impacted due to the presence of these contaminants in the surface waters. Also, there is a potential threat to the population utilizing these creeks for recreational or drinking purposes.

A no action alternative would provide no additional protection to the public health or environment and the contamination of the groundwater and surface waters would be expected to continue.

Alternative No. 2 - Downgradient Pumping to Collect Groundwater at the Edge of the Existing Plume in the Buried Valley

This alternative involves installation of two lines of pumping wells, one across the buried valley at the northern edge of the plume and one across the valley at the southern edge in order to collect the EDC, VCM and TCE contaminated groundwater. (see Fig. 8)

EDC and VCM have been detected in monitoring well OW-5 (at 1,6000 and 310 parts per billion(ppb), respectively during August 1984 sampling). Well OW-32, 300 feet downgradient of OW-5, has not shown these compounds. Likewise, OW-22, further downgradient, has never shown EDC or VCM. Therefore, the edge of the plume is somewhere between OW-5 and OW-32.

Through August 1984, OW-3 had consistently shown traces of EDC (less than 5ppb) but no VCM. In the December 1984 sampling, EDC and VCM were detected. The northern line would consist of six wells each pumping 1015gpm. OW-5 could be incorporated into this line of pumping wells. Any EDC/VCM/TCE that may have migrated past OW-5 towards OW-2, will be drawn back toward and withdrawn by the northern line of pumping wells.

Six piezometers would be installed both upgradient and downgradient of this line of wells. Water levels will be taken on a quarterly basis for the duration of the pumping to demonstrate that the system is effectively intercepting all EDC, VCM, and TCE contamination in the identified plume area.

The southern line of pumping wells would trend northeast from Route 13 through OW-16. Through the action of these wells, all EDC, VCM and TCE flowing to the south from the existing plume area can be intercepted. OW-30 showed EDC (1,100 ppb) and VCM (50 ppb) for the first time during August 1984 sampling. EDC/VCM/TCE in the vicinity of OW-30 will be drawn back to the proposed line of pumping wells. Six piezometers would be installed both upgradient and downgradient of this line of wells, so that accurate water level data can be collected. In this way it can be shown that all EDC/VCM/TCE from the identified plume is being intercepted. Similar to the northern line, six pumping wells would be required. Existing monitoring well OW-16 could be incorporated as one of the pumping wells. Each pumping well in the northern and southern lines would consist of six-inch diameter casing and ten feet of screen. Well depths would range from 50 to 70 feet below the surface and each well would be pumped at 10 to 15 gpm. The piezometers would consist of two-inch diameter casing and screen and be screened at the same hydrogeologic setting as the pumping wells. The lower portion of the Columbia aquifer has been shown to be contaminated with EDC, VCM and TCE in the February 4, 1983, hydrogeology report.

These two lines of wells are designed to intercept and collect water from the deeper portion of the aquifer that contains the EDC, VCM and TCE. The exact number, location and pumping rates will be adjusted, if necessary, during the final design phase of the remedial program to ensure complete capture of the groundwater plume.

The recovery wells will be operated until the concentrations of VCM, EDC and TCE in these wells reach 1 ppb, 0.94 ppb, and 2.7 ppb respectively for two consecutive sample analysis.

This alternative also includes replacement of the Getty Gas Station, Stapleford Chevrolet and Telephone Company Relay station wells. A pilot hole to 300 feet below land surface will be drilled and sediment cores will be logged at regular intervals. A suitable water-bearing unit in either the Magothy or Upper Potomac aquifers will then be selected as an alternative source of water to these businesses.

Two monitoring wells will be installed at the southern edge of the plume to monitor the movement of the contaminated plume. These wells will be sampled semi-annually for VCM, EDC and TCE. Downgradient residents using well water will be provided a permanent potable water supply, if EPA/DNREC determine at any time, that contamination of the residential wells is imminent.

This alternative provides for plume control, groundwater remediation and alternate water supplies.

Alternative No. 3 - Downgradient and Within Plume Pumpage to Collect All Contaminated Groundwater

This alternative involves the two lines of pumping wells described in Alternative No. 2. In addition, a third line of wells would be set up within the existing plume area. Use of the three lines of wells would speed up the clean-up time, becausc more water would be collected. (see Fig. 8)

The third line of wells would consist of eight new pumping wells spaced approximately 125 feet apart. The line would extend from the vicinity of existing monitoring well OW-17 towards monitoring Well OW-1. Both four-inch diameter monitoring Wells OW-17 and OW-1 could be used as part of this system. The total of ten wells in this line would be pumped at 10 gpm each which would adds an extra 100gpm of pumpage to this alternative.

The third line of new wells within the existing plume area would effectively intercept contaminated groundwater flowing from the identified sources. The two lines in the buried valley would effectively intercept groundwater containing EDC, VCM and TCE from the edge of the existing plume.

Each well in the third line of wells would consist of a six-inch diameter casing with five feet of screen. These wells would be shallower than their buried valley equivalents due to the higher elevation of the underlying aquitard. It is estimated that these wells will be 50 feet deep. The exact number, location and pumping rates will be adjusted, if necessary, during the final design phase of the remedial program to ensure complete capture of the groundwater plume.

It is recommended that ten 2-inch diameter piezometers be installed both upgradient and downgradient of this third line to effectively measure the extent of the radius of influence of this line to the west.

This system of three lines of pumping wells has one major advantage. One volume (from the sources to the intercept wells) of the identified plume can be removed in half the time that an equal volume of contaminated water would be captured through implementation of Alternative I. The third line is located downgradient of a lower permeability area where groundwater flow rates are significantly slower than in the buried valley. Thus the cleanup of the plume could be completed in less time. A potential disadvantage of this expanded system is that the larger volume of water removed (280 gpm total) may limit choices for disposition of water.

The recovery wells would be shut off when the concentrations of VCM, EDC and TCE in the recovery wells reach 1 ppb, 0.04 ppb, and 2.7 ppb respectively for two consecutive sample analyses.

This alternative includes replacement of the Getty Gas Station, Stapleford Chevrolet and Telephone Company Relay Station Wells as described in Alternative No. 2.

Two monitoring wells will be installed at the southern edge of the plume to monitor movement of the contaminated plume. These wells will be sampled semi-annually for VCM, EDC and TCE. The three lines of wells are designed to intercept and collect water from the deeper portion of the aquifer that contains the EDC, VCM and TCE. The exact number, location and pumping rates of these wells will be adjusted, if necessary, during the final design phase of the remedial program to ensure complete capture of the groundwater plume.

Alternative No. 4 - Plume Management

The fourth alternative is plume management. Plume management involves implementation of a monitoring network to track the movement of the plume to receptors. Under natural conditions, groundwater in the buried valley flows either to the north or south to discharge into Red Lion Creek or Dragon Run respectively (Figure 8). The rate of movement of the existing plume to the north appears to be slower than movement to the south because sediments to the north are significantly less permeable than those to the south (based on pump test results). (see Fig. 9)

A number of items must be addressed in implementing any plume management alternative. These are:

1. The projected path(s) of the plume must be verified.

2. The identified sources must be abated so the plume is allowed to flush itself naturally.

3. An adequate monitoring system must be set up over the lifetime of the existing plume.

4. Domestic wells in the path of the plume, particularly at the same horizon in the aquifer, must be identified so alternative supplies of water can be provided, if necessary.

5. The future use of lands above the plume must be determined so as to prevent supply wells from inadvertently being installed into the plume.

6. The effects (if any) of plume discharge into receptors must be determined.

This alternative allows continuing contamination of the aquifer and demands extensive monitoring and institutional controls. EPA has determined that this does not meet all public health and environmental standards as defined by CERCLA.

Alternative No. 5 - Delaware DNREC - Remedial Alternative

The State of Delaware proposed an additional alternative to the four described above. In the State's proposal an industrial water supply wellfield would be developed along either the east or west side of Route 13. The resulting water supply could be used by Stauffer/Formosa for one or more purposes in ongoing operations. The State assumed that the groundwater would have a maximum concentration of EDC and/or VCM of 1000 ppb. The actual detections provide an average concentration of 7,000 ppb EDC, 400 ppb VCM, and 10ppb TCE for groundwater collected by the recovery wells. Groundwater flow paths were projected from the identified sources to each of the potential recovery wells. The highest levels of VCM, EDC and TCE recorded at each monitoring well within a flow path were averaged. Each of these numbers was then averaged. These calculations take into account 25% dilution by uncontaminated water withdrawn along with the plume water.

Such a wellfield would accomplish the major goals described in the State's proposal. The major goals of the State's proposed alternative are to provide water from a wellfield while ensuring protection of the deeper aquifer system. An ancillary benefit is the removal of water containing EDC, VCM and TCE. The State also proposed to construct a waterline for the residences along the discharge path as part of the cleanup. However, Malcolm Pirnie determined that this alternative would not effectively remove all EDC, VCM and TCE from the identified plume. In particular, the DNREC's alternative would be unable to capture all of the plume unless wells are installed along the entire width of the plume, parallel to the buried valley and in poor waterbearing areas.

CONSISTENCY WITH OTHER ENVIRONMENTAL LAWS

Alternatives were examined in light of applicable Federal, State and local environmental program requirements and in light of all CERCLA requirements.

The remedial actions proposed will be coordinated with the State to insure that the water and air quality will meet all applicable standards.

RECOMMENDED ALTERNATIVE (see Table 6)

Section 300.68(j) of the National Contingency Plan (NCP) states that the appropriate extent of remedy shall be determined by the lead agency's selection of a remedial alternative which the agency determines is cost-effective (i.e., the lowest cost alternative that is technically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare and the environment). In selecting a remedial alternative, EPA must consider all environmental laws that are applicable. Based on the evaluation of the cost effectiveness of each proposed alternative, the analysis contained above and the comments received from the public and information from the Delaware Department of Natural Resources and Environmental Control (DNREC), we recommend the following remedial alternative for the six-identified sources and the groundwater:

1. Off-grade Batch Pits - Excavate and Remove PVC sludges and contaminated soils to the levels to be determined at the design stage; install a double synthetic (or RCRA conforming equivalent) liner, install monitoring wells and perform quarterly sample analysis for TCE, EDC and VCM. The excavated material

will be directly processed and recovered (estimated by the companies to be 80-85%) as a saleable finished product to the maximum extent possible. Non-recoverable material will be disposed of off-site at an approved RCRA facility. Since this alternative involves recovery of contaminated sludges, the risk of groundwater contamination from these sludges will be eliminated.

The double liner will provide the most protection against leakage of the contaminants.

2. RV Pond - The same remedy as described above for the off-grade batch pits.

3. Unlined Ditches - Excavate and remove PVC sludge, intall a single synthetic liner. The excavated material will be disposed of off-site at an approved RCRA facility. Excavation and removal of PVC sludges will eliminate the risk of groundwater contamination from these sludges. The single synthetic liner will provide protection against leakage of the contaminants into the groundwater.

4. Aerated Lagoons - Excavate and remove PVC sludge, clean and repair lagoons, install a double synthetic (or RCRA conforming equivalent) liner and monitoring wells. The excavated material will be recovered (estimated by the companies to be 80-85%) and the non-recoverable material will be disposed of off-site at an approved RCRA facility. The recovery of contaminated sludges will eliminate the risk of groundwater contamination from these sludges. Cleaning and repair of the concrete liner and installation of a double liner on top will provide the most protection against leakage of the contaminants into the groundwater.

5. Closed Buried Sludge Pits - Place a drainage layer on top of the original liner. Then cover with a second synthetic liner (or comparable substitute in compliance with the requirements of RCRA), topsoil and revegetate. The double synthetic cover will provide protection against stormwater percolation and groundwater contamination.

6. Former PVC Storage Area - Cover and cap the entire area with a double synthetic (or comparable substitute in compliance with the requirements of RCRA) cap and revegetate. The cap will protect the groundwater from the leaching of the contaminants.

7. Groundwater - Install one line of six groundwater recovery wells at the northern edge of the plume, and another six wells at the southern edge. Reuse the collected groundwater in Formosa's plant and during the low water demand at the plant dispose of the groundwater at the wastewater treatment plant. Install two monitoring wells at the southern edge of the plume. The recommended recovery system will collect the contaminants and prevent the plume from migrating further.

OPERATION AND MAINTENANCE

Periodic inspection and maintenance will be required for all the liners and the caps to assure that they are functioning properly. Periodic inspection and maintenance will also be necessary during operation of the recovery system. The operator of the recovery system should have experience with a municipal wellfield or contaminated groundwater pumping system or have demonstrated experience in a groundwater related field.

Proper maintenance of the groundwater treatment system will be required to ensure compliance with the NPDES and the Clean Air Act.

The groundwater monitoring program for the sources and recovery well system will commence after installation of the liners, caps and the recovery wells (est. 12 months). Periodic analysis will evaluate the effectiveness of the selected remedy.

EVALUATION OF ALTERNATIVES NOT SELECTED

OFF-GRADE BATCH PITS AND RV POND

The alternative that involved installation of a clay liner was not chosen, because it may not be completely reliable due to the potential for cracking.

The alternative that involved installation of a single synthetic liner was not chosen, because it was less reliable than the double synthetic liner. If the wastewater penetrates the single synthetic liner it would cause groundwater contamination. Overall, both the clay and single synthetic liners are less reliable and environmentally effective than the double synthetic liner.

The double liner is more reliable in preventing leakage than the clay or single liner over time and represents a small increase in cost ($500,000 vs. $460,000 and $450,000 for off-grade batch pits and $250,000 vs. $232,000 and $227,000 for RV Pond).

Both clay and single synthetic liners do not meet all public health and environmental standards as defined by CERCLA.

UNLINED DITCHES

The single synthetic liner was chosen over the concrete liner alternative. The concrete liner was less environmentally effective than synthetic liner due to the possibility of cracking. The concrete liner was also more expensive than the synthetic liner ($115,000 vs. $65,000).

The single synthetic liner meets all public health and environmental standards as defined by CERCLA.

AERATED LAGOONS

The alternative that involved cleaning and repair of the existing concrete liner was not chosen, because it would still be sensitive to cracking and erosion during its operation. If the cracking occurs, it could cause further groundwater contamination.

The alternative that considered installation of a single synthetic liner was not chosen because it was less reliable and environmentally less affective than the double synthetic liner.

The double synthetic liner is more reliable in preventing leakage than single synthetic liner or concrete liner over time and represents a small increase in cost ($425,000 vs. $343,000 and $278,000).

Both the concrete and single synthetic liners do not meet all public health and environmental standards as defined by CERCLA.

CLOSED BURIED SLUDGE PITS

The alternative that involved keeping the existing cap was not chosen because it was less environmentally effective than the double synthetic cap. It did not meet all public health and environmental standards as defined by CERCLA.

Total excavation and removal of contaminated sludges was rejected, because it offered comparable protection to the double synthetic cap, but was considerably more expensive ($5,946,000 vs. $155,000).

FORMER PVC RESIN STORAGE AREA

The alternative that involved excavation and removal of highest contamination areas was not chosen, because the concentrations of contaminants left on-site would cause further degradation of the groundwater through leaching of the contaminants.

The alternative that involved capping the highest contamination areas with synthetic liner was not chosen because the uncovered areas would also cause further degradation of the groundwater.

Capping the entire area with single synthetic liner was rejected because it was less environmentally effective than the double synthetic cap.

The double cap is more reliable than the single cap over time and represents a small increase in cost ($295,000 vs. $180,000).

Furthermore, all three of the alternatives described above do not meet all public health and environmental standards as defined by CERCLA.

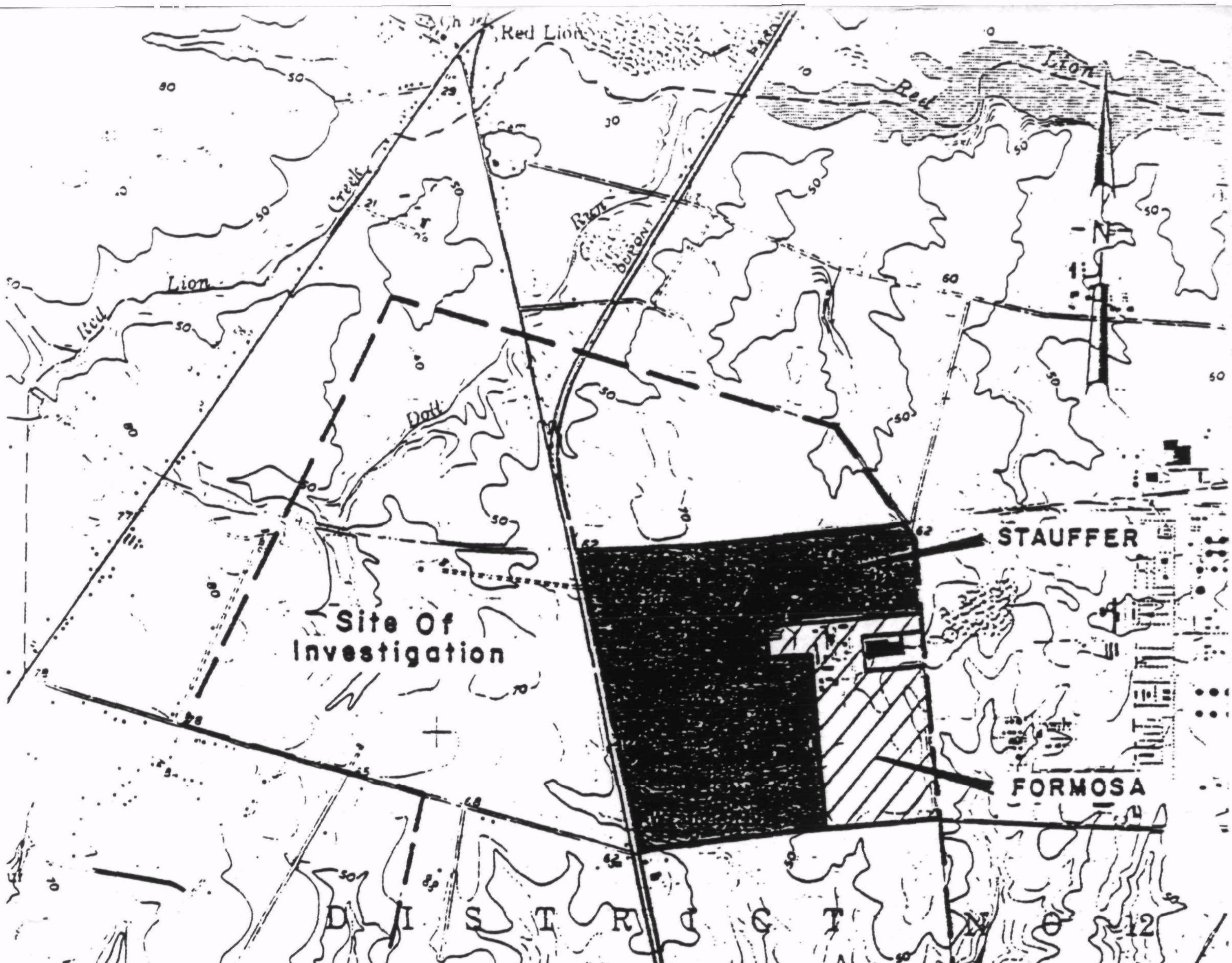
GROUNDWATER

Alternative No. 3 (i.e., 3 lines of recovery wells) was rejected, because the only advantage it had over Alternative No. 2 (i.e., 2 lines of wells) was that it would take a shorter time to clean-up the groundwater. However, it was more expensive while offering the same level of protection as Alternative No. 2 ($839,000 vs. $599,000).

Both the plume management alternative and Alternative No. 5 were more expensive and offered less protection than Alternative No. 2 ($1,720,000 and $2,285,000 vs. $599,000).

Plume management was also rejected because it allows for contamination of the aquifer and natural "finishing" of the contaminants rather than "cleanup" of the groundwater.

Alternative No. 5 was rejected because it was determined that it would not collect all of the contamination in the groundwater.



SUBJECT

SITE LOCATION MAP

PREPARED FOR
STAUFFER CHEMICAL COMPANY
Delaware City, Delaware

ROUX ASSOCIATES	COMPILED BY	J. DE MARTINIS	SCALE 1" = 2000'	FIGURE 1
	PREPARED BY	C. ROBERTSON	DATE JAN. 1983	
	PROJECT MGR	P. ROUX		

FIG. 1

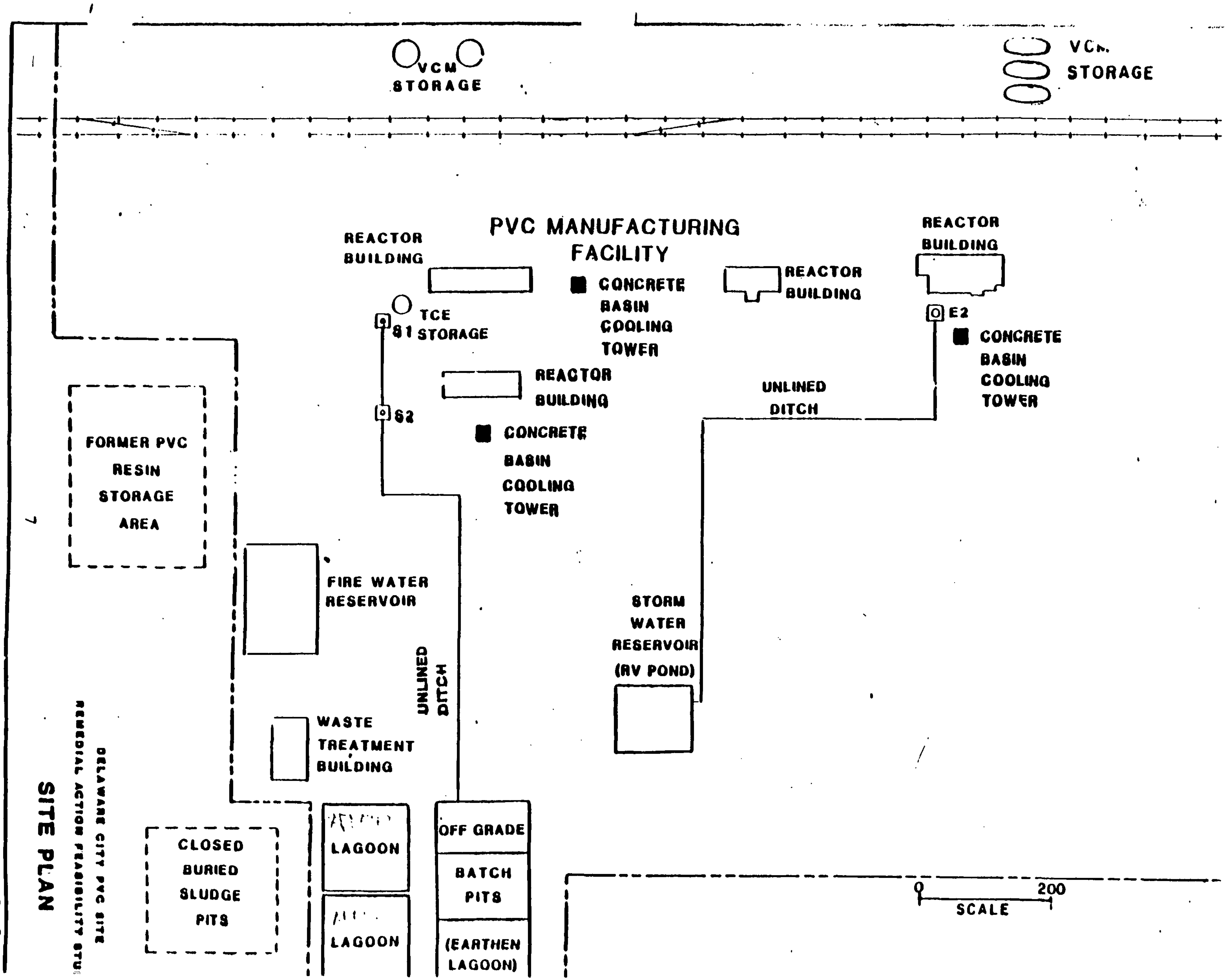
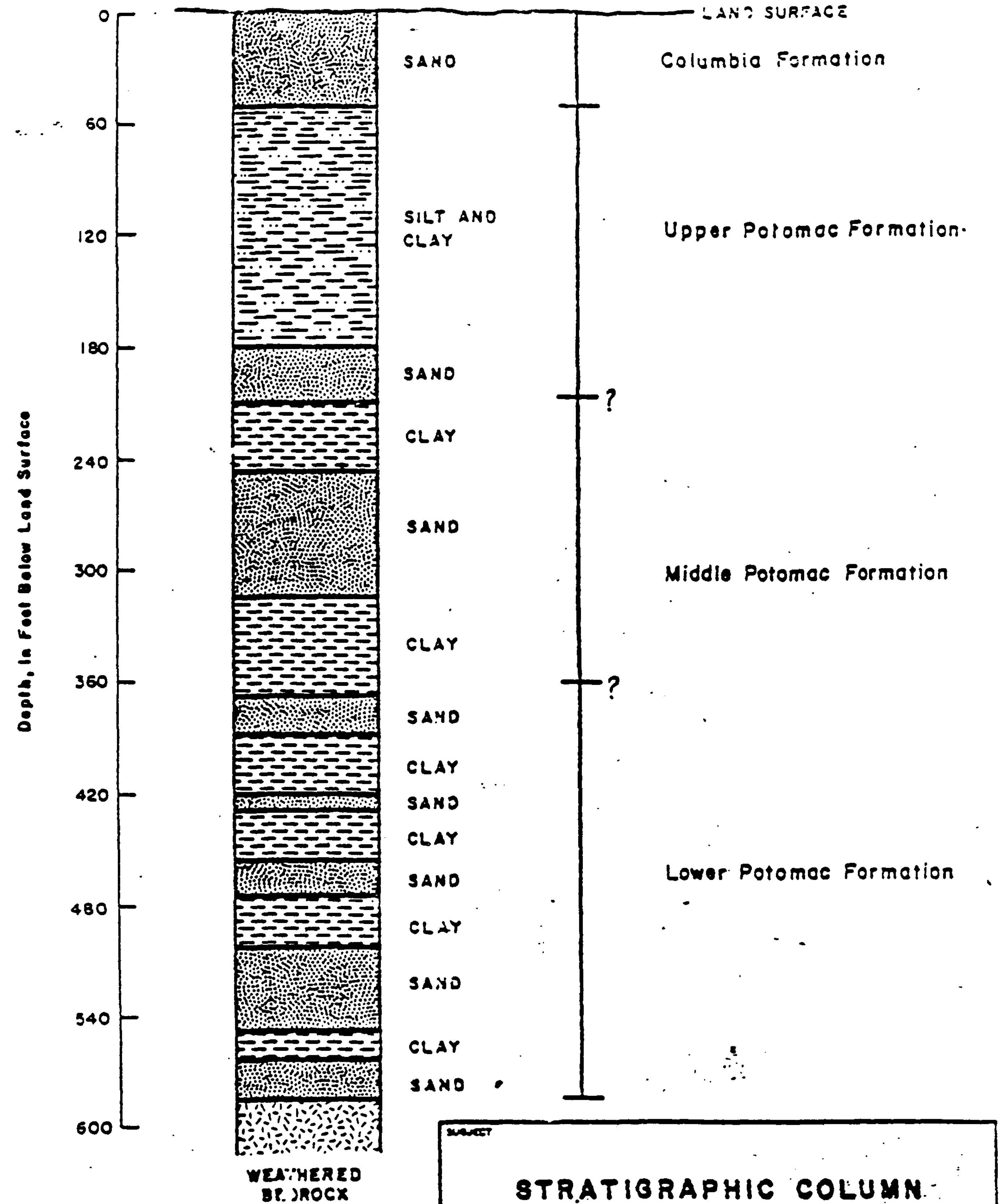


FIG. 2

SITE PLAN

DELAWARE CITY PVC SITE
REMEDIAL ACTION FEASIBILITY STU[illegible]



SUBJECT

STRATIGRAPHIC COLUMN

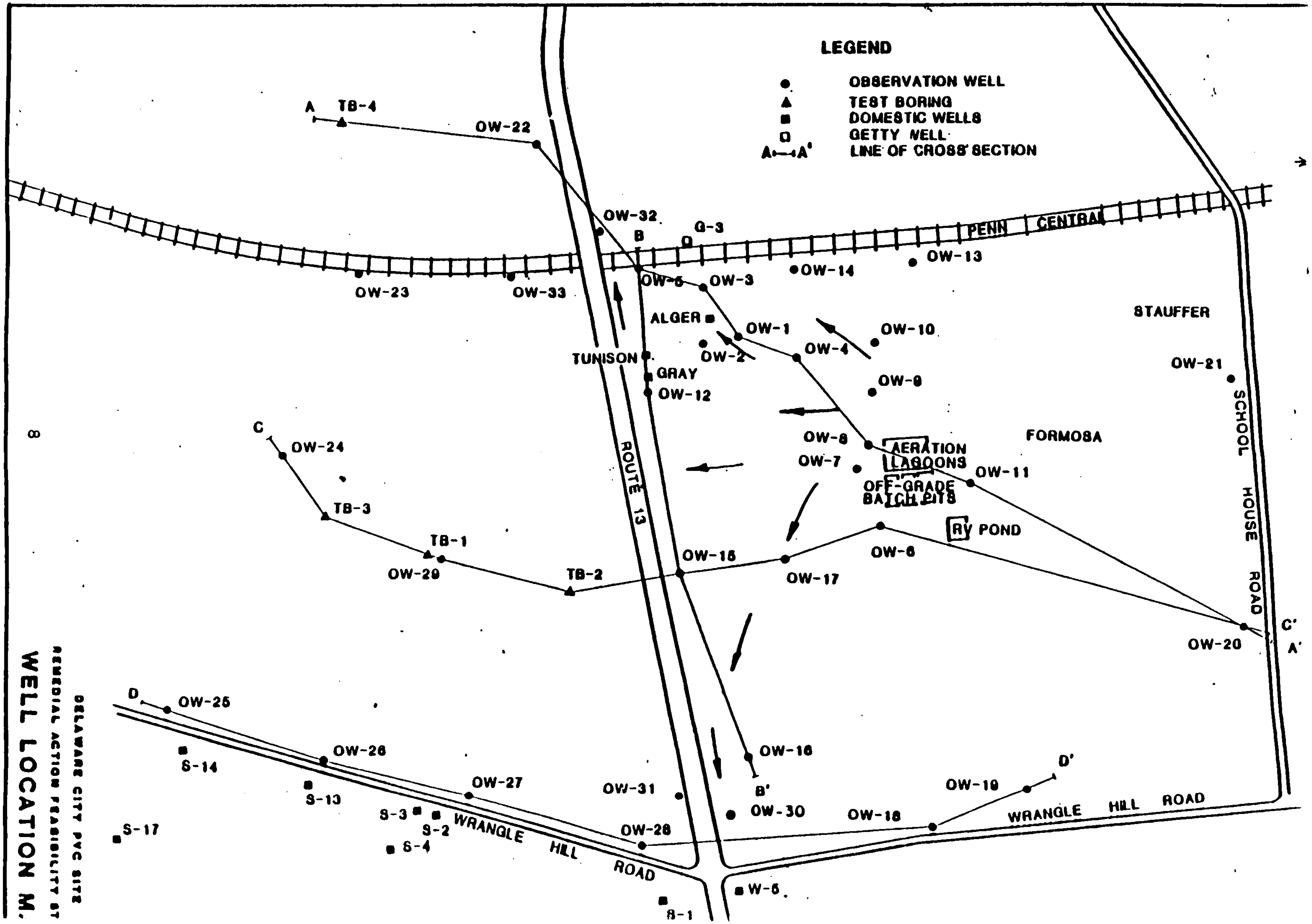
(FROM DRILLERS LOG OF WELL 6-1)

PREPARED FOR

STAUFFER CHEMICAL COMPANY
Delaware City, Delaware

P.H. Roux & Associates, Inc.	COMPILED BY	SCALE SHOWN	FIGURE
	PREPARED BY	DATE JUNE 1982	
	PROJECT MGR.		

FIG. 3



DELAWARE CITY PVC SITE
REMEDIAL ACTION FEASIBILITY ST

WELL LOCATION M.

FIG. 4

TABLE 1

ANALYSIS OF DELAWARE CITY OBSERVATION WELLS FOR VCM, EDC, AND TCE[1]

SAMPLES COLLECTED AUGUST 21 - AUGUST 23, 1984
SAMPLES ANALYZED AUGUST 24 - AUGUST 31, 1984

Sample	Concentration (ppb) VCM	EDC	TCE	Other Compounds
OW-3	ND[3]	Det[4]	ND	ND
OW-5	310	1,600	13	ND
OW-10	Det	230	4	One at 100 ppb
OW-11	250	40	4	Three at 17,000, 50, and 25 ppb
OW-13	ND	ND	4	ND
OW-14	ND	ND	9	ND
OW-16	ND	ND	Det	ND
OW-17	210	3,400	15	One at 3,400 ppb
OW-17A	ND	Det	Det	ND
OW-18[2]	ND	ND	ND	ND
OW-19[2]	ND	ND	ND	ND
OW-22	ND	ND	ND	ND
OW-28[2]	ND	ND	15	ND
OW-29[2]	ND	ND	ND	ND
OW-30	50	1,100	Det	ND
OW-31	ND	ND	7	ND
OW-32[2]	ND	ND	ND	ND
OW-33	ND	ND	ND	ND
Lower Limit of Detection	1	1	1	10
QA spikes at 10 ppb (Average percentage recovery from duplicate analysis)	105%	93%	94%	

Notes:

1. Modified version of EPA Method 624 (Purge and trap gas chromatography with flame ionization detection).
2. Sample split with EPA's contractor, NUS.
3. ND - Not detected.
4. Det - Detected below the lower limit of quantitation, 3 ppb.

TABLE 2

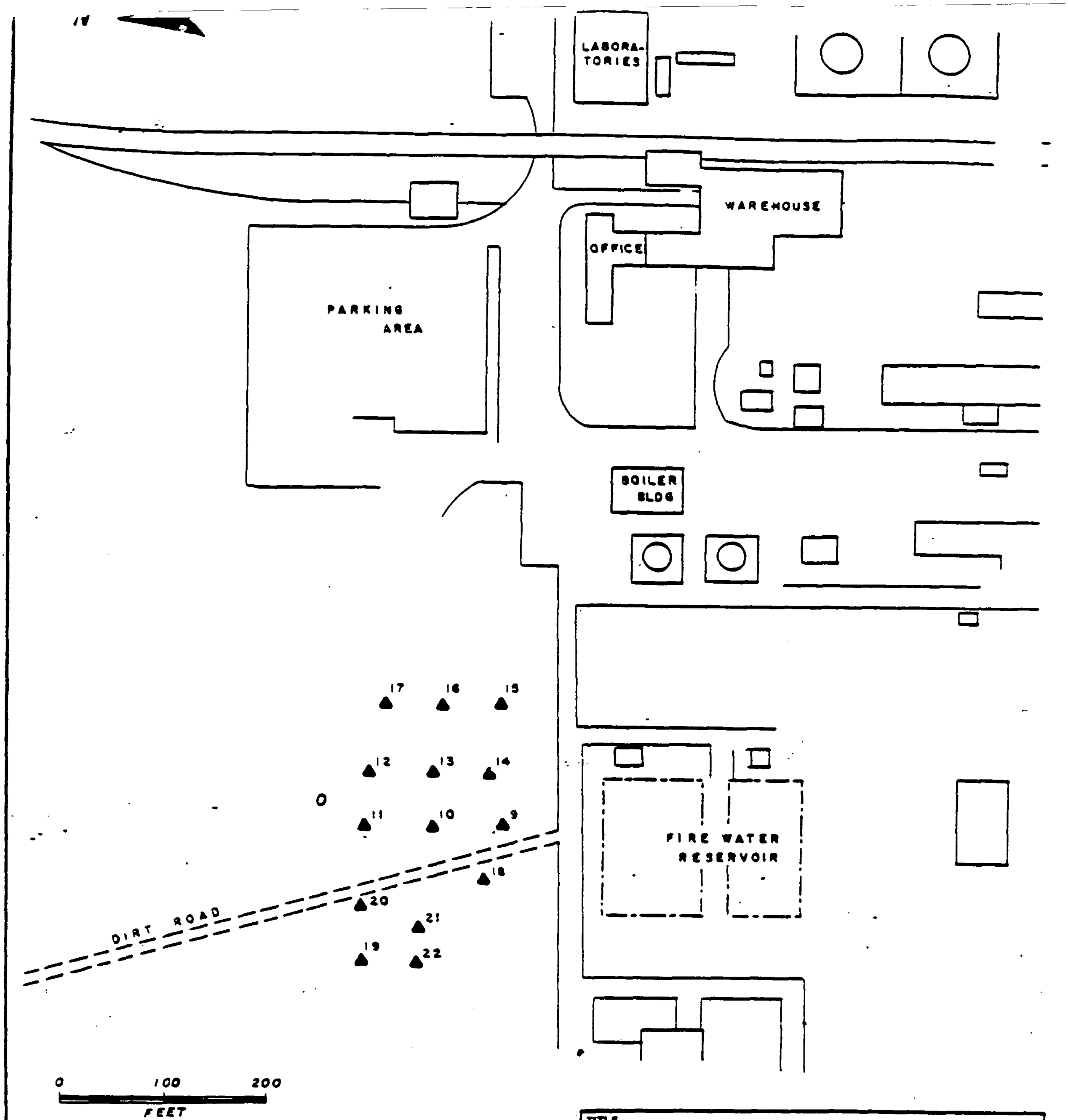
ANALYSIS OF DELAWARE CITY OBSERVATION WELLS FOR VCM, EDC AND TCE[1]

SAMPLES COLLECTED DECEMBER 19 - DECEMBER 20, 1984
SAMPLES ANALYZED DECEMBER 27- DECEMBER 31, 1984

Sample	Concentration (ppb) VCM	EDC	TCE
OW-3	200	2,000	5.7
OW-3 (duplicate)	210	2,100	5.9
OW-5	1,500	14,000	21
OW-11 (Top)	2,600	31	22
(Middle)	2,600	36	22
(Bottom)	2,500	31	21
OW-12	1,400	27,000	25
OW-15	60	25,000	14
OW-16	ND[2]	Det[3]	Det
OW-20	ND	ND	ND
OW-21	ND	ND	8.3
OW-30	100	2,600	4.7
OW-31	ND	ND	4.1
OW-32	ND	ND	ND
Detection Limit	1	1	1
Q.A. Spikes at 10 ppb and 100 ppb (Average % Recovery)	115%	106%	115%

Notes:

1. Modified version of EPA Method 624 (Purge and trap gas chromatography with flame ionization detection).
2. ND - Not Detected.
3. Det - Detected below the lower limit of quantitation, 3 ppb.



▲ Location of Test Pit

TITLE

LOCATIONS OF TEST PITS

PREPARED FOR

Stauffer & Formosa Plastics

ROUX Consulting Ground-Water Geologists ROUX ASSOCIATES INC

SCALE SHOWN

DATE JAN 1986

FIGURE

FIG. 5

DELAWARE CITY SOIL ANALYSIS[1]
SAMPLES COLLECTED 10/23/84
SAMPLES ANALYZED 10/29/84 - 11/02/84

Test Pit No.	Sample No.	Depth (inches)	Description	Concentration (ppm) VCM	EDC	TCE
TP-9	1	12	Soil and white powder[2]	ND[3]	ND	ND
TP-9	2	54	Blackish residue	Det[4]	27	Det
TP-10	1	36	Soil and white powder	ND	14	Det
TP-10	2	36	Brown virgin soil	ND	ND	ND
TP-10	3	84	Brown virgin soil	ND	ND	ND
TP-11	1	12	Soil and white powder	ND	18	20
TP-11	2	24	Brown virgin soil	ND	ND	ND
TP-12	1	12	Soil and white powder	ND	22	ND
TP-12	2	24	Brown virgin soil	ND	ND	210
TP-12	3	12	Brown soil	ND	ND	ND
TP-13	1	12	Soil and white powder	ND	14	Det
TP-13	2	30	Brown virgin soil	ND	ND	Det
TP-13	3	52	Brown virgin soil	ND	ND	ND
TP-14	1	42	Fine white powder	ND	120	150
TP-14	2	32	White slimy clay	ND	63	Det
TP-14	3	16	White powder	ND	24	ND
TP-14	4	74	Brown virgin soil	ND	ND	ND
TP-15	1	53	Red soil, strong odor	ND	ND	ND
TP-15	2	10	Soil and white powder	ND	ND	ND
TP-15	3	32	Brown virgin soil	ND	ND	ND
TP-16	1	7	Soil and white powder	ND	ND	ND
TP-16	2	49	Red soil/sand	ND	ND	ND
TP-17	1	4	White powder	ND	Det	ND
TP-17	2	48	Red soil/sand	ND	ND	ND
TP-18	1	12	Red soil	ND	ND	ND
TP-18	2	36	Red soil	ND	ND	ND

Notes:

1. Modified version of EPA Method 624 (Dispersion of soil in tetraglyme followed by purge and trap gas chromatography with flame ionization detection).
2. White powder and white slimy clay have been identified as PVC resin. As shown in Appendix C, this material is typically present as a thin layer approximately 6 to 12 inches thick within the top 2 feet of the surface.
3. ND indicates less than 4 ppm (detection limit).
4. Det indicates less than 12 ppm (lower limit of quantitation).

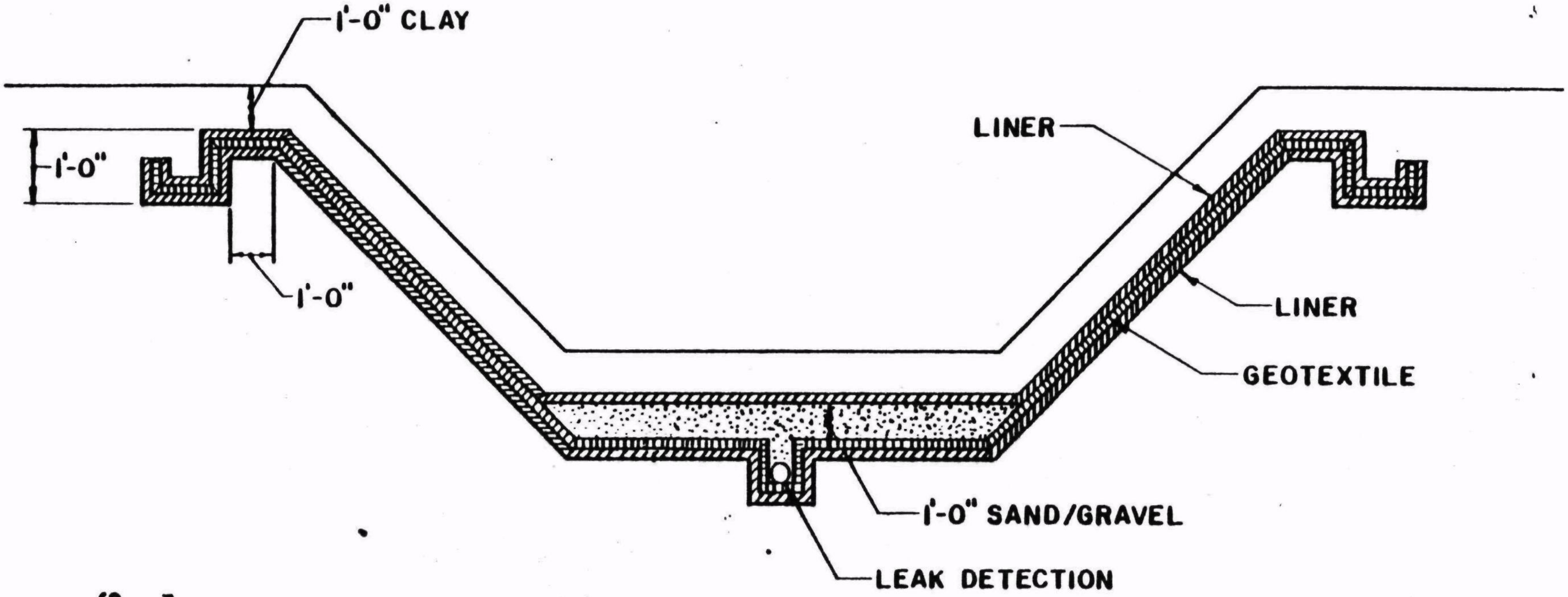
TABLE 4

DELAWARE CITY SOIL ANALYSIS[1]
SAMPLES COLLECTED 11/29/84
SAMPLES ANALYZED 12/17/84 - 12/26/84

Test Pit No.	Sample No.	Depth (inches)	Description	Concentration (ppm) VCM	EDC	TCE
TP-19	1	18	Brown virgin soil	ND	ND	ND
TP-19	2			ND	ND	ND
TP-19	3			ND	ND	ND
TP-19	4			ND	ND	ND
TP-20	1	48	Brown soil with	ND[2]	ND	ND
TP-20	2		traces of white	ND	ND	ND
TP-20	3		soil	ND	Det[3]	ND
TP-20	4			ND	ND	ND
TP-21	1	48	Brown soil, no	ND	ND	ND
TP-21	2		visible powder	ND	ND	ND
TP-21	3			ND	ND	ND
TP-21	4			ND	ND	ND
TP-22	1	36	Brown virgin soil	ND	ND	ND
TP-22	2			ND	ND	ND
TP-22	3			ND	ND	ND
TP-22	4			ND	ND	ND

Notes:

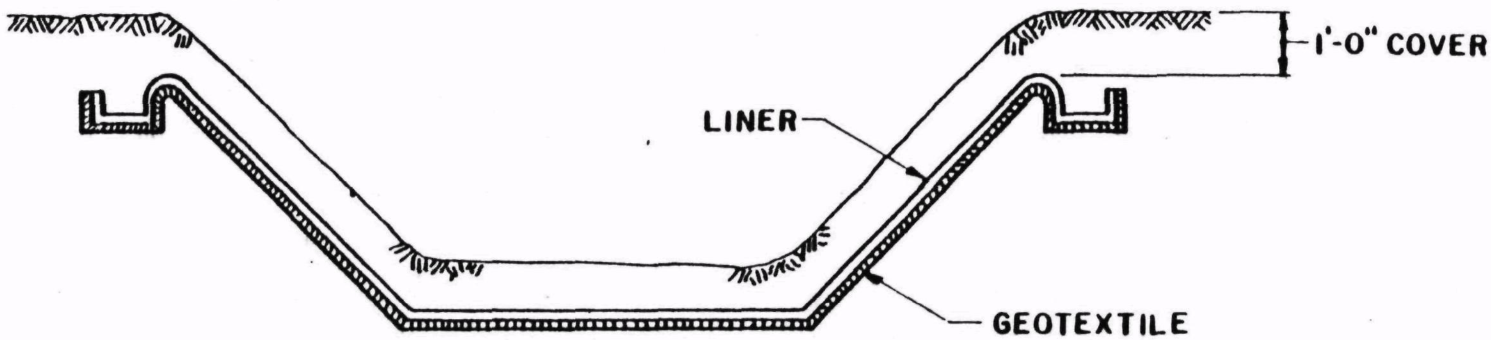
1. Modified version of EPA Method 624 (Disperson of soil in tetraglyme followed by purge and trap gas chromatography with flame ionization detection).
2. ND indicates less than 2 ppm (detection limit)
3. Det indicates less than 6 ppm (lower limit of quantitation)



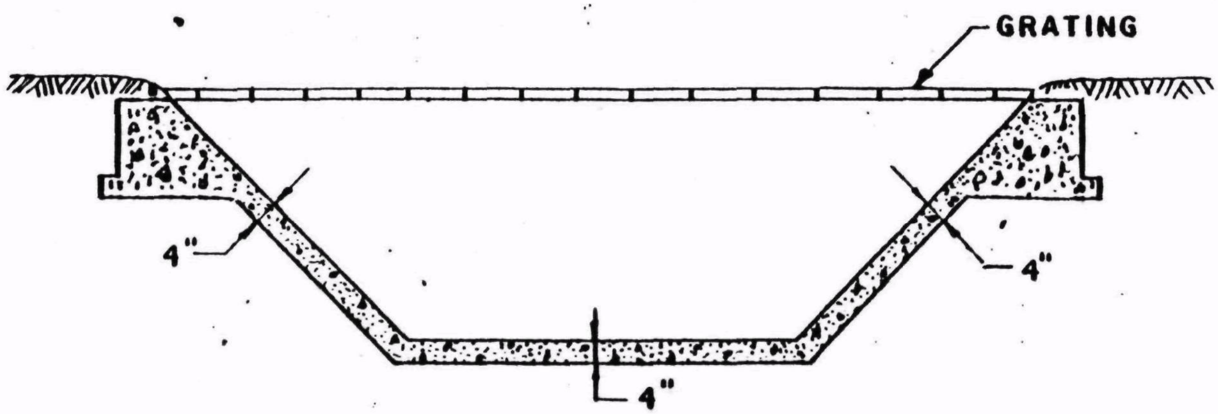
DELAWARE CITY PVC SITE
REMEDIAL ACTION FEASIBILITY STUDY

SYNTHETIC LINED BASIN
(TYPICAL)

FIG. 6



SYNTHETIC LINED DITCH
(TYPICAL)



CONCRETE LINED DITCH
(TYPICAL)

DELAWARE CITY PVC SITE
REMEDIAL ACTION FEASIBILITY STUDY

SYNTHETIC LINED DITCH
AND
CONCRETE LINED DITCH
(TYPICAL)

FIG. 7

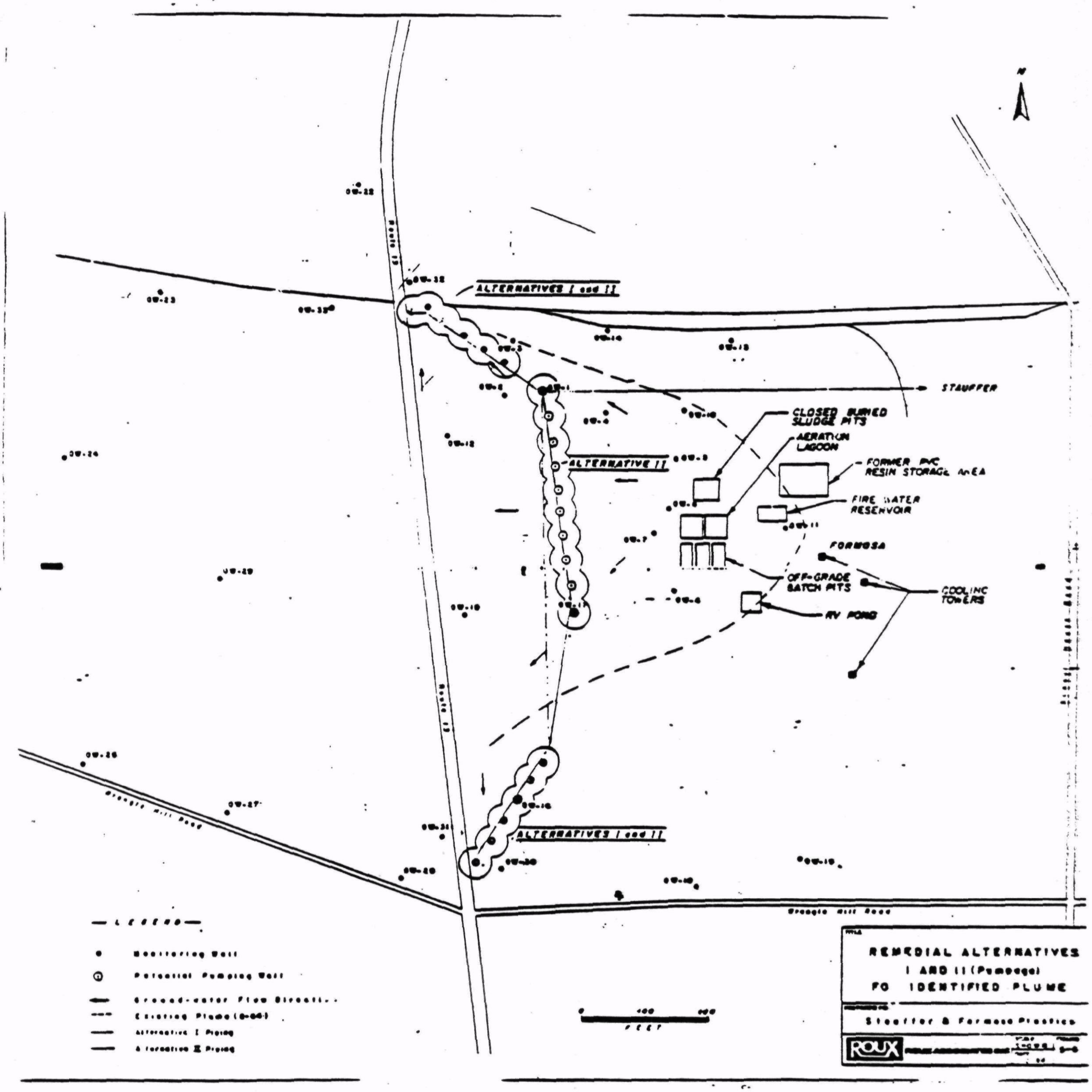
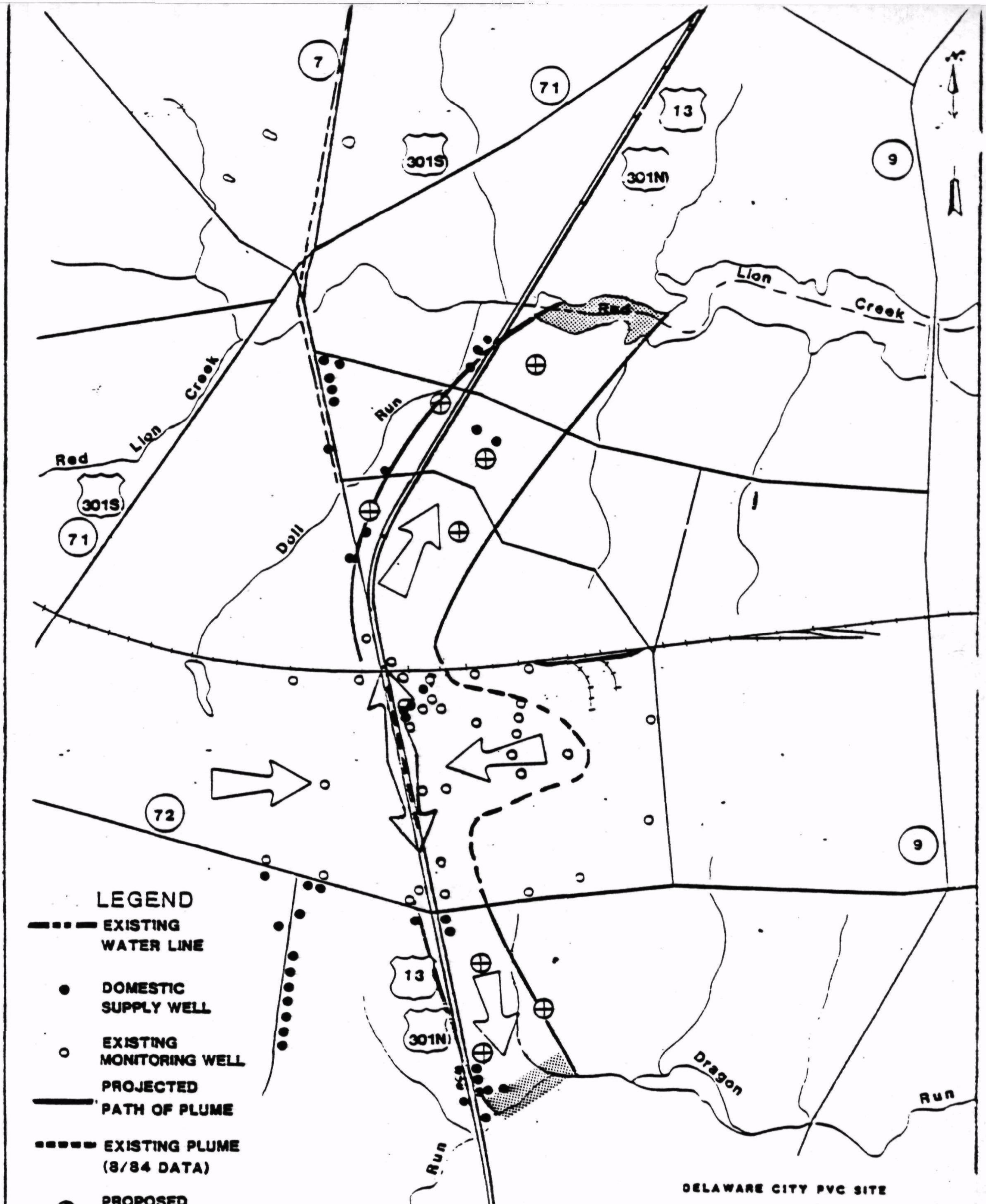

ALTERNATIVES I and II
STAUFFER
CLOSED BURIED SLUDGE PITS
AERATION LAGOON
FORMER PVC RESIN STORAGE AREA
FIRE WATER RESERVOIR
ALTERNATIVE II
FORMOSA
OFF-GRADE BATCH PITS
COOLING TOWERS
RV POND
ALTERNATIVES I and II
LEGEND
Monitoring Well
Potential Pumping Well
REMEDIAL ALTERNATIVES
I AND II (Pumpage)
FOR IDENTIFIED PLUME
FEET
ROUX

FIG. 8



7
71
13
301S
301N
9
Red Lion Creek
Doll Run
72
Dragon Run
LEGEND
EXISTING WATER LINE
DOMESTIC SUPPLY WELL
EXISTING MONITORING WELL
PROJECTED PATH OF PLUME
EXISTING PLUME (8/84 DATA)
PROPOSED MONITORING WELL
EXPECTED GROUNDWATER DISCHARGE LOCATIONS
DELAWARE CITY PVC SITE
REMEDIAL ACTION FEASIBILITY STUDY
ALTERNATIVE III
PLUME MANAGEMENT

FIG. 9

Table 5

DELAWARE CITY PVC SITE
Remedial Action Alternatives

	Source Area		Alternative Description	Present Worth Costs (Recovery of the sludge and disposal at RCRA facility) (I)	Present Worth Costs (Disposal at municipal landfill) (II)	Present Worth Costs (Disposal at RCRA landfill) (III)
)	Off-grade Pits Batch	A)	Excavate, remove sludges, provide double synthetic liner	$ 500,000	$ 455,000	$1,440,000
		B)	Excavate, remove sludges, provide single synthetic liner	450,000*	405,000	1,310,000
		C)	Excavate, remove sludges	460,000*	415,000	1,320,000
2)	RV Pond	A)	Excavate, remove sludges, provide double synthetic liner	250,000	208,000	578,000
		B)	Excavate, remove sludges, provide single synthetic liner	227,000*	185,000	570,000
		C)	Excavate, remove sludges, provide clay liner	232,000*	190,000	575,000
3)	Unlined Ditches	A)	Excavate PVC sludge, provide synthetic liner	----	45,000	65,000
		B)	Excavate PVC sludge, provide concrete trench	----	90,000	115,000
		C)	Install concrete trench (no contamination removed)	87,000	87,000	87,000

* As es[illegible]ated by EPA

Table 5 (continued)

DEL ARE CITY PVC SITE
Remedial Action Alternatives

Source Area		Alternative Description	Present Worth Costs (Recovery of the sludge and disposal at RCRA facility) (I)	Present Worth Costs (Disposal at municipal landfill) (II)	Present Worth Costs (Disposal at RCRA landfill) (III)
4) Aerated Lagoons	A)	Clean, repair	$ 278,000*	$ 225,000	$ 820,000
	B)	Clean, repair, Provide single liner	393,000*	340,000	935,000
	C)	Clean, repair, provide double synthetic liner	425,000	372,000	835,000
5) Closed Buried Sludge Pits	A)	Maintain existing cap (no contamination removed)	15,000	15,000	15,000
	B)	Excavate, remove, regrade, cover, revegetate	----	1,500,000	5,946,000
	C)	Cap (double synthetic membrane), cover, revegetate (no contamination removed)	155,000	155,000	155,000
6) Former PVC Storage Area	A)	Cover & cap (synthetic membrane) contaminated area (no contamination removed)	30,000	30,000	30,000
	B)	Cap (single synthetic membrane) entire area, cover, revegetate entire area (no contamination removed)	180,000	180,000	180,000

* As estimated by EPA

Table 5 (continued)

DELAWARE CITY PVC SITE
Remedial Action Alternatives

Source Area		Alternative Description	Present Worth Costs (Recovery of the sludge and disposal at RCRA facility) (I)	Present Worth Costs (Disposal at municipal landfill) (II)	Present Worth Costs (Disposal at RCRA landfill) (III)
	C)	Cap (double synthetic membrane) entire area, cover, revegetate entire area (no contamination removed)	295,000	295,000	295,000
	D)	Excavate, remove contaminated materials, regrade cover, revegetate entire area	----	65,000	143,000

		Description	Present Worth Costs
Groundwater	A)	Downgradient pumpage to collect ground water at the edge of the existing plume in the buried Valley (includes monitoring)	$ 590,000
	B)	Downgradient and within plume pumpage to collect all contaminated groundwater (includes monitoring)	830,000
	C)	Plume management	1,720,000
	D)	Delaware DNREC Remedial Alternative	2,285,000

* As est ed by EPA

Table 6

DELAWARE CITY PVC SITE

RECOMMENDED REMEDIAL ALTERNATIVES

	Source/Alternative	Capital Cost($)*	O/M ($/Yr.)*	Present Worth($)
1)	Off-grade Batch Pits (Alternative #1-A-I)	$450,000	$5,300	$500,000
2)	RV Pond (Alternative #2-A-I)	$237,000	$1,400	$250,000
3)	Unlined Ditches (Alternative #3-A-III)	$ 55,000	$1,100	$ 65,000
4)	Aerated Lagoons (Alternative #4-C-I)	$407,000	$2,000	$425,000
5)	Closed Buried Sludge Pits (Alternative #5-C-I)	$139,000	$1,700	$155,000
6)	Former PVC Storage Area (Alternative #6-C-I)	$281,000	$1,500	$295,000
7)	Groundwater (Alternative #7-A)	$335,000	$30,000	$590,000
	TOTAL	$1,904,000	$43,000	$2,280,000

*as estimated by EPA

RESPONSIVENESS SUMMARY

DELAWARE CITY PVC SITE
NEW CASTLE COUNTY, DELAWARE

SEPTEMBER 1986

This community relations responsiveness summary is divided into the following sections:

Section I: Overview - A discussion of EPA involvement at the site and a description of the EPA's preferred remedial action alternative.

Section II: Summary of Public Comments Received During the Public Comment Period and Agency Responses - A summary of comments categorized by topic and followed by EPA responses.

Section III: Remaining Concerns - A description of remaining community concerns that EPA and the Delaware Department of Natural Resources and Environmental Control should consider in conducting the remedial design and remedial actions at the site.

In addition to the above sections, a list of EPA community relations activities conducted at the Delaware City PVC site is included as Attachment A of this responsiveness summary.

I. Overview

In 1983, the Delaware City PVC site was included on the National Priorities List (NPL).

In May, 1984, EPA and the Delaware Department of Natural Resources and Environmental Control (DNREC) entered into a Consent Order with Stauffer and Formosa to perform a Feasibility Study (FS) for the site and to implement the Approved Remedial Action. The FS evaluated 18 alternatives for remediating the six identified sources of contamination and four alternatives for groundwater remediation.

Community interest and involvement during the time between the signing of the consent order and the opening of the comment period on the preferred alternative were very limited.

The FS was released to the public for review and comment on July 27, 1986. This marked the opening of the comment period, which extended until September 3, 1986. During the comment period, the EPA and the DNREC recommended preferred remedial alternatives for the six contamination sources as well as for groundwater remediation.

The alternatives are described in detail in Section 5.0 of the FS Report. In summary, the EPA's and DNREC's recommended alternatives for the six contamination sources and groundwater are as follows:

Description of the Selected Remedy:

1. Off-grade Batch Pits - Excavate and remove existing polyvinyl chloride (PVC) sludge and contaminated soils to the levels to be determined at the design stage; install a double synthetic liner, install monitoring wells and perform quarterly sample analysis for trichloroethylene (TCE), 1,2, dichloroethane (EDC) and vinyl chloride monomer (VCM), the contaminants of concern at the site. The excavated material will be directly processed and recovered as a saleable finished product to the maximum extent possible. Non-recoverable material will be disposed of off-site at an approved RCRA facility (est. 1 year).

2. Stormwater Reservoir (RV Pond) - The same remedy as described for the above off-grade batch pits (est. 1 year).

3. Unlined Ditches - Excavate and remove PVC sludge, install a single synthetic liner. The excavated material will be disposed of off-site at an approved RCRA facility (est. 8 months).

4. Aerated Lagoons - Excavate and remove PVC sludge, clean and repair lagoons as necessary, install a double synthetic liner, install monitoring wells and perform quarterly sampling analysis for TCE, EDC and VCM. The excavated material will be recovered to the maximum extent possible and non-recoverable material will be disposed of off-site at an approved RCRA facility (est 18 months).

5. Closed Buried Sludge Pits - Place a drainage layer on top of the existing synthetic cap, and cover with a second synthetic cap (or comparable substitute in compliance with the requirements of RCRA) and topsoil and then revegetate (est. 1 year).

6. Former PVC Storage Area - Cover and cap the entire area with a double synthetic cap (or comparable substitute in compliance with the requirements of RCRA) and then revegetate (est. 6 months).

7. Groundwater - Install a line of six groundwater recovery wells at the northern edge of the contaminant plume, and another six wells at the southern edge. Reuse the collected groundwater in Formosa's plant operations. During periods of low water demand in the plant, treat the groundwater in the existing waste water treatment plant. Install two monitoring wells at the southern edge of the plume. Provide an alternate water supply for existing contaminated wells.

8. Operation and maintenance (O&M) for the remedy will include as a minimum, regular inspections and, as necessary, repairs to the liners and caps. The groundwater recovery system will be routinely monitored to assure that it is capturing the contaminated plume.

II. Summary of Public Comments Received During the Public Comment Period and Agency Responses

Comments raised during the Delaware City PVC site public comment period are summarized briefly below. The comments received during the comment period, July 27 to September 3, 1986, are categorized by relevant topics.

Remedial Alternative Preferences

1. One commentor suggested that EPA and DNREC should consider an alternative which would completely remove all of the contaminants and dispose of them in a separate landfill or appropriate facility. This same commentor was concerned about the preferred alternative leaving contaminants in place for future generations.

   EPA Response - High cost and dwindling landfill space makes landfilling of all contaminated material undesireable when similar environmental results can be achieved by the techniques described. However, EPA will consider total removal before signing the ROD.

2. A suggestion was made to create a common hazardous waste treatment plant or disposal facility for all of the sites in the Delaware City area.

   EPA Response - DNREC answered that at this time, private industry has not indicated an interest in building such a plant.

Technical Questions/Concerns Regarding Remedial Alternatives

1. One commentor questioned whether there is an existing market for refined PVC sludge.

   EPA Response - Formosa Plastics Corporation is currently recovering PVC sludge from the lagoons on site, rather than disposing the sludge as a waste.

2. Who has the final selection authority?

   EPA Response - After considering all relevant comments, EPA will decide which option is most environmentally sound and economically feasible.

3. A question was raised regarding the time frame for cleanup at the site.

   EPA Response - Following the close of the public comment period, EPA will prepare a formal Record of Decision (ROD) identifying the recommended alternative. Subject to the conditions in the Consent Order, the responsible parties will have 30 days to begin implementation of the preferred alternative.

4. One commentor asked what would be left behind after the remedial cleanup is completed.

   EPA Response - Under the preferred alternative, all PVC sludge will be excavated and removed from four of the six contamination sources, including the off-grade batch pits, RV pond, unlined ditches and aerated lagoons. The excavated material will be directly processed and recovered as a saleable finished product to the maximum extent possible. Non-recoverable material will be disposed of off-site at an approved RCRA facility. Synthetic liners will also be installed. The closed buried sludge pits will be covered with a RCRA type cap, and revegetated. The former PVC storage area will be capped with a RCRA type cap and revegetated.

5. Another commentor questioned what would be done to alleviate groundwater contamination.

   EPA Response - Under the preferred alternative, the remedial action would include installing one line of six wells at the northern edge of the contaminant plume, and another six wells at the southern edge. The collected groundwater would be reused in Formosa's plant operations. During periods of low water demand in the plant, the groundwater would be treated in the existing waste water treatment plant. Two monitoring wells would be installed at the southern edge of the plume and an alternate water supply would be provided for existing contaminated wells.

6. One commentor asked how much PVC sludge was estimated to be in the lagoons.

   EPA Response - According to the Feasibility Study, there are approximately 84 tons of PVC sludge contained in the lagoons on site.

7. Formosa Plastics Company commented that it was in agreement with EPA's and DNREC's concept of excavation of sludges and engineering controls to eliminate future contamination, however, it disagreed with EPA's and DNREC's requirement for disposal of excavated material as a hazardous waste.

   EPA Response - It is EPA's policy that all CERCLA-designated hazardous substances be disposed of at a facility in compliance with all requirements of RCRA. In fact, the agency interprets CERCLA as requiring their disposal at a RCRA facility.

8. Stauffer Chemical Company commented that it agreed with EPA's and DNREC's preferred alternative for remediation of the groundwater, however it disagreed with EPA's and DNREC's requirement that the closed buried sludge pits and the former PVC storage areas be capped with a double synthetic membrane cover because it is not cost effective. In the alternative, Stauffer commented that consideration should be given to the use of a soil member having equivilent permeability characteristics as one of the two synthetic membrane members proposed.

   EPA Response - EPA believes that the double synthetic membrane cover is far more environmentally effective and reliable than a single synthetic cap. Given this additional protection and the fact that EPA does not believe that the cost for this alternative far exceeds the cost of a single synthetic cover, EPA believes that the preferred alternative represents a cost-effective remedy for these sources. EPA will consider the use of a soil membrane having equivalent permeability characteristics as the synthetic membrane proposed.

Public Health/Environmental Concerns

1. A question was raised concerning how the EPA and the DNREC can justify leaving carcinogenic materials at the site.

   EPA Response - EPA explained that the major threat to the public exists from migration of the groundwater plume toward receptors. The recovery wells will interest and collect the contaminated groundwater before it reaches the downgradient users. The RCRA caps and liners proposed will prevent further contamination of the groundwater by stopping leaching of these contaminants into the groundwater.

Other Issues

1. One commentor asked if the Stauffer Chemical Company had commented on the preferred remedial alternative.

   EPA Response - Yes, the comments received from the Stauffer Chemical Company are described in this document.

2. A question was raised concerning the Consent Order - is there any clause in the order that prevents Formosa from selling its land holdings, which in turn may compromise the cap and recovery wells?

   EPA Response - Deed restrictions would prevent this.

III. Remaining Concerns

Issues and concerns expressed during the comment period that the EPA was unable to address during remedial planning activities include:

1. Concern was raised about the financial security of Formosa Plastics Corporation and their ability to make assurances that the remedial actions will be carried out to completion and repaired as necessary.

2. Concern remained over how much of the PVC sludge could be recoverable. (It is estimated by Formosa to be 80-85%)

3. The liability of both companies (Formosa and Stauffer) was raised as a point of concern. One commentor recommended that the companies should post bonds to ensure their liability.

Attachment A

Community Relations Activities Conducted at the Delaware City PVC Site

- A press release announced that public comments would be accepted on the administrative consent order, May 1984.
- A press release announced the extension of the comment period on the consent order, July 1984.
- The completion of the Feasibility Study, its availability at local repositories and the opening of the public comment period on the proposed cleanup alternatives were announced in a press release, July 1986.
- A fact sheet identifying the preferred remedial alternatives was prepared, August 1986.
- An informal meeting was held on August 27, 1986 to answer questions and accept comments on the proposed cleanup.