SITE REMEDIAL INVESTIGATION PLAN

1.1 Introduction, Historical Review and Description of the Site

1.1.1 Introduction

The Site was previously utilized as the location of a single cylinder creosote and pentachlorophenol wood treating plant for 22 years. The plant was constructed in 1962 and closed in 1984. Arkwood, Inc. (AI) operated the site from 1962 until 1973. Mass Merchandisers, Inc. (MMI) operated the plant under lease from 1973 to 1984. In January, 1985, the 12 year lease was not renewed by MMI. MMI ceased operations in June 1984 and sold or removed all inventory. The owner dismantled the plant in 1986.

In 1981, detectable levels of pentachlorophenol (PCP) were found in springs and domestic wells in the immediate vicinity of the Site. Reports of the Arkansas Department of Pollution Control & Ecology (ADPC&E) are included in the Hazard Ranking System (HRS) package utilized by the Environmental Protection Agency (EPA) Update No. 4 to the National Priorities List which proposed to add the Site in late 1985 (Appendix A). An Administrative Order of Consent was entered into by EPA and MMI on May 15, 1986. The Consent Order required an RI/FS plan to be developed by MMI for the Site.

A RI/FS Work Plan developed for MMI by Geraghty and Miller, Inc. (GMI) was finalized on December 1, 1986 (Appendix B). The Plan provided a scope of work for the remedial investigation activities at the Site. The stated purposes of the remedial investigation were: (1) to determine the nature and extent of the problems at the Site; and (2) to gather all necessary data to support the feasibility study. The stated purpose of the feasibility study was to develop and evaluate remedial alternatives for the Site. Cranmer & Associates, Inc. (CAI) reviewed the GMI-MMI RI/FS Work Plan beginning in April 1987. It is the opinion of CAI that the RI/FS Work Plan proposed by GMI-MMI included many non-relevant activities which escalated expenses without increasing Site knowledge and contained components which if implemented could pose a substantial and imminent risk to the environment. The GMI-MMI RI/FS contains many factual error regarding NPL listing, ownership and discussions not relevant to implementing a RI/FS. The RI/FS contains references to past clients apparently included by utilizing verbatim segments of previously developed plans for other sites. CAI recognizes, however, that portions of the GMI RI/FS Plan is presented in sufficient detail to be utilized by CAI. In order to reduce costs and minimize delays, CAI will adopt GMI efforts whenever possible. In addition work products cited in the GMI work plan has been utilized whenever possible. For example, the comments by Alan Gates to EPA have been referred to and relied upon. CAI offers the following RI/FS Study Plan as an alternative to the GMI Plan.

1.1.2 Site Location and Description

The Site occupies part of Section 27, T21N 421W located on the Omaha, Arkansas-Missouri Quadrant Map west of U.S. Highway 65, one-half mile southwest of the city of Omaha, Boone County, Arkansas, as shown in figure 1-1. The Site is located at the head of a valley west of U.S. Highway 65, as shown in Figure 1-2. The

Site covers a total of 15 - 20 acres that were used for treating wood with PCP and creosote and storage of treated posts. A branch line of the Missouri Pacific Railroad (MPR) tracks are adjacent to the northern edge of the Site. To the south and west the Site is bounded by the unpaved Cricket Road. An aerial photograph of the Site as it was in February, 1984, is shown in Figure ( ). The acreage was developed in the early 1900's when the MPR excavated to a depth of 40 to 50 feet below natural grade to obtain fill dirt for the construction of railroad embankments.

The Site elevation falls from south-east to north-west along a smooth surface which resulted when the MPR removed the topsoil and after owner/tennant improvements. The Site falls approximately 100 feet in elevation from south-east to north-west. The Site surface has been channeled and little water flows from south to north, although this would have been the case prior to excavation. Excavation resulted in exposing the porous and occasionally cavernous underlying limestone to surface water entrainment. Several sinkholes are evident on the Site. Numerous aquifer channels exist immediately below the Site. A deep cased well with the well pump set at 920 feet is located on the south-west side of the northern end of the Site.

A steep bluff approximately 50' high exists on the lower one half of the north eastern boundary of the Site. A disposal area (pit) on the north-eastern boundary of the Site and next to the railroad tracks was covered with fill dirt in 1986.

The current Site improvements include no intact buildings, several foundations, one shed structure, one deep well, a fence with gate, underground pipes and power poles. Several areas show surface tar and discarded steel band scraps. A sawdust pile is located in the most southern extremity of the excavated area. A quantity of tires and steel belts (after burning) are located on the south end extremity.

1.1.3 Historical Review

A summary of the reference documents available for detailed study is included as Appendix C. Figures showing the sampling locations used for all sampling events on-Site and off-Site have been included as Figures ( ) and ( ), respectively. The location for each sampling point has been numbered and identified by name. The locations are listed by number and name in the tables that present the relevant data.

Since cessation of Site operations, there have been a considerable number of investigative activities to determine the impact of the Site on the surrounding environment. These activities have included Site residue characterization and sampling of known springs and wells within 3 miles of the Site. Analysis of this data suggest that an improvement of off-Site Areas appears to be developing since cessation of Site operation. In addition, an imminent and substantial risk to man and the environment does not exist.

Overview of Site Investigations

The MMI operation of the Site was the subject of an inspection on May 19, 1981, by a representative of the ADPC&E and the Boone County Sanitarian. The inspection resulted from a complaint filed by Missouri Pacific Railroad with the ADPC&E concerning spring water contamination in the railroad tunnel adjacent to the Site.

In October, 1981, MMI retained MCE to assist MMI in bringing the Site into compliance. MCE began the collection of ground-water quality data relating specifically to the Site.

Analytical data from samples taken by MCE are presented in Appendix D and indicate that contamination of the ground water by PCP was present in 1981. Contamination of the type found on the Site was found off-Site in Cricket Spring Channel west of the Site, in three domestic water supply wells, and in a spring to the east inside the railroad tunnel.

On October 22, 1981, representatives from MMI met in Little Rock with the ADPC&E and a representative from MCE. The outcome of the meeting was to develop a plan to study the problem. The plan was to be developed by MMI and MCE. The plan was to: (1) outline the problem areas; (2) propose a plan of action to correct the problem; and (3) contain a schedule of activities for implementing the identified corrective actions. This schedule was submitted to ADPC&E in December, 1981.

Monthly ground-water sampling was initiated in May 1982. Modified Standard Operating Procedures (SOP's) were designed to permit MMI to reduce the quantity of oil, creosote, and PCP being released to the environment. In May, 1982, MMI-MCE submitted a report to ADPC&E outlining the modified Standard Operating Procedures for the Site. Actions taken in August, 1982 included: (1) pouring a concrete pad over the "Sinkhole"; (2) constructing a concrete drip pad in front of the treating cylinder; and (3) grading the area around the drip pad to impede rainfall runoff from entering the process area.

In July, 1982, Thomas Millard, an independent consultant, was retained by MMI to make a preliminary assessment of the Site-specific geology as well as the direction of the ground-water flow. Mr. Millard issued a rough draft report briefly describing the Site-specific geology (July 2, 1982, correspondence from Thomas Millard, Appendix E), as well as stating that the ground-water flow is predominately to the west, following the regional dip of the outcropping limestone.

In the summer of 1982, MMI had a new water supply well drilled for Mr. Behrens, to replace the well that had shown contamination by PCP during earlier sampling events by MCE. The well completion report was forwarded to ADPC&E in September, 1982. The only action at the Site was continued ground and surface water sampling by MCE for the remainder of 1982, all of 1983, and the first several months of 1984.

R. David Orr arrived on June 19, 1981 at the plant accompanied by Mike Youngblood, Boone County Sanitation, Arkansas Department of Health. They met Mr. Roy Horn and told Mr. Horn about the complaint that was received concerning "bad looking water coming from a spring inside a railroad tunnel adjacent to the property". They asked for a brief tour of the treatment process.

The treatment process involved steam pressure treatment with pentachlorophenol and creosote on a four-day cycle. After treatment, the wood posts were piled in small groups to cure. No means of containment was observed below the piles. Several pools of blackish water were observed on the property and adjacent to the property along a railroad right-of-way.

After the tour of the treatment process, the men drove along the railroad tracks to a tunnel where a repair crew was repairing tracks. There, the men were met by Mr. Gary Benham, Motor Car Operator. Inside the tunnel, they observed a spring flowing from the north side which discharged through metal pipes. The water appeared clear. Further inside the tunnel, another spring flowed about 30 feet above the tracks. The water appeared somewhat clear but further down the ditch, it formed an oil film on the surface and stained the walls and dirt surfaces. On the east side of the tunnel, more oil film was observed which collected in pools. The drainage flowed off the railroad track right-of-way into a large pool of water with a thick brownish oil film on top. Further study showed that this creek flowed into Barren Creek.

Samples were taken on the east side of the tunnel (sample #1), inside the tunnel at the west end below westside spring on the south side (sample #2) and at the spring on the north side of the tunnel (sample #3). The following are the results of analysis of these samples for pentachlorophenol:

Sample #	Log #	Description	Pentachlorophenol
1	24503	East Side of Tunnel	8.56 mg/l
2	24504	Inside Tunnel at Westend	2.1 mg/l
3	24505		not detected

The Site was notified under RCRA as a generator of hazardous waste. Mike Bates of ADPC&E visited the site on October 5 and 6, 1981, for the purpose of conducting an interim status standards inspection and to follow-up the initial complaint.

MMI of Harrison operated the Site. MMI representatives Bob Barker and Devoe Gregory of the Wood Products Group supplied background information during a meeting on October 6, 1981.

According to Mr. Barker and Mr. Devoe, the waste from the wood treating operation was dumped into a cave at the treating plant from the beginning of the operation until around 1970. The cave was then covered by boarding the entrance and covering it with a layer of dirt (the entrance is flush with the ground surface). As of October 5, 1981, the waste consisted of the wash down of the treatment room floor and the cleaning of the treatment cylinder between the use of pentachlorophenol and creosote. These wastes were accumulated in a tank and then sprayed over the storage yard for use as dust control. Mr. Barker estimated that MMI generated

approximately 500 gallons/year (6000-7000 lbs/year) of these wastes. Steam was also used in the treatment process, the steam was said to be reused in the process. Some of the steam was bled off to discharge behind the office building adjacent to the Missouri Pacific railroad.

The Site could have been classified as a Small Quantity Generator, according to the generation amounts furnished by Mr. Barker, if MMI had disposed of their waste properly. As of October 5, 1981, the Site was disposing of their waste improperly by spreading the material for dust control and by dumping it in several places at the northeastern end of their property near Highway 65. The frequency of these "dumpings" were approximately every three weeks according to a Roy Horn, treatment plant manager. The area around the treatment plant was saturated with the treatment chemicals. There were pools of oily material around the treatment cylinder and the storage tanks. The tanks were not diked (with the exception of the raw pentachlorophenol storage tank) nor was there any type of containment to prevent the washing of the oily substances off-Site during rains. The storage yard where the treated wood products were taken to "cure" was saturated in many areas with what appeared to be the treatment chemicals leaching from the wood products. Mr. Horn indicated that this saturated soil was scooped out periodically and piled up along the entrance road when the storage areas got too mushy to operate the machinery.

The steam bleed-off discharge mentioned previously existed on the slope behind the office building. The slope below the discharge pipes was oil stained; at the base of the stained area there was an impoundment which contained a black oily looking liquid. Mr. Horn had said that nothing had been discharged through the pipes except steam and that nothing had been put in the impoundment for years. The impoundment was approximately 15' X 40', depth unknown. There was approximately 2' of freeboard with no evidence of overtopping. The impoundment was located adjacent to the Missouri Pacific railroad approximately 400' northwest of the railroad tunnel mentioned in the initial complaint.

The tunnel was situated in a northwest/southeast line and is approximately 1/2 - 3/4 of a mile in length. There had been a construction crew working on the northwest entrance of the tunnel to widen it. Their work had reportedly involved a considerable amount of blasting. Gary Benham with the construction crew accompanied Mike Bates into the tunnel on October 5, 1981. There were three springs inside the tunnel; the first of which (approaching from the northwest) was located about halfway through the tunnel on the northern side. The other two were located in the southeast one third of the tunnel, discharging from the south side of the tunnel. The first two springs discharged through pipes imbedded in the tunnel wall approximately 20-30' above the tracks. The southeastern most spring broke out near the roof. Mr. Benham stated that the crew complained that the spray from the springs burned their eyes.

The water in the ditches along the tracks was brown in color and had a dark brown to black film on the surface. The tunnel walls and sides of the ditches were oil stained. Both ditches showed signs of contamination, however, the southern ditch appeared to be more heavily contaminated.

The southern ditch flowed southeasterly from the tunnel for about 1000' before it dropped off into a depression formed by the points of two ridges interecting the railroad. The trees growing in the bottom of this depression had oil stains on them up to 12' above the present level of the water (with oil film). This depression was the receiving point of three drainage patterns. Mike Bates did not observe a drainage point under the railroad. This depression could possibly have been a sinkhole. Mark Witherspoon of ADPC&E agreed with Mike Bates about this possibility but indicated that a closer study would be needed to confirm it.

The northern ditch also flowed in a southeasterly direction for about 1000' before turning north and dropping sharply to intersect Walnut Creek on the eastern side of the railroad. The tunnel springs appeared to be supplying most of the water in Walnut Creek as of October 5, 1981. The creek bed was dry approximately 600' downstream from the point where the tunnel spring water intersected with the creek. The rocks in the dry bed of Walnut Creek were tinted brown whereas the rocks of an intersecting intermittent stream from the northeast (dry also) were not. This could have been an indication of the past flow of contaminants down Walnut Creek.

There were approximately 14 homes which used individual wells as drinking water within a mile radius of the Site, assuming that all of the residences within the city limits were on city water and discounting the homes along Highway 65 which should also have been on city water.

The Omaha city water supply is a well located in the NE1/4, NE1/4 Sec. 27T21NR21W, inside the city limits near the Post Office. This well is also within one mile of the Site, the total depth of the well is 1315' with a casing depth of 60'. The only well water sample taken had been from the Site. The depth of the Site well was unknown, however, Mr. Horn stated that the pump (submergable) was set at 920'.

ADPC&E received another complaint from a representative of the railroad who charged that a wood treating plant near Cricket was letting liquid wood preservatives out of a holding area and that the material was getting into a railroad tunnel. The complaint also stated that railroad people were getting sick from the fumes in the tunnel. This complaint was considered by Mike Bates to have some validity. There were definitely wood treating chemicals getting into the tunnel, however, as stated earlier, Mike Bates did not observe any discharge or evidence of the overtopping of the dikes of the impoundment below the Site. The railroad people may have been getting sick from fumes inside the tunnel, but Mike Bates thought that the fumes most likely came from the train engine exhaust, especially since the trains had to travel at a slow speed through the tunnel (complaint reported 10 mph).

Mike Bates considered this situation to be a serious threat to the groundwater and surface water quality in the area. The representatives of Arkwood were said to have voiced their willingness to cooperate and do what was necessary, within their means, to alleviate any environmental damage stemming from their operation. In Mike Bates' opinion, there were several things that should be accomplished.

1. Seal the on-Site cave, with concrete or other water tight material, to prevent any contaminants from entering it.

2. Cease the on-Site dumping or spreading of wastes fom the treatment process.

3. Clean up all contaminated soil on-Site and properly dispose of it.

4. Establish drip pads and runoff containment from the treated wood products storage area.

5. Eliminate any oily discharge and close out or maintain the impoundment according to RCRA (if it contains a hazardous waste).

6. Determine the source of contamination inside tunnel and implement measures to correct it.

7. Clean up all off-Site contamination.

8. Sample residential wells in the area for presence of contaminants.

The following are the descriptions and results from analysis of samples taken at the Site on October 6, 1981.

DESCRIPTION OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample No.	Description
Arkwood - 1	Dump area - sawdust and oily material - black - approximately 350' NW of Highway 65 near NE property.
Arkwood - 2	Dump are - sawdust and oil material - black - approximately 100" SW of Arkwood - 1.
Arkwood - 3	Water from drainage pipe leaving property NW of office - light brown - foamy.
Arkwwod - 4	Water from office - (well on Site) - pump set at 920'.
Arkwood - 5	Water from Walnut Creek.
Arkwood - 6	North RR ditch (SE of tunnel) where 't drops to Walnut Creek - water
Arkwood - 7	South RR ditch directly across from Arkwood - 6 - water.
Arkwood - 8	Discharge behind Arkwood office - water.
Arkwood - 9	SE corner of impoundment below Arkwood - 8 - sediment.

RESULTS OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample Description	Pentachlorophenol detected (ppm)
#1: On-site dump - sediment	30,000
#2: On-site dump- sediment	23,000
#3: Discharge pipe - water	18
#4: On-site well - water	<0.01
#5: Walnut Creek - water	2.8
#6: Railroad ditch - water	3.4
#7: Railroad ditch - water	2.0
#8: Steam discharge - water	21
#9: Impoundment - sediment	5600

Monthly sampling events by MCE continued at the Site until January, 1985. All the analytical data generated by these and subsequent sampling events were provided to the ADPC&E by MCE.

In February of 1985, GMI was retained by MMI to conduct a preliminary hydrogeologic investigation of the Site. The investigation was carried out in April 1985 and consisted of: (1) water quality sampling of wells, springs and streams; and (2) soil borings in the Site. Soil boring locations were selected and boring was attempted using hand-held augers. These borings were of limited effectiveness due to the extreme difficulty of sampling with a hand-held auger in soils characterized by clays and chert. Water samples were collected from a large number of wells in the vicinity, and the elevations of the measuring points were surveyed. Unfortunately, the analytical results were not considered to be valid (the samples were not analyzed by the laboratory within holding time limits) and were not reported by the laboratory. These problems were avoidable and indicative of inattention. Any RI/FS must provide mechanisms to ensure that such errors do not recur. This is especially true when activities such as boring holes through the Site strata which acts as an aquitard.

In May, 1985, sampling at the Site was conducted by McKesson Environmental Services, Inc. (MES). The samples were analyzed for organic priority pollutants. The data from this sampling event has been included as part of Table ( ). This was the first sampling event that including sampling and analysis of sludges, ground and surface water for other than PCP content. Analyses included PCP, polynuclear aromatics

(PNA), chlorinated volatile organic compounds (VOA-CL), and volatile aromatic compounds (VOA-AR).

Sludge and soil samples collected during this sampling event exhibited varying concentrations of PCP and PNA compounds. PCP was detected at the parts per million (ppm) Cricket Spring channel. PNA concentrations at the parts per billion (ppb) level were detected in the Birmingham well.

On May 15, 1986, MMI entered into an Administrative Order on Consent with Region VI of the Environmental Protection Agency (EPA). A RI/FS Work Plan was prepared for MMI by GMI in accordance with that Consent Order.

On December 1, 1986, GMI developed a RI/FS paln.

On May 6, 1987, CAI took samples at the Site.

On June 1, 1987, CAI developed an alternative RI/FS Plan.

1.1.4 Criticism of GMI-MMI RI

The objective of the GMI-MMI Remedial Investigation (RI) was stated by GMI to be to determine fully the nature and extent of the threat to public health, welfare or the environment caused by the release or threatened release of pollutants from the site. Unfortunately, the (RI) plan offered by GMI-MMI does not meet the stated objectives. In addition and most importantly, a substantial risk to the environment is posed by some of the plan's activities (many penetrations of underlaying strata). The primary objectives defined by GMI- MMI for the RI and some of the more obvious reasons why the work plan falls short follows:

Objective: To characterize the wastes present at the Site, including identifying the locations and probable quantities of subsurface wastes through the use of geophysical methods.

Shortcoming: Geophysical methods are ancillary and will not provide either a qualitiative or quantitative description of organic wastes on the Site, such as creosote or pentachlorophenol (PCP). Webster defines geophysical as relating to, or based on geophysics and geophysics as the physics of the earth including the fields of meteorologoy, hydrology, oceanography, seismology, volcanology, magnetism, radioactivity and geodesy. None of these disciplines are directly applicable to the determination of type or quantity of organic wastes.

Objective: To evaluate the hydrogeologic conditions at the Site, including identifying all local aquifer and aquitards.

Shortcoming: The area of the Site is laced with sinkholes and a honeycomb of connecting passageways. The Railroad removed all the topsoil and exposed the limestone base over 50 years ago. It is impossible to identify all local aquifers and aquitards. Even if this goal were realized, it should be appreciated that there would be

little benefit in that any penetrations (wells) or excavation would/could alter the aquitards and therefore the aquifers.

A more reasonable approach is to determine, in a non-destructive way if possible, the major aquifer potentially affected by residues from plant operations.

Objective: To determine the horizontal and vertical distribution of ground-water contamination in the aquifers beneath the site.

Shortcoming: It is very likely that these goals can be met in a substantial way without additional description of the aquitard; however, it is not the aquifer under the Site which is of major concern. The aquifer radiating from the Site is of major concern.

1.5 Description of Wood Treatment Techniques

The GMI-MMI RI/FS work plan description of Site Operations and Practices contains substantial errors with respect to the operation of a wood treatment plant utilizing pentachlorophenol (PCP) and creosote. Therefore, the following discussion is offered as an explanation of the processes utilized by the wood treating industry in general and AI and MMI in specifics. The discussion is relevant to practices through 1984 when MMI discontinued operations.

Wood preservatives used at the Site were oil-based mixtures of either pentachlorophenol or creosote. These mixtures were used to treat wood for the prevention of decay and deterioration which occurs as a result of weather, soil conditions, or the infestation by organisms such as insects and fungi.

Coal tar creosote came into use for wood treatment in 1839 with the development of the Bethell full cell pressure treatment process. The lumber or posts are enclosed in a cylinder and subjected to an initial vacuum to remove air and water from the wood cells, followed by injecting creosote into the wood under pressures varying from 125-200 pounds per square inch (PSI) at temperatures of 180-210°F. Treatment continues until the wood is saturated with creosote. Pressure is then released, the cylinder drained, and the wood removed.

Treatment processes relevant to the Site (the Lowry and the Reuping) were developed in the early years of this century. These are empty cell treatments in which the excess preservative is removed from the wood cells when a final vacuum phase is added to the process, leaving the wood cells coated rather than filled with treatment solution. Since less preservative was used, overall treatment costs were significantly reduced.

In the Lowry Process, the preservative is injected into the wood in the treatment vessel under high pressure and temperature conditions. The air naturally present in the wood is compressed in the injection process. To complete the treatment process, the pressure is released and the cylinder drained. The excess preservative is forced out of the wood by expansion of the compressed air. The only major variation in the Reuping Process is an initial application of pressure in the range of 25-75 psi prior to flooding the cylinder with creosote.

Solutions of creosote with crude coal tar or petroleum oils are effective and less costly for wood treating. As a result, creosote pressure applications by the empty cell method have predominated in the railroad industry since the 1920's.

Pentachlorophenol (PCP) was available for use as a bulk wood preservative since 1947 for commercial wood preservation purposes. It is applied in heavy to light petroleum carriers or solvents by pressure methods similar to those used for creosote treament.

The described treatment chemicals are commonly used for utility poles, lumber, posts and numerous other wood products. Few if any railroad ties are treated with PCP because it imparts brittleness to the wood causing excessive wear and splitting from the repeated compression and expansion.

In 1981, 98% of wood treating done commercially in the United States was by the pressure process. AI and MMI used the pressure process. All pressure treatment processes are conducted with similar equipment and techniques. The wood to be treated is loaded onto trams. They are connected in series to fit the length of the cylinder. They are pushed into the cylinder. The cylinder is sealed via a pressure-tight door and the treatment cycle is initiated. The total length of time for treatment varies with the specific type of wood preservative solution, process, end-point product use, and other factors such as wood moisture content. At the end of the cycle the treating solution is pumped to storage tanks for later re-use, the door is opened, and the treated material on tram cars is pulled from the cylinder. The tram cars are moved to a transfer point and the wood is off-loaded and stacked for storage and/or shipment. The length of time between withdrawal from the cylinder and off-loading can vary from a few minutes to a day or more.

Most of the wood products utilized for the pressure processes must undergo some form of pretreatment to reduce moisture to a predetermined percentage of residue. This improves the service life of the preservative chemicals and permits the wood to accept the treatment solutions in sufficient concentration to meet performance specifications. A method of pretreatment available at the Site was a steam and vacuum treatment. Steam conditioning was followed by a vacuum to remove the excess moisture. The process was commonly used for pretreating southern pine during either the creosote or PCP oilborne preservative systems.

The full cell treatment process is only used with creosote when maximum preservative retention is required. The empty cell processes control the quantity of preservative retained in the wood and provide a better penetration depth with a cleaner surface.

Creosote remains the primary wood preservative used in the United States. It is defined by the industry today as a distillation product of coal tar produced by the high temperature carbonization of bituminous coal. It has a boiling range of 390°F to approximately 750°F. Other quality control specifications such as specific gravity, water content, etc. have been established by the industry. Creosote is composed principally of higher molecular weight aromatic hydrocarbons in addition to tar acids

and bases. This preservative has 200 or more identified components, but less than 20 are present in amounts exceeding 1%. It is estimated that 10,000 or more compounds are present in creosote. Compositions vary with batch lots, depending on the coal source and production conditions. The major components of typical samples are phenanthrene (21%), fluorene and fluoranthrene (each 10%) and acenaphthene and pyrene (each about 9%).

Creosote is used directly or in combination with coal tar or petroleum oil. Commonly, it is mixed with a "topped" coal tar to increase the heavy aromatic content and toxicity to soil or marine organisms in addition to other physical or chemical properties desired of wood treatment. "Topped" coal tar has had the light boiling fraction removed by distillation. The percentage of "topped" coal tar used varies from 20-50% to the final product blend. Higher costs of petroleum and related products have affected blends of creosote/coal tar or petroleum solutions are blended to meet the AWPA specifications. It can be done at the treatment plant, but typically is purchased premixed.

The quantities and types of wood products treated in 1981 with creosote solutions are as follows:

Poles	1,129,000 number
Crossties	32,862,000 number
Lumber and Timbers	113,048,000 board feet
Fence posts	6,568,000 number
Pilings	18,422,000 linear feet
Switchties	76,757,000 board feet
Crossarms	93,000 number

In the late 70's methods were developed for pressure treatment which utilized volatile solvent-carriers. The Cellon® Process is done with liquified petroleum gas (LPG) extraction followed by pressure application of PCP on diisopropyl ether. The Dow® Process used methylene chloride as the solvent-carrier for pentachlorophenol. Both provide a cleaner non-oily surface lighter in color and more aesthetically acceptable.

Creosote solutions are usually applied alone. However, they may be used as part of a dual treatment system where specific additional preservative properties are needed. Mixtures of creosote and other preservatives have been used in the past, but are not currently used in commercial operations. Creosote containing 2% PCP has increased toxicity to soil organisms, but creates corrosion problems with treating equipment. As a result, its use is very limited.

Pentachlorophenol use became popular in the mid 1960's and became the second most commonly used wood preservative in the United States by the 1980's. Records indicate that 39,730,000 pounds of dry PCP was used in 1979. This does not include the sodium salt form used for dip and spray applications to green lumber. PCP is used primarily as a 5% solution in petroleum solvent carriers to treat poles, crossarms, lumber, timbers, fence posts, and other applications where a clean, paintable surface is not required. The petroleum carriers most commonly used for these purposes are the P-9 Type A or Type C oils. Type A is a light oil similar to diesel fuel. Type C solvent is a petroleum fraction with a boiling range comparable to mineral spirits. In a few specialized applications, a wax water-repellent has been added with PCP in a solvent carrier, such as Type C oil.

In the early 1980's use of PCP with more volatile solvents, which quickly evaporated from the wood after impregnation, gave a cleaner, less colored, and paintable treated surface. The most common of these is a combination of LPG and ether, licensed by Koppers Company as the Cellon Process. Another volatile solvent system, P-9 Type D uses methylene chloride by the Dow Process. Both of these processes, while providing excellent results for ground contact application uses, accounted for only a very small fraction of the total PCP treatments.

Only three companies manufactured PCP in the United States in 1981. They were Dow, Reichhold, and Vulcan Chemical. PCP was produced in flake form or as 1,000- and 2,000-pound (cylinder shaped) blocks. Some commercial sources also supplied PCP already dissolved in oil solutions delivered by tank truck to treating plants. MMI purchased PCP as oil solutions.

At larger plants, the block PCP is typically dissolved in oil or solvent in the treating cylinder or tank, diluted to the final use concentration, and then pumped to storage. Automated feed hopper silo systems are available for flaked PCP. It is fed from bulk storage mechanically to the mix tank, oil is added, and the mixture heated to dissolve the PCP. After Quality Control checks, it is pumped to storage for use as needed. Manual dumping and mixing of flake PCP from bags only occurs at smaller treatment operations for limited additions to solutions to bring PCP concentration up to the required minimum strength. Al only used sacks of flaked PCP.

Commercial PCP manufacturing results in the formation of secondary reaction contaminants such as the tri- and tetra- chlorophenol isomers, chlorinated dibenzodioxins, dibenzofurans, and phenoxyphenols. To a much lesser extent, this is also true of the Dow Chemical, Dowicide EC-7. This has been specifically processed to remove most of the side reaction dioxin compounds of environmental and occupational concern. Compositional data on PCP and the Dowicide EC-7 are shown in the table below.

COMPARISON OF COMPOSITION OF COMMERCIAL GRADE AND PURIFIED GRADE PENTACHLOROPHENOL (PCP)

Component	Commercial[a] (Dowicide 7)	Purified[b] (Dowicide EC-7)
Pentachlorphenol	88.4 %	89.8 %
Tetrachlorophenol	4.4 %	10.1 %
Trichlorophenol	0.1 %	0.1 %
Chlorinated phenoxyphenols	6.2 %	---
Octachlorodioxins	2500 ppm	15.0 ppm
Heptachlorodioxins	125 ppm	6.5 ppm
Hexachlorodioxins	4 ppm	1.0 ppm
Octachlorodibenzofurans	80 ppm	1.0 ppm
Heptachlorodibenzofurans	80 ppm	1.8 ppm
Hexachlorodibenzofurans	30 ppm	1.0 ppm

[a]Sample 9522 A
[b]Technical grade PCP reduced by distillation

Because of increased costs for the PCP distillation, Dow Chemical discontinued the manufacturing of the EC-7 product line. The EPA Position Document-4 on Wood Preservative Pesticides (July 1984) discusses the chemical industry's ability, but resistance to producing an environmentally safe product. This reluctance has indirectly contributed to the potential problems at the Site.

Creosote and Solutions of Creosote

Creosote is a distillate fraction from coal tar, a by-product in the conversion of coal to coke, which is used in the manufacture of steel. However, the chemical distillate creosote is a coal-derived product with a specific boiling range of 300° to 700°F.

In commercial wood treatment plants, the distillate material can be used solely but, in most treating operations, creosote is blended with coal tar, tar bottoms, and/or heavy oils; these may be of coal or petroleum origin. Although all are referred to as creosote, there are significant compositional variations between plants. The coal utilized in the coking process can also affect both the composition of the coal tar and creosote derived. No specific details are available through the literature or industry sources.

There is a substantial body of compositional and general information available on creosote distillates and commercial blends used in wood treatment processes (Lorenz and Gjovik, 1972 as cited in EPA PD-2/3 on Wood Preservative Pesticides, 1981). It is known that they contain some of the aromatic amines and nitrogen compounds of occupational concern for latent health effects, such as skin, lung or bladder carcinomas. Sulfur compounds are also present, but little data is available on concentrations in creosote. These have been shown by some investigations to act as accelerators or promoters of the carcinogenic process in laboratory animal studies (Norton, 1961; Lijinsky, 1957).

Data on the composition and distribution of aromatic and polynuclear hydrocarbons indicates a significant percentage of the 3 to 5-ring fused compounds (Lorenz and Gjovik, 1972; Combes, 1954). While many have been specifically identified, there is a paucity of quantitative data on the two most potent carcinogens of these chemical groups; i.e., benz (*a*) pyrene and dibenzanthracene.

The variety of blended materials used for creosote treating would realistically preclude quantifying the range of these specific known carcinogenic compounds in the commercial mixtures. More importantly, this type of specific PNA analysis in the past has not provided a more reliable index of potential skin contact or inhalation hazard than total benzene extractable organics because individual compounds in the creosote mixtures, independently or in combination, can act as carcinogens directly, or as accelerators, promoters, and carcinogenic inhibitors.

Direct skin contact with creosote, if not properly removed, results in chemical burns . The Pesticide Exposure Response System of EPA contains a number of reports of skin erythema and frequent chemical burns in personnel handling creosote-treated wood products. Skin burns and allergic reactions from creosote contact have also been reported in a survey of the accident history of fifty pressure treating plants (Johnson, 1978a; McMillian, 1976).

The occupational limits in use as a guide for health risk control purposes are based on composition and uses, boiling range and plant experience. This conservative approach is based, in part, on historic human experience related to the compounds and mixtures present in creosote, and on slack wax and other industries and occupations (Mauro, 1951; Shambaugh, 1935; Combes, 1954).

A number of occupational exposure surveys to creosote materials in wood treating operations have been conducted. Some were NIOSH Health Hazard Evaluations (Markel *et al.*, 1975, 1977). Others done in late 1978 and 1979 by the wood treating industry were in response to the EPA-RPAR on the wood preservative pesticides. Generally, the data indicate that most personal exposures do not routinely exceed the current coal tar pitch volatile (CTPV) occupational standard of 0.2 mg/m^3. There were a few high values reported which the investigators felt were due to sample contamination. All the creosote exposure data generated in both the Health Hazard Evaluations and industry studies utilized the NIOSH cyclohexane extraction gravimetric procedure. That data indicates the personnel most exposed are those working adjacent to the pressure cylinders during the opening, wood removal, and re-filling tasks. Other more remote personnel assisting in loading and unloading, sorting timber, etc., appeared to have less exposure, and these were consistently well below the limits for benzene soluble airborne particulates.

Creosote is commonly handled and controlled occupationally as though similar to coal tar in health effects as a contact irritant, photosensitizer, and potential carcinogen with routine, prolonged contact, or inhalation. There is neither positive nor negative human experience data in the wood treating industry to indicate that additional or less restrictive exposure control is appropriate.

Pentachlorophenol

The composition of technical grade PCP is approximately 90% pentachlorophenol. The tri- and tetra- homologs comprise most of the remaining 10%. Dioxins and dibenzofurans have also been quantified as side reaction products, however, they are present at less than one percent (Buser and Bosshardt, 1976; Johnson, 1978c).

The acute toxicity effects reported from plant experience with PCP exposure are basically attributable to the pentachlorophenol and the tri- and tetrachloro isomer secondary reaction products rather than the dioxins or dibenzofurans. The material used in the treatmen plant has been shown to be toxic by both inhalation and dermal absorption in addition to its skin irritating and photosensitizing properties.

A number of acute occupational and non-occupational cases of poisoning have occurred, several of which have been fatal (Gordon, 1956; Menon, 1958). The acute cases documented have occurred in applications where there was significant contact and/or close proximity to obvious airborne sources such as when spraying solutions of pentachlorophenol for wood preservative surface treatment and in dipping operations. Most incidents predate the mid 1960's. A later documented acute epidemic also occurred when the material was inadvertently used as a disinfectant (Armstrong, 1969). In that instance, the symptoms which occurred were from skin absorption and resulted in the death of two infants. Other short-term effects published include eye and upper respiratory irritation from the emissions of hot treating solutions.

Severe dermatitis and neurological disturbances have been noted in humans from chronic skin or inhalation exposure. Typically, the first symptoms are bronchitis and/or chloracne. Generally, when chronic symptoms occur, the recovery time is lengthy and can require up to a year (Baader and Bauer, 1951). Other medical problems which have been reported in man are reduction in libido and central nervous system effects. The latter are somewhat less certain since, in most instances, the exposures were not exclusively to PCP (Campbell, 1952).

The symptoms observed in man from excessive acute or chronic occupational exposures and accidental poisoning have basically been duplicated in animals (Deichman, 1942; Knudson, 1974; Goldstein, 1977). The commercial product has been shown to be highly toxic by ingestion, inhalation, skin contact, and absorption for several species. There are no animal data indicating that technical grade PCP is carcinogenic. Studies have been done at dietary levels of up to 30 mg/kg per day for rodents with no significant increase in the incidence of tumors for the full lifetime of the animals (Schwetz, 1973; Johnson, 1978c). Similar results were obtained with mice. Dermal applications did not promote tumorigenic activity when used in conjunction with a known carcinogen in a single application (Boutwell and Bosch, 1959).

Pentachlorophenol was included in the NCI Bio-assay Program. No data indicating that PCP or the predominant secondary reaction products have significant biological activity (NCI, 1978) has been received.

In contrast, it has been demonstrated to be fetotoxic, causing significant anomalies (Schwetz, 1974b; Hinkle, 1973). This data is from studies of pregnant rats fed the material at different levels during the critical stages of gestation. Some of the minor side reaction products in PCP are known to be embryotoxic and possibly teratogenic when administered orally to rodents (Schwetz *et al.*, 1973).

In past occupational exposure studies conducted at wood treatment plants, significant tasks of concern were typically identified as the short intervals of exposures occurring when opening pressure cylinders or emptying bags of PCP to make up treating solutions. None of the data, though relatively recent, describe possible contributions from skin contact. Some reports discuss work practices and skin protection and historic causes of skin problems, such as chloracne or photosensitization.

Some of the older operations such as AI utilized PCP received in bags for preparing treating solutions. By 1980, this was done only to a limited extent and primarily at plants with infrequent or minimal use. PCP in bags was used at a few plants to provide the additional poundage for one and two thousand blocks for making up a specific strength treating solution based on the volume of oil or solvent. Flaked material, now commonly available delivered in bulk truck-lots at commercial operations, is conveyed in essentially closed systems with appropriate dust collection, to mix tanks for bulk solution blending.

1.6 Site Operations and Practices Specific to the AI/MMI Site

Two wood preservative mixtures were used at the Site. The wood preservative used from 1962-1965 was exclusively a mixture of 50% creosote and 50% No. 6 road oil. Beginning in 1965, a sizeable percentage of posts were treated with pentachlorophenol (PCP) mixed with wood treating oil (#3 diesel fuel with a suspension additive) to give a 5% wood treating solution (5% PCP and 95% oil). Both preservative mixtures were applied in the same manner in the wood treatment process. The treatment process consisted of a single pressure-cylinder in which the wood was treated.

The amount of wood inside the treating cylinder was calculated in cubic feet. Normal treatment for fence posts, as recommended by the American Wood Preserver's Association (AWPA), was to retain 6 pounds of wood treating mixture for each cubic foot of wood treated. The specific gravity of the wood treating mixture is 7.7 to 7.8 pounds per gallon, depending on temperature. Therefore, for each cubic foot of wood in the treating cylinder, the wood must retain 0.77 gallons of wood treating mixture.

An operational expectation of MMI was that the wood would retain the proper amount of preservatives when 2 1/2 times the calculated required amount of treating mixture was introduced under pressure in the treatment cylinder. After maximum penetration of the treatment chemicals into the wood was obtained, the pressure cylinder was drained of preservative and the cylinder was put under a vacuum to draw any excess treatment mixture out of the wood cells. For example, treatment cylinder was evacuated to a vacuum equal to 25 inches of mercury for a period of 45 minutes to one hour.

1.7 Operations Resulting in Contamination with PCP and Creosote

The treated wood was then removed from the pressure cylinder and transported to the yard for storage or shipment. The treated wood dripped, especially in hot weather when maximum treatment had been effected, for example to meet Federal specifications. This dripping and exposure to dust and rain would be expected to result in general contamination of the area.

The treatment room contained a recessed work area around the treatment cylinder. The recessed area drained into a sump. The sump contained waste from the treatment cylinder, sludge drained from the recessed work area, and water from leaking pipes. The wastes were pumped from the sump into the top of a separation tank east of the treatment room, see Figure ( ).

The treatment room was washed down periodically to remove any oil film or residue on the floor. This wash water drained into the sump and was pumped into a wastewater holding tank. When full, the holding tank was set on a forklift or trailer and emptied as the tank was driven around the yard. This is a source of general contamination and the most likely source of contamination in the wood chip pile, see Figure ( ).

Some waste oil from clean-up operations in the treatment area was also deposited in a "Sinkhole" located near the treating cylinder room. Disposal to the Sinkhole was discontinued when the walls collapsed and it would no longer receive material. The Sinkhole was concreted over in 1981 at the request of the ADPC&E.

Contamination also occurred in areas in addition to the Sinkhole: Oil sludge was dumped into a "Railroad Ditch Pit" located in the railroad right-of-way north of the treatment cylinder and treating room. Periodically the oily sludge in the ditch would be burned. Other areas included the "Ash Pile" (ashes from a wood-fired boiler located in the treatment room), the trolley tracks leading away from the treatment cylinder and in yard areas used to store treated wood products.

1.8 Nature and Extent of Problem

Types and Amounts of Wastes

The product mix (creosote-treated products versus PCP-treated products) varied from year to year depending upon consumer demand. Both treatment products are major sources of the oily sludge found in the Sinkhole.

Not enough is known about the dimensions and composition of the disposal areas to provide a reliable estimate of the total quantity of wastes remaining. A soil boring drilled at the Sinkhole in 1985 showed a four-foot thickness of a oily sludge to be present.

Previous Site investigations have identified several Site locations that could act as sourses by releasing contaminants to the environment. A Site inspection by the

EPA in July, 1986, determined that materials were present in the ground between the plant entrance and the treatment facility. According to Mr. Bob Barker of MMI, these materials are uncontaminated wood shavings that resulted from shaving and planing the raw wood before treatment. This area is not thought to represent a potential source of contamination and therefore has not been included in the source characterization activities of the sampling plan, but the area will be sampled as part of the large scale grid.

Soil samples were taken under the "Wood Chip Pile" from three different locations during June, 1985 after all operations at the Site had ceased (Appendix I). The analytical results showed PCP to be present in concentrations of 0.5 ppm, 2.1 ppm, and 170 ppm (parts per million). In 1986, the sawdust pile had a surface area of approximately 2100 square feet and an average depth of six to nine inches. This results in a total volume for the wood chip pile of less than 60 cubic yards. Additionally, wood chips are scattered about the northeastern corner of the property. The depth and extent of these wood chips is steadily diminishing and was estimated by CAI as 40 yards in May of 1987.

Data are available for 1981 for the amount of chemicals purchased by MMI: (1) 52,595 gallons of creosote; (2) 217,900 gallons of wood treating oil; and (3) 159,500 pounds of PCP. Mr. Barker has estimated that 500 gallons of uncontrolled waste were generated in 1981 by GMI-MMI at the Site.

In summary, wastes from the wood treatment processes at the Site were disposed of by techniques of convenience. Locations include the Sinkhole, the Railroad Ditch Pit and the Ash Pile. Visually contaminated material included debris along the bank above the railroad track and "Yard Area". Liquid wastes (containing PCP-oil waste mixture) were sprayed on the yard and on top of the Wood Chip Pile for dust control purposes.

1.9 Evaluation of Potential Impacts

In order to adequately evaluate the current and future impacts of environmental contamination from wood treatment production, the individual waste characteristics must be evaluated in the context of specific micro and macro environmental settings. This task is simplified because the contaminants at the Site are limited to residues of creosote, PCP, and wood treating oil.

Regional Climatology

The Site receives approximately 45 inches of precipitation per year. December, January and February are the driest months. The wettest months [illegible] April to June. Precipitation is generally well distributed throughout the year as shown in Figure ( ). Precipitation of a tenth of an inch or more occurs on an average on one day out of five. One or more snowstorms occur every winter, but the snow cover generally does not remain for more than a few days. On an average, from 9 to 10 inches of snow falls wach season (National Data Center, Ashville, North Carolina).

The summers are long and warm, with minimum nighttime temperatures in the mid-60's (degrees Fahrenheit). The daytime temperatures reach 100 degrees or higher in most summers, with average daily maximum temperatures in the high 80's and 90's. The winters are generally mild, with the temperatures falling to below zero about every other year. Daily maximum daily temperatures have never been as low as 0°. Minimum temperatures of 0° or below on any season do not prevail for more than a few days.

Site and Regional Geology

Recent advancements in applied geophysics have produced equipment and technology which are easily accessible to professional consultants, industry and government through several reliable manufacturers and scientific equipment suppliers.

The field portability, cost-effectiveness, and ability to collect data which does not require obtaining actual samples of subsurface material provides several considerations for incorporating surface geophysical surveys into groundwater contaminant investigation programs. As part of the preliminary Site investigation, surface geophysical surveys may be conducted to identify potential trends or anomalous areas prior to selecting the locations of sampling points for the monitoring system. Utilizing geophysical surveys to screen areas of investigation will increase the effectiveness of the monitoring systems and site evaluation by providing a geophysical-data base for correlation with samples obtained in the field and analytical data from the laboratory.

Surface Geophysical Survey Techniques

This discussion includes five of the most widely used techniques for conducting groundwater contaminant investigations. They are characterized by relatively simple operational principles, field procedures, and data analyses and interpretation. The five surface techniques include: seismic refraction, ground penetrating radar, electrical resistivity, electromagnetic conductivity and magnetometry. Seismic refraction and ground penetrating radar both identify subsurface interfaces which are used to determine the thickness and depth of materials and to locate isolated buried objects. Electrical resistivity, electromagnetic conductivity, and magnetometry identify lateral and vertical variations in subsurface geologic formations by locating lateral and vertical variations in bulk electrical, and magnetic properties of the subsurface materials.

Valid interpretations of geophysical data collected in the field require correlation with information obtained from both conventional sampling and analytical programs. The types of geophysical and conventional data required to describe the subsurface environment will vary, depending upon the physical, chemical, and structural complexity of the subsurface, and the intended application of the field study.

Seismic Refraction. Seismic methods are useful tools in determining the thickness and depth of geologic units. In addition, the velocity with which seismic waves are either reflected or refracted is an indication of the physical properties of the

subsurface materials. Seismic refraction surveys consist of transmitting a wave into the subsurface by means of an acoustic source. The wave travels through the subsurface in all directions and at differing velocities until contact is made with a geologic interface. The wave is refracted to the surface and received by an array of geophones. The travel time of the refracted wave is recorded on a seismograph. Figure A presents a schematic cross section of all the components used to conduct a seismic refraction survey to determine the thickness of layer V1 which overlies layer V2.

The seismograph produces a seismic record which graphically depicts all the vibrations received at each geophone during the survey. The seismic record is interpreted to identify the "travel time" of the seismic wave from the acoustic source to each geophone. Travel times of refracted waves are identified on the seismic record as "first arrivals" at each geophone, and they are dependent upon the depth to which the refracted wave traveled, and the seismic velocity of the wave.

First arrival times at each geophone are plotted on arithmetic graph paper as the time vs distance plots for data interpretation (Figure B). The travel times and corresponding distances at each geophone will generally plot along one of several linear segments on the graph. The slope of each linear segment corresponds to the seismic velocity of each seismic layer. The velocity and either the intercept time or the critical distance are used to calculate the depth to the interface between the layers (Figure B).

Seismic velocities are directly related to material density. Bulk densities may vary as a result of composition, water content, age and depth, weathering, fracturing, and degree and type of consolidation. Different soil and rock types are characterized by certain overlapping ranges in seismic velocity. By correlating observed data with information obtained from conventional studies, the types and distribution of geologic units present may be interpreted. The most common application of seismic refraction surveys in groundwater contaminant investigations is to define the thickness of the overburden (soil) and to map the stratigraphy.

Limitations to consider when evaluating the suitability of the seismic refraction method for a given site include the following: (1) subsurface layers of limited thickness (generally less than five feet) are not detected; (2) sufficient contrast in seismic velocities (bulk density) between subsurface layers must be present for the accurate location of interfaces; (3) bulk densities of subsurface materials must increase with depth.

Electrical Resistivity. Bulk electrical resistivities of subsurface materials are determined by injecting an electric current into the ground by a pair of electrodes and measuring the resulting drop in voltage through the ground by a second pair of electrodes (Figure C). The magnitude of the voltage drop depends on the lithology, moisture content and concentrations of dissolved solids in pore water of the subsurface materials. By varying the spacing and position of the electrode array, lateral and vertical resistivity trends can be determined. Results from a resistivity survey can be used to (1) map lateral and vertical variations in the thicknesses of subsurface materials with similar resistivities; (2) delineate resistivity boundaries

associated with variations in grounowater quality; and (3) identify waste burial areas or locate buried tanks associated with local resistivity anomalies.

Field surveys are conducted to complete either lateral profiles or vertical electrical soundings (VES). Resistivity profiles are completed by utilizing a fixed electrode spacing and obtaining an electrical resistivity value at each selected station along the profile traverse (Figure D). A number of profiles may be completed to construct a resistivity map of an entire site or of selected features at a site. Lateral variations in subsurface electrical resistivity may be used to assess: (1) changes in groundwater quality; (2) groundwater contaminant plumes and saltwater intrusion; and (3) variations in the composition of subsurface materials.

Vertical electrical soundings are completed by measuring a series of electrical resistivity values at one location. Each measured value corresponds to one of a series of selected electrode spacings. The resulting set of electrical resistivity values obtained at each VES station are generally plotted against electrode spacing to produce sounding curves that may be empirically evaluated to identify trends (Figure D). The data may also be solved graphically by using master curves to determine resistivity layer thicknesses, depths, and true resistivities.

Electrical resistivity surveys have been successfully used to locate groundwater aquifers, delineate groundwater contaminant plumes, map salt water intrusion, determine subsurface stratigraphy, map thicknesses of surficial deposits, map fracture zones in bedrock areas, map karst features, locate buried man-made objects and to implement in-place electrical leak detection systems for surface impoundments and underground storage tanks. In addition, research is on-going to evaluate the ability of resistivity for detecting and mapping organic plumes.

The field application of electrical resistivity techniques can be affected by the presence of nearby power lines, fences, railroad tracks, and buried pipes and cables. These cultural features may create electrical interference or alter the subsurface pattern of current flow distribution. In addition, in order to complete electrical resistivity surveys you must be able to "seat" the electrodes in the ground to establish electrical continuity with the subsurface materials to be studied.

Data analysis and interpretation of electrical resistivity data may be limited because: (1) resistivity values may be associated with any one of several geologic units (*i.e.*, a silty sand unit may have similar resistivity values as a sand unit saturated with salt water); (2) thin beds of lower resistivity will be masked when they are sandwiched between two layers of higher resistivity; and (3) the interpreted layer thickness will be greater than the actual thickness due to the anisotropic nature of the individual layers, which are generally characterized as having greater vertical resistivity values than horizontal.

Electromagnetic Conductivity. The electromagnetic conductivity survey is similar to the electrical resistivity survey in the sense that both methods quantify electrical characteristics of subsurface materials. However, there are vast differences between the field techniques and the data and analyses which characterize the individual methods. The electromagnetic conductivity survey consists of directing an

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electromagnetic field into the ground from an above ground source to create a secondary electromagnetic field that is measured by a receiver. As a result, direct measurements of bulk subsurface conductivities are obtained (Figure E).

Field equipment required for a survey consists of a low frequency transmitter coil and a receiver coil. The receiver coil intercepts a portion of the secondary electromagnetic field and produces an output voltage which is linearly related to subsurface conductivity.

Inducing an electromagnetic field eliminates the need for an electrode array and, therefore, the electromagnetic field method is a more rapid tool for surveying. The elimination of electrodes to measure electrical properties of subsurface materials also enables electromagnetic surveys to be conducted in many areas where resistivity surveys cannot be considered (*i.e.*, pavement areas, very dry sandy soils, frozen ground, railroad tracks, etc.). Electromagnetic conductivity surveys may also be used to produce rapid continuous profiles up to depths of 15 meters.

Electromagnetic (EM) surveys are most widely used to create profiles or maps of a subsurface conductivity. Lateral variations in conductivity, at a given depth, may be interpreted as contaminant plumes, sand and gravel deposits, clay deposits, karst features, salt water intrusion or buried objects (Figure F). Because field surveys may be completed rapidly, EM techniques are often implemented to map large sites and to provide detailed maps of variable site subsurface features such as isolated karst features, and buried tanks or 55 gallon drums.

Computer-data processing techniques can be utilized to interpret and present results obtained from site surveys in order to filter out unwanted cultural interferences, and to evaluate plume characteristics. Correlation of EM maps with field-collected geologic information is essential for the final interpretation of the survey data. Two and three layer conductivity models can be constructed using quantitative techniques. The resulting models are generally less detailed in the vertical resolution of the subsurface layers than those produced from vertical electrical soundings.

Electromagnetic surveys may not be conducted in areas characterized by unusually high or low values of subsurface conductivity. In addition, electromagnetic methods are subject to interference from many cultural features and the presence of nearby electrical fields. Finally, the ability of electromagnetic conductivity surveys to identify groundwater contaminant plumes requires that a significant electrical conductivity contrast exists between contaminated and natural groundwater.

Ground Penetrating Radar. Ground penetrating radar (GPR) is an impulse radar system that provides a continuous profile of subsurface conditions by radiating electromagnetic pulses into the subsurface and displaying the reflections from surface and subsurface "interfaces" on a strip chart recorder (Figure G). The term "interface" in this geophysical method refers to any discontinuity in electrical properties such as soil or geologic boundaries or imbedded objects such as drums, or boulders.

The GPR system consists of five major components, these include: (1) power distribution unit; (2) radar control unit; (3) antenna transceiver; (4) graphic recorder;

and (5) tape recorder. The power distribution unit provides proper AC/DC voltages to all the GPR equipment. The radar control unit triggers the antennae transceiver to produce the electromagnetic pulse. The reflected portions of the transmitted pulse are received by the antennae transceiver, converted to the audio frequency range and processed by the radar control unit. Processing is an operator-initiated procedure and allows for the selection and enhancement of that portion of the data which is of greatest importance to the objective of the survey. The processed data is sent to the graphic recorder which produces a permanent chart profile of the subsurface interfaces. Processed data may also be sent to the tape recorder for storage, reprocessing, or printing at a later date. Data may be collected at a rate as much as 16 times faster than the graphic recorder by tape recording the data.

Field surveys may be completed on foot or by utilizing vehicles for mounting equipment and towing the antennae transceiver. The resulting GPR profile which is produced by the graphic recorder prints strong signals as black and weak signals as white (Figure H). The result is a display of dark bands extending across the profile at varying depths. These bands represent the reflection from an interface. The horizontal scale of the profile is dependent upon the travel time of the antennae transceiver. The vertical scale is dependent upon the travel time of the GPR pulse. The travel time of the GPR pulse may be converted to depth if either the dielectric constant of the medium being profiled or the depth to a specific interface is known.

Typical applications of GPR surveys include, mapping depth to bedrock, and mapping interfaces including changes in soil type, geologic formations, and depth to water table. Buried objects and excavations may also be located and in some cases identified, as well as buried cultural features including pipes, cables, and conduits.

The effective penetration depths of the GPR system is dependent upon the bulk conductivity of the subsurface materials being profiled. The GPR signal is rapidly attenuated within highly conductive materials (*i.e.*, clays, highly ionic groundwater) which severely limits the penetration depths.

Other limitations of GPR profiles include: (1) masking of a reflection as a result of overlaping interfaces, such as, where the surface of the water table is level with the top of a buried drum; (2) variation in identifying reflectors depending upon the orientation of the traverse to the buried object; and (3) the presence of vegetative cover, surficial debris and irregular surface topography which may limit the penetration depth of the return signal or the ability to traverse the Site with the GPR system.

Magnetrometry. Magnetometers measure with accuracy and precision. the intensity of the earth's magnetic field. By mapping lateral and/or vertical magnetic gradients, subsurface features such as geologic ore deposits, bedrock features, buried drums and buried pipes may be located (Figure I). Nonferrous metals such as aluminum, copper, tin and brass cannot be detected by magnetometers.

Several types of magnetometers are presently available, however, the two most widely referenced in engineering and groundwater publications are the proton and the fluxgate magnetometers. Proton magnetometers measure the earth's total magnetic field intensity by utilizing the precision of spinning protons in a sample of hydrocarbon

fluid to generate a small signal whose frequency is precisely proportional to the total magnetic field intensity. Fluxgate magnetometers measure variations in the intensity of the total earth's magnetic field by measuring changes in the magnetic saturation level of an iron core sensor. Unlike the proton magnetometer, the signal output of a single fluxgate magnetometer is extremely sensitive to orientation. To overcome this sensitivity, the gradient of the earth's magnetic field may be measured by mounting two fluxgate sensors together to form a gradiometer. The gradiometer is the most common method of obtaining measurements with the fluxgate magnetometer.

Proton magnetometers are generally more sensitive than fluxgate magnetometers, however, they are also more sensitive to interference from unwanted magnetic objects (*i.e.*, fences, debris and automobiles). Fluxgate magnetometers also provide the advantage of obtaining continuous measurements and data readout for conducting total Site surveys.

The magnitude of an anomaly produced by a buried object is directly related to the magnetic mass and magnetic intensity of the body, and inversely related to the depth of the body. Magnetic anomalies, such as the contact between a non-magnetic sedimentary deposit and a magnetic igneous rock body, that are identified on magnetic profiles or contour maps can be located using qualitative techniques (Figure J). Computer data processing and analytical techniques can determine the depth of burial, the mass of the buried objects, the geologic structure, and the depth to bedrock.

Magnetometer surveys are limited to identifying or locating subsurface magnetic features or objects. Magnetometer surveys may be hindered by the presence of unwanted local magnetic fields associated with power lines, railroad tracks, etc. Diurnal variations, which are natural changes in the earth's magnetic field over time, must be compensated for during a magnetometer survey. During magnetic storms, which may occur as often as several times a month, significant variations in the earth's magnetic field will result, making completion of a magnetic survey impractical. Finally, identification of local anomalies are affected by the presence of many cultural features including steel fences, vehicles, buildings and iron debris. The search for buried objects may also be limited by the presence of natural iron ore deposits and bog irons, or by other variations in subsurface geology.

Groundwater Applications. Currently, there are several publications which document applying surface geophysical techniques to groundwater contaminant investigations. Two conclusions drawn in all of the above referenced publications are: (1) geophysical surveys provide several useful nondestructive test methods for evaluating subsurface geohydrologic conditions; and (2) these methods may often improve the quantity and quality of the data base obtained from conventional destructive test methods, while reducing overall investigation and monitoring costs.

Advantages of geophysical surveys include the cost effective benefits provided for by the rapid acquisition of data. Geophysical survey techniques can be implemented during preliminary project stages in order to establish a site data base, and thereby identify anomalies which require more detailed evaluations. In addition, continuous data collection techniques may be utilized for mapping features to a

greater degree of resolution not generally attainable by using conventional sampling techniques.

The use of geophysical survey techniques at the Site would be advantageous prior to completing on-site test drilling or excavation activities. The application of geophysical techniques in locating suspected container burial areas would reduce the likelihood of unexpected contact personnel or equipment with buried hazardous materials. Site characterization with surface geophysical techniques also helps in identifying the proper procedures and precautions that should be implemented during the conventional phases of an investigation, in order to eliminate the possible spread or release of materials.

Selected Illustrative Models. Two illustrative models of geophysical surveys are briefly presented to provide examples of the results that can be obtained by completing surface geophysical surveys. The models include an electromagnetic conductivity survey to identify groundwater contaminant plumes and contaminant sources and an evaluation of limestone terrain with seismic refraction and electromagnetic conductivity surveys.

Summary and Potential Applications to the Site

Five cost-effective surface geophysical survey techniques have been described which are widely used in groundwater site investigations. By employing geophysical techniques to complement conventional methods of subsurface exploration, a monitoring network can be designed that has an overall increase in efficiency and is cost-effective.

The application of these surface geophysical techniques to groundwater contaminant investigations include the following: (1) regional and local evaluations of subsurface geohydrologic conditions; (2) feasibility studies of proposed field application Sites and manufacturing, storage and disposal facilities; (3) design of monitoring systems; (4) characterization of existing field application Sites and manufacturing, storage and disposal facilities; and (5) design of leak detection systems utilizing electrical resistivity techniques.

The detection of wood treatment pesticide contaminant plumes, originating from generally non-ionic organic chemicals, presents a difficult situation to effectively monitor by utilizing applicable geophysical techniques such as electrical resistivity and electromagnetic conductivity. However, this reportedly has been successfully accomplished where contaminant concentrations in groundwater are greater than 10 mg/l. At high contaminant concentrations the detection of organic plumes may be possible as a result of the formation of a conductivity low which is associated with the non-ionic contaminants in contrast to the surrounding highly ionic groundwater. Hydraulic processes occurring in the unsaturated zone of fine grained soils may also result in the accumulation of organic compounds above the water table forming a low conductivity anomaly overlying the organic contaminant plume. It is also possible that degradation by-products may create a mappable ionic contaminant plume.

Several reports have been published which describe the design and implementation of electrical and electromagnetic early warning and/or leak detection systems. The general premise by which the systems operate is that by establishing an electrical resistivity or conductivity map of a Site or facility in its natural state the effects of potential Site discharges to groundwater can be monitored by continued Site surveying. It is also possible that the establishment of a baseline conductivity map at selected depths, for example 1.0 meters, 3.0 meters and 7.5 meters, may prove to be useful in determining areas where subsurface migration of wood treatment pesticides or their degradation products is occurring. Such techniques may be applicable to unsaturated and saturated zone monitoring programs.

The Site is located on an excavated area in rolling pine-covered hills that are characteristic of the Ozark Mountain chain. The surficial cover derived from cherty clay residuum is readily visible from past Site excavations. The Site is flat, with the area surrounding the Site featuring a considerable amount of relief, including a steep drop towards the railroad tracks on the north-eastern edge of the property. Non-commercial land in the area is used primarily for grazing.

Also characteristic of the Ozark Mountains is the "karst" topography and hydrology. Groundwater flow in karst terrain is typically through fractured limestone. These fractures dissolve to create channel flow condition, accompanied by the creation of sinkholes.

A regional generalized hydrogeologic column for the Omaha, Arkansas, area is provided in Figure ( ), and provides preliminary descriptions of lithology and estimates for the thicknesses of individual geologic formations. It should be noted that the formations vary in thickness and may be absent within the Site area. Figure ( ) shows a generalized stratigraphic cross-section for the area of the Site. Figure ( ) shows the trace of this cross-section and indicates which wells were used to develop the cross-section.

Figure ( ) is an hypothetical cross-section because conflicting information exists on the elevation of the Chattanooga Shale (if present). The figure respresents the hypotheses in which the Chattanooga Shale is around 900 feet above sea level in the Site area. This hypothesis is based on driller logs and correlated with information of Purdue & Miser. On the other hand, according to Mr. O. A. Wise the Chattanooga Shale would be at a higher elevation and could outcrop in the studied area. This descrepancy will be resolved during the Site investigation.

Regionally, the surficial cover is a cherty clay residuum derived from the Boone Formation. At the Site, the surficial materials are classified as cherty silty loams which are partly by-products of the blasting related to railroad construction.

Below the residuum is the Boone Formation, which consists of varying amounts of chert and limestone. The thickness of the formation at the Site is reported to be approximately 120 ft to 250 ft, excluding the St. Joe Member. Limestone in the formation is nearly pure calcium carbonate. The limestones are very soluble in ground water and contain subsurface cracks, joints and fissures. Sinkholes are common where limestone is present at the surface. Many of the large joints and fissures are

filled are filled with red clay and boulders. Chert (a very dense, microcrystalline siliceous rock) occurs frequently in the Boone Formation and is the principal rock in the basal section. The distribution of chert is the limestone varies from scattered nodules to sheet-like masses in excess fo 100 feet in thickness.

The St. Joe member of the Boone Formation is regionally on the most laterally persistent and conspicuous beds present. The thickness of this unit is approximately 50 feet. The rocks of the St. Joe member are composed of [illegible] fine limestone. At the base of the unit , immediately above the Chattanooga Shale (where this formation is present), fractures have been widened extensively by solution.

The Devonian-aged Chattanooga Shale may or may not be present in the vicinity of the Site. The basal section is generally a black, carboeceous, thinly fissile (tendency to form thin sheets) shale which weathers into flakes. It contains numerous vertical joints. The upper section is black to brown, with occasional phospatic sandy streaks. The upper section is less fissile than the basal part and weathers into prismatic blocks irrespective of bedding. Total thickness of the shale varies from 0 to 50 feet. This layer (where present) may act as an aquitard between the Boone Formation and the underlying carbonate units.

Where the lower section of the Chattanooga Shale is absent, the upper section typically overlies the Sylamore member. The Sylamore member is composed of sandstone generally 2 to 5 feet thick and consists of one or more massive (without stratification) beds, although it may be locally thin-bedded.

The Ordovician-aged Powell Formation underlies the Chattanooga Formation. The formation consists primarily of crystalline dolomite, with minor amounts of green, carbonaceous shale containing chert congomerate. The thickness of the unit ranges from 0 to several hundred feet. The formation weathers rather easily. In the upper part of the formation, numerous veins and masses of sandstone are present. The veins range from approximately one-half inch to six inches in thickness and extend downward 20 feet from the top of the dolomite. The largest of the masses are 75 feet in diameter and 40 feet in height. Horizontal joints and vertical slickensides (grooved and striated surfaces produced on rocks by movement along a fault) are found at many locations.

The Cotter Formation dolomite underlies the Powell Formation. It contains minor amounts of shale, chert and sandstone. The formation consist primarily of two types of dolomite; a fine-grained, argillaceous (clay containing), relsatively soft variety and a more massive medium-grained variety. The two varieties are generally interbedded with thinner layers of sandstone, shale and chert. The total thickness of this formation is estimated to be more than 500 feet.

The Roubidoux Formation unconformably underlies the Cotter Formation. The Roubidoux consists of dolomite, sandstone and minor amounts of chert. The dolomite is mostly lightly colored, and is finely granular to medium crystalline. Light colored sandstones are present throughout the Roubidoux Formation. The sandstones are composed of loosely to well cemented (siliceous or calcareous cement), fine to medium grained, angular to rounded, frosted quartz grains. Cherts in the formation

are generally dense and light colored, and may be considered representative of the Roubidoux. In northern Arkansas, thickness of the formation ranges between 130 ft to 455 ft.

The Gasconade-Van Buren Formations (underlying the Roubidoux) are undifferentiated in northern Arkansas and will be considered as one unit in this report. The Gasconade-Van Buren Formations (excluding the Gunter member) are generally light colored finely granular to medium crystalline, containing light colored dense cherts. The cherts in the lowere section occasionally are slightly sandy or contain minor amounts of dolomite. The thickness of this undifferentiated unit ranges between 320 to 600 ft.

At the base of the Gasconade-Van Buren unit, the Gunter member is found. Generally, the Gunter is described as a sandstone which may contain s few thin sandy or silty dolomite beds. The sandstone is loosely cemented by siliceous or calcareous material. Thickness of the Gunter ranges upwards to 40 feet.

Site and Regional Hydrogeology

The Site surficial clay deposits may be somewhat impervious due to compaction by heavy yard machinary. The vertical coefficient of permeability of a compacted clay sample was measured in the laboratory to be 4.5×10^{-6} cm/sec (September 29, 1982 correspondence from Tom Millard, Appendix E). Permeability of the in-situ material may vary from this value. A very wide range of permeabilities was observed across the Site during percolation tests run by Millard. These percolation tests ranges from 2 minutes per inch of infiltration to 8 hours for less than one inch of infiltration.

Below the surficial residuum, the Site hydrogeology is believed to be similar to the regional hydrogeology described below.

The Chattanooga Shale, where present, may or may not act as a low permeability layer (aquitard). If the Chattanooga Shale acts as an aquitard, ground water may be present in three aquifer (water bearing) systems: (1) a shallow aquifer system above the Chattanooga Shale; (2) an upper deep aquifer system directly below the Chattanooga Shale; and (3) a lower deep aquifer system. If the Chattanooga Shale is not present or does not act as an aquitard, the ground water may be present in two aquifer systems. These systems have highly heterogeneous vertical permeabilities.

Shallow Aquifer System

The shallow (unconfined) aquifer system consists primarily of deeply weathered cherty limestones of the Boone Formation. The limestone of the Boone Formation has undergone extensive solution on the Omaha area resulting in what is commonly referred to as "karst" topography and hydrology. Karst topography is characterized by vast numbers of depressions of all sizes, dolines, sinks and other solution features, an almost total lack of surface streams (sinking streams), and large springs in deeper valleys.

Typically, rainfall which is normally mildly acidic, percolates through the carbon dioxide-rich organic soil, further lowering the pH of the infiltrating rainfall. Entering the limestone strata, the moving water enlarges joints and fractures in the bedrock by dissolving the bedrock, producing solution channels along which ground-water flow can occur. The ease by which percolating surface water can movce through the unsaturated zone will also increase the potential for ground-water contamination.

Local ground-water patterns (especially in the shallow aquifer system) are difficult to determine because of the nature of karst hydrology. In general, depending on the location of recharge and discharge zones, as well as the karst influences, the static water table in the shallow aquifer will follow (in a subdued manner) the topography. Deviations from this general pattern can be expected to be observed during seasonal variations in precipitation.

Deep Aquifer System

The deep aquifer system may be divided into an upper group and a lower group. The upper group would consist of the Powell and Cotter Formations. The lower group would consist of the Roubidoux Formation, the Gasconade-Van Buren Formations, and the Gunter member.

The upper-deep aquifer system consists mainly of limestones and dolomites of the Powell and Cotter Formations. This aquifer system commonly yields 5 to 10 gpm (gallons per minute) from solution channels, bedding planes and fractures.

The lower-deep aquifer system consists mainly of sandstones and dolomites of the Roubidoux Formation, the Gasconade-Van Buren Formations, and the Gunter member. Sandstones are generally more productive water-bearing rocks than dolomites. The sandstones of the Roubidoux Formation can average up to 150 gpm and yields of as much as 450 gpm can be obtained from some wells. The Gunter member of the most productive waterbearing rock of this lower group. Wells that tap this sandstone commonly yield 150 to 300 gpm and may yield as much as 500 gpm. The Omaha city well appears to be pumping from the lower-deep aquifer system.

Ground-water hydraulic heads in the lower-deep aquifer system could be higher than those in the upper-deep and shallow aquifer systems (Arkansas Geological Commission). This head distribution may act to create an upward ground-water flow potential from the deep to the shallow systems. Therefore, even if the Chattanooga Shale is not present or does not act as an aquitard, this head distribution suggests that dissolved contaminants in the shallow aquifer sysyem would be unable to hydraulically migrate to the lower deep aquifer system. However, the lower aquifers could be contaminated by heavier-than-water contaminants coming from shallow aquifers through uncased wells.

Site Surface Hydrology

Surface drainage at the Site is primarily to the northwest by a tributary of Cricket Creek. Cricket Creek is several thousand feet west of the Site and flows in a generally northwesternly direction. Some of the drainage from the"Railroad Ditch Pit" Site could conceivably drain to the east along the railroad tracks into the Walnut Creek basin under heavy rain conditions. Walnut Creek lies approximately 3/4 of a mile to the south and east of U.S. Highway 65, and flows to the southeast. The karst topography present in the area is typified at the Site by an absence of perennial surface streams.

Table 1-1 lists organic compounds typically found as residues at wood treating plant sites where creosote and PCP were used and relevant physical and chemical properties for each of the major constituents. Target pollutants are highlighted.

Table 1-1 . Components of Creosote and PCP Used for Wood Protection.

Creosote Components	Solubility in Water (ppm)	Density
Napthalene	33.1	1.1621
Acenaphthene	3.42	1.024
Fluoranthene	0.26	1.252
Fluorene	1.84	1.203
Acenaphthylene	3.93	0.8988
Phenanthrene	1.15	1.182
Anthracene	0.59	1.24
Chyrsene	0.002	1.274
Pyrene	0.136	1.271
Benzo (a) anthracene	0.012	
Commercial PCP Components		
Pentachlorophenol	14	1.978
Toluene	535	0.866
2,4,6-Trichlorophenol	800	1.490
2,4-Dichlorophenol	4500	1.383
2-Chlorophenol	28,500	1.256
Phenol	93,000	1.072
2,4-Dinitrophenol	5,600	1.683
2-Nitrophenol	2,100	1.495
4-nitrophenol	16,000	1.270
2,4-Dimethylphenol	17,000	1.023
4,6-Dinitro-o-cresol		6.82
'p-Chloro-m-cresol	3,850	
Benzene	1,770	0.879
Ethylbenzene	152	0.867

Most of the components of creosote are only sparingly soluble in water. While PCP is not very soluble, once the sodium salt is formed, PCP becomes very soluble in water as are most PCP contaminants. Oil solutions of these compounds can separate into three-phases. First, there can be a lighter-than-water (floating) phase containing light oil, as well as creosote compounds and PCP dissolved in the oil. Second, there can be a water phase, which will contain those contaminants that have become dissolved in water or have the same density as water. Thirdly, there can be a heavier-than-water (sinking) phase, consisting primarily of the dense free phase organics

(PCP, aromatics associated with creosote compounds, and heavier fractions of the wood treatment oil).

Concerns have been expressed by APCED that residue from the Site may affect ground-water supplies and surface water quality via Cricket Spring Channel (which discharges into Cricket Creek). No data available to date demonstrate any impact on Cricket Creek below the confluence with Cricket Spring Channel. Additional, theoretically possible but unlikely, impacts include effects on soils, biota, and ambient air quality.

Several springs and domestic wells, as well as the community water supply well for Omaha, Arkansas are located within three miles of the site. In all, approximately 660 persons live within three miles of the site and depend primarily upon ground water from the deep aquifer systems as a source of drinking water.

An inventory of all the registered water supply wells within a three mile radius of the site is provided in the following table. This table tabulates construction details of some of the wells, including well depths. The data has been compiled from all available well completion forms submitted to the State by drilling contractors. No completion data were available for the Site well or the Omaha City Well.

Table: Water Well Inventory and Construction Details of Wells Within Three Mile Radius of the Arkwood Plant, Omaha, Arkansas.

Well Owner	Use of Well	Date Well Completed	Depth Interval of Water Producing Formation (ft)	Type of Formation	Depth to Water (ft-bls)	Total Depth of Well (ft-bls)
Omaha City Well*	Municipal			Dolomite		2100
John Atchison	Domestic	09-08-80	780-785	Limestone	400	795
Frank Atchison	Domestic	09-08-78	525-530	Limestone	380	550
Robert Behrens	Domestic	07-17-82	274-274.5	Limestone	240	565
Robert Behrens	Domestic	01-26-80	280-300	Limestone	350	400
Robert Behrens - abandoned	Domestic	01-26-80	280-300	Limestone	350	496
Dean Curhow	Domestic	10-20-78	664-670	Limestone	410	775
Mildred Davidson	Domestic	10-20-78	660-665	Limestone	–	687
Bud Essary	Domestic	07-15-76	210-215	Limestone	160	300
Bud Essary	Domestic	07-20-81	640-650	Limestone	300	688
Clifford Ford	Domestic	10-02-75	384-385	Limestone	250	415
Clinton Hicks	Domestic	09-18-72	470-480	Limestone	360	650
John Huston	Domestic	12-10-79	441-445	Limestone	350	496
Fernam Jones	Domestic	03-15-79	520-530	Limestone	450	550
Norman Klasener	Domestic	10-30-77	450-470	Sandstone	375	505
James Lovell	Domestic	11-20-74	400-440	Limestone	300	480
Leonard Matlock	Domestic	08-20-76	645-690	Sandstone	430	705
McGinnis	Domestic	07-29-75	593-594	Limestone	400	610
Charles McMahon, Jr.	Domestic	06-15-77	348-352	Limestone	–	412
Don Moore	Domestic	07-28-75	519.5-520	Limestone	350	550
New Hope Baptist Church	Domestic	05-17-71	190-195	Sandstone	330	555
Nelson Rice	Domestic	09-74	–	–	–	783
Sid Richardson	Domestic	01-08-77	770-772	Limestone	375	775
John Robinson*	Domestic	07-15-73	600-610	Limestone	400	640
T.C. Sallee	Domestic	08-01-73	580-690	Limestone	430	710
Cam Tong	Domestic	05-17-71	725-730	Limestone	380	735
John Wood, Sr.	Domestic	02-23-73	145-253	Limestone	–	253
Nelson Rice	Domestic	09-74	–	–	–	783
Omaha School Well	Domestic	–	–	–	–	–
Cathy Duggan	Domestic	–	–	–	–	–
Binam	Domestic	–	–	–	–	–
Birmingham	Domestic	–	–	–	–	–
Birmingham - abandoned	Domestic	–	–	–	–	–
David Miles	Domestic	–	–	–	–	–
O.C. White	Domestic	–	–	–	–	–
O.C. White	Domestic	–	–	–	–	–
Tate	Domestic	–	–	–	–	–
Arkwood, Inc. Site*	Industrial	–	–	–	–	–
House w/ Satellite Dish	Domestic	–	–	–	–	–
Turney	Domestic	–	–	–	–	–

*The Omaha City water supply is located within one mile of the Site. The total depth of the well is 1315' with a casing depth of 60'. The only water well sample taken was from the Site. The depth of the well is unknown, however, the pump (submergable) was set at 920'.

2.1 Sampling Plan

2.1.1 Objectives

The activities detailed in the CAI sampling plan have been developed to provide samples which when analyzed should yield data of sufficient technical quality and quantity to identify major contaminants, pathways of contaminant transport and the potential of transported contaminants to adversely impact on the environment.

2.1.2 Equipment and Protocol

This section covers the general considerations of planning and preparation necessary for the proper use of equipment in the field. A list of the sampling equipment and protocols are presented in Appendix F.

The Site coordinator will designate an equipment officer. It is the responsibility of this person to: (1) collect, check, pack and ship equipment and supplies; (2) calibrate instruments prior to their use in the field; (3) provide home-base suuport in the supply of supplies and spare parts; (4) coordinate the analytical program, including dates, with the contract laboratory staff in order to have correct sample containers prepared and shipped by the laboratory.

2.1.3 Analyses of Interest

Previous sampling and analysis of the Site soils, surface and ground water have identified the chemical compounds expected to be potential off-Site contaminants. Analysis performed during Phase I of the RI/FS will occasionally also include tetra through octa chlorinated isomers of dibenzodioxin and dibenzofurans. Target parameters that are representative of the different phases and mobility of the compounds known to be present have been determined to include pentachlorophenol (PCP), napthalene, acenapthalene, fluorene, xylene, acetone and toluene. These compounds cover the range of solubilities and densities expected to be presented by Site wastes.

The data for Site waste characterization in soils and sediments will be used to determine extent to cleanup levels required. A target of 1 µg/gm (ppm) is as acceptable limit of detection with the exception of dioxin and furan analysis. For dioxins and furans, the cleanup guidelines (as shown in footnote (1) of Table ( )) for each isomer will be used. The data on surface water, ground water, and springs will be used to determine the extent of potential impact of drinking water quality.

2.1.4 Sample Types, Locations and Frequencies

The type of sample to be collected at any Site is dependent upon the surface characteristics of the Site, the Site hydrogeology, and the nature and amount of possible contaminants. Areas from which samples have been taken include those that are most likely to contain hazardous material (such as the Sinkhole, Railroad Ditch Pit and the Trolley/Treatment Area).

There will be three primary kinds of samples taken from the Site and vicinity. Samples will be collected from areas of known or obvious contamination for source characterization. Surface water, ground water, soil and sediment samples will be taken to characterize the mobility of the pollutants and the soil attenuation capacity. Biota will be sampled to define the extent of the impact of the contaminant releases from the Site. All samples collected will be retained to the maximum permitted by holding time limits. Soil samples collected during small grid and large grid sampling will be extracted and then stored to permit extended retention times. Analyses of stored samples can then be carried out based on need as determined by the decision logic presented in the following discussions.

Phase 1 sampling activities will include: (1) soil boring and sampling on a large grid system covering the entire plant site to characterize the horizontal and vertical extent of contamination; (2) extensive soil boring and sampling of the areas most obviously impacted; and (3) sampling feeder stream sediments, surface water and ground-water sources to determine the extent of off-Site impacts and the interrelation of these environmental pathways. Sample types, locations and frequencies are listed in Table ( ) through ( ).

It is anticipated that there may be sampling locations which will not be identified until initial RI data are available. Possible locations could include springs identified during the field mapping portion of the investigation, as well as the locations of abandoned wells. These locations might eventually be used as part of the long-term monitoring network. Locations will be plotted on a map of sufficient scale to permit accurate and convenient identification. The map will be submitted to EPA as part of the package seeking their approval of the selected sampling locations.

2.1.4.1 Waste Source Characterization

The Railroad Ditch Pit Area, Ash Pile and Trolley/Treatment Areas will be sampled as described in the small grid sampling section under soil boring and sampling. Additional data to be used in characterizing these three waste sources are presented in Table ( ).

A composite sample of the Sinkhole fluid will be collected using a Composite Liquid Waste Sampler (COLIWASA) and will be analyzed for creosote and PCP components, dibenzodioxins and dibenzofurans, and tetra through octa isomers. The sample will be allowed to settle in a jar to determine if phases are present. If phases are detected, additional samples of discrete phases may be necessary. Data from past sampling of the Sinkhole are presented in Table ( ). The dimensions and contents of the Sinkhole will be defined to the extent possible in anticipation of pumping and excavation.

2.1.4.2 Soil Boring and Sampling

During a Site inspection in July, 1986, EPA observed waste oil in a shallow concrete pit. Since that Site visit, the Site owner has covered the pit with dirt. The soil in the pit will be sampled as a part if the large grid sampling.

Small Grid Sampling: The most extensive soil boring and sampling will obviously be in the three areas most obviously impacted by wastes: (1) The Railroad Ditch Pit Area; (2) the Trolley/Treatment Area by the treatment cylinder; and (3) the Ash Pile on the embankment of the railroad ditch. Sampling equipment and protocols are described in Appendix F. All boreholes will immediately be grouted after sampling to minimize vertical transport of pollutants.

The grid sampling plans describe the locations where samples will be taken and is based on the reported dimensions of the impacted areas. These grids will be modifed in the field if necessary in order to maximize representative sampling under actual existing conditions. All field modifications will be presented to the on-site EPA project coordinator for review and approval.

Railroad Ditch Disposal Area: Fifteen soil borings will be completed to auger refusal in a 15' grid pattern, as shown in Figure ( ). This grid is established based on the reported dimensions of the disposal area of approximately 15' across by 40' long. Should the actual dimensions of the disposal area be considerably greater, the grid distances will be increased accordingly. The grid pattern has been laid out to cover an area sufficiently large to show that the area of contamination has been entirley defined. To define the area, the outermost samples will be beyond the disposal area. This area will be drilled using a hollow stem auger to prevent cross contamination from sludge. The boreholes will be immediately grouted to minimize vertical transport of pollutants.

The depth interval for sampling is dependent upon the depth of bedrock which is unknown for this area. Sampling intervals will be at surface, 2.5' below land surface (bls), 5' bls, then at 5' intervals until auger refusal. If phased waste are present, each distinct phase will be addressed in the sampling. Sampling intervals will be modified to sample each phase. If phases are present at very close intervals, additional intervals will be added based on field determination. An estimated 60 samples will be collected, the actual number will depend on auger refusal depth .

The sample will be analyzed for target pollutants. Two center samples at 2.5' and 5' bls will also be analyzed for dibenzodioxins and dibenzofurans, tetra through octa isomers.

If the first analyses indicate contamination extends beyond this sampling pattern, the decision tree that will be used to select additional samples for analysis is shown in Figure ( ). Second round analysis will be for target parameters to be selected based on pollutant and dioxin/furan analyses from round 1.

Trolley/Treatment Area by treatment cylinder: Nine soil borings will be completed to auger refusal in a rectangular 15' by 50' grid pattern, as shown in Figure ( ). The obviously impacted area by the trolley measures approximately 15' wide by 80' long. The grid pattern used for sampling this area is rectangular, as not much variation is contamination is anticipated along the length of the trolley tracks. The outermost samples will be beyond visually contaminated areas. Actual sampling locations will be determined in the field to include visually contaminated areas. Potential areas may

be under former sumps and/or tanks. The boreholes will be immediately grouted after sampling to minimize vertical transport of pollutants.

The depth of sampling to auger refusal may not be deep due to previous excavation. Deep boring will be accomplished with great caution due to the risk of introducing additional vertical pathways for pollutant migration. The sampling intervals will be surface, 5'bls, 10' bls, 15' bls, 20' bls, 25' bls and 30' bls. If full depth is obtainable, an estimated 63 samples will be collected. All boreholes will be immediately grouted to minimize vertical transport of pollutants.

Initially, samples will be analyzed for target parameters at surface locations. If the first analyses indicate that the contamination has extended beyond the sampling pattern, the decision tree that will be used to select additional samples for analysis is shown in figure ( ). Second round analyses will be based on the results of round 1. Extended sampling if neceassary would probably include at 5' bls and along the center transact at 10' bls, 20 bls, and 30' bls. Additionally, the surface sample will be analyzed for dibenzodioxins and dibenzofurans, tetra through octa isomers.

Ash Pile: Twelve soil borings will be completed to a depth of 10' bls in a 15' grid pattern as shown in figure ( ). The Ash Pile measured approximately 8' across by 25'-30' long prior to recent Site modifications by the Site owner. The grid dimensions will be developed in the field to cover the current Ash Pile dimension. If testing shows that the grid pattern does not completely define the extent of contamination, an additional transact will be added.

The 10' depth of borings is due to the nature of the Ash Pile. The Ash Pile is an unstable mass, incapable of supporting any heavy equipment. This area will be drilled using a gas powered hand held auger.

Samples will be taken at surface, 5' bls and 10' bls. In all, 36 samples will be taken. One ash sample will be analyzed for dibenzodioxins and dibenzofurans tetra through acta isomers. Target parameters analyses will be completed on 12 additional samples: 4 at the surface, at 5' bls and 10' bls, assuming these bls samples are below the residuum.

An interim waste source removal and on-site isolation is part of Phase 2. If boring 10' bls does not reach the residuum, additonal soil borings to at least 10' below the top of the residuum, will be done as part of Phase 2 after the Ash Pile has been removed.

Large Grid Sampling: Soil boring and sampling will be carried out over the entire Site using a grid with 100' centers, as illustrated in Figure ( ). The sampling grid includes areas of visible contamination (including debris along the entire length of the railroad ditch), as well as several background samples from areas outside the plant. One sample will be taken in the old road. One additional boring will be located northwest of sample if there is visible contamination. Additional sampling locations may be determined in the field to include visually contaminated areas. Drainage pathways on-site and debris along the bank will be included. In the area of scattered wood chips, five shallow borings (locations to be field determined) through the wood chips to the top of residuum will be made with a hand auger. These samples will be visually

inspected for signs of contamination. Any of these samples that appear to be more contaminated than the surface sample from boring ( ) will be analyzed for target parameters.

The borings will be extended to a depth of 5', and samples will be taken from the surface (4"-6" bls), and at 5' bls. In all, 68 samples will be preserved.

The surface samples (4"-6" bls) will be analyzed for target parameter analyses chosen based on results of small grid sampling. If there is indication of contamination, 5' bls samples will be immediately extracted to permit acceptable holding times. If the contamination extends more than 5' bls, deeper borings will be done as part of Phase 2. The Trolley Area surface and subsurface samples will be used to determine if different target parameters are appropriate for subsurface samples in the large grid. Verification of target parameters will be done by analyzing one surface sample and one 5' bls sample for target pollutants. The boring chosen for this verification will be one in which contamination is found in the surface but not the subsurface using target parameters.

2.1.4.3 Stream Sediment, Surface- and Ground-Water Sampling

Stream Sediments: Stream sediment sampling will be done on-site at two locations. Analysis of target pollutants in sediments in Cricket Spring Channel and Walnut Creek will also be performed. The sample locations are shown in Figure ( ) and are described as follows:

- Cricket Spring will be sampled at the source (Sample location ( ), Figure ( )).
- Cricket Spring Channel will be sampled at the intersection with Cricket Road. This will involve collecting approximately two samples.
- Cricket Creek will be sampled at one point above and one point below the confluence with Cricket Spring Channel. Sample 9 will serve as a background sediment sample.
- Walnut Creek will be sampled three times on 500' centers east of the railroad tunnel and analyzed for target pollutants. Visual inspections in 1981 indicated this creek to be less contaminated than Cricket Spring Channel.
- Barren Fork will be sampled once, below the confluence with Walnut Creek. There have been no indications in the past that Barren Fork has been impacted by the Site, and this sample will be confirmational. This sample location is not shown on Figure ( ). The location will be field-verified and presented to EPA for review and approval.
- On-site locations to be sampled and analyzed for target pollutants include the runoff areas at the entrance of the Railroad Tunnel and at the Site entrance gate (Samples ( ), Figure ( )).

Surface and Ground-Water Sampling: Surface and ground-water sampling will be performed at various locations, see Table ( ). Seasonal sampling will be conducted on a quarterly basis throughout the course of the RI/FS. This sampling will span periods of high precipitation and periods of low precipitation, to develop information about the interrelation of surface-water flow, ground-water flow, and zones of discharge/recharge on a regional basis. The climatological data for the area around the Site has been provided in Figure ( ). These data show that the months of December and January are the driest months, and the months of April to June are the wettest months. Analysis of samples will be fro target pollutants.

- Site Well and Selected Abandoned Wells will be sampled on a quarterly basis for target pollutants.
- Off-Site Wells and Springs selected will be sampled initially and then on a quarterly basis.
- Cricket Spring will be sampled quarterly at the source (Sample number ( ) on Figure ( )), for target pollutants. Additionally, a sample will be taken for analyses of tetra through octa chlorinated isomers of dibenzodioxin and dibenzofuran .
- Cricket Spring Channel (this is the channel flowing from Cricket Spring to Cricket Creek) will be sampled quarterly at one point above the confluence with Cricket Creek (Sample number ( ), Figure ( ))
- Cricket Creek will be sampled quarterly above and below the confluence with Cricket Spring Channel (Sample numbers ( ) and ( ), Figure ( )). The sample above the confluence is the background sample.
- Canning Factory Spring will be sampled quarterly at the source (Sample number ( ), Figure ( )).
- Walnut Creek will be sampled quarterly just east of the railroad tunnel (Sample number ( ), Figure ( )).
- Barren Fork will be sampled quarterly below the confluence with Walnut Creek (not shown on Figure ( )).
- Rainfall Runoff will be sampled at least once per quarter to determine if surface water runoff from the site has an off-site impact. Samples of runoff will be collected at all major runoff points (to include drainage culvert, entrance of Railroad Tunnel, and Site entrance gate, see locations ( ), ( ) and ( )on Figure ( )). These samples will be a grab sample, collected during a rainstorm.

Seasonal sampling will be conducted on a quarterly basis to determine variations in quality and water level elevations for surface water and ground water monitoring wells selected for use in the hydrogeologic investigation.

2.1.5 Quality Assurance/Quality Control

A Quality Assurance Project Plan (QAPP) has been prepared by CAI for the Site RI/FS. The QAPP will be reviewed and approved by EPA porior to initiating any field activities. The QAPP presents in detail targets for quality of the sampling, laboratory testing, and data analysis process, and establishes the procedures to be followed to ensure that these targets are met.

The QAPP consists of the following elements:

- Title Page;
- Table of Contents;
- Project Description;
- Project Organization and Responsibility;
- Quality Assurance Objectives for Measurement of Data;
- Sampling Procedures;
- Chain-of-Custody Procedures;
- Calibration Procedures and Frequency;
- Analytical Procedures;
- Data Reduction, Validation, and Reporting;
- Internal Quality Conntrol Checks and Frequency;
- Specific Routine Procedures to Assess Data Precision, Accuracy and Completeness;
- Corrective action; and
- Quality Assurance Report to Management.

QUALITY ASSURANCE (QA) OBJECTIVES FOR DETERMINING PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

QA objectives for precision, accuracy and completeness for target pollutants, dibenzofuran and dibenzodioxin are provided in the table at the end of this section.

1. **Precision:** Precision is a measure of the reproducibility of the data. The precision of measurements made for each project will be evaluated and reported. Precision will be enhanced by the use of high purity materials, standards traceable to higher levels of authority, knowledge and experienced laboratory personnel, procedures consistent with good scientific practice. Precision will be further be ensured by rigorous internal quality control. Examples of activities which can be used to assess precision include: duplicate samples taken as identically as possible. Comparison of duplicates permit determination of the reproducibility of the analytical technique. Monitors are samples or sites located in close physical proximity to one another in order to test the reproducibility of the sampling technique. Instrument checks are designed to minimize analytical errors due to improperly calibrated equipment. Duplicate sample data and data from monitors must be within the predetermined acceptance limits of variation for analytical data to be acceptable for purposes of quantitating residues at the Site. Each instrument used for analytical measurements shall have routine checks performed to demonstrate that variables are within predetermined acceptance limits.

2. **Accuracy:** Accuracy is a measure of nearness of the reported data to the "true value", and will always be reported with the analytical data from Site samples. Independent quality control audits will utilize standards which are separate from those used during routine operations and will be compared for consistency with published data from the applicable literature, and Federal and State regulations and guidelines.

   Accuracy will be enhanced through the application of quality calibration standards. Rigorous documentation of data will permit complete reconstruction of files from initial field records through data generation will always be ensured. EPA-approved methodologies will be used. Reference and/or fortified samples will also be utilized. Performance audits, including percentage recovery of known standard additions added to representative samples will be frequent. Each measurement program will be subjected to performance audits to demonstrate that all measurements are within acceptable, predefined control limits.

   Accuracy is usually expressed as the difference between the true value, T, and reported value, X, but is also expressed as a percentage of the reference or true value, 100 (X-T)/T.

3. **Completeness:** Completeness is a measure of the amount of valid data obtained from a measurement program compared to the amount that would be

expected to be obtained under ideal conditions. The data base resulting from any project will be routinely assessed on the basis of expected versus actual data capture. The data base will be subjected to statistical analysis when applicable.

4. **Representativeness:** All samples will be representative of the actual conditions at the sampling location. This will involve detailed consideration of the Site being sampled, the methods used to obtain environemntal samples at the Site, and the appropriateness of the analytical method to the type of sample obtained.

5. **Comparibility:** All data will be reported in units consistent with both Federal and State regulations, methods and guidelines and in units comparable with previously published work with similar methods within the same type of sample. Comparibility between data bases will also be achieved by standardized Site sampling, methods of analysis and data formats.

   To maintain consistency of units of expression, the SI system of units will be used to express all results.

Parameter	Units
Temperature	°C
Barometric Pressure	mm Hg
Concentration	mg/liter (liquids) µg/mg (dry weight basis for solids)
Flow	liter/min

The following table details the quality assurance objectives for analytical measurements.

Quality Assurance Objectives for Measurement Data

General Chemical and Physical Analysis[1]

Measurement Parameter	method Reference	Sample Type	Precision Std. Dev.	Accuracy
Oil and grease	EPA600/4-79-0020 420.1	Water	10 %	10 %
Oil and grease	EPA600/4-79-0020 420 1	Solid	20 %	20 %
pH	SW/846-method 9040	Water	10 %	10 %
Specific conductance	EPA600/4-70-020 120.1	Water	10 %	10 %
Temperature	EPA600/4-79-020 170.1	Water	10 %	10 %
Total organic carbon	EPA600/4-79-029 415.1	Water	10 %	10 %
Total organic carbon	EPA600/4-79-029 415.1	Solid	20 %	20 %

[1]Completeness for all analyses listed in this table is 90 %.

Potential Target Parameter Analyses

measurement Parameter	Method	Media	Precision Std. Dev.	Accuracy	Detection Limit
Acenapthalene	604	Water	25	25	50 µg/L
Acenapthalene	8310	Solids	40	40	1 µg/g
Anthracene	SW/846-8240	Water	25	25	1 µg/l
Anthracene	SW/846-8240	Solid	40	40	1 µg/g
Benzene	602	Water	20	20	10 µg/l
Benzene	SW/846-8240	Water	20	20	1 µg/l
Benzene	8020	Solids	25	25	1 µg/l
Benzene	SW/846-8240	Solids	40	40	1 ppm
Ethyl Benzene	SW/846-8240	Water	20	20	1 µg/l
Ethyl Benzene	SW/846-8240	Solid	25	25	1 µg/g
Napthalene	610	Water	40	40	10 µg/L
Napthalene	8310	Solids	50	50	1 µg/g
Pentachlorophenol	604	Water	40	40	10 µg/L
Pentachlorophenol	8040	Solids	50	50	5 µg/g
Phenathrane	610	Water	30	30	10 µg/L
Phenathrane	8310	Solids	40	40	2 µg/g
Toluene	SW/846-8240	Water	25	25	1 µg/l
Toluene	SW/846-8240	Solid	40	40	2 µg/g

Quality Assurance Objectives For ~~MeasureMCEnt~~ Data

Dibenzodioxins And Dibenzofurans

~~MeasureMCEnt~~ Parameter	Method[1] Reference	Sample Type	Recovery[2] Limits %	Relative[2] Percent Diferences	Detection[3] Limits Water (ppt) Solid (ppb)
Dibenzodioxins Chlorinated isomers:					
Tetra	SW846 Method 8280	Water	60-140 %	≤50 %	0.4
	SW846 Method 8280	Solids	60-140 %	≤50 %	0.8
Penta	SW846 Method 8280	Water	60-140 %	≤50 %	1.3
	SW846 Method 8280	Solids	60-140 %	≤50 %	1.3
Hexa	SW846 Method 8280	Water	60-140 %	≤50 %	2.2
	SW846 Method 8280	Solids	60-140 %	≤50 %	2.3
Hepta	SW846 Method 8280	Water	60-140 %	≤50 %	2.8
	SW846 Method 8280	Solids	60-140 %	≤50 %	4.7
Octa	SW846 Method 8280	Water	60-140 %	≤50 %	3.9
	SW846 Method 8280	Solids	60-140 %	≤50 %	6.4
Dibenzofurans Chloinated isomer:					
Tetra	SW846 Method 8280	Water	60-140 %	≤50 %	0.6
	SW846 Method 8280	Solids	60-140 %	≤50 %	0.5
Penta	SW846 Method 8280	Water	60-140 %	≤50 %	1.6
	SW846 Method 8280	Solids	60-140 %	≤50 %	0.9
Hexa	SW846 Method 8280	Water	60-140 %	≤50 %	2.5
	SW846 Method 8280	Solids	60-140 %	≤50 %	2.2
Hepta	SW846 Method 8280	Water	60-140 %	≤50 %	NA
	SW846 Method 8280	Solids	60-140 %	≤50 %	NA
Octa	SW846 Method 8280	Water	60-140 %	≤50 %	NA
	SW846 Method 8280	Solids	60-140 %	≤50 %	NA

(1) Method proposed for inclusion third edition of SW846 (not yet published.)
(2) Reference: Cal Method Laboratory
(3) Reference: SW846 Method 8280, September 15, 1986, draft version
NA = Not available

Sample Containers, Preservatives, And Storage Requirements

Measurement[a]	Container[b]	Preservative[c]	Maximum Holding Time[d]
Total organic carbon	P,G	?	?
Oil and grease	G	Cool, 4° C H_2SO_4 to pH <2	28 days
Hydrogen ion (pH)	P,G	Determine on site	2 hours
Organic compounds			
Extractables (phenols)	G, Teflon-lined septum	Cool, 4° C H_2SO_4 to pH <2 0.008 %, $Na_2S_2O_3$	7 days (until extraction) 30 days (after extraction)
Purgeables (acrolein and acrylonitrite)	G, Teflon-lined septum	Cool, 4° C 0.008 %, Na2S2O3	0 days
Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans	G, Teflon-lined cap	Cool, 4° C	Extract within 30 days, analyze within 45 days
Phenols	P, G	Cool, 4° C H_2SO_4 to pH <2	28 days

Notes:

a Parameter to be measured in sample.
b Polyethylene (P) or Glass (G).
c Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection if possible. Aliquots of the composite, which would require multiple preservations, should be preserved only by maintaining at 4° C until compositing and sample splitting is completed.
d Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid.
e Samples should be filtered immediately on-site before adding preservative for dissolved metals.
f Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific organic compounds.

CHAIN-OF-CUSTODY

Sample custody is an important part of field and laboratory operations when samples are needed for enforcement actions or litigation. Chain-of-custody procedures will document sample possession from time of collection to disposal, in accordance with the guidelines established in the EPA *Safety Manual for Hazardous Waste Site Investigations* (September 1980). In order to maintain and document sample custody, the following chain-of-custody procedures will be followed. For the purpose of these procedures, a sample is considered in custody if it is:

- It is in actual possession of the responsible person;
- In view, after being in physical possession;
- Locked so that no one can tamper with it, after having been in physical custody; or
- In a secured area, restricted to authorized personnel.

Prior to sampling, all personnel involved will have received copies of the chain-of-custody procedure. A briefing for these personnel will be held and documented in conjunction with the Health and Safety training program. The chain-of-custody procedure will be covered, as well as sampling and sample handling procedures. Briefing of personnel is the responsibility of the Field Supervisor.

Sampling Transfer and Shipment

The following guidelines will be followed in transferring and shipping samples.

- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate record prepared for each laboratory. Shipping containers will be padlocked or otherwise secured for shipment to the laboratory.
- When transferring possession of samples, the individual relinquishing the sample and the new custodian will sign the record and denote the date and time. A copy of the signed record will be made by the previous custodian and sent to the receiving laboratory to allow tracking of sample possession. All change of custody of samples must be a person-to-person exchange of custody documents and samples.

The following documentation will supplement the chain-of-custody records:

- Field log book, which will be filled upon completion on the project files;
- Sample tag of each sample;
- Sample seal on each sample; and

- Photographic records, wherever practical and to the extent economically feasible.

Laboratory Custody Procedures

The following general guidelines should be used by the laboratory sample custodian in maintaining the chain-of-custody once the samples have been received in their laboratory.

- Upon receipt of samples in custody, the package will be inspected and any damage to the sealing tape or other custody seals will be noted.
- The samples received by the laboratory will be crossed-checked to verify that the information on the sample tags matched that on the chain-of-custody record included with the shipment.
- If all the data and samples are correct, and there has been no tampering with the custody seals, the "received by laboratory" box is signed and dated.
- The samples will be distibuted to the appropriate analysts, with names of individuals who receive samples to be recorded in internal laboratory records.
- Upon sample destruction or disposal, the custodian responsible for the disposal will complete the chain-of-custody record, file a copy, and send a copy to the Project Manager for recordkeeping. All samples not consumed during analysis shall be kept for three months.

CRANMER & ASSOCIATES, INC.
CHAIN-OF-CUSTODY RECORD

Page_____of________

Project/Number ______________

Location:________________

Shipping Container ID: ________

Laboratory:_______________

Sample(s) __________________

Sample Identity	Date Sampled	Sample Container Description	Total	Remarks

Total No. of Containers

Relinquished by:__________ Organization:___________ Received by:__________ Organization___________

Date:__________ Time:________ Date:__________ Time:_________

Relinquished by:__________ Organization:___________ Received by:__________ Organization___________

Date:__________ Time:________ Date:__________ Time:_________

Relinquished by:__________ Organization:___________ Received by:__________ Organization___________

Date:__________ Time:________ Date:__________ Time:_________

Delivery method:__________________________ (attach shipping bill, if any) (Use extra sheets, if necessary)

Sample Identification

Each field sample will be identified by a sample tag which is filled out using water resistant ink. Included on the tag (usually supplied by the laboratory) are the sample identification number, date, time and location of sample collection, designation of the sample (grab, pump, or composite), the type of sample and preservative, any pertinent remarks, and the signature of the sampler.

The information will be recorded in the bound logbook along with any in-situ measurement data and field observations. After collection and identification, the sample will be indicated for and maintained under the Chain-of-Custody procedures outlined below. If the sample collected is to be split with Federal or State agencies, then the appropriate sample receiver will be indicated on the split sample tag which is affixed on the container containing the split sample aliquot.

Sample Custody In the Field

The following general guidelines will be used for establishing and maintaining custody of field samples:

- Sample tags will be completed for each sample, using waterproof ink, making sure that the tags are legible and affixed firmly on the sample container.
- All information will be recorded in the field in bound notebooks with sequentially numbered pages, using sample identification numbers from the tags as references.
- The field investigator will be personally responsible for the care and custody of the samples collected until they can be transferred or properly dispatched.
- A chain-of-custody record willl be initiated in the field for every sample or set of samples that are being shipped to the same laboratory. A copy of this record will accompany the sample.

CALIBRATION PROCEDURE AND FREQUENCY

A calibration procedure establishes the relationship between a known calibration standard and the measurement of that standard by an instrument or analytical procedure. Standards are run at least once each time an instrument or procedure is used.

Calibration For Field Analysis

Plans will be developed and implemented for all field analysis tests, collection equipment, and calibration standards used, which will include the following: (a) calibration and maintenance intervals, (b) a list of the required calibration standards, (c) the environmental conditions that warrant calibration, and (d) a system of recording documents.

Any equipment used to qualitatively detect unsafe/unhealthful or potentially dangerous conditions for workers, such as photoionizers, will be calibrated before each measurement period. Equipment used to quantitatively measure environmental parameters will be calibrated at a minimum of once a day by comparison to a calibration standard prepared either gravimetrically or from commercially prepared stock solutions. Measurement devices that do not allow for calibration (i. e. thermometers) will have their accuracy determined by comparison to thermometers that have been calibrated according to the relevant ASTM standards.

For sampling of hazardous waste streams and containers, the sampling methods described by the EPA and EPA-approved methologies (e.g. ASTM standards) will be followed, including calibration procedures described.

Calibration of Laboratory Equipment

For chemical analyses, a calibration curve is made or at least checked for each batch of samples. The accuracy of the calibration is assured by careful attention to standard solutions. These solutions are prepared either gravimetrically or from commercially available stock solutions. Whenever a new stock solution is prepared, it will be compared to the old standard to assure consistency. All samples can be calculated using a linear least-squares fit of the calibration curve. To ensure that instrumental response is not changing as a function of time, one standard from the calibration standards should be run every ten samples, and a complete calibration curve should be run at least every thirty samples.

All calibration and recalibration procedures and methodologies used during chemical analyses will be followed as provided in EPA publications SW-846 "Test Methods for Evaluating Solid Wastes" and EPA600/4-79-020 "Methods for Chemical Analysis of Water and Wastes". The calibration procedures that are followed will be documented and will indicate what tests of the calibration are applicable, the standards, and provide for labeling the calibration data with the appropriate dates to ensure usage of the current calibration curve.

For performing water, sludge and soil/waste chemical analyses, the following references are used:

- "Test Methods for Evaluating Solid Wastes; Physical/Chemical Methods", SW-846, EPA, July, 1982.
- "Methods fpr Analytical Quality Control in Water and Wastewater Laboratories", EPA600/4-79-019, EPA, March 1979.
- "Standard Methods for the Examination of Water and Wastewater", 15th or 16th Editions, APHA, AWWA, WPCF, 1985.

Documentation

Laboratory testing programs will utilize prepared forms to systematically and uniformly document administrative and technical information. These forms shall be prepared prior to initiating the test programs. Chemical analysis documentation and soil sample test forms shall be completed during the testing and subsequent data reduction. All requested information shall be addressed. This information shall include, as appropriate:

- Project name and number,
- Identification of test personnel.
- Identification of calibrated equipment used (test equipment list giving equipment and identification number),
- Test data and subsequent data reduction,
- Test results in the form of tables and curves, and
- Unusual conditions encountered.

All laboratory administrative forms, test data, computer printouts and checkpoints shall be organized and maintained by the Laboratory Directors until transferred to the Project Manager.

2.2 Health and Safety Plan

Establishing appropriate personnel health and safety requirements is an important part of any hazardous waste Site investigation. A Health and Safety Plan has been developed for the Site, and is included. This plan has been developed to be consistent with the Department of Labor, Occupational Safety and Health Administration (OSHA), state and local requirements.

The Health and Safety Plan has the following elements:

- Introduction;
- Designation of Responsibility;
- Determination of Work Areas;
- Site Preparation;
- Site Description and Waste Characteristics;
- Personnel Protection Program;
- Permissible Exposure Limit Provisions;
- Notification of Emergencies;
- Exposure Monitoring;
- Emergency Situations;
- Personnel Protection Zone Requirements;
- Visitor Protection;
- Housekeeping;
- Waste Disposal;
- Medical Surveillance;
- Emergency First Aid Requirements;
- Safety Equipment Required On-Site; and
- Recordkeeping.

A copy of the Health and Safety Plan will be made available to EPA for use by EPA field personnel, to ensure consistent health and safety prpocedure are employed at the Site for all personnel involved in RI/FS activities.

INTRODUCTION

A personnel Safety and Health Plan has been prepared by Cranmer & Associates, Inc., (CAI) for the Site, as described in the Remedial Investigation and Feasibility Study (RI/FS) Work Plan Proposal for the Site.

The requirements of the Safety and Health Plan are based upon the scope of Site work described in the RI/FS which was based in large part on an earlier Site investigation conducted by CAI, various engineering consulting firms, ADPC&E, and EPA between 1981 and 1987. The level of personnel protection is based upon the data obtained from the above referenced.

The technical objective of on-Site investigations has been divided into two phases: a Remedial Investigation and a Feasibility Study. The purpose of this Safety and Health Plan is to address the safety and health concerns during the implementation of the RI/FS and those tasks required to obtain representative soil and water samples at the Site and conduct feasability studies and remedial actions.

The following guidance regarding worker safety was provided by EPA in its final agency position of Pentachlorophenol (PCP) and Creosote found in PD-4 July, 1984.

- EPA permitted the disposal of treated wood which contained 10,000 ppm PCP and 100,000 ppm creosote by ordinary trash collection or burial. EPA warned that treated wood should not be burned in open fires or stoves or fireplaces because toxic chemicals may be produced in the smoke and ashes. EPA advised that large quantities of treated wood from commercial or industrial use (e.g., construction sites) may be burned in commercial or industrial incinerators in accordance with State and Federal regulations.

- Protective Clothing and Equipment. Applicators must wear gloves* impervious to the wood treatment formulation in all situations where dermal contact is expected (e.g., handling freshly treated wood and manually opening cylinder doors).

  Creosote: Applicators who manually open cylinder doors must wear gloves* and a respirator (properly fitting, well-maintained, half-mask cannister or cartridge respirator which is MSHA/NIOSH-approved for polynuclear aromatics and organic vapors).

*Examples of acceptablle materials for protective clothing (e.g. gloves, overalls, jackets and boots) required during application and handling of creosote are polyvinyl acetate (PVA), polyvinyl chloride (PVC) and NBR (Buna-N); for pentachlorophenol, acceptable materials are polyvinyl acetate, polyvinyl chloride, neoprene, NBR and nitrile. In addition, plasticated disposable coveralls impervious to dust are acceptable for dust protection (pentachlorophenol). Examples of protective clothing (e.g., gloves, overalls, jackets and boots) required during application and handling of inorganic arsenicals are vinyl, polyvinyl chloride, neoprene, NBR, rubber and polyethylene.

Pentachlorophenol: Applicators who manually open cylinder doors must wear gloves and a respirator (properly fitting, well-maintained, half-mask cannister or cartridge respirator which is MSHA/NIOSH-approved for organic vapors and acid gases).

Creosote and Pentachlorophenol: Applicators who enter pressure treatment cylinders and other related equipment that is contaminated with the wood treatment formulation (e.g., cylinders that are in operation or are not free of the treatment formulation) must wear protective clothing (including coveralls, jacket, gloves and boots)* impervious to the wood treatment formulation and a respirator as described in the previous section.

It would be nearly impossible for the most careless worker on the Site to obtain exposures as high as those anticipated by EPA for workers at an active treatment plant.

Cranmer and Associates, Inc., Responsibility

All reasonable precautions shall be taken by Cranmer & Associates, Inc. (CAI) and other contractors to ensure the safety and health of workers and the general public. CAI and contractors shall comply with all Federal, State and local safety and health regulations and requirements. CAI and contractors shall also comply with all safety and health requirements delineated in the Remedial Investigation and Feasibility Study of Waste Storage Facilities at the Site. Evidence of compliance will be provided by the monitoring records generated from safety and health programs.

Scope

This Site Safety and Health Plan describes the methods to be used to monitor and protect personnel during the characterization and remediation of the waste disposal areas at the Site. Applicable safety and health standards are specified and the responsibilities for carrying out this plan are described. Guidance on program requirements and hazard control and monitoring is included. It is important that the standards and procedures be understood and observed by all personnel and contractors.

ORGANIZATION AND RESPONSIBILITIES

Staffing and Lines of Authority

Personnel at the Site will include an On-Site Health and Safety Officer (OSHSO) to ensure that all work activities are conducted in accordance with the requirements of this plan. An alternate to the OSHSO will also be named. Lines of authority for safety and health management will be independent of those for operational management to assure that Site safety and health functions are not overridden by operational concerns.

The OSHSO and alternate will communicate Site-specific safety and health questions to the Site Safety and Health Coordinator who will confer with the OSHSO concerning deviations in the Safety and Health Plan.

SITE DESCRIPTION AND WASTE CHARACTERISTICS

A description of each Site waste, what is known of the disposal procedures, and the substances that may be present are assembled in the following pages along with CAI's recommendations for personnel protection for the on-Site monitoring that will be conducted throughout the progress of the sampling program. Toxicological data for each of the chemical suspected at the Site are included.

Process Treatment and Sinkhole Area

Site Description. The treatment process area consisted of treatment solution tanks and a pressure cylinder. During the treatment process, the pressure cylinder was drained of preservative and a vacuum was created to remove the excess treatment mixture from the wood. Oil from clean-up procedures was disposed of by washing it into a sinkhole located near the treating cylinder. Constituents known to be present in subsoil are: Pentachlorophenol (PCP) and creosote (polynuclear aromatic hydrocarbons, PAHs). Soil samples collected in June, 1985, indicated lower levels of polychlorinated dioxins and furans that might have been anticipated.

Substances of Safety and Health Concern:

Based upon the information made available to CAI, after the treatment process ended, the treated materials were then transferred from the pressure cylinder to the storage yard for shipment. Some preservative solution dripped off of the treated wood around the trucks up to the treatment cylinder. Constituents expected to be present in subsoil are: PCPand creosote.

Substances of Safety and Health Concern:

PCP and Creosote Components

Level of Personal Protection

Level C: excavation, pumping, barreling

Level D: normal Site movement

SAFETY AND HEALTH PROGRAM REQUIREMENTS

Site Preparation

The support area and decontamination corridors will be prepared for foot and vehicular traffic by removal of any remaining obstruction at the Site.

Worker Training

Training will be provided to all contractor and service personnel assigned to or regularly entering the Site for the purpose of performing or supervising work, for health, safety, security, or administrative purposes, for maintenance, or for any other Site investigation-related function. The training session will be at least two hours in duration and will include all the items listed below and emergency instruction for chemical exposure or release, fire or explosion, and personal injury.

- Site Safety and Health Plan
- Physical health hazards identified at the Site including acute and chronic effects of waste constituents identified at the Site.
- Personal hygiene
- Safety equipment and procedures required for personal protection.
- Proper use and fitting of respirators.
- Work zones established at the Site.
- Prohibitions while on areas:

  1. Beards and long sideburns
  2. Eating, smoking, chewing
  3. Personal articles, e.g., watches and rings
  4. Working when ill

- Buddy system
- Medical surveillance
- Heat stress monitoring

Personnel will not be allowed to enter the Site to perform work who have not successfully completed the required training.

In addition to worker training, all Site personnel will attend a daily refresher safety meeting to discuss safety procedures in regard to the day's planned activities.

Recordkeeping

Records of all monitoring required as described below and shown in Table 1 will be maintained.

1. The dates, number, duration, and results of air samples taken. These measurements shall be written in an instrument log book that shall be available for inspection at all times.

2. A description of the sampling and analytical methods used.

3. Type of respiratory protective devices worn.

4. Name, social security number, and job classification of the employee monitored.

Complaints

Employees are to be encouraged to report to the OSHSO, either directly or through their authorized employee representative, any conditions or practices which they consider detrimental to their health or safety or which they believe are in violation of applicable safety and health standards. Such complaints may be made orally or in writing. Each contractor shall also have available a form to be used in reporting violations (Attachment A).

An employee, or representative of employees, who believes that an imminent danger exists that threatens to result in death or serious physical harm, is encouraged to bring this matter to the immediate attention of the OSHSO for resolution. In the event of inadequate corrective action, the employee and/or authorized representative may also contact the local agency having jurisdiction, the Project Office, the Health and Safety Officer, or the Occupational Safety and Health Administration (OSHA) by telephone and arrange an appointment for an inspection.

Restrictions

A worker under age 21 shall neither be employed in, or allowed to enter, controlled areas when conditions exist that may be potentially injurious to his/her health.

Internal Audits

Internal safety and health audits shall be conducted to ensure compliance with the requirements of this plan. An initial audit will be conducted by the OSHSO within three weeks of commencing waste characterization sampling and will provide follow-up actions if any violation of safety and health standards. Additional audits will be conducted periodically, at least once a month.

Controlled Areas

Controlled areas shall be established to protect the workers from unnecessary exposure to residues of PCP or creosote, and to prevent the spread of contamination. Controlled areas include, but are not limited to, any work area subject to penetration or excavation or where the potential exists for significant dispersal of contaminated material from a work area, through personnel or equipment transfer.

Control od access for people, vehicles, and equipment will prevent inadvertent exposure and spread to contaminated material. The entire Site will occasionally be considered a controlled area. The Site is currently fenced. The integrity of the fence will be improved. In addition, a map, updated daily if necessary, will be provided to workers clearly delineating controlled areas.

Posting

Controlled areas will be conspicuously marked at points of potential access with appropriate sign or signs according to applicable posting and labeling requirements set forth in 29 CFR 1910.

At times when it is necessary to barricade or "rope-off" an area, all barricades, ropes , and warning signs, whether used in roadway or not, shall be in accordance with ANSI Standards D-6.1-1971.

OCCUPATIONAL MONITORING AND PERSONAL PROTECTION

Medical Surveillance

Services of an occupational physician and a local physician will be made available to provide medical examinations to all employees involved with on-Site investigations. Representatives of regulatory agencies will be provided, upon request, medical evidence that each on-site person is in good health and is capable of wearing the appropriate dermal and respiratory protective clothing/equipment necessary during the sampling program. All individuals associated with the on-Site investigations shall have undergone an acceptable physical examination no more than 12 months prior to the start date. A list of medical parameters to be included in the physical examination are described in Attachment B.

Determination of Work Areas

The following areas at each drilling site will be defined and identified. Equipment and personnel in the areas are specifically defined below (see Figure).

Zone 1: Exclusion Zone -- The exclusion zone is the zone where contamination exists or could occur. All people entering the exclusion zone will wear the prescribed level of protection (see Personnel Protection Zone Requirements). An entry and exit check point will be visually defined at the periphery of the exclusion zone to regulate the flow of personnel and equipment into and out of the zone. The entire Site may occasionally be designated the exclusion zone, with the exception of the uncontaminated area used for raw wood storage, located just inside the Site gate.

Zone 2: Contamination Reduction Zone -- The area between the exclusion zone and the support zone is the contamination reduction zone. This zone provides a transition between contaminated area and the clean zone. Zone 2 serves as a buffer to further reduce the possibility of the clean zone becoming contaminated. It provides additional assurance that the physical transfer of contaminating substances on people, equipment, or in the air is limited through a combination of decontamination, distance between exclusion and support zones, air dilution, zone restrictions, and work functions. At the boundary between the exclusion and contamination reduction zones, decontamination stations will be established, as described in the decontamination procedures (Attachment C). The contamination reduction zone will be located in the new wood storage area as shown in the Figure .

Zone 3: Support Zone -- This area is the area outside the zone of contamination. The support zone shall be marked and shall be protected against contamination from the work/sampling site. The function of the area includes:

a. An entry area for personnel, material, and equipment.

b. An exit area for decontaminated personnel, materials and equipment.

c. A storage area for clean safety and work equipment.

d. An area for rest breaks, the consumption of food and beverage, and all other activities.

e. Location of Site office support zone, will be located just inside the entrance gate.

Personnel Protection Program

CAI has established and will maintain as part of the Site Safety and Health Plan a Personnel Protection Program for all personnel working at the Site. The usual level of protection required at the site has been determined to be Level D. This determination is based upon a preliminary hazard evaluation of the Site and previously documented information (see Site Description and Waste Characterization). The appropriateness of the level of specified protection will be verified before initiating field activities. The hazards associated with the Site will vary slightly as a function of the specific locations. These variations have been described in previous data and primarily concern the disposal of waste oils, woods treatment process waste, tar acids and bases in the soil and ground water. Areas of active investigation, however, may be required to have Level C personnel protection. The results of air monitoring may allow the level of personnel protection to be downgraded to level D. The measured air concentrations that allow this judgement are described below (Permissible Exposure Limit Provisions).

Personnel Protection Zone Requirements

Protective gloves, boots, and suits will be of material resistant to organic chemicals present at the Site. All respiratory protective equipment will be approved by

the National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA).

The level of personal protection required for the active stages of the project (excavation, pumping) has been determined to be Level C Protection as summarized below:

Level C Protection.

a. NIOSH-approved full-face piece, air-purifying, cartridge equipped respirator, equipped with organic vapor cartridges and dust/mist prefilter.

b. Polyethylene-coated Tyvek clothing, long sleeves, one or two pieces.

c. Gloves (chemical resistant, e.g., nitrile).

d. Steel toe boots/shoes.

e. Hard hat (face shield optional)

f. Options as required.

1. Inner chemical-resistant gloves.

2. Disposable outer boots (chemical-protective, heavy rubber vinyl disposables as appropriate).

If level of protection is Level D, following protection is required:

a. Work uniform.

b. Steel toe boots/shoes.

c. Hard hats.

d. Eye protection (safety glasses or goggles)

Decontamination Procedures

Procedure for Full Decontamination - Level C Protection (See Figure).

Station 1: Segregated Equipment Drop

Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross-contamination.

Equipment: Various size containers

Plastic liners
Plastic drop cloths

Station 2: Outer Garment, Boots and Gloves, Wash and Rinse

Scrub outer boots and gloves with decon solution or detergent/water. Rinse gloves, boots and garment with hand pump spray bottle into plastic bucket.

Equipment: 2 containers (30-50 gallon)
Hard pump spray device (garden sprayer)
Water
Detergent
Scrub brushes

Station 3: Outer Boot and Glove Removal

Remove outer boots (if worn) and gloves with accompanying tape. Tape should be placed in a container with a plastic liner. Disposable clothing will be placed in a container with a plastic liner for screening and/or disposal.

Equipment: 2 Container (30-50 gallon)
Plastic liners
Bench

Station 4: Cartridge Change

If a worker leaves the exclusion zone to change a cartridge on his/her respirator, this is the last step in the decontamination procedure. Once the worker's cartridge is exchanged, the outer gloves and boot covers are donned with joints taped. The worker may then return to the exclusion zone.

Equipment: Respirator cartridges and prefilters
Tape
Extra gloves
Boot covers (if worn)

Station 5: Boots, Gloves and Outer Garmet Removal

Removal of boots, gloves (inner) and outer garment and place in decontamination zone. The outer chemically resistant garment should be deposited in a plastic lined container.

Equipment: Container (30-50 gallon)
Bench or stool
Plastic liners

Station 6: Respiratory Protection Removal

Remove the face piece respirator, deposit used cartridges in a plastic lined container and wipe the face piece with clean water and paper towels. Store respirator in clean, dry place, away from contamination.

Equipment: Container (30-50 gallon)
Plastic liners
Paper towels
Detergent solution and disinfectant
Rinse water

Section 7: Field Wash

Thoroughy wash hands and face and shower as soon as possible.

Equipment: Water
Soap
Wash basins/buckets

Procedure for Decontamination - Level D Protection (See Figure 3)

Station 1: Segregated Equipment Drop

Deposit equipment used on site (tools, sampling devices and containers, monitoring equipment, radios, clipboards) on a plastic drop cloth or in different containers with plastic liners.

Equipment: Various size containers
Plastic liners
Plastic drop cloth

Station 2: Outer Garment, Boots and Gloves, Wash and Rinse

Scrub outer boots and gloves with decon solution or detergent/water, rinse gloves, boots and garment with hand pump spray device into plastic bucket.

Equipment: 2 containers (30-50 gallon)
Hard pump spray device
Water
Detergent
Scrub brushes

Station 3: Boot, Gloves, and Outer Garment Removal

Boots and outer gloves are removed and placed outside the decontamination zone. Inner gloves and Tyvek suits are deposited in separate containers lined with plastic.

Equipment: Containers (30-50 gallon)
Plastic liners

Bench or stool

Station 4: Field Wash

Thoroughly wash hands and face. Shower as soon as possible.

Equipment: Water
Wash basin/bucket
Soap

Exposure Monitoring

Exposure monitoring will be performed prior to and during all field activities at the Site.

Draeger tubes will be used by field personnel during drilling, excavation and/or exploratory activities. A hand or battery powered metering pump is used to pull the known volume of air through the tube. The hand metering pump will be calibrated prior to use as follows:

1. A detector tube will be connected between the inlet of the pump and the outlet of a soap bubble meter.

2. The time (seconds required to displace various volume) will be checked using a stop watch.

3. The calibration data will be entered in the field personnel logbook. Each pump will be identified with a serial number and/or pump number.

4. Detector tubes that have been certified by NIOSH (National Institute for Occupational Safety and Health) will be used.

5. All calibration data and field measurements will be recorded and maintained in the field personnel logbook.

Respiratory Selection

Employees will be provided respirators from those approved by the National Institute for Occupational Safety and Health under provisions of 30 CFR Part II. CAI's written respiratory protection program (see Attachment D) will be kept on-site. Contractors will be required to provide similar respirators and canisters for their employees throughout the duration of the project. Contractors must also provide a written respiratory protection program in accordance with the requirements of 29 CFR 1910.34.

All members of the investigative team who wear a respirator will be required to wash their face and respirator face piece to prevent skin irritation associated with the use of a respiratory device. In addition, all workers are responsible for the cleanliness

of their respirators in minimizing the potential contact of their face or lungs with contaminated soil or ambient on-site air.

Permissible Exposure Limits Provisions

Employees' exposure to airborne concentrations of total ionizable pollutants should be less than 10 ppm throughout the course of the investigation. This level of protection shall be enforced by the use of a full-face respirator equipped with disposable organic vapor cartridges with a dust/mist prefilter. The respirators will be replaced with a new canister every 4 hours (MSA canister identification, GMA-SS). In order to protect the health of workers at the site, a photoionization device (Photovac, Inc., TIP) will be used to compare measurable levels of air contaminants. If levels of greater than 10 ppm total ionizable pollutants are detected, additional measurements will be taken using detector for specific chemicals (benzene, toluene, or other known solvents on-Site).

The photoionization detector will be used to spot check for "hot spots" or volatile organic vapors. The TIP will be used by field personnel during drilling and/or exploratory activities and whenever the potential exists for high concentrations of volatile organic vapors. The TIP will be calibrated as follows:

1. The Manufacturer's operating procedures will be followed.

2. The TIP will be spanned and zeroed in accordance with the operating instructions.

3. The appropriate documentation relative to the span, zero, drifts, etc. of the TIP will be noted in the field personnel log.

4. All field measurements will be recorded and maintained in the field personnel logbook.

A Photovac TIP will be calibrated prior to use each morning to an isobutylene standard (100 ppm) to provide comparable readings during the day and to provide a source of comparison during the investigation. Under no circumstances will Site personnel enter the exclusion zone without the use of a respirator where required.

An action level of 100 ppm total ionizable pollutants have been assigned (based upon a 100 ppm 150 isobutylene standard) to determine the need to reevaluate the frequency of cartridge change and the level of protection. Complete removal of respirators within the exclusion zone (when required) is absolutey forbidden and may result in the dismissal of the employee from the project. Intermittent evaluation (every 30 minutes) of the breathing zone for organic vapors using a TIP (Photovac Incorporated, Photoionization Detector) will document and support the necessity of maintaining Level C protection. If airborne levels are consistently less than 5 ppm for 1 hour or more, then field activities can be completed at Level D upon notification of the On-Site Health and Safety Officer. Intermittent evaluation of contaminants in the breathing zone will be performed while Level D protection is used, as with Level C.

The detection of organic vapors at a concentration of 100 ppm for several minutes (3 minutes) at Level C personal protection will necessitate an immediate halt in all work until the vapors diminish to below 20 ppm (T.I.P.) for a period of 10 minutes. A decision of initiate work by the OSHSO will require a phone call to the Safety and Health Officer of the Project Manager to discuss the monitoring results and agreement of start up conditions. Should continued drilling result in concentrations that exceed 100 ppm total ionizable pollutants (TIP), the Project Manager should be contacted by the OSHSO to consider relocating the well or upgrading protective equipment.

Heat Stress Monitoring

If the On-Site Health and Safety Officer requires personnel to wear chemically impervious clothing, heat stress monitoring will be required. Monitoring by the OSHSO shall commence when the ambient temperature is 70°F or above. The frequency of monitoring shall increase as the ambient temperature increases or as recovery rates diminish. When temperatures exceed 85°F, workers shall be monitored for heat stress after every 30 to 60 minute work period.

- Heart rate (HR) shall be measured by the radial pulse for 30 seconds as early as possible in the 10 to 15 minute resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period shall be shortened. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle shall be shortened.

- Body temperature shall be measured as early as possible in the resting period. Temperature at the beginning of the rest period should not exceed 99°F. If it does, the next work period shall be shortened. However, if the temperature is 99.7°F at the beginning of the next rest period, the following work cycle shall be further shortened. Temperature shall be measured again at the end of the rest period to make sure that it has dropped below 99°F.

Notification of Emergencies

A phone will be installed at the Site prior to initiating field activities. The OSHSO will have access to several copies of a laminated list of emergency numbers to contact in case of an emergency (Table 2). A phone will be connected at the Site as part of the initial Site activities. The emergency list will include:

Fire
Police
Ambulance
Poison Control
Hospital

The on-Site Safety and Health Officer is responsible for the initial telephone contacts necessary to protect the safety and health of all workers. The on-Site Safety and Health Officer is also responsible to write an on-Site report of all accidents requiring a break in work time as described in Table 3.

Emergency Situations

Written Plan: A written plan for emergency situations has been developed to address the needs of on-Site emergency activities (Figure 4). The plan describes the action that shall be implemented in the event of an emergency. Emergency entry and escape routes are shown on Figure 5.

Alerting Employees

Alarms: Where there is a possibility of employee exposure to physical harm, the potential for an explosive situation, or elevated levels of organic vapors, the on-site Safety and Health Officer shall be responsible to call to the employee's attention the emergency situation by voice command (or horn where appropriate).

Evacuation: Employees not engaged in correcting the emergency shall be restricted from the area and shall not be permitted to return until the emergency is abated.

First Aid Requirements

Emergency medical care services at a nearby medical facility and establish emergency routes will be prearranged (Figure).

Table 3. Emergency Report

1. Date_____
2. Time of Accident_____

   Climatic Conditions_____
3. On-Site Coordinator_____
4. Employee Injured_____
5. Company Affiliation_____
6. Social Security Number_____
7. Insurance Company_____
8. Number of Workers at Site_____

Names of Workers	Company Affiliation
1. _____	_____
2. _____	_____

3. _____ _____

4. _____ _____

5. _____ _____

9. Circumstances of the Injury/Emergency Action_____

_____

10. Emergency Actions Taken_____

_____

11. What first aid was provided?_____

_____

12. Was an emergency phone call made to the Project Safety Officer?_____

If so, time:_____

13. Ambulance Services Used_____

14. Hospital Used_____

15. Attending Physician_____

16. Company Representatives Contacted_____

17. Contractor Representatives Contacted_____

In the event of any emergency associated with or resulting from work at this Site which, in the opinion of the on-Site Safety and Health Officer, materially endangers life, property, or the environment, all sampling will cease at the Site. Appropriate personnel will take diligent action to remove or otherwise minimize the cause of the emergency; render full assistance to local authorities to remedy any impact on local residents or property; and institute whatever measures might be necessary to prevent any repetition of the conditions or actions leading to or resulting in the emergency.

Visitor Protection

All visitors to the Site shall be instructed to stay outside the work zones and remain with the support zone during the extent of their stay. Visitors shall sign a Visitors Log Book and record all information noted in the log.

Visitors will be cautioned to avoid skin contact with contaminated or suspected contaminated surfaces. During visitation, hand-to-mouth transfers on-site will be reduced with special precautions not to eat, drink, smoke, or chew (gum or tobacco).

Visitors requesting observation of the work zone (Zone A) must wear all appropriate personnel protective wear prior to entering the work zone. Should respiratory protective devices be necessary (Level C), visitors who wish to enter the work zone must produce evidence that they have had a complete physical examination and respiratory protection training and fit testing within the past twelve months. Visitor admittance to the work zone will be left to the discretion of the OSHSO.

Housekeeping

General. The contractor shall implement a housekeeping program for the sampling program to minimize the spread of contaminants beyond the work site (exclusion area).

The program shall include:

1. Periodic (at least weekly) inspection of the work area for debris including paper products, cans and other materials brought on Site.

2. Periodic (at least daily) changing of wash water and rinse for hand, face, and equipment.

3. Periodic removal (daily minimum) of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing (Tyvek).

Waste Disposal

General. Contractors will not remove material from the Site that may potentially endanger the safety and health of on-Site employees or the general public from the work place.

Protective Wear. All gloves, boots, hats, and protective outerwear that can be cleaned and reused shall be scrubbed and cleaned in containers provided within the decontamination zone prior to reuse and removed from the Site at the end of each working day. All contaminated and potentially contaminated disposable garments and duct tape will be disposed of as hazardous waste unless testing shows the garments to be non-hazardous.

All contaminated and potentially contaminated disposable garments and duct tape will be disposed of as hazardous waste unless proven to be non-hazardous.

Waste Food Containers. During and following lunch and break periods, all waste materials shall be collected (by all individuals) and disposed in waste containers provided.

Safety Equipment.

- Emergency eye wash
- First aid kit
- 17 lb halon fire extinguisher or equivalent
- Photoionization Detector (TIP)
- Organic vapor analyzer
- Drinking cups
- Decontamination facilities
- Explosion meter
- Emergency horn
- Garbage bags
- Paper towels
- Garbage cans
- Brushes
- Spray container

Noise

Noise suppression devices shall be used where appropriate and the use of hearing protective devices shall be encouraged. During operations such as air rotary drilling for which noise levels exceed 85 DBA, hearing protection will be required.

Personal Precautions

- Eating, drinking, chewing gum or tobacco smoking, or any practice that increases the chance of hand-to-mouth transfer and ingestion of material is prohibited in areas designated contaminated as determined in the initial site survey. Attention is specifically called to "No Smoking" areas posted at various locations throughout the site. All employees must strictly adhere to the regulations governing these areas.

- Hands and face shall be thoroughly washed upon leaving the work area.

- No facial hair which interferes with the mask-to-face-seal shall be allowed on personnel who may be required to wear a face fitting respirator.

- Contact with contaminated or suspected contaminated surfaces shall be avoided by personnel working in contaminated areas.

HAZARD CONTROL

General Precautions

Personnel working at excavation or drilling sites may encounter conditions that are unsafe or potentially unsafe. In addition to the danger due to the physical, chemical, and toxicological properties of the material(s) present, other types of hazards - electricity, water, heavy equipment, falling objects, loss of balance, or

tripping for example, can have an adverse effect on the safety and health of personnel. The following sections describe the requirements that will be implemented to minimize these potential adverse effects.

Buddy System

For all on-Site activities, the buddy system will be implemented in active areas to ensure safety of personnel. Workers will be required to perform all activities at Level C with another individual. At no time will workers be permitted to wander the Site alone.

Fire and Explosion Prevention

Contractors shall maintain a fire and explosion prevention and control effort appropriate for the needs at the Site as determined in the initial Site survey. An explosion meter will be used to ensure safe levels during field activities.

Safety Precautions Near Utility Lines

While in use, the minimum distance of a crane or drilling rig to a power line shall be:

- 10 feet from a 50 KV line.
- 20 feet from a 345 KV line.
- 34 feet from a 750 KV line.

In transit, with the boom on a derrick lowered, the closest approach to a power line shall be:

- 4 feet to a 50 KV line.
- 10 feet to a 50-345 KV line.
- 16 feet to a 345-750 KV line.

The OSHSO shall be consulted if drilling near buried lines is necessary. Buried pipes will be identified during initial Site activities.

Sanitation

Toilet facilities shall be provided in accordance with 29 CFR 1926.51. The location of these will be determined following the initial Site survey.

Potable water for drinking and washing prior to eating shall be provided for all employees.

ATTACHMENT A

SAFETY AND HEALTH COMPLAINT FORM

DATE:_____

SITE:_____

COMPLAINT:_____

COMPANY AFFILIATION:_____

SITE SAFETY AND HEALTH OFFICER:_____

PLEASE CHECK APPROPRIATE AREAS OF CONCERN

- NATURE OF COMPLAINT:_____

_____

_____

_____

_____

Work Areas	____	Sanitation	____
"Right-to-Know"	____	Personal Hygiene	____
Personal Protection Level	____	Emergency Procedures	____
Safety Equipment	____	Waste Disposal	____
Exposure Monitoring	____	Recordkeeping	____
Heat Stress	____	Respirator Protection	____
Housekeeping	____	Worker Training	____
Noise	____	Protective Clothing	____
Safety Precautions	____	Other _____	
Decontamination	____	_____	

Signature_____

Date_____

ATTACHMENT B

PHYSICAL EXAMINATION PARAMETERS

The following physical requirements have been evaluated by a qualified occupational health physician on all personnel associated with the investigation to assure that they are certified to perform work at the Site.

1. Compilation of a complete occupational health history.
2. Compilation of a complete family health history.
3. Blood analysis (SMAC-25).
4. Urine analysis.
5. Chest X-ray (front only).
6. Hearing examination.
7. Sight examination.
8. Pulmonary function examination.
9. Electrocardiogram examination.
10. Complete physical examination.

Occupational Health Guideline for Coal Tar Pitch Volatiles

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

Anthracene

- Formula: $C_{14}H_{10}$
- Synonyms: None
- Appearance and odor: Pale green solid with a faint aromatic odor.

Phenanthrene

- Formula: $C_{14}H_{10}$
- Synonyms: None
- Appearance and odor: Colorless solid with a faint aromatic odor.

Pyrene

- Formula: $C_{16}H_{10}$
- Synonyms: None
- Appearance: Bright yellow solid

Carbazole

- Formula: $C_{12}H_9N$
- Synonyms: None
- Appearance and odor: Colorless solid with a faint aromatic odor.

Benzo(a)pyrene

- Formula: $C_{20}H_{12}$
- Synonyms: BaP, 3,4-benzopyrene
- Appearance and odor: Colorless solid with a faint aromatic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for coal tar pitch volatiles is 0.2 milligram of coal tar pitch volatiles per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit for coal tar products be reduced to 0.1 mg/m^3 (cyclohexane-extractable fraction) averaged over a work shift of up to 10 hours per day, 40 hours per week, and that coal tar products be regulated as occupational carcinogens. The NIOSH Criteria Document for Coal Tar Products and NIOSH Criteria Document for Coke Oven Emissions should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- Routes of exposure

Coal tar pitch volatiles can affect the body if they are inhaled or if they come in contact with the eyes or skin.

- Effects of overexposure

Repeated exposure to coal tar pitch volatiles has been associated with an increased risk of developing bronchitis and cancer of the lungs, skin, bladder, and kidneys. Pregnant women may be especially susceptible to exposure effects associated with coal tar pitch volatiles. Repeated exposure to these materials may also cause sunlight to have a more severe effect on a person's skin. In addition, this type of exposure may cause an allergic skin rash.

- Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to coal tar pitch volatiles.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to coal tar pitch volatiles at potentially hazardous levels:

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

1. *Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the oral cavity, respiratory tract, bladder, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders, for premalignant and malignant lesions, and evidence of hyperpigmentation or photosensitivity.

—Urinalysis: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. A urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment, as well as a test for red blood cells.

—Urinary cytology: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. Employees having 5 or more years of exposure or who are 45 years of age or older should have a urinary cytology examination.

—Sputum cytology: Coal tar pitch volatiles are associated with an excess of lung cancer. Employees having 10 or more years of exposure or who are 45 years of age or older should have a sputum cytology examination.

—14" x 17" chest roentgenogram: Coal tar pitch volatiles are associated with an excess of lung cancer. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Coal tar pitch volatiles are reported to cause an excess of bronchitis. Periodic surveillance is indicated.

—A complete blood count: Due to the possibility of benzene exposure associated with coal tar pitch volatiles, a complete blood count is considered necessary to search for leukemia and aplastic anemia.

—Skin disease: Coal tar pitch volatiles are defatting agents and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis, and semi-annually for employees 45 years of age or older or with 10 or more years' exposure to coal tar pitch volatiles.

• Summary of toxicology

Coal tar pitch volatiles (CTPV) are products of the destructive distillation of bituminous coal and contain polynuclear aromatic hydrocarbons (PNA's). These hydrocarbons sublime readily, thereby increasing the amounts of carcinogenic compounds in working areas. Epidemiologic evidence suggests that workers intimately exposed to the products of combustion or distillation of bituminous coal are at increased risk of cancer at many sites. These include cancer of the respiratory tract, kidney, bladder, and skin. In a study of coke oven workers, the level of exposure to CTPV and the length of time exposed were related to the development of cancer. Coke oven workers with the highest risk of cancer were those employed exclusively at topside jobs for 5 or more years, for whom the increased risk of dying from lung cancer was 10-fold; all coke oven workers had a 7-½-fold increase in risk of dying from kidney cancer. Although the causative agent or agents of the cancer in coke oven workers is unidentified, it is suspected that several PNA's in the CTPV generated during the coking process are involved. Certain industrial populations exposed to coal tar products have a demonstrated risk of skin cancer. Substances containing PNA's which may produce skin cancer also produce contact dermatitis; examples are coal tar, pitch, and cutting oils. Although allergic dermatitis is readily induced by PNA's in guinea pigs, it is only rarely reported in humans from occupational contact with PNA's; these have resulted largely from the therapeutic use of coal tar preparations. Components of pitch and coal tar produce cutaneous photosensitization; skin eruptions are usually limited to areas exposed to the sun or ultraviolet light. Most of the phototoxic agents will induce hypermelanosis of the skin; if chronic photodermatitis is severe and prolonged, leukoderma may occur. Some oils containing PNA's have been associated with changes of follicular and sebaceous glands which commonly take the form of acne. There is evidence that exposures to emissions at coke ovens and gas retorts may be associated with an increased occurrence of chronic bronchitis. Coal tar pitch volatiles may be associated with benzene, an agent suspected of causing leukemia and known to cause aplastic anemia.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data—Anthracene

1. Molecular weight: 178.2
2. Boiling point (760 mm Hg): 340 C (644 F)
3. Specific gravity (water = 1): 1.24
4. Vapor density (air = 1 at boiling point of anthracene): 6.15
5. Melting point: 217 C (423 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Phenanthrene

1. Molecular weight: 178.2
2. Boiling point (760 mm Hg): 340 C (644 F)
3. Specific gravity (water = 1): 1.18
4. Vapor density (air = 1 at boiling point of phenanthrene): 6.15
5. Melting point: 100.5 C (213 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• Physical data—Pyrene

1. Molecular weight: 202.3
2. Boiling point (760 mm Hg): Greater than 360 C (greater than 680 F)

3. Specific gravity (water = 1): 1.28
4. Vapor density (air = 1 at boiling point of pyrene): 6.9
5. Melting point: 150.4 C (303 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Carbazole**
1. Molecular weight: 167.2
2. Boiling point (760 mm Hg): 355 C (671 F)
3. Specific gravity (water = 1): Greater than 1
4. Vapor density (air = 1 at boiling point of carbazole): 5.8
5. Melting point: 246 C (475 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Benzo(a)pyrene**
1. Molecular weight: 252.3
2. Boiling point (760 mm Hg): Greater than 360 C (greater than 680 F)
3. Specific gravity (water = 1): Greater than 1
4. Vapor density (air = 1 at boiling point of benzo(a)pyrene): 8.7
5. Melting point: 179 C (354 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**
1. Conditions contributing to instability: None hazardous
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: None
4. Special precautions: None

• **Flammability**
1. Flash point: Anthracene: 121 C (250 F) (closed cup); Others: Data not available
2. Autoignition temperature: Anthracene: 540 C (1004 F); Others: Data not available
3. Flammable limits in air, % by volume: Anthracene: Lower: 0.6; Others: Data not available
4. Extinguishant: Foam, dry chemical, and carbon dioxide

• **Warning properties**

Grant states that "coal tar and its various crude fractions appear principally to cause reddening and squamous eczema of the lid margins, with only small erosions of the corneal epithelium and superficial changes in the stroma, which disappear in a month following exposure. Chronic exposure of workmen to tar fumes and dust has been reported to cause conjunctivitis and discoloration of the cornea in the palpebral fissure, either near the limbus or, in extreme cases, across the whole cornea. Occasionally, epithelioma of the lid margin has been attributed to contact with coal tar."

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Coal tar products may be sampled by collection on a glass fiber filter with subsequent ultrasonic extraction and weighing. An analytical method for coal tar pitch volatiles is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with condensed coal tar pitch volatiles, where skin contact may occur.

• If employees' clothing may have become contaminated with coal tar pitch volatiles, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with coal tar pitch volatiles

should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of coal tar pitch volatiles from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the coal tar pitch volatiles, the person performing the operation should be informed of coal tar pitch volatiles's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where condensed coal tar pitch volatiles may contact the eyes.

SANITATION

• Workers subject to skin contact with coal tar pitch volatiles should wash with soap or mild detergent and water any areas of the body which may have contacted coal tar pitch volatiles at the end of each work day.

• Employees who handle coal tar pitch volatiles should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

• Areas in which exposure to coal tar pitch volatiles may occur should be identified by signs or other appropriate means, and access to these areas should be limited to authorized persons.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to coal tar pitch volatiles may occur and control methods which may be effective in each case:

Operation	Controls
Liberation from extraction and packaging from coal tar fraction of coking	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a binding agent in manufacture of coal briquettes used for fuel; use as a dielectric in the manufacture of battery electrodes, electric-arc furnace electrodes, and electrodes for alumina reduction	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of roofing felts and papers and roofing	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use for protective coatings for pipes for underground conduits and drainage; use as a coating on concrete as waterproofing and corrosion-resistant material; use in road paving and sealing	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture and repair of refractory brick; use in production of foundry cores; use in manufacture of carbon ceramic items	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If condensed coal tar pitch volatiles get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• Skin Exposure

If condensed coal tar pitch volatiles get on the skin, wash the contaminated skin using soap or mild detergent and water. Be sure to wash the hands before eating or smoking and to wash thoroughly at the close of work.

• Breathing

If a person breath[illegible] in large amounts of coal tar pitch volatiles, move th[illegible]posed person to fresh air at once. If breathing [illegible]s st[illegible]ed, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of releases until cleanup has been completed.

• If coal tar pitch volatiles are released in hazardous concentrations, the following steps should be taken:

1. Ventilate area of spill.

2. Collect released material in the most convenient and safe manner for reclamation or for disposal in sealed containers in a secured sanitary landfill.

• Waste disposal method:

Coal tar pitch volatiles may be disposed of in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR COAL TAR PITCH VOLATILES

Condition	Minimum Respiratory Protection* Required Above 0.2 mg/m³
Particulate and Vapor Concentration	
2 mg/m³ or less	A chemical cartridge respirator with an organic vapor cartridge(s) and with a fume or high-efficiency filter. Any supplied-air respirator. Any self-contained breathing apparatus.
10 mg/m³ or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s) and with a fume or high-efficiency filter. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and with a full facepiece and a fume or high-efficiency filter. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
200 mg/m³ or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode. A powered air-purifying respirator with an organic vapor cartridge and a high-efficiency particulate filter.
400 mg/m³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 400 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates, including pesticide respirators which meet the requirements of this class. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

Occupational Health Guideline for Pentachlorophenol

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: C_6Cl_5OH
- Synonyms: PCP; penta
- Appearance and odor: Light brown solid with a pungent odor when hot.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for pentachlorophenol is 0.5 milligram of pentachlorophenol per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- Routes of exposure

Pentachlorophenol can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- Effects of overexposure

Exposure to pentachlorophenol may cause irritation of the eyes and respiratory tract. Bronchitis has been reported to occur. Systemic effects from either a large exposure or repeated smaller exposures include weakness, loss of appetite, nausea, vomiting, shortness of breath, chest pain, excessive sweating, headache, and dizziness. In fatal cases the temperature is often very high and death may occur as early as three hours after the onset of symptoms. The risk of serious intoxication is greater in hot weather. Persons with decreased liver or kidney functions are more susceptible to poisoning from this chemical. Repeated exposure to pentachlorophenol may cause an acne-like skin rash and liver damage. Commercial pentachlorophenol may be contaminated with dioxin compounds which are much more toxic than pentachlorophenol.

- Reporting signs and symptoms:

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to pentachlorophenol.

- Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to pentachlorophenol at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the cardiovascular system, eyes, upper respiratory tract, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders. Analysis of the urine for pentachlorophenol may be helpful in estimating the extent of absorption.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- Summary of toxicology

Pentachlorophenol dust and mist cause irritation of the eyes and upper respiratory tract; absorption results in an increase in metabolic rate and hyperpyrexia; prolonged skin exposure causes an acneform dermatitis. Human exposure to dust or mist concentrations greater than 1 mg/m^3 causes pain in the nose and throat, violent sneezing, and cough; 0.3 mg/m^3 may cause some nose irritation; persons acclimated to pentachlorophenol can tolerate concentrations up to 2.4 mg/m^3. Pentachlorophenol readily penetrates the skin; systemic intoxication is cumulative and has been fatal. Intoxication is characterized by weakness, anorexia, weight loss, and profuse sweating; there also may be headache, dizziness, nausea, vomiting, dyspnea, and chest pain. In fatal cases, the body temperature is frequently extremely high and

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

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death has occurred as early as 3 hours after the onset of symptoms. The risk of serious intoxication is increased during hot weather; persons with impaired liver or kidney function are more susceptible to the effects of pentachlorophenol. The dust, mist, and vapor cause eye irritation. Prolonged exposure of workers has caused an acneform dermatitis; 10 workers engaged in production of pentachlorophenol for 5 to 10 months developed a widely disseminated skin eruption characterized by small and large furuncles, brown pigmentation, and some cicatrization; 7 workers also developed severe bronchitis; all but 1 worker still showed signs of extensive acne more than a year after cessation of exposure, and 4 still complained of bronchitis. On the skin, solutions of pentachlorophenol as dilute as 1% may cause irritation if contact is repeated or prolonged.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 266.3
  2. Boiling point (760 mm Hg): 311 C (592 F) (decomposes)
  3. Specific gravity (water = 1): 2.0
  4. Vapor density (air = 1 at boiling point of pentachlorophenol): Not applicable
  5. Melting point: 182 – 190 C (360 – 374 F)
  6. Vapor pressure at 20 C (68 F): 0.00017 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F): 0.002
  8. Evaporation rate (butyl acetate = 1): Not applicable
- **Reactivity**
  1. Conditions contributing to instability: None.
  2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
  3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, chlorinated phenols, and carbon monoxide) may be released when pentachlorophenol decomposes.
  4. Special precautions: None.
- **Flammability**
  1. Not combustible
- **Warning properties**
  1. Odor Threshold: The AIHA *Hygienic Guide* states that pentachlorophenol has a characteristic odor. No quantitative information is available, however, concerning the odor threshold of this substance.
  2. Irritation Levels: The *Documentation of TLV's* states that "dusts are particularly irritating to the eyes and nose, in concentrations appreciably greater than 1 mg/m^3, but some irritation of the nose may occur at 0.3 mg/m^3. Hardened workers can tolerate up to 2.4 mg/m^3."
  3. Evaluation of Warning Properties: Through its irritant effects, pentachlorophenol can be detected within three times of the permissible exposure limit. For the purposes of this guideline, therefore, pentachlorophenol is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for pentachlorophenol is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

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RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with pentachlorophenol or liquids containing pentachlorophenol.
- If employees' clothing has had any possibility of being contaminated with pentachlorophenol or liquids containing pentachlorophenol, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing which has had any possibility of being contaminated with pentachlorophenol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of pentachlorophenol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the pentachlorophenol, the person performing the operation should be informed of pentachlorophenol's hazardous properties.

• Where there is any possibility of exposure of an employee's body to pentachlorophenol or liquids containing pentachlorophenol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with pentachlorophenol should be removed immediately and not reworn until the pentachlorophenol is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of pentachlorophenol or liquids containing pentachlorophenol contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to pentachlorophenol or liquids containing pentachlorophenol, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with pentachlorophenol should be immediately washed or showered with soap or mild detergent and water to remove any pentachlorophenol.

• Workers subject to skin contact with pentachlorophenol or liquids containing pentachlorophenol should wash with soap or mild detergent and water any areas of the body which may have contacted pentachlorophenol at the end of each work day.

• Eating and smoking should not be permitted in areas where pentachlorophenol or liquids containing pentachlorophenol are handled, processed, or stored.

• Employees who handle pentachlorophenol or liquids containing pentachlorophenol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to pentachlorophenol may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of preservatives, pesticides, and fungicides	Process enclosure; local exhaust ventilation; personal protective equipment
Application as a preservative for wood, starch, paint, adhesives, leather, latex, and oils; use in slime-algae control; use as a pesticide, herbicide, and snail control agent	Personal protective equipment
Manufacture of pentachlorophenol	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If pentachlorophenol or liquids containing pentachlorophenol penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of pentachlorophenol, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When pentachlorophenol or liquids containing pentachlorophenol have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency

rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If pentachlorophenol is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and depost in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing pentachlorophenol should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Pentachlorophenol may be disposed of in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR PENTACHLOROPHENOL

Condition	Minimum Respiratory Protection* Required Above 0.5 mg/m³
Particulate or Vapor Concentration	
2.5 mg/m³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class.** Any supplied-air respirator.** Any self-contained breathing apparatus.**
25 mg/m³ or less	Any chemical cartridge respirator with a full facepiece, an organic vapor cartridge(s), and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust, fume, and mist filter, including pesticide respirators which meet the requirements of this class. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
150 mg/m³ or less	

**If eye irritation occurs, full-facepiece respiratory protective equipment should be used.

ACETONE

EXPOSURE LIMITS

- PEL: 1000 ppm
- TLV: 750 ppm
- IDLH: 20,000 ppm
- Other (Specify): NIOSH 10 hr TWA = 250 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (Fragrant, mint-like, sweetish odor; odor threshold: 20-680 ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 9750 mg/kg
- Rabbit Dermal LD_{50}: 20,000 mg/kg
- Rat LC_{50}: NDF
- Human Data: TC_{LO}=500 ppm (eye irritation effects); TD_{LO}=10 mg/m^3/6 hours
- Other Data: Rat LC_{LO}= 16,000 ppm/4 hours

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

An eye and upper respiratory tract irritant. Prolonged inhalation of high concentrations may produce irritation of the respiratory tract, coughing, narcotic symptoms such as headache, drowsiness, incoordination and, in extreme cases, coma. Repeated skin exposure may cause dermatitis due to defatting action.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 266
- Solubility in water (%) @ 20°C: 100

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

BENZENE

EXPOSURE LIMITS

- PEL: 10 ppm
- TLV: 10 ppm
- IDLH: 2000 ppm
- Other (Specify): NIOSH 1 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 3800 mg/kg
- Rabbit Dermal LD_{50}: NDF
- Rat LC_{50}: 10000 ppm/7H
- Human Data: Inhalation - Mammal LC_{Lo} 2000 ppm/5M
- Other Data:

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

Locally benzene is a strong irritant producing reddening of skin, burning and blistering. Acute poisoning causes dizziness, and confusion which can lead to a coma. The chronic form of benzene exposure is a recognized leukomogen. Human and epidemiological cases have confirmed the relationship of benzene exposure to leukemia. In chronic poisoning, symptoms may include fatigue, headache, dizziness, loss of appetite, nosebleeds and weight loss.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 7.5
- Solubility in water (%) @ 20°C: 0.18%

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

ETHYLBENZENE

EXPOSURE LIMITS

- PEL: 100
- TLV: 100
- IDLH: 2000
- Other (Specify):

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (Aromatic odor; odor threshold: 140 ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 3500 mg/kg
- Rabbit Dermal LD_{50}: 5000 mg/kg
- Rat LC_{50}: 4000 ppm/hr
- Human Data: TC_{Lo} = 100 ppm/8 hr
- Other Data:

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

Ethyl benzene is primarily an irritant of skin and upper respiratory tract. With exposure to high concentrations, irritating effects are more pronounced and a person may begin to feel weak, dizzy, drowsy, and become unconscious. Systemic absorption causes depression of the central nervous system with narcosis at very high concentrations.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 7.1
- Solubility in water (%) @ 20°C: 0.015%

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

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NAPTHALENE

EXPOSURE LIMITS

- PEL: 10 ppm
- TLV: 10 ppm
- IDLH: 500 ppm
- Other (Specify): Maximum Allowable Concentration USSR = 20 mg/m^3 (4 ppm)

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (Mothball, tarlike odor; odor threshold: 0.3-24 ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 1780 mg/kg
- Rabbit Dermal LD_{50}: NDF
- Rat LC_{50}: NDF
- Human Data: LD_{LO} = 74 mg/kg
- Other Data: Dog Oral LD_{LO} = 400 mg/kg

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

Eye irritant and poison. Inhalation or ingestion may cause abdominal cramps, nausea, vomiting, diarrhea, headache, tiredness, confusion, painful urination, and bloody or dark urine. May cause destruction of red blood cells with anemia, fever, yellow jaundice, kidney and liver damage. Repeated skin exposure may cause allergic rash.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 0.05
- Solubility in water (%) @ 20°C: 0.003

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

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PENTACHLOROPHENOL

EXPOSURE LIMITS

- PEL: 0.5 mg/m^3 (skin)
- TLV: 0.5 mg/m^3 (skin)
- IDLH: 150 mg/m^3
- Other (Specify): NE

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 50 mg/kg
- Rabbit Dermal LD_{50}: NDF
- Rat LC_{50}: NDF
- Human Data: Oral LD_{LO} = 29 mg/kg; Oral TD_{LO} = 196 mg/kg: CNS effects
- Other Data: Rat Dermal LD_{50} = 105 mg/kg; Rabbit Oral LD_{LO} = 70 mg/kg

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

A skin, eye and upper respiratory tract irritant. Systemic effects include weakness, loss of appetite, nausea, vomiting, shortness of breath, chest pain, excessive sweating, fever, headache, and dizziness. Chronic exposure may cause acne-like skin rash and liver damage.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 0.0002
- Solubility in water (%) @ 20°C: 0.002

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

PHENOL

EXPOSURE LIMITS

- PEL: 5 ppm (skin)
- TLV: 5 ppm (skin)
- IDLH: 100 ppm
- Other (Specify): NIOSH 10-hr TWA = 5.2 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (sweet, tarry odor; odor threshold: 0.05-5ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 414 mg/kg
- Rabbit Dermal LD_{50}: 850 mg/kg
- Rat LC_{50}: 316 mg/m^3
- Human Data: Oral LD_{LO} = 140 mg/kg
- Other Data: NA

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

Corrosive; causes severe burning on contact with tissue. Dilute amounts may cause severe dermatitis. Systemic effects may occur from any route of exposure, especially after skin contact since it is readily absorbed. Systemic effects include abdominal pain and distress, cyanosis, muscular weakness, tremors and convulsions followed by collapse within minutes to several hours. Symptoms of chronic poisoning include vomiting, difficulty in swallowing, diarrhea, lack of appetite, headache, fainting, dizziness, dark urine, mental disturbances, skin rash and discoloration. Damage to the liver, kidneys, pancreas, spleen, and lungs may also occur in both acute and chronic poisoning.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 0.36
- Solubility in water (%) @ 20°C: 9

STYRENE

EXPOSURE LIMITS

- PEL: 100 ppm
- TLV: 50 ppm
- IDLH: 5000 ppm
- Other (Specify): NIOSH 10-hr TWA = 50 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (Solvent, rubbery odor; odor threshold: 0.1-300 ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 5000 mg/kg
- Rabbit Dermal LD_{50}: NDF
- Rat LC_{50}: NDF
- Human Data: LC_{LO}=10,000 ppm/30 min; TC_{LO}=376 ppm (central nervous system effects)
- Other Data: Rat LC_{LO}=5000 ppm/8 hours

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

An eye, skin, and upper respiratory tract irritant and central nervous system depressant. Signs and symptoms of inhalation and skin absorption overexposure include narcotic effects such as nausea, sleepiness, dizziness and unconsciousness. Dermatitis may occur with repeated skin contact.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 4.5
- Solubility in water (%) @ 20°C: 0.03

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

TOLUENE

EXPOSURE LIMITS

- PEL: 200 ppm
- TLV: 100 ppm
- IDLH: 2000 ppm
- Other (Specify): NIOSH 10-hr TWA = 100 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation (Rubbery, mothball odor; odor threshold: 2-40 ppm)

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 5000 mg/kg
- Rabbit Dermal LD_{50}: 14000 mg/kg
- Rat LC_{50}: NDF
- Human Data: TC_{LO} = 100 ppm
- Other Data: Mouse LC_{50} = 5320 ppm/8 hours

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

An eye, skin, and respiratory tract irritant. Causes central nervous system depression; symptoms include fatigue, weakness, confusion, headache, numbness, dizziness, and drowsiness. Very high concentrations may cause unconsciousness and death. Chronic exposure to skin may cause dermatitis. May cause liver and kidney damage. May also cause bone marrow depression, but without the severe or fatal damage present in benzene poisoning.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 22
- Solubility in water (%) @ 20°C: 0.05

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

XYLENE

EXPOSURE LIMITS

- PEL: 100 ppm
- TLV: 100 ppm
- IDLH: 10,000 ppm
- Other (Specify): NIOSH 10-hr TWA = 100 ppm

POTENTIAL ROUTES OF ENTRY:

_____ Inhalation

_____ Skin Absorption

_____ Skin/Eye Contact

_____ Ingestion

TOXICOLOGY

- Rat Oral LD_{50}: 4300 mg/kg
- Rabbit Dermal LD_{50}: NDF
- Rat LC_{50}: 5000 ppm/4 hours
- Human Data: TC_{LO} = 200 ppm; LC_{LO}=10,000 ppm/6 hours
- Other Data: Rat LC_{50}-6700 ppm/4 hours (mixed xylene)

HEALTH EFFECTS/SIGNS AND SYMPTOMS OF EXPOSURE:

Eye, skin and upper respiratory tract irritant and central nervous system depressant. May cause nacrotic effects such as dizziness, staggering, nausea, vomiting, abdominal pain, drowsiness, and unconsciousness. May cause reversible damage to the kidneys and liver. May also cause blood changes reflecting mild toxicity to the hematopoietic system. Repeated skin exposure may cause dermatitis.

PHYSICAL DATA:

- Vapor Pressure @ 20°C in mm Hg: 8
- Solubility in water (%) @ 20°C: Insoluble

NOTE: NE = None Established; NDF = No Data Found; NA = Not Applicable

2.3 Data Management Plan

The administration of any RI/FS will involve the generation of a considerable number of project-related documents. A Data and Records Management Plan has been developed for the Site, and is included in Appendix i. This plan identifies and establishes requirements for handling and storing laboratory and field data documentation, project files, and project-related progress documents.

The Data and Records Management Plan includes the following elements:

- Introduction;
- Data Management Procedure and Guidelines;
- Field and Laboratory Documentation;
- Remedial Response Data Management Requirements; and
- Technical Progress and Financial Reports.

Management will assume that sampling team members will be familiar with the required documentation procedures before field activities begin.

DATA REDUCTION, VALIDATION AND REPORTING

Laboratory Procedures

The reduction of the laboratory data from the raw instrument readings to a final value for the concentration of the compound determined is detailed under the individual analytical procedures to be found in the references listed under **Calibration of Laboratory Equipment** section. Included in these references are: (a) the equations used to calculate the concentration of the determined, and (b) units to be used for the expression of results in a manner consistent with other reported results. In general, the reduction of data occurs by one of three methods:

- Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets;
- Input of raw datas for computer processing; and
- Direct acquisition and processing of raw data by a computer.

If data is manually processed by an analyst, all steps in the computation shall be provided including equations used and the source of the input parameters such as response factors, dilution factors, and calibration constants. If calculations are not performed directly on the data sheet, calculations should be shown in full and attached to the data sheets. The analysts will sign their full signature and date in link each page of the calculations.

For data that are input by an analyst and processed using a computer, a copy of the input shall be kept and identified with the project number and other information as

needed. The samples analyzed shall be clearly noted and the input signed and dated by the analyst.

If the data are directly acquired from instrumentation and processed, the analyst will verify that the following are correct: (a) project and sample numbers, (b) calibration constants and response factors, (c) output parameters such as units, and (d) numerical values used for detection limits if a value is reported as less than. The analyst will sign and date the resulting output.

The quality of all data generated must be validated before the data are used. The principal criteria used to validate the integrity during the collection and reporting of data are:

- Accuracy - QA/QC procedures will be designed to measure the accuracy of all analytical data. The subject of internal quality control checks will be discussed in detail in the next section.

- Precision - The QA/QC procedures used to demonstrate that the measurement processes are reproducible will be discussed in detail in the next section.

- Completeness - The QA/QC procedures described in the next section identify the quantity of data needed to meet the program goals, and

- Comparability - The data will be reported in units consistent with other published data and in a standardized format to allow comparison with other similar programs of environmental assessment.

Quality control samples routinely included during analytical activities will be used to set up a system of data validation to identify analytical processes that are out of control. Control limits will be established for each analysis that is based on the results of all the quality control samples for that analysis. The control limits will reflect a 95% confidence level. By the use of control charts, all quality control samples will be compared to the upper and lower control limits and flagged if they exceed the limits.

If any quality control samples exceed the control limits, all data from the analytical run are examined in detail. If more than one quality control sample is out of limits or if any unusual instrument response is observed on the strip chart, all samples will be reanalyzed. If only one of three or four quality control samples is out of limits and all other parameters indicate that the analytical process is in control, the data are released.

The data validiation process, from the collection of raw data through the issuance

DATA VALIDATION PROCESS

Activity	Responsibility
Data Processing	Analyst
Checking of Data Processing	Independent Analyst or Group Leader
Preparation of Data Summaries And Draft Reports	Group Leader
Checking of Draft Data Report	Group Leader or Analyst
Final Review	Operations Manager
Approval for Issue	Laboratory Manager

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INTERNAL QUALITY CONTROL CHECKS

This section discusses the different types of samples which are routinely added to the normal laboratory sample stream to demonstrate that the laboratory os operating within prescribed requirements for accuracy and precision. Quality control samples are of known content and concentration (with the exception of the field blanks) so that accuracy and precision can be determined and control charts can be prepared.

The following are the types of quality control samples that will routinely be analyzed as part of the laboratory analytical scheme. All quality control checks will be performed in accordance with the EPA-approved methodologies and procedures referenced previously.

Quality Control Samples

Type of Sample	Description
Field Blank	A 40 ml vial is filled with organic-free water and taken with field sample collection kit. This type of sample is used to verify that contamination of samples for volatile organics analysis (VOA) has not occurred due to shipment and sample containers being in the field. Two field blanks should be sent with every set of collection vials sent to the field.
Reagent Blank	This type of QC sample is used to determine the background of each reagent/solvent used in an analysis, including zero and span gases. Conditions identical to actual analysis, including the detection system, must be used. The background levels present must not interfere with the type of intended analysis. Needs to be performed for each new batch of reagents/solvents.
Method Blank	The analysis is performed using only the reagents and solvents used in the method. Determines the cumulative interference. If the interference cannot be eliminated, it must be considered when computations are performed. The QC sample should be analyzed with each group of samples, or at the beginninng and end of each run. For GC/MS, the method is spiked with surrogates 1 out of 10.
QC Check Samples	A known concentration of parameters of interest spiked into reagent water and then split into four aliquots for analysis for initial, one-time demonstration of analyst, method, and equipment; or as a single reagent water sample spiked with the parameters of interest and analyzed as part of the sample stream, in the event that the adopted criterion for accuracy is not met by conventional spiked analysis.

Field Equipment Blank	One field equipment blank will be obtained on each day of sampling by filling the sampler with deionized water or pumping deionized water through the sampling device, and transferring this water to sampling bottles. The blanks are then preserved, transported and analyzed similarly to other types of samples.
Blind Repeat	A previously analyzed sample is introduced into the sample log by the Quality Control Officer as a sample of unknown concentration. It is then analyzed and the replicate values compared. This type of QC sample should be used at least every 1 out of 100 samples.
Duplicate (Replicate)	An aliquot of a sample known to the analyst. This type of sample is used to calculate the Relative Percent Deviation, and should be run 1 out of every 15 samples. At a minimum, it should be run with each group of 5 or more samples.
Spiked Samples	A known concentration of a specific parameter is added to a sample with the matrix of interest. The percent recovery is determined and spike is compared against an unspiked aliquot. This type of sample should be run 1 out of every 15, at a minimum with each group of 5 or more samples.
Surrogate Standards	For GC/MS analysis, the addition of nonpriority pollutants as spikes in standards, method blanks, and samples. When used with the daily 3-point calibration curve, this type of QC sample determines the mean, Warning and Control Limits. This should be done for all types of samples, method blanks, and standards.
Internal Standards	Nonpriority pollutant spiked into sample and method blank after extraction to monitor instrument performance and sensitivity should surrogate standards indicate a problem.
Calibration Standards	Standards prepared by a recognized external agency and used to determine the performance of the entire system, instrumentation, and analysts. These samples are analyzed on a periodic basis, such as quarterly or semi-annually.

Laboratory Quality Control Checks

Quality control samples routinely included during analytical activities will be used to set up control charts. Control charts are used to identify analytical processes that are "out of control", or those that are lacking precision and/or accuracy. Control limits will be established for each analyte that are based on the results of all the quality

control samples for the analyte. The control limit will reflect a 95% confidence level in the data.

Interlaboratory Verification Samples

On at least an annual basis, the contracting laboratory should participate in an interlaboratoory round robin testing program for organic and inorganic parameters which are common to all laboratories. The results of the round robin program will include the "true" value, acceptable statistical ranges and values determined by a specific laboratory. In addition to other quality control programs planned for the project, samples will be split periodically between the laboratory performing the analytical work and another equally qualified lab in which each laboratory will perform redundant analyses. This will allow an additional quality control check on the laboratory's analytical performance.

PERFROMANCE AND SYSTEM AUDITS

To verify compliance with the stated Quality Assurance/Quality Control objectives, the Quality Assurance Officer can perform planned and documented audits of project activities. These audits will consist of, as appropriate, an evaluation of quality assurance/quality control procedures and the effectiveness of their implementation, an evaluation of work areas and activities, and a review of project documentation. Audits will be performed in accordance with written checklists by technical specialists possessing the requisite education and background. Audit results will be formally documented and sent to the Project Manager.

Audits will include, but not be limited to the following areas:

- Subcontractor performance,
- Field operations and records,
- Laboratory testing and record,
- Identification and control of samples,
- Numerical analyses,
- Computer program verification and documentation,
- Transmittal of information, and
- Record control and retention.

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA, PRECISION, ACCURACY AND COMPLETENESS

Laboratory Procedures to Assess Analytical Data

The type of data required to assess data precision, accuracy and completeness is both qualitative and quantitative. Examples of activities which must be carried out to assess data accuracy are given below.

- Reference or spike sample: Recoveries must be within predetermined acceptance limits.

- Performance audits: Each task will include performance audits to demonstrate that all measurements are within acceptable limits. The standards used to preparing audit samples must be independent of, or different from, those used during routine analyses. If available, EPA quality control or Performance Evaluation samples will be carried.

Examples of activities which must be carried out in order to assess precision are:

- Replicate samples: Replicate sample data must be within predetermined acceptance limits.

- Instrument performance checks: For each measurement device routine checks must be performed as part of the analyses to demonstrate that the variables are within predetermined acceptance limits. Control charts will be kept for each parameter in the study.

Some of the applicable statistical procedures are given below:

- Central tendency and dispersion: arithmetic mean, range, standard deviation, relative standard deviation, pooled standard deviation, and geometric mean;

- Measures of variability: accuracy, bias, and precision; within laboratory and between laboratories; and

- Significance test: u-test, t-test, F-test, and Chi-square test, confidence limits, and testing for outlaying values.

For non-measurement-type data (e.g., compilation of the types of wastes that might occur at the Site) procedures will be set in place to ensure that all data and/or information collected is reliable, complete, and accurate to the maximum extent possible. For example, this will be assured by instituting a system using checks and cross-checks, using internal peer review personnel who were not associated with the collection effort.

CORRECTIVE ACTION

Non-conformance items and activities are those which do not meet the project requirements, or the approved work procedures.

Laboratory Corrective Action

Non-conformance can be detected and identified by:

- Project staff: During the performance of field investigation and testing, supervision of subcontractors, and preparation and verification of numerical analyses;
- Laboratory staff: During the preparation for and performance of laboratory testing and calibration of equipment; and
- Quality assurance officer: During the performance of audits.

Each non-conformance will be documented by the personnel identifying or originating it. Documentation, when necessary, will include:

- Identification of the individual(s) identifying or originating the non-conformance;
- Description of the non-conformance;
- Any required signatures;
- The method(s) used to correct the non-conformance (corrective action) or description of the variance granted; and
- Schedule for implementing corrective action.

Documentation will be made available to the project management, laboratory and/or quality assurance management and, if applicable, subcontractor management. It is the resposibility of the Project Manager, Laboratory Director, or Quality Assurance Officer to then notiify the appropriate personnel of the non-conformance.

Completion of corrective actions for significant non-conformance should be verified by the Quality Assurance Officer as part of future auditing activities.

Any significant recurring non-conformance should be evaluated by project, laboratory, and/or quality assurance personnel to determine its cause and institute appropriate changes in the project requirements and procedures to prevent future recurrence. When such an evaluation is performed, the results shall be documented.

Field Corrective Action

In the field sampling program, each non-conformance will be documented by the personnel identifying or originating it. Documentation of these events will include:

- Identification of the individual(s) identifying or originating the non-conformance;
- Description of the non-conformance;
- Any required signatures;
- The method(s) used to correct the non-conformance (corrective action) or description of the variance granted; and
- Schedule for implementing corrective action.

If, at any time, the analytical non-conformance and audit repoort indicate a review of appropriateness and adequacy of the tasks, the laboratory manager(s) can present recommended changes to the Project Quality Assurance Officer.

QUALITY ASSURANCE REPORTS TO MANAGEMENT

Once chemical and microbiological testing of environmental samples is started under a project, a schedule for the laboratories to periodically report to the Quality Assurance Officer on the performance of the measurement systems and the reliability of the data will be established. Both the Laboratory Quality Control Coordinator and the Project Quality Assurance Officer are responsible for preparing reports indicating the effectiveness of the QAPP. As a minimum, these reports will include:

A. QA management (any changes)
B. Status of the completion of the QA project plan
C. Measurement of data quality from the project
D. Significant quality problems, quality accomplishments, and status of corrective actions
E. Results of QA performance audits
F. Results of QA systems audits
G. Assessment of data quality in terms of precision, accuracy, completeness, representativeness, and comparability
H. Quality Assurance related training
I. Assessment of indicators used in the project.

2.4 Task 3 - Site Investigation

2.4.1 Phase 1 RI Activities

This section presents a description of the Phase 1, RI activities.

The objectives of the remedial investigation are to obtain information concerning:

- Waste source characterization;
- The nature and extent, both lateral and vertical, of contaminant migration in pathways on and from the Site.
- The hydraulic characteristics of pertinent water-bearing strata and the extent of hydraulic interaction a[illegible] these units;
- The factors effecting [illegible]nd-water movement and the extent of contaminant migration on-site and o[illegible]e;
- The evaluation of pote[illegible] remedial action alternatives; and
- Performance of an e[illegible]ngerment assessment to evaluate the magnitude and probability of actual o[illegible]tential harm to the public health, welfare,and the environment by the th[illegible]ned or actual release of hazardous substances, if no remedial action is take[illegible] the Site.

General procedures, p[illegible]cols, and an associated reference listing are presented in this section for use in pla[illegible] and conducting the RI.

Activities in Phase 2 o[illegible] RI will be guided by results obtained in Phase 1. For example, in Phase 1, soil [illegible]ns will be conducted to define vertical and harizontal contaminant profiles. If this [illegible]t achieved, additional borings to greater depth may be performed. Hence, the pro[illegible]re to revise the Work Plan is briefly described here. As necessary and appropria[illegible] revised detailed Plan will be developed addressing changes in the location, n[illegible]er and depths of sample locations or the need for on-Site monitoring wells, or c[illegible]es in field or analytical methodologies. The revised plan will be incorporated i[illegible] original plan, and shall present sufficient background and Site-specific detail c[illegible]ing the revision to enable a detailed review by the EPA.

Revisions to the Work [illegible] must be approved by the EPA prior to implementation. The following information [illegible]ification will be provided to EPA:

- The objective of the [illegible];
- The need for the re[illegible]d
- All quality assuranc[illegible]nts and field operations plan elements pertinent to the revision.

Some revisions may be sufficiently minor to permit verbal resolution with the EPA. Even so, documentation outlining the change will be provided to the EPA within 10 days, containing a full description of the changes.

2.4.1.1 Initial Site Activities

Initial activities shall consist of a data review, development of a more accurate site map for existing conditions if necessary, and establishment of a Site office. The following are some of the data needs for the site:

- Lateral and vertical extent of soil and/or ground-water contamination;
- Migration pathways and mechanisms;
- Identification and assessment of potential confining aquitards to vertical contaminant migration;
- Depth, profile, and volume of wastes contained in the Trolley/Treatment Area, Railroad Ditch Pit, Sinkhole, and any other major waste sources;
- Detailed hydrogeological assessment of aquifers including an assessment of the degree of interconnection of the aquifers; and
- Relationship between local surface waters, springs, and aquifers.

Site Map

The preparation if necessary of an alternate Site map will require a topographic and aerial survey.

Topographic Survey: A field survey of the Site and immediate surrounding areas will be conducted by a licenced land surveyor. The survey will provide:

- Topographic map(s) of the Site areas with contour intervals of 2.0 feet or less. The topographic map(s) should include Site drainage patterns, Site erosion areas, ponding areas within the process areas, Site landmarks, local surface waters, springs, sink holes, and Site boundaries.
- The topographic map(s) shall include locations of all Site landmarks and details, surveyed to ±0.5 foot (horizontal). Also included will be well points, stream guages, and a sampling point grid system. The preceding horizontal requirement also applies to buildings and roads.
- A benchmark will be established at one point within the plant Site to serve as a reference for future elevation readings, after excavation or other work that would change the topography of the Site.

All elevations shall be presented as feet above mean sea level (msl).

Aerial Survey: After proper ground controls for the Site have been established, an aerial survey will be performed. A site map will be prepared with a horizontal scale of 1-inch equals 50 feet and with 2-foot contours of the Site and surrounding vicinity. It is estimated that approximately 60 acres will be included in the Site and vicinity map. The map will include areas of the adjacent property including nearby drainage ways.

The contour map will be used to delineate current Site drainage directions. The Site map will be used for locating remedial features, layout of on-site alternatives, determination of excavation (and fill) quantities and in preparation of a proper Site drainage network. Off-site locations will be plotted on an enlarged USGS map depicting topography, with a scale of 1-inch equals 500 feet.

Site Office

A Site office will be established to support Site work including preparing samples for shipment, recordkeeping, and conducting Site meetings and orientation for Site visitors.

2.4.1.2 Waste Characterization

The following information needs to be developed for each of the waste sources identified:

- The quantities involved;
- Characterization and profile of contaminants (for exposure assessment and treatment options);
- Extent of biodegradability of the contaminants (for evaluation of remedial alternatives); and
- Action levels or concentrations necessary for clean-up (for quantities and concentrations potentially released to the environment).

Most of this information is available from historical data. Furhter sampling and analysis will be performed to characterize the waste locations and determine the vertical and lateral extent of the wastes.

2.4.1.3 Geologic and Hydrogeologic Investigation

Purpose

The purpose of the geologic and hydrogeologic investigation is to:

- Identify major connected aquifers and aquitards in the immediate vicinity of the facility;

- Determine flow directions and pathways in and between the aquifers and surface waters;
- Determine horizontal and vertical distribution of contaminants and predict the long-term disposition of contaminants;
- Predict hydraulic characteristics of pertinent water-bearing strata and the extent of hydraulic interaction among these units; and
- Catalogue factors affecting ground-water movement and the extent of contaminant migration on-Site and off-Site.

General and Specific Data Gaps

Based upon a study of the available Site-specific hydrogeologic data, the following general data gaps have been defined.

- The vertical delineation and lateral extent of the aquifers under the Site is uncertain.
- A definition of the degree of interaction between the aquifers (i.e., is a confining layer present to prevent downward vertical migration of contaminants?) is unavailable.
- A definition of the relationship between the surface waters (including springs) and these aquifers, based upon the karst hydrology that is prevalent in the area is unavailable.

These general data gaps may be refined into specific information gaps that need to be filled:

Chattanooga Shale:

- Is this formation present beneath the site?
- How thick is it?
- Is it laterally extensive?
- What are the elevation contours of the top of this formation?

For each major identified aquifer:

- What are the top and bottom elevations of each aquifer?
- What are the elevation contours of the tops and bottoms of these formations?

Within each major identified aquifer:

- What are the more permeable layers within the formation?
- How thick are these more permeable zones?
- How laterally extensive are these zones?
- What are the elevations of the top and bottom for each of these more permeable zones?

For the major flow pathways:

- What is the water quality in the major flow pathways?
- What are the major flow pathways in each major identified aquifer?
- What are the flow pathways between the three major identified aqifers?
- What is the degree of interconnection between tje ground-water flow and the surface water (springs and streams) in the vicinity of the Site?

These data gaps will be filled by the field operations portion of the Hydrogeologic Investigation.

Field Operations

The field operations portion of the Hydrogeologic Investigation will initially investigate the migration of contaminants from the Site.

One of two possible situations may exist:

- Scenario 1: Chattanooga Shale formation is present and acts as an aquitard; and
- Scenario 2: Chattanooga Shale formation is fractured enough not to act as an aquitard, or is absent.

The field operations program has been designed to be able to contend with either set of conditions.

Phase 1 activities of the Hydrogeologic Investigation are presented below.

Step 1: Review of available geological and hydrogeological data.

Step 2: Geologic Investigation, consisting of:

a) Fault and fracture trace analysis of aerial photographs. This method is useful for detecting possible main ground-water pathways in carbonate rocks; and

b) Geologic field mapping of out-crops, especially in the creek. The purpose of field mapping is to gather all pertinent geological data, to determine the local stratigraphic and structural conditions that have an impact on the hydrogeology of the area, and the relationships between aquifers and the directions of their ground-water flow.

Step 3: Inventory of wells and springs, to include:

a) Selection of a portion of these wells and springs for further investigation.

The criteria for selecting wells and/or springs for further study include:

- The location of the well and/or spring within the water system. The points (a well or spring is one point) used to generate a regional contour map need to be spread out evenly over the study area to the maximum extent possible to avoid making excessive extrapolation between points.
- The location of the well and/or spring witrh respect to the waste source(s). Wells and/or springs closer to the Site are the most likely points to potentially be impacted by off-site migration of hazardous waste.

b) Topographic survey of the monitor wells and springs selected.

Step 4: Well logging of the existing Site well, selected abandoned wells, and new monitoring wells for:

a) Determining the presence and thickness of the Chattanooga Shale by gamma ray and resistivity logs, and

b) Determining the location of more fractured and dissolved layers in th limestones and dolomites, by sonic amplitude and density logs;

c) Determining the relative pressures in the more fractured layers by a formation tester;

d) Determining in existing wells the differences in ground-water quality in the more fractured layers by water resistivity logging and by formation tester sampling and analysis. This is necessary to differentiate the various water-bearing farmations. This information will be used to determine the extent of contaminant migration in all pathways.

Step 5: Determination of recharge and discharge areas, and main flow direction using:

a) Water level measurements and

b) Water level contour map(s)

Step 6: Ground-water and surface water sampling and anlysis (see Well and Spring Sampling).

Step 7: Aquifer testing in the existing Site well and selected abandoned wells:

a) Pumping tests (entire well type tests) to determine specific capacities (by step drawdown tests) and hydraulic characteristics (by constant discharge rate tests); and

b) Packer tests for the more fractured zones (determined in steps 4 and/or 7) to determine hydraulic characteristics by performing slug tests (or, if possible, small pumping tests), and possibly to determine flow rate velocities by using a flow meter.

Step 8: Surface geophysical investigation:

a) At the beginning of the Site investigation, an on-site geophysical investigation by electrical resistivity, seismic refraction and induced polarization, for profiling the top of rock, and its limestone channels and sink holes; and

b) At the end of step 4 (well logging) an on-site and off-site geophysical investigation of limestones and an off-site geophysical investigation of top of rock similar to step 8-a, for extending the findings of step 4 and step 7. The protocol for geophysical investigation is included in Appendix J.

Step 9: Interpretation of Phase 1 Data for determining the extent of contaminant migration in all pathways:

2.4.1.4 Well and Spring Sampling

An inventory of existing wells has been presented in the section on "Evaluation of Potential Impacts". The locations for the wells previously sampled are shown in Figures ( ) and ( ).

Sampling has occurred on and around the Site for a number of years. Samples were taken monthly at a number of locations from the summer of 1982 until June, 1984. In april and June of 1985 there were major sampling events. Since September, 1985, there has been quarterly sampling at the following ten sampling locations:

Cricket Spring
Railroad tunnel spring, south side
Canning Factory spring
Birmingham old well
Binam well
Behren cistern
Behren new well
Miles well
Birmingham new well
Omaha City well

Quarterly sampling of these ten wells and springs and of those wells and springs selected during step 3 of the Geologic and Hydrogeologic Investigation will continue during the Phase 1 RI activities.

In all selected abandoned wells, ground-water samples will be collected: (1) at the top of the standing column of water in the well (if possible) to determine the presence or absence of a floating phase; (2) as close to the bottom of the well as is possible to determine the presence or absence of a sinking phase; and (3) from the middle of the water column to determine the presence or absence of a dissolved phase.

Also, monthly ground-water level measurements will be taken in all on-site and off-site wells to determine any seasonal interaction between surface and ground waters.

2.4.1.5 Soils and Sediments Investigation

The objectives of the soils and sediments investigation are to:

- Determine the lateral and vertical extent of soil contamination; and
- Characterize wastes in the railroad ditch sludge pond, trolley area and ash pile.

The selection of the soil and sediment sampling locations is discussed in the Sampling Plan. The samples will be collected using the sampling protocol detailed in Appendix D. The soils and sediments investigation is a one-time event, except as noted where follow-up studies become necessary.

2.4.1.6 Surface Water Investigation

Sampling and Analysis

Quarterly surface and ground-water episodes will be performed to correlate seasonal flows with precipitation. The quarterly sampling episodes were discussed in the Sampling Plan and shown in Table ( ).

Stream Flow Measurements

Stream flow measurements will be conducted on a continuous basis for Cricket Spring Channel and Walnut Creek just east of the railroad tunnel in order to estimate mass loadings on the streams. Locations for stream flow monitoring stations will be field-verified.

Continual stream flow measurements wil be made using a stream level guaging station for the two identified locations. The stream level guaging station will include a water level indicator operated continuously. Flow measurements will be made from sections where the stream channel geometry is relgular (to enable an estimate of the flow rate past that point) and the water flow is regular (i.e. low turbulence, uniform). Placement will also consider security from vandalism.

Data from water level guaging stations will aid in determining whether contaminant migration is influenced more by lateral hydraulic gradients to the adjacent streams or more by downward hydraulic gradients to the ground-water system. Stream level guaging data shall be presented to the EPA as part of the Monthly Status Report.

Continual flow measurements will also be made on Cricket Spring and the Tunnel Spring. Data collected will aid in determining the connection between these springs and the various layers of the aquifer systems.

2.4.1.7. Ecological Assessment

Ecological assessments can include surveys of flora and fauna. Animal surveys for ecological studies are difficult to conduct because animals move about and are less dependable indicators of impacts than plants, which are stationary. In addition, the wood treatment chemicals on Site have some modest toxicity to some species. An assessment of any impact on fish could follow in Phase 2, if it is determined during Phase 1that off-site impacts may have reached or is likely to reach fish habitats at toxic concentrations.

The plant species normally composing the vegetation in the area of the Site will be identified by a botanist familiar with Arkansas if pollutants are above the target level. The description will be qualitative. The botanist will be provided with a large-scale map of the study area, with established reference points, to use during the survey. Referencing the map, the botanist will describe the general abundance of different species.

If areas contain obviously impacted vegetation, comparison with an adjacent, undisturbed area will be made to determine the magnitude of pollutant impact. The findings of the survey will be compiled in the Phase 1RI Activities Summary Report, and will include a vegetation map with notations of specific types of vegetation, major plants, and location of any special plants.

2.4.1.8 Phase 1 RI Activities Summary Report

Following the Phase 1 RI activities, a summary report will be submitted to the EPA for review and comment. The report will summarize the information obtained and the conclusions drawn. Additionally, recommendations pertaining to additional information and activities to be performed in Phase 2 will be presented in detail.

The Phase 1 RI Activities Summary Report will follow the general outline of the remedial Investigation Report, Section 2.6.3. Following submission of the Phase 1 RI Activities Summary Report to the EPA, no further work concerning Phase 2 RI activities shall be performed until approved by EPA.

2.4.2 Phase 2 RI Activities

Phase 2 RI activities will be done to obtain additonal information concerning site contamination that may be required for remediation. A Work Plan for Phase 2 will be developed and submitted to EPA for review and approval, prior to commencing Phase 2 activities. Activities in Phase 2 may include:

- Completion of on-Site and/or off-Site soil borings with sampling and analysis to assess the extent of soil contamination;
- Additional aquifer testing to define characteristics and interaction of water-bearing strata;
- Expanded Geological and Hydrogeological Field Surveys;
- Installation of additional ground-water monitoring wells, where needed, to investigate the movement of contaminants and to determine hydraulic characteristics of water-bearing strata;
- Characterization of Cricket Spring impacts on biota; and
- Continued seasonal sampling od springs, surface and ground-waters.

Concurrently with Phase 2 RI activities, the following remediation activities may be performed:

- Interim soil removal and temporary isolation on-Site to avoid future surface runoff or subsurface percolation. This will also provide an opportunity for early pilot scale evaluation of microbiological treatment options.

Consistent with previous statements, the Work Plan will be appended to the QAPP and submitted to the EPA for approval prior to starting Phase 2 RI activities.

2.4.2.1 Soil Sampling

The objectives of Phase 2 soil sampling will be to: If needed, supplement data collected during Phase 1 RI activities so that an adequate information base exists concerning contaminant sources and migration paths for remedial action feasibility studies.

The sample collection methods for all additional sampling will be consistent with those used in Phase 1 unless they have proven to be inappropriate.

2.4.2.2 Ground-Water Monitoring Wells.

Investigation of the migration of contaminants may be expanded if the Phase 1 data indicate off-Site impacts beyond the selected zones. Off-Site ground-water monitoring wells may be needed to monitor contaminant migration and to refine aquifer characteristics. Information possibly required include the establishing of:

1. Downgradient ground-water monitoring well(s) to monitor the migration of contaminants and define migration paths and patterns (vertical, lateral, or both).

2. Additional shallow monitoring wells might be located:

   a. Downgradient of any contaminant plume (if found) to assess long-term contamination migration from the Site;

   b. Within the contaminant plume to define aquifer characteristics, if not previously defined; and

   c. Additional downgradient deep monitoring wells (and/or sampling of existing drinking water wells completed in the major aquifer) to determine the extent of ground-water contamination in the deep aquifer.

2.4.2.3 Aquifer Testing

If needed, pumping and slug tests shall be performed to define the aquifer characteristics and hydraulic interaction of the residuum and the deeper aquifers. In addition, aquifer information pertinent to the horizontal and vertical migration of contaminants from the Site into the shallow and deep aquifer systems shall also be defined if needed.

2.4.2.4 Cricket Creek Sampling

If the Cricket Creek Channel sampling program indicates that contaminants have entered Cricket Creek, then a more intense creek sampling effort may be justified. Samples from the creek would be taken from water (above and below the confluence point) at 100' transects, sediments (at the same stations), and biota (i.e. fish or other naturally occurring edible biota).

2.4.2.5 Seasonal Sampling

It may be necessary to continue to monitor specific points on, and adjacent to, the Site to permit the correlation and association of meteorological events and Site activities with contaminant release and transport. There are limited data available (since February 1985) and hence this quarterly water sampling program should be continued indefinitely.

2.4.2.6 Optional Soil Isolation at Specific Areas

Optionally, and apart from the Phase 2 RI activities, contaminated soils in the Railroad Ditch Pit, Trolley Area and Ash Pile my be excavated and stored on-Site. The horizontal and vertical extent of contamination will be identified in Phase 1. This information, in connection with on-Site analysis for target compounds during excavation, will be used to define the lower extent of soil and/or waste removal necessary. Preliminary guidelines have been developed by the Center For Disease Control (CDC) of 150 mg/kg PCP and 100 mg/kg PNA for soils. Actual action levels will be developed specifically for this site.

Additionally, the remaining woodchip piles will also be removed. This material may be disposed at appropriate on- or off-Site disposal facilities.

2.5 Task 4 - Site Investigation Analysis

2.5.1 Site Investigation Analysis Reporting

This task will ensure that data generated during the RI are sufficient in quality and quantitiy to achieve the RI/FS objectives.

The results and data generated will be consolidated and organized to evaluate potential relationships between the environmental features of the Site and waste characterisitics. Findings will be summarized and presented in Interim Quarterly Reports.

2.6 Task 5 - Laboratory and Bench-Scale Studies

In 1985, preliminary laboratory studies by "Bio-Clean" (St. Paul, MN) were performed on one surface sample collected in the railroad ditch sludge pool. These results indicated that: 1) resident bacteria do exist in the soil; 2) maximum degradation occurred for PCP when the contamination was less than 500 ppm (achieved through dilution with other soil); and 3) final clean-up levels less than CDC Guidelines were achieved in less than 48 hours reactor time.

These encouraging data will be further investigated through additional lab and pilot-scale studies. The isolated soil to be stored on-Site could be used to develop a pilot-scale system on-site. Particular attention will be directed toward developing the Pilot Scale system.

Other constituents beyond PCP and PNA's have been identified in quantities above action levels, including dioxins and furans, although the extent of contamination has not been determined. Careful consideration will be given to other technology which will address treatment and disposal of these contaminants as appropriate. For bench or pilot tests, a study protocol (including sampling and analysis protocols) will be developed prior to assessment. This protocol will be submitted to EPA for approval prior to initiating these studies.

2.7 Task 6 - RI Reporting Requirements

The scope of work for the RI of the Site requires the proper documentation and reporting of the data, assessments, and conclusions produced. The desired result is a remediation plan which protects human health, welfare, and the environment and is cost-effective. Proper reporting throughout the RI will help achieve this goal by:

- Ensuring the major issiues are addressed adequately;
- Tracking project progress;

- Consolidating data;
- Recording the methods used and the results of the work done; and
- Supporting the decisions made and conclusions drawn during the subsequent feasibility study.

The implementation of this work plan will involve the monthly reporting to EPA on technical progress of the RI. In addition, Quarterly Written Reports will be provided to EPA.

2.7.1 Monthly Project Status Reports

Written monthly status reports will be prepared to assist in managing and evaluating the progress of the Site RI. The reports will identify and/or summarize: (1) activities conducted this period; (2) work progress, during this reporting period and to date, and percent complete; (3) work planned for next reporting period; (4) work revisions; (5) schedule status; (6) testing/data results; and (7) support activities. These reports will be prepared by the Site RI Official and Project Manager and will be submited to the EPA by the tenth of each month.

2.7.2 Quarterly Reports

Data and interpretive information will be submitted to EPA on a quarterly basis. This information will supplement the monthly reports and provide further information on the state of knowledge of the Site.

2.7.3 Remedial Investigation Report

Following the RI activities, a Remedial Investigation Report will be prepared presenting the findings of the RI for EPA's review and comment. The report shall present information of the Site, conclusions and interpretations.

The report should include, as a minimum:

- Physical description of the Site and Site history
- Technical approach to the investigation
- Sampling procedures
- QA/QC program
- All data generated
- Interpretation of data
- Deliverables generated during the study
- Investigation results
- Source identification
- Source contamination, nature and extent

The following list of data and information shall be included, as a minimum, in the RI report:

- Lithologic boring logs, including written and graphical representations;
- Seismic refraction survey results and cross sections, if performed;
- EM survey results and diagrams;
- Fence diagrams of pertinent subsurface strata and extent of contamination;
- Contour map(s) of the major subsurface formations;
- Sampling logs;
- Topographic map(s) of the Site and surrounding areas showing surface drainage patterns, all sampling locations, structures and surface features;
- Sample analysis includinng a description of QA/QC performed and QA/QC results for the entire investigation;
- Parameters comprising the pollutant analysis and hazardous substances with their associated laboratory detection limits;
- Monitoring well locations and elevations;
- Monitoring well construction details;
- Pumping and recovery test data (if performed), diagrams, plots, and interpretations;
- Potentiometric surface maps;
- Analysis of ground-water flow rates and directions;
- Analysis of surface water flow rates and directions;
- Analysis of surface water/ground-water interrelationships;
- Water quality diagrams (trilinear or Stiff);
- Contour maps of contaminant concentration(s);
- All sampling results, in tabular form;
- Analysis of contaminant transport via ground-water, surface water, and sediment pathways;
- Discussion of data and interpretation limitations; and
- Analysis of impacts on flora and fauna.

Prior to writing the repoort, a report outline shall be submitted to the EPA for review and approval. Ten copies of the Draft Remedial Investigation Report will be submitted to the EPA for review. After review and comment, a final report will be prepared and submitted.

2.7.4 Endangerment Assessment

An Endangerment Assessment shall be performed to evaluate the environmental hazards posed by contaminants at the Site. This shall include a pathway evaluation, identification of the receptors, and a preliminary hazard analysis and shall be consistent with the National Contingency Plan.

The objective of the endangerment assessment will be to determine if there is a probability of actual or potential harm, and if so the magnitude of risk to the public health, welfare, and the environment by the threatened or actual release of hazardous substances if no remedial action were taken at the Site. The endangerment assessment itself will identify and characterize:

1. The concentrations of chemicals or mixtures present in all relevant environmental media;

2. Environmental fate and transport mechanisms within environmental media, including hydrogeological evaluations and assessments;

3. Intrinic toxicological properties of hazardous wastes;

4. Exposure pathways and extent of expected exposure ;

5. Populations at risk; and

6. Extent of expected harm and the likelihood of such harm occurring.

An Endangerment Assessment is an evaluation of the collective demographic, geographic, physical, chemical, and biological factors which describe the extent of the impacts of a potential or actual release of a hazardous waste substance(s).

With the available information, the Endangerment Assessment shall evaluate the adequacy, occurrance/precision, comprehensiveness, reliability, and overall quality of identified information and data. This evaluation shall use the following outline and use qualitative and/or quantitative terms as appropriate:

1. Physical Description of the Site and Site History

   a. Geographic location
   b. Management practices/Site use/Site modifications
   c. Chronological survey
   d. Facility descriptions/containment systems
   e. Substances on-Site (identity, quantity, form, and manner of disposal or holding

2. Site Contamination/Off-Site Contamination

   a. Identity of substances detected
   b. Concentration of substances detected
   c. Analytical methodology and QA/QC
   d. Survey of environmental monitoring studies (detailed discussion of environmental media and contamination levels)

3. Environmental Fate and Transport

   a. Physical-chemical properties of specified chemicals/substances (e.g., soil/sediment adsorption coefficients, vapor pressures, solubility, etc.)
   b. Photodegradation rates, decomposition rates, hydrolysis rates, chemical transformations, etc.
   c. Local topography
   d. Description of the hydrological setting and flow system
   e. Soil analyses
   f. Climatic factors, other factors affecting fate and transport
   g. Prediction of fate and transport (where necessary using modeling methods)

4. Toxicological Properties (hazard identification)

   a. Metabolism
   b. Acute toxicity
   c. Subchronic toxicity
   d. Chronic toxicity
   e. Carcinogenicity
   f. Mutagenicity
   g. Teratogenicity/reproductive effects
   h. Other health effects; including neurotoxicity, immuno-depressant activity, allergic reactions, etc.
   i. Epidemiological evidence (chemical-specific or Site-specific)
   j. Aquatic/non-human terrestrial species toxicity/environmental quality impairment

5. Exposure Assessment

   a. Demographic profiles of populations at risk including subpopulation at special risk
   b. Background chemical exposures
   c. Lifestyle and occupation histories
   d. Population macro- and micro-environments
   e. Exposure route

6. Risk Assessment and Impact Evaluation

   a. Carcinogenic risk assessment
   b. Probability of non-carcinogenic human health effects

c. Non-human species risk assessment
d. Environmental impacts/ecosystem alterations

7. Conclusions

8. Support documentation (appendices)

Prior to development of the Endangerment Assessment, the criteria used in assessing endangerment will be submitted to the EPA for comment.

The Endangerment Assessment shall be published as a separate document. The Endangerment Assessment shall be performed concurrently with the latter part of the Phase 2 RI activities and the initial deliberations of the Feasibility Study.

The completed draft Endangerment Assessment will be submitted to the EPA for review and comment. Ten copies of the draft Endangerment Assessment shall be submitted to the EPA for review and approval. The draft Endangerment Assessment shall be revised as required by the EPA's comments and 10 copies if the Final Endangerment Assessment shall be submitted.

2.8 Task 7 - Community Relations Support

Prior to initiating Site field activities, a community relations plan will be developed by EPA, with input from the Potentially Responsible Parties (PRI's). The document will be prepared in accordance with the "Community Relations in Superfund; a Handbook, Interim Version", Environmental Protection Agency, Office of Emergency and Remedial Response, September, 1983.

The EPA, ADPC&E, and MMI representatives have been in contact with one another and with affected individuals. No public meetings have been held to date.

Organized groups involved with community environmental affairs will be identified. Contact will be established and maintained throughout the remedial action portion of the project. Other interested parties that will be kept abreast of happenings at the Site include:

- Elected representatives, including State and Federal representatives and Senators;
- Arkansas Department of Pollution Control and Ecology; and
- Boone County Health Department, Harrison.

Community relations plans generally specifiy two types of techniques to maintain public awareness and to meet the community relations objectives: (1) providing periodic progress reports on the findings of the remedial investigation, and (2) eliciting and documenting comments and concerns from citizens, local officials, and community or environmental groups.

The objectives of the Community Relations Plan are to:

- Ensure that local residents, State and local officials, and concerned groups are notified of major findings, activities and the reasons for these activities and decisions in a timely manner;
- Provide the media with detailed, accurate information about the Remedial Investigation and Feasibility Study;
- Effectively address citizen inquiries and concerns to ensure that the best possible information is provided. Provide accessible, consistent sources for people to contact and allow an ample time period for the public to respond;
- Provide local residents and State and local officials with the opportunity to comment on remedial action alternatives identified during the Feasibility Study; and
- Keep abreast of changes in community concerns, information needs and activities and modify the community relations plan as necessary to address these changes.

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Update No. 4 to the NPL propsed an HRS score of 34.21 for the Site. This calculation was based, in part on an estimated total quantity of waste of 6,234 tons. This estimated quantity of waste, in turn, is the total of three separate items:

1. Bob Barker, one of the Arkwood plant managers, estimated to ADPC&E inspectors in 1981 that the plant produced a total of 500 gallons of waste per year during his tenure. The HRS calculation in Update No. 4 multiplied this 500 gallon per year figure by the 22 years that the plant was in operation, for a total of 11,000 gallons, or 220 fifty gallon drums, for a scoring equivalent of 55 tons.

2. A pit or ditch adjacent to the plant site which contained sludge and soil contaminated with creosote and pentachlorophenol, was estimated to be 40 feet long, 15 feet wide, and 3 feet deep. These dimensions resulted in a total volume of 68 cubic yards, or a scoring equivalent of 68 tons.

3. A sawdust pile at the east end of the plant yard was estimated to be 275 feet long, 150 feet wide and 4 feet deep. These dimensions resulted in a volume of 6,111 cubic yards, or a scoring equivalent of 6,111 tons.

These waste quantity calculations erroneously counted the same wastes more than once and consequently, overstated the value used in the HRS scoring for total quantity of waste.

The first item in EPA's calculations represented an estimate of waste generated over the operating life of the plant. The second item, the railroad ditch, is one of the areas where these wastes were placed. Thus, all of the wastes placed in the railroad ditch were counted once as part of Item No. 1, and a second time as part of Item No. 2. The total volume of the contaminated soil in the railroad ditch is undoubtedly larger than the volume of waste which is contaminating the soil. Under the Hazard Ranking System; however, it is inappropriate to base a score on the total volume of contaminate soil or other contaminated matrix at a Site. Only the amount of the contaminating hazardous substance is to be included in the waste quantity calculation. Uncontrolled Hazardous Waste Site Ranking Users Manual. 47 Federal Register 31187, at 31229 (published July 16, 1982).

Item No. 3 in the calculation of total waste represents an even more significant error in the estimate of waste quantity. The pile of sawdust and shavings at the east end of the plant yard had been generated by wood planing equipment and had been used exclusively on untreated wood. Consequently, the sawdust and shavings themselves originally contained no treatment chemicals. Sampling evidence indicates, however, that the sawdust pile is now contaminated with pentachlorophenol

in the low parts per million range.* The only possible source of the pentachlorophenol observed in the sawdust pile was MMI's use of the liquid wastes included on Item No. 1, above, for dust control purposes.

Consequently, as with the railroad ditch, all of the wastes in the sawdust pile were counted once by EPA as part of Item No. 1, and once again as part of the sawdust pile. Furthermore, inclusion of the entire volume of the sawdust pile improperly adds to the waste calculations a substantial volume of soil and sawdust on top of a quantity of wastes which have contaminated them.

If, for any reason, the sawdust pile was included in the calculation of hazardous waste, MMI noted that the dimensions attributed to the sawdust pile by EPA overstated its volume by more than two orders of magnitude. In order to establish more accurate dimensions, MMI photographed and surveyed the sawdust pile. A drawing with surface and depth measurements is attached. MMI's measurements indicated that the sawdust pile had a surface area of 2108 square feet and an average depth of six to nine inches. These dimensions resulted in a total volume of less than 60 cubic yards.

EPA's estimate of 6,111 cubic yards for the volume of the sawdust pile was based upon an April 1985 memorandum from Dolce Hughes, a geologist with ADPC&E, to Tim Perdue in the Region VI Office. MMI discussed its photograph and survey with Mr. Hughes. Mr. Hughes indicated that the dimensions he originally reported to EPA were only an estimate and that a subsequent visit to the Site convinced him that his estimate significantly overstated the size of the sawdust pile. Mr. Hughes indicated that he did not question the accuracy of MMI's measurements.

Based on the foregoing facts, MMI believed that Item No. 2, the railroad ditch, and Item No. 3, the sawdust pile should be assigend a HRS scoring value of 2. 47 Fed. Reg. 31187, at 31229 (published July 16, 1982). When this new scoring value was substituted for the original waste quantity value, the final HRS score for the Site was reduced from 34.21 to a corrected score of 26.32. An itemized comparison of the original HRS calculation and the revised calculation for the Site follows these Comments.

EPA's HRS scoring sheets and Documentation Record assigned a Groundwater Targets value of 29 for the Site. This Groundwater Targets value was based, in part, on the assumption that there were "no significant aquitards" separating the shallow groundwater system in the immediate vicinity of the plant, which had shown trace contamination off-Site, and the deep aquifer that supplied the Omaha municipal water system and other groundwater users within a three mile radius of the plant. MMI believed that EPA's assumption was mistaken and that there was a substantial barrier between the shallow groundwater system affected by the Site, and the deep aquifer

*The documentation Record of EPA's HRS scoring indicateds that the sawdust pile was included in the calculation of waste quantity because two 1979 soil and sawdust samples taken by the ADPC & E showed pentachlorophenol contamination at levels of 30,000 and 23,000 ppm. MMI questioned the levels of pentachlorophenol reported in these samples and they took three samples from three different portions of the sawdust pile for independent verification. The samples taken by MMI were analyzed by the McKesson Environmenta Services Laboratory in Dublin, CA. The analytical results showed penrachlorophenol at 0.5 ppm, 2.1 ppm, and 170 ppm.

supplying the Omaha municipal water system and other groundwater users in the area.

MMI retained GMI to conduct a geohydrologic investigation of the Site and the surrounding area. GMI's initial Site assessment and monitoring data indicated that the contaminants had been found to reside only in the shallow (less than 50 feet below land surface) interconnected solution cavities found at the base of the limestone formation. Water that entered the shallow drainage system flowed laterally westward through the shallow solution features, emerging as springs along Cricket Creek about 400 yards from the Site. Most of the domestic wells within about a mile of the Site had been tested; only three wells located in a very small area between the Site and spring contained the contaminants. It was believed that the contaminants entered the wells via the shallow solution channels because the wells were cased only into the top of the limestone (and not to the depth of the solution channels), and a 300-foot thick confining bed existed below the shallow water-bearing zone.

It was GMI's belief that the 2100-foot Omaha municipal water well was not in any way threatened by waste from the Site. Several hydrogeologic reasons supported this conclusion:

1. The hydraulic gradient at Arkwood had been determined to be northwestward (the Omaha well was located to the northeast);

2. The distance between the Site and the Omaha well was about one mile;

3. Several domestic water wells were located between the Site and the Omaha well that had not been found to be contaminated and , if designated as such, could act as an early warning system;

4. Several thick aquicludes existed between the shallow zone in which contamination had been observed and the aquifer that was tapped by the Omaha well; and

5. A properly cased 900-foot well that was located on the Site itself had been sampled repeatedly and was free of any contamination.

Based upon the data generated by GMI, MMI believed that two corrections should have been made in the Groundwater Targets value for the Site. First, the Groundwater Use factor should be reduced from 3 to 2, because users of domestic wells in the vicinity of the Site had a municipal watr supply available nearby which drew from an alternate, unthreatened source. Second, the population served by domestic wells in the immediate vicinity of the Site which could have been affected by contamination in the shallow groundwater system totaled less than ten houses, or a scoring equivalent of 33 people. This population fell into the 1 to 100 population range that was assigned a scoring value of 1. Use of this revised population value, together with the revised Groundwater Use factor, lowered the Groundwater Targets score from 29 to 16. The revision of the Groundwaters Targets value, in turn, lowered the overall HRS score for the Site from 34.21 originally proposed by EPA to a corrected score of 18.87.

When the corrections suggested by these Comments for total quantity of waste and Groundwater Targets were both included in the calculation, the final HRS score for the Site was reduced from 34.21 to a corrected score of 14.52. An itemized comparison of the original and revised MMI-HRS calculations follows these Comments.

MMI recognized that it was EPA's policy not to consider the status of previous response or clean-up actions when scoring a potential NPL site. See Fed. Reg. 31187 (July 16, 1982); 48 Fed. Reg. 40664 September 8, 1983). Nevertheless, MMI believed that the current status of Site investigation and remedial activity was relevant on considering the relative priority or need for Superfund attention at a given site.

MMI respectfully submitted that the HRS score proposed for the Site had been based on an overestimate of the total quantity of waste and an erroneous assumption regarding the use of affected groundwater. Correction of either error significantly reduced the overall HRS score for the Site. When both errors were corrected, the revised HRS calculations reduced the overall score for the Site from 34.21 to a corrected score of 14.52.

HRS CALCULATIONS

	Original EPA Proposed	Water Quality Revised	Groundwater Targets Revised	Both Revisions
Line 1 - Observed Release	45	45	45	45
Line 4 - Waste Characteristics				
Toxicity/Persistence	18	18	18	18
Hazardous Waste Quantity	8	2	8	2
	26	20	26	20
Line 5 - Targets				
Groundwater Use (X 3)	9	9	6	6
Distance to nearest well/population served	20	20	10	10
	29	29	16	16
Line 1 X Line 4 X Line 5	33,930	26,100	18,720	14,400
Divided by 57,330	0.5918367	0.455259	0.3265306	0.2511773
Multiplied by 100	59.18367	45.5259	32.65306	25.11773
Divided by 1.73	34.2	26.32	18.87	14.52

CAI SITE FEASIBILITY STUDY

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EXECUTIVE SUMMARY

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- 1.1 Site Background Information
- 1.2 Nature and Extent of Problem
- 1.3 Objectives of Remedial Action

2.0 DEVELOPMENT OF ALTERNATIVES
- 2.1 Preliminary Remedial Technologies
- 2.2 Synthesis of Alternatives

3.0 SCREENING OF ALTERNATIVES
- 3.1 Technical Criteria
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4.0 REMEDIAL ACTION ALTERNATIVES
- 4.1 Alternative 1 - No Action
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5.0 ANALYSES OF MOST LIKELY REMEDIAL ACTION ALTERNATIVES
- 5.1 Non-Cost Criteria Analyses
  - 5.1.1 Technical Analysis
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6.0 SUMMARY OF ALTERNATIVES

7.0 RECOMMENDED REMEDIAL ACTION: CONCEPTUAL DESIGN

8.0 REPORTING REQUIREMENTS

REFERENCES

APPENDICES

EXECUTIVE SUMMARY

The purpose of the CAI FS; is to define the Site, its background, and its problems; the feasible remedial action alternatives; and to the recommend remedial action and its advantages over other potential alternatives. The body of the CAI-FS is divided into Chapters.

The CAI Feasibility Study (FS) is an essential component of determining the appropriate remedial action to be implemented at the Site. The RI combined with the CAI-FS allows the systematic and logical evaluation of remedial alternatives and supports the eventual choice of the remediation alternative.

The CAI-RI and the CAI-FS are performed concurrently. The CAI-RI places emphasis on data collection and site characterization, while the CAI-FS emphasizes evaluation of alternatives.

The CAI-FS objective is to develop and evaluate remedial action alternatives for the containment and/or cleanup of the waste constituents present at the Site. These evaluations facilitate the choice of the alternative which best meets the remediation criteria. The CAI-FS has utilized, to the maximum extent possible, the data acquired during all previous investigations. Other technical and applicable literature has been, and will continue to be utilized, to develop and screen appropriate remedial actions.

Alternatives have been evaluated based on technological, public health, institutional, environmental, and cost factors. Recommendations for further evaluation of remedial alternatives will be made, if required.

Descriptions of proposed responses have and will continue to be developed using Site-specific information for characterization. Applicable technologies corresponding to the chosen response actions have been identified and evaluated. General response actions and associated technologies which passed the initial evaluation were utilized to develop alternatives capable of remediating the Site. Alternatives meeting Selection criteria received further evaluation. The CAI-FS will be presented to EPA and ADPC&E, after client acceptance and prior to development of the final document, as a preliminary regulatory agency report.

Chapter 1. Introduction: The introduction to the report characterizes the Site in terms relevant to the analysis of remedial action strategies. The introduction has three main topics: Site background information, the nature and extent of contamination problems at the Site, and remedial action objectives.

Chapter 2. Development of Alternatives: This section presents the initial master list of remedial action technologies prepared at the start of the CAI-FS and briefly discusses their applications. Initial subjective evaluation of technologies is presented along with documentation of why given technologies were not further developed. These technologies are then combined into applicable preliminary remedial action alternatives.

Chapter 3. Evaluation of Alternatives: This section summarizes the selected process used to identify the most appropriate remedial action alternatives to undergo detailed analysis. The following four categories of selection criteria are discussed:

- Technical criteria;
- Environmental and public health criteria;
- Cost criteria; and
- Other site-related criteria.

The discussion explains the reasons for eliminating any alternatives.

Chapter 4. Remedial Action Alternatives: A summary of the remedial action alternatives identified as promising during the initial evaluation is presented in this section. Specific elements discussed should include:

- Intent of the alternative (i.e., source control vs. mitigation of migration);
- Key features of the alternative;
- Control, storage, treatment, and/or disposal requirements;
- Phasing of work;
- Special considerations;
- Operation, maintenance, and monitoring requirements (short and long term); and
- Strengths/shortcomings of the alternative.

Chapter 5. Analyses of Remedial action Alternatives: The detailed analyses of the alternatives presented in the preceding section are discussed here. The majority of the analyses (i.e., support calculations, raw data, etc.) are presented as appendices to the CAI-FS report. This section presents an overview of these analyses and is divided into two subsections: non-cost criteria analyses (technical, environmental, public health, and institutional analyses) and cost analysis.

Chapter 6. Summary of Alternatives: This section of the CAI-FS report summarizes the remedial alternatives and presents the results of the analyses. The alternatives are compared, with statements of advantages and disadvantages. A decision matrix is presented and the recommended alternative identified.

Chapter 7. Recommended Remedial Action: Conceptual Design: The conclusion section draws upon the summary to describe any features which could

effect (positive or negative) the remediation of the Site. A recommendation for a single site specific alternative has been made. This recommendation has been made on the alternative's superiority to be cost effective, environmentally sound, and minimize short and long term risks.

Chapter 8. Reports:

INTRODUCTION

1. Site Background Information

Chapter 1.1 defined conditions at the Site and to developed requirements for the remedial action alternatives. This information formed the foundation from which subsequent tasks were defined.

Site background information and site characteristics have been obtained from the initial scoping task of the CAI-RI and will be updated as warranted with newly developed data. This information provides a comprehensive overview of the site and identifies the wastes, their characteristics and actual and potential exposure and/or migration pathways.

1.1 Geographic Location

The Site occupies part of Section 27, T21N 421W located on the Omaha, Arkansas-Missouri Quadrant Map west of U.S. Highway 65, one-half mile southwest of the city of Omaha, Boone County, Arkansas. The Site is located at the head of a valley west of U.S. Highway 65, as shown in Figure 1.a.1. The Site covers a total of 15 - 20 acres that were used for treating wood with PCP and creosote and storage of treated posts. The total contiguous acreage of the Site owned by Mary Bank was 83 acres. A branch line of the Missouri Pacific Railroad (MPR) tracks are adjacent to the northern edge of the Site. To the south and west the Site is bounded by the unpaved Cricket Road. An aerial photograph of the Site in operation by Mass Merchanisers, Inc. (MMI) in February, 1984, is shown in Figure 1.a.2. The acreage was developed in the early 1900's when the Missouri Pacific Railroad (MPR) excavated to a depth of 40 to 50 feet below natural grade to obtain fill dirt for the construction of railroad embankments.

The Site elevation falls from south-east to north-west along a smooth surface which resulted when the MPR removed the topsoil and after owner/tennant improvements. The Site falls approximately 100 feet in elevation from south-east to north-west. The Site surface has been channeled and little water flows from south to north, although this would have been the case prior to excavation. Excavation resulted in exposing the porous and occasionally cavernous underlying limestone to surface water entrainment. Several sinkholes are evident on the Site. Numerous aquifer channels exist immediately below the Site. A deep cased well with the well pump set at 920 feet is located on the south-west side of the northern end of the Site.

A steep bluff approximately 50' high exists on the lower one half of the north eastern boundary of the Site. A disposal area (pit) on the north-eastern boundary of the Site and next to the railroad tracks was covered with fill dirt in 1986.

1.2 Management Practices/Site Use/Site Modification

Techniques of Treatment

The following discussion is offered as an explanation of the processes utilized by the wood treating industry in general and Arkwood, Inc. (AI) and MMI in specifics. The discussion is relevant to Site practices through 1984 when MMI discontinued operations.

Wood preservatives used at the Site were oil-based mixtures of either pentachlorophenol or creosote. These mixtures were used to treat wood for the prevention of decay and deterioration which occurs as a result of weather, soil conditions, or the infestation by organisms such as insects and fungi.

Creosote was not new when AI began operating the Site. Creosote had come into use for wood treatment in 1839 with the development of the Bethell full cell pressure treatment (FCT) process. Lumber or posts are enclosed in a cylinder and subjected to an initial vacuum to remove air and water from the wood cells. This step was followed by injecting creosote into the wood under pressures varying from 125-200 pounds per square inch (PSI) at temperatures of 180-210°F. Treatment continued until the wood was saturated with creosote or PCP. Pressure was then released, the cylinder drained, and the wood removed.

Treatment processes relevant to the Site (the Lowry and the Reuping) were developed in the early years of the 20th century. These processes are referred to as empty cell treatments (ECT) in which the excess preservative is removed from the wood cells when a final vacuum phase was added to the process, leaving the wood cells coated rather than filled with treatment solution. The ECT process was popular because less preservative was used and the cost of chemicals was significantly reduced.

In the Lowry Process, the preservative penetrated into the wood due to the high pressure and temperature of the treatment cylinder. The air naturally present in the wood was compressed during the pressurization process. The treatment process was completed when the pressure was released and the cylinder drained. The excess preservative was forced out of the wood cells by expansion of the compressed air. The only major variation in the Reuping Process was an initial application of pressure in the range of 25-75 psi prior to flooding the cylinder with creosote or PCP.

Solutions of creosote and crude coal tar or petroleum oils were effective and less costly for wood treating. As a result, creosote pressure applications by the empty cell method had predominated in the railroad industry since the 1920's. a 1:1 mixture of creosote and oil was used at the Site.

Pentachlorophenol (PCP) was available for use as a bulk wood preservative in 1947, however, its use at the Site began in approximately 1968. PCP was applied in heavy to light petroleum carriers or solvents by pressure methods similar to those used for creosote treament. A 5% PCP solution was used at the Site.

PCP and creosote were commonly used to treat utility poles, lumber, posts and numerous other wood products. Few if any railroad ties were treated with PCP because it imparted brittleness to the wood causing excessive wear and splitting from the repeated compression and expansion.

In 1981, 98% of wood treated commercially in the United States was done so with the pressure process. Both AI and MMI exclusively used the pressure process. Pressure treatment at the Site with PCP or creosote was conducted with the same equipment and techniques. The wood to be treated was loaded onto a tram. The tram was then pushed into the cylinder. The cylinder was sealed via a pressure-tight door and the treatment cycle was initiated. The total length of time for treatment varied with the specific type of wood preservative solution, process, end-point product use, and other factors such as wood moisture content. At the end of the cycle the treating solution was pumped to storage tanks for later re-use, the door was opened, and the treated material on the tram was pulled from the cylinder. The tram was moved to a transfer point and the wood was off-loaded and stacked for storage and/or shipment. The length of time between withdrawal from the cylinder and off-loading could vary from a few minutes to a day or more.

Wood products utilized at the Site for the pressure processes often underwent some form of pretreatment to reduce moisture to a predetermined percentage of residue. Pretreatment improved the service life of the preservative chemicals and permitted the wood to accept the treatment solutions in sufficient concentration to meet performance specifications. Methods of pretreatment available at the Site included air drying or steam and vacuum treatment. Steam conditioning was followed by a vacuum to remove the excess moisture. The process was commonly used for pretreating southern pine during either the creosote or PCP oilborne preservative systems.

The full cell treatment process was only used when maximum preservative retention is required. The empty cell process controled with reasonable accuracy the quantity of preservative retained in the wood and provides a good penetration depth with a cleaner surface.

The amount of wood inside the Site treating cylinder was calculated in cubic feet. Treatment of fence posts normally met recommendations by the American Wood Preserver's Association (AWPA). The usual target was to retain 6 pounds of wood treating mixture for each cubic foot of wood treated. The specific gravity of the wood treating mixture is 7.7 to 7.8 pounds per gallon. Therefore, for each cubic foot of wood in the treating cylinder, the wood must retain about 0.8 gallons of wood treating mixture.

An operational expectation at the Site was that the wood would retain the target amount of preservatives when 2 1/2 times the amount of treating mixture taken up by the wood was introduced under pressure into the treatment cylinder. After maximum penetration of the treatment chemicals into the wood was obtained, the pressure cylinder was drained of preservative and the cylinder was put under a vacuum to draw any excess treatment mixture out of the wood cells (ECT). For example, treatment cylinder was evacuated to 25 inches of mercury for a period of 45 minutes to one hour.

Operations Resulting In Contamination with PCP and Creosote

When the treated wood was removed from the pressure cylinder and transported to the yard for storage or shipment, it dripped. This was especially true in hot weather when maximum treatment (FCT) had been effected, for example to meet Federal specifications. This dripping and exposure to dust and rain would be expected by CAI to result in general contamination of the area. Process related contamination would be expected to be highest in the Trolley/Treatment Area.

The treatment room contained a recessed work area around the treatment cylinder. The recessed area drained into a sump. The sump contained waste from the treatment cylinder, sludge drained from the recessed work area, and water from leaking pipes. The wastes were pumped from the sump into the top of a separation tank east of the treatment room, see Figure 1.b.1.

The treatment room was washed down periodically to remove any oil film or residue on the floor. This wash water drained into the sump from which it was pumped into a wastewater holding tank. When full, the holding tank was set on a forklift or trailer and emptied as the tank was driven around the yard. Dust control was a source of general contamination and the most likely source of contamination in the wood chip pile. Dust control with process waste was discontinued by MMI in 1982 at the direction of MCE and ADPC&E.

Waste oil from clean-up operations in the treatment area was periodically deposited in a "Sinkhole" located near the treating cylinder room. Disposal in the Sinkhole was discontinued when the walls collapsed and it would no longer receive material. The Sinkhole was concreted over in 1982 at the direction of MCE and ADPC&E.

Contamination also occurred in non-treatment areas. Oil sludge was dumped into a "Railroad Ditch Pit" located in the railroad right-of-way north of the treatment cylinder and treating room. Periodically the oily sludge in the ditch would be burned. Other areas included the "Ash Pile" (ashes from a wood-fired boiler located in the treatment room), the trolley tracks leading away from the treatment cylinder and in yard areas used to store treated wood products. See 1.d. for additional details.

Steam condensate was contaminated with PCP and discharged by pipe over the side of the embankment and into the railroad ditch. Sludge was collected and deposited in various areas including sinkholes on the south east end of the Site.

1.3 Chronology of Events at Arkwood Plant, Omaha, Arkansas.

Early 1900's

Site was developed as an open pit mine for railroad ballast to construct railbeds for the Missouri Pacific Railroad.

1961

February 22 — Hallie C. Ormond acquires the land from the railroad that will eventually become the Site.

1962

H.C. Ormond constructs treating plant on-Site. C.C. "Bud" Grisham supervises operations of the treating facility on the Site as C.C. and Mary Jo Grisham , d/b/a as Arkwood Treatment Company.

1965

June 16 — Arkwood, Inc. (AI) incorporated to operate the Site. Initial shareholders include: Hallie C. Ormond, C.C. Grisham, Mary Jo Grisham, and Ina Ann Farmer.

1967 or 1968

PCP use begins.

1969-1970

Piping used to transfer boiler blowdown waste.

1970 — Bob Barker as Plant Manager.

1972

MMI funds expansion of AI and encourages purchase of Roese Tie Company.

Bob Barker becomes General Manager. Devoe Gregory becomes Plant Manager.

1973

January 11 — Hallie C. and Jean Ormond lease lthe Site to Mountain Enterprises, Inc. (MEI), a wholly-owned subsidiary of Mass Merchandisers, Inc. (MMI) for twelve years. MMI assumes operation of the treatment facility.

March 29 — AI conveys all corporate assets to MEI in exchange for MMI stock.

1974

August 13 — AI is dissolved by MMI.

1980

May 1	Missouri-Pacific (MP) train derailment near the east end of railroad tunnel.
1981	
Jan - Feb	MP railroad initiates new construction on railroad tunnel, including blasting.
May 19	Arkansas Department of Pollution Control and Ecology (ADPC&E) field inspector and Boone County Sanitarian conduct inspection of the MMI operation at the Site (As a result of a complaint received of contamination inside the railroad tunnel).
October 6	ADPC&E collects sediment and surface water samples at the Site, including samples from railway tunnel in Walnut Creek.
October 22	Meeting was held between ADPC&E, MMI - Wood Products Division, and McClelland Consulting Engineers (MCE) (MMI's consultants) to discuss problems at the Site. ADPC&E requests sampling and surface housekeeping.
Dec. 16	MMI submits A Site Correction Schedule to ADPC&E.
1982	
Winter	MPR concludes railroad tunnel construction.
January 25	Inspection of the Site by D. Hughes and M. Bates from the ADPC&E.
Feb 11	MCE obtains soil permeability tests.
April 14, 15	MCE conducts soil, surface and ground-water sampling to determine the extent of the contamination.
May 26	MCE updates ADPC&E on Site Activities. Production at MMI Site is down by 50%.
June 3	MMI asks the ADPC&E to withdraw Part A of the RCRA permit application for the Site.
June 29	MCE conducts soil, surface and ground-water sampling to determine the extent of the contamination.
July 26	Tom Millard, an independent consultant specializing in natural resource inventories, prepares a report on the geology of the Site.
July 26	MCE collected water samples for pentachlorophenol (PCP) analysis.

August 23	MCE collected surface and ground-water samples for analysis of PCP.
October 9	MCE collected surface and ground-water samples for analysis of PCP.
October 30	MCE collected surface and ground-water samples for analysis of PCP.
December 14	MCE collected surface and ground-water samples for analysis of PCP.
1983	
January 15	MCE colleced surface and ground-water samples for analysis of PCP.
January 31	MCE collected surface and ground-water samples for analysis of PCP.
February 23	MCE collected surface and ground-water samples for analysis of PCP.
April 1	MCE collected surface and ground-water samples for analysis of PCP.
May 3	MCE collected surface and ground-water samples for analysis of PCP.
May 27	MCE collected surface and ground-water samples for analysis of PCP.
June 28	MCE collected surface and ground-water samples for analysis of PCP.
August 1	Samples taken.
September 7	MCE collected surface and ground-water samples for analysis of PCP.
September 30	MCE collected surface and ground-water samples for analysis of PCP.
October 31	MCE collected surface and ground-water samples for analysis of PCP.
November 30	MCE collected surface and ground-water samples for analysis of PCP.
1984	

January 6	MCE collected surface and ground-water samples for analysis of PCP.
February 3	MCE collected surface and ground-water samples for analysis of PCP.
February 20	MCE collected surface and ground-water samples for analysis of PCP.
February 28	MCE collected surface and ground-water samples for analysis of PCP.
March 5	Meeting held between MMI (Erwin, Conner, and Barker) and Bob Behrens (whose well water was contaminated by PCP), where the subject of MMI buying his land was discussed.
March 12	MMI tenders an offer to purchase farm from Bob Behrens.
March 23	MCE collectedsurface and ground-water samples for analysis of PCP.
May 11	MCE collected surface and ground-water samples for analysis of PCP.
June 1	MCE collected surface and ground-water samples for analysis of PCP.
June 14	MMI ceases wood treatment operations.
August 24	MCE collects one water sample for analysis of PCP content.
Fall	MMI sells and removes remaining inventory of treated wood and treating materials from the Site.
October 7	MCE collect additional surface and ground-water samples for analysis of PCP content.
December 7-19	MCE collected surface and ground-water samples for analysis of PCP.

1985

January 11	Twelve-year lease to MMI from Hallie C. and Jean Ormond expires.
April 14-17	Geraghty & Miller, Inc. (GMI) collects water samples from springs and wells, and performs initial soils boring program.
April 29	C.R. barker filed a Certificate of Exemption and stated that the Site was complying with 40 CFR 261.5.

June 4-5	GMI, IT Corporation (IT), McKesson Environmental Services (MES) collect water samples from wells and springs, soil samples, and samples of sludge for waste characterization, preliminary hydrogeologic investigation.
September 18	The Site is proposed for addition to the National Priorities List in EPA's Update No. 4, published in 50 Federal Register 37950 (date of publication September 18, 1985), (based on a Hazardous Ranking System score of 34.21).
September	A meeting was held between MMI, MES and the ADPC&E to present status of site investigation and present remedial action plans.
1986	
May 15	MMI and Region VI Environmental Protection Agency (EPA) sign Administrative Order on Consent for Remedial Investigation/ Feasibility Study (RI/FS) for the Site.

1.4 Facility Description/Containment Systems

The current Site improvements include no intact buildings, several foundations, one shed structure, one deep well, a fence with gate, underground pipes and power poles. Several small areas show surface tar and discarded steel band scraps are found on the embankment overlooking the railroad. A sawdust pile is located in the most southeastern extremity of the excavated area. A quantity of tires and residue after burning (steel belts) are located on the southeast extremity of the Site.

Detailed insight into the Site condition in 1981 is provided by the study of reports of ADPC&E. R. David Orr of ADPC&E arrived at the Site on June 19, 1981 accompanied by Mike Youngblood, Boone County Sanitarian, of the Arkansas Department of Health. They met Mr. Roy Horn of MMI and informed Mr. Horn of the complaint that had been received concerning bad looking water coming from a spring inside a railroad tunnel adjacent to the Site. Mr's Orr and Youngblood asked for a brief tour of the Site.

The treatment process at the Site was observed by ADPC&E to involve steam pressure treatment of wood posts with pentachlorophenol and creosote on a four-day cycle. After treatment, the wood posts were piled in small groups to cure. Mr.'s Orr and Youngblood observed no means of containment of excess wood treatment chemicals below the piles of wood posts. Several pools of blackish water were reported as observed on the Site and adjacent to the Site along a railroad right-of-way.

After the tour of the treatment process, Mr.'s Orr and Youngblood drove along the railroad tracks to a tunnel where a repair crew was repairing tracks and were met by Mr. Gary Benham, MPC Motor Car Operator. Inside the tunnel, Orr and Youngblood reported observing a spring flowing from the north side which discharged through metal pipes. The water appeared clear. Further inside the tunnel, another spring flowed about 30 feet above the tracks. The water appeared somewhat clear but further down the ditch, it formed an oil film on the surface and stained the walls and dirt surfaces. On the east side of the tunnel, more oil film was observed which collected in pools. The drainage flowed off the railroad track right-of-way into a large pool of water with a thick brownish oil film on top. Further study showed that this drainage flowed into Barren Creek.

Samples were taken by Orr on the east side of the tunnel (sample #1), inside the tunnel at the west end below westside spring on the south side (sample #2) and at the spring on the north side of the tunnel (sample #3). The following are the results of analysis of these samples for pentachlorophenol:

Sample #	Log #	Description	Cranmer and Associates, Inc. Pentachlorophenol
1	24503	East Side of Tunnel	8.56 mg/l
2	24504	Inside Tunnel at Westend	2.1 mg/l
3	24505	North Side Spring	not detected

MMI had notified ADPC&E that the Site, under RCRA, was a generator of hazardous waste. Mike Bates of ADPC&E visited the site on October 5 and 6, 1981, for the purpose of conducting an interim RCRA status standards inspection and to follow-up the initial complaint and visit by Mr.'s Orr and Youngblood of June, 19th. Bob Barker and Devoe Gregory of MMI Wood Products Group supplied background information for the Site visit during a meeting with Mike Bates on October 6, 1981.

Mr. Mike Bates reported that according to Mr. Barker and Mr. Devoe of MMI, waste from the wood treating operation had been placed into the Sinkhole at the Site from the beginning of the operation until around 1970. The Sinkhole was then covered by boarding the entrance and covering it with a layer of dirt. The entrance was flush with the ground surface as of Mr. Bates' visit on October 6, 1981. As of October 6, 1981, process waste resulted from the wash down of the treatment room floor and residues from cleaning of the treatment cylinder between the use of pentachlorophenol and creosote. These wastes were accumulated in a tank and then sprayed over the storage yard for dust control. Mr. Barker estimated that MMI generated approximately 500 gallons/year of these wastes. Steam was also used in the treatment process, the steam was said to be reused in the process. Some of the steam was bled off to discharge behind the office building adjacent to the Missouri Pacific railroad tracks.

Mr. Bates reported that the Site could have been classified as a Small Quantity Generator under RCRA, according to the generation amounts furnished by Mr. Barker, if MMI had disposed of their waste properly. As of October 5, 1981, Mr. Bates reported that MMI was disposing of waste improperly at the Site by spreading the material for dust control and by dumping it in several places at the northeastern end of their property near Highway 65. The frequency of these "dumpings" were approximately every three weeks according to a Roy Horn, treatment plant manager. The area around the treatment plant was saturated with the treatment chemicals. There were pools of oily material around the treatment cylinder and the storage tanks. The tanks were not diked (with the exception of the raw pentachlorophenol storage tank) nor was there any type of containment to prevent the washing of the oily substances off-Site during rains. The storage yard where the treated wood products were taken to "cure" was saturated in many areas with what appeared to be the treatment chemicals leaching from the wood products. Mr. Horn indicated to Mr. Bates that this saturated soil was scooped out periodically and piled up along the entrance road when the storage areas got too mushy to operate the machinery.

Mr. Bates reported that signs of the steam bleed-off discharge mentioned previously existed on the slope behind the office building. The slope below the

discharge pipes was oil stained; at the base of the stained area there was an impoundment which contained a black oily looking liquid. Mr. Horn had said to Mr. Bates that nothing had been discharged through the pipes except steam and that nothing had been put in the impoundment for years. The impoundment was approximately 15' X 40', depth unknown. There was approximately 2' of freeboard with no evidence of overtopping. The impoundment was located adjacent to the Missouri Pacific railroad approximately 400' northwest of the railroad tunnel mentioned in the initial complaint.

At the time of Mr. Bates' visit, the railroad tunnel was situated in a northwest/southeast line and is approximately 1/2 - 3/4 of a mile in length. There had been a construction crew working on the northwest entrance of the tunnel to widen it. Their work had reportedly involved a considerable amount of blasting. Gary Benham with the construction crew accompanied Mike Bates into the tunnel on October 5, 1981. There were three springs inside the tunnel; the first of which (approaching from the northwest) was located about halfway through the tunnel on the northern side. The other two were located in the southeast one third of the tunnel, discharging from the south side of the tunnel. The first two springs discharged through pipes imbedded in the tunnel wall approximately 20-30' above the tracks. The southeastern most spring broke out near the roof. Mr. Benham stated that the crew complained that the spray from the springs burned their eyes.

The water in the ditches along the tracks was brown in color and had a dark brown to black film on the surface. The tunnel walls and sides of the ditches were oil stained. Both ditches showed signs of contamination, however, the southern ditch appeared to be more heavily contaminated.

The southern ditch flowed southeasterly from the tunnel for about 1000' before it dropped off into a depression formed by the points of two ridges intersecting the railroad. The trees growing in the bottom of this depression had oil stains on them up to 12" above the present level of the water (with oil film). This depression was the receiving point of three drainage patterns. Mike Bates did not observe a drainage point under the railroad. This depression could possibly have been a sinkhole. Mark Witherspoon of ADPC&E agreed with Mike Bates about the possibility of a sinkhole but indicated that a closer study would be needed to confirm it.

The northern ditch also flowed in a southeasterly direction for about 1000' before turning north and dropping sharply to intersect Walnut Creek on the eastern side of the railroad. The tunnel springs appeared to be supplying most of the water in Walnut Creek as of October 5, 1981. The creek bed was dry approximately 600' downstream from the point where the tunnel spring water intersected with the creek. The rocks in the dry bed of Walnut Creek were tinted brown whereas the rocks of an intersecting intermittently wet stream from the northeast (dry also) were not. This could have been an indication of the past flow of contaminants down Walnut Creek.

Mr. Bates determined that there were approximately 14 homes which used individual wells as drinking water within a mile radius of the Site, assuming that all of the residences within the city limits of Omaha were on city water and discounting the homes along Highway 65 which should also have been on city water.

The Omaha city water supply is a well located in the NE1/4, NE1/4 Sec. 27T21NR21W, inside the city limits near the Post Office. This well is also within one mile of the Site, the total depth of the well is 1315' with a casing depth of 60'. A well water sample was taken from the Site. The depth of the Site well was unknown, however, Mr. Horn stated that the pump (submergable) was set at 920'.

ADPC&E received another complaint from a representative of the railroad who charged that the Site was releasing liquid wood preservatives out of a holding area and that the material was getting into a railroad tunnel. The complaint also stated that railroad personnel were getting sick from the fumes in the tunnel. This complaint was considered by Mike Bates to have some validity. Mr. Bates believed that wood treating chemicals were in fact getting into the tunnel, however, as stated earlier, Mike Bates did not observe any discharge or evidence of the overtopping of the dikes of the impoundment below the Site. The railroad personnel may have been getting sick from fumes inside the tunnel, but Mike Bates thought that the fumes most likely came from the train engine exhaust, especially since the trains had to travel at a slow speed through the tunnel (complaint reported 10 mph).

Mike Bates considered the Site as operated by MMI in 1981 to be a serious threat to the groundwater and surface water quality in the area. The representatives of MMI were said to have voiced their willingness to cooperate and do what was necessary, within their means, to alleviate any environmental damage stemming from their operation. In Mike Bates' opinion, there were several things that needed to be accomplished.

1. Seal the Sinkhole, with concrete or other water tight material, to prevent any contaminants from entering it.

2. Cease the on-Site dumping or spreading of wastes fom the treatment process.

3. Clean up all contaminated soil on-Site and properly dispose of it.

4. Establish drip pads and runoff containment from the treated wood products storage area.

5. Eliminate any oily discharge and close out or maintain the impoundment according to RCRA.

6. Determine the source of contamination inside tunnel and implement measures to correct it.

7. Clean up all off-Site contamination.

8. Sample residential wells in the area for presence of contaminants.

1.5 Substances on Site

Identity

Two wood preservative mixtures were used at the Site. The wood preservative used from 1962-1965 was exclusively a mixture of 50% creosote and 50% No. 6 road oil. Beginning in 1968, a sizeable percentage of posts were treated with pentachlorophenol (PCP) mixed with wood treating oil (#3 diesel fuel with a suspension additive) to give a 5% wood treating solution (5% PCP and 95% oil). Both preservative mixtures were applied in the same manner in the wood treatment process. The treatment process consisted of a single pressure-cylinder in which the wood was treated.

Creosote

Creosote remains the primary wood preservative used in the United States. It is defined by the industry today as a distillation product of coal tar produced by the high temperature carbonization of bituminous coal. It has a boiling range of 390°F to approximately 750°F. Other quality control specifications such as specific gravity, water content, etc. have been established by the industry. Creosote is composed principally of higher molecular weight aromatic hydrocarbons in addition to tar acids and bases. This preservative has 200 or more identified components, but less than 20 are present in amounts exceeding 1%. It is estimated that 10,000 or more compounds are present in creosote. Compositions vary with batch lots, depending on the coal source and production conditions. The major components of typical samples are phenanthrene (21%), fluorene and fluoranthrene (each 10%) and acenaphthene and pyrene (each about 9%).

Creosote is used directly or in combination with coal tar or petroleum oil. Commonly, it is mixed with a "topped" coal tar to increase the heavy aromatic content and toxicity to soil or marine organisms in addition to other physical or chemical properties desired of wood treatment. "Topped" coal tar has had the light boiling fraction removed by distillation. The percentage of "topped" coal tar used varies from 20-50% to the final product blend. Higher costs of petroleum and related products have affected blends of creosote/coal tar or petroleum solutions are blended to meet the AWPA specifications. It can be done at the treatment plant, but typically is purchased premixed.

The quantities and types of wood products treated nationwide in 1981 with creosote solutions are as follows:

Poles	1,129,000 number
Crossties	32,862,000 number
Lumber and Timbers	113,048,000 board feet
Fence posts	6,568,000 number

Pilings	18,422,000 linear feet
Switchties	76,757,000 board feet
Crossarms	93,000 number

In the late 70's methods were developed for pressure treatment which utilized volatile solvent-carriers. The Cellon® Process is done with liquified petroleum gas (LPG) extraction followed by pressure application of PCP on diisopropyl ether. The Dow® Process used methylene chloride as the solvent-carrier for pentachlorophenol. Both provide a cleaner non-oily surface lighter in color and more aesthetically acceptable.

Creosote solutions are usually applied alone. However, they may be used as part of a dual treatment system where specific additional preservative properties are needed. Mixtures of creosote and other preservatives have been used in the past, but are not currently used in commercial operations. Creosote containing 2% PCP has increased toxicity to soil organisms, but creates corrosion problems with treating equipment. As a result, its use is very limited.

Pentachlorophenol

Pentachlorophenol use became popular in the mid 1960's and became the second most commonly used wood preservative in the United States by the 1980's. Records indicate that 39,730,000 pounds of dry PCP was used in 1979. This does not include the sodium salt form used for dip and spray applications to green lumber. PCP is used primarily as a 5% solution in petroleum solvent carriers to treat poles, crossarms, lumber, timbers, fence posts, and other applications where a clean, paintable surface is not required. The petroleum carriers most commonly used for these purposes are the P-9 Type A or Type C oils. Type A is a light oil similar to diesel fuel. Type C solvent is a petroleum fraction with a boiling range comparable to mineral spirits. In a few specialized applications, a wax water-repellent has been added with PCP in a solvent carrier, such as Type C oil.

In the early 1980's use of PCP with more volatile solvents, which quickly evaporated from the wood after impregnation, gave a cleaner, less colored, and paintable treated surface. The most common of these is a combination of LPG and ether, licensed by Koppers Company as the Cellon Process. Another volatile solvent system, P-9 Type D uses methylene chloride by the Dow Process. Both of these processes, while providing excellent results for ground contact application uses, accounted for only a very small fraction of the total PCP treatments.

Only three companies manufactured PCP in the United States in 1981. They were Dow, Reichhold, and Vulcan Chemical. PCP was produced in flake form or as 1,000- and 2,000-pound (cylinder shaped) blocks. Some commercial sources also supplied PCP already dissolved in oil solutions delivered by tank truck to treating plants MMI purchased PCP as oil solutions.

At larger plants, the block PCP is typically dissolved in oil or solvent in the treating cylinder or tank, diluted to the final use concentration, and then pumped to storage. Automated feed hopper silo systems are available for flaked PCP. It is fed from bulk storage mechanically to the mix tank, oil is added, and the mixture heated to dissolve the PCP. After Quality Control checks, it is pumped to storage for use as needed. Manual dumping and mixing of flake PCP from bags only occurs at smaller treatment operations for limited additions to solutions to bring PCP concentration up to the required minimum strength. Al only used sacks of flaked PCP.

Commercial PCP manufacturing results in the formation of secondary reaction contaminants such as the tri- and tetra- chlorophenol isomers, chlorinated dibenzodioxins, dibenzofurans, and phenoxyphenols. To a much lesser extent, this is also true of the Dow Chemical, Dowicide EC-7. This has been specifically processed to remove most of the side reaction dioxin compounds of environmental and occupational concern. Compositional data on PCP and the Dowicide EC-7 are shown in the table below.

COMPARISON OF COMPOSITION OF COMMERCIAL GRADE AND PURIFIED GRADE PENTACHLOROPHENOL (PCP)

Component	Commercial[a] (Dowicide 7)	Purified[b] (Dowicide EC-7)
Pentachlorphenol	88.4 %	89.8 %
Tetrachlorophenol	4.4 %	10.1 %
Trichlorophenol	0.1 %	0.1 %
Chlorinated phenoxyphenols	6.2 %	—
Octachlorodioxins	2500 ppm	15.0 ppm
Heptachlorodioxins	125 ppm	6.5 ppm
Hexachlorodioxins	4 ppm	1.0 ppm
Octachlorodibenzofurans	80 ppm	1.0 ppm
Heptachlorodibenzofurans	80 ppm	1.8 ppm
Hexachlorodibenzofurans	30 ppm	1.0 ppm

[a]Sample 9522 A
[b]Technical grade PCP reduced by distillation

The Dow product was more expensive due to the increased complexity of the distillation process. The increased costs hampered sales and Dow Chemical discontinued the manufacturing of the EC-7 product line. The EPA Position Document-4 on Wood Preservative Pesticides (July 1984) discusses the chemical industry's ability, but resistance to producing an environmentally safe product. This reluctance has indirectly but obviously contributed to the potential problems at the Site.

The product mix at the Site (creosote-treated products versus PCP-treated products) varied from year to year depending upon consumer demand. Both treatment products are major sources of the Site contamination.

Data are available for 1981 for the amount of chemicals purchased by MMI: (1) 52,595 gallons of creosote; (2) 217,900 gallons of wood treating oil; and (3) 159,500 pounds of PCP. Mr. Barker has estimated that 500 gallons of uncontrolled waste were generated in 1981 by MMI at the Site. This represents about 0.2% loss rate. PCP would then represent 73% of the treatment and creosote, 27%.

The following are the descriptions and results from analysis of samples taken at the Site on October 6, 1981.

DESCRIPTION OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample No.	Description
1	Dump area - sawdust and oily material - black - approximately 350' NW of Highway 65 near NE property.
2	Dump are - sawdust and oil material - black - approximately 100" SW of Site Sample no. 1.
3	Water from draina, pipe leaving property NW of office - light brown - foamy.
4	Water from office - (well on Site) - pump set at 920'.
5	Water from Walnut Creek.
6	North RR ditch (SE of tunnel) where it drops to Walnut Creek - water
7	South RR ditch directly across from Site Sample no. 6 - water.
8	Discharge behind Arkwood office - water.
9	SE corner of impoundment below Site Sample no. 8 - sediment.

RESULTS OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample Description	Pentachlorophenol detected (ppm)
#1: On-site dump - sediment	30,000
#2: On-site dump- sediment	23,000
#3: Discharge pipe - water	18

#4: On-site well - water	<0.01
#5: Walnut Creek - water	2.8
#6: Railroad ditch - water	3.4
#7: Railroad ditch - water	2.0
#8: Steam discharge - water	21
#9: Impoundment - sediment	5600

Waste Quantity Calculation

The quantity of PCP and creosote derived waste at the Site has been controversial.

Update No. 4 to the NPL propsed an HRS score of 34.21 for the Site. This calculation was based, in part on an estimated total quantity of waste of 6,234 tons. This estimated quantity of waste was based on three separate items:

1. ADPC&E inspectors in 1981 relied on estimates of Bob Barker of MMI. Mr Barker stated to ADPC&E representatives that the plant produced a total of 500 gallons of waste per year during his tenure. The HRS calculation in Update No. 4 multiplied this 500 gallon per year figure by the 22 years that the plant was in operation, for a total of 11,000 gallons. (CAI has estimated the total to be 8,600 gallons, if the oil is included, or 190 gallons of PCP and 2,375 gallons of creosote.)

2. The Railroad Ditch Pit contained sludge and soil contaminated with creosote and pentachlorophenol. The volume of the Railroad Ditch Pit was estimated to be 67 cubic yards (40 feet long, 15 feet wide, and 3 feet deep). (CAI has estimated that 1.5 cubic yards of PCP exists in the Railroad Ditch Pit.) (CAI estimates that less than 1 lb of PCP remains in the sawdust.)

3. The Sawdust Pile at the east end of the Site was estimated to be 6,111 cubic yards (275 feet long, 150 feet wide and 4 feet deep).

MMI, via its attorney Alan Gates, took issue with EPA and correctly commented that the waste quantity calculations for the Site improperly recorded wastes more than once and consequently, overstated the value used in the HRS scoring for total quantity of waste.

Important points were made in a letter from Alan Gates, attorney for MMI, to EPA. Gates pointed out that the first item in EPA's calculations represented an estimate of waste generated over the operating life of the plant. The second item, the railroad ditch, is one of the areas where these same wastes were placed. Thus, all of the wastes placed in the railroad ditch were already counted once as part of Item No. 1. It was inappropriate to count the wastes a second time as part of Item No. 2. The total volume of the contaminated soil in the railroad ditch is undoubtedly larger than the volume of waste which is contaminating the soil. Gates' point was that under the Hazard Ranking System, it is inappropriate to base a score on the total volume of contaminate soil or other contaminated matrix at a Site. Only the amount of the contaminating hazardous substance is to be included in the waste quantity calculation. Uncontrolled Hazardous Waste Site Ranking Users Manual. 47 Federal Register 31187, at 31229 (published July 16, 1982). CAI calculated the PCP waste in the Railroad Ditch Pit to be less than 2 cubic yards.

Item No. 3 in the calculation of total waste represented an even more significant error in the estimate of waste quantity. The pile of sawdust and shavings at the east end of the Site had been generated by wood planing equipment and had been used exclusively on untreated wood. The sawdust and shavings themselves originally contained no treatment chemicals. Evidence obtained by MMI indicated, however, that the sawdust pile,in 1986, was only contaminated with pentachlorophenol in the low parts per million range.* The most reasonable source of the pentachlorophenol observed in the sawdust pile was derived from Bob Barker's statement that MMI's used the liquid wastes included on Item No. 1, above, for dust control purposes.

The wastes in the sawdust pile were counted twice; by EPA first as part of Item No. 1, and second as part of the sawdust pile. Inclusion of the entire volume of the sawdust pile improperly added a substantial volume of soil and sawdust.

MMI, via its attorney, Alan Gates, noted that the dimensions attributed to the sawdust pile by EPA overstated its volume by more than two orders of magnitude. MMI photographed and surveyed the sawdust pile. MMI's measurements indicated that the sawdust pile had a surface area of 2,108 square feet and an average depth of six to nine inches. These dimensions resulted in a total volume of less than 60 cubic yards. CAI estimated that in May 1987, the volume of the Sawdust Pile was less than 40 cubic yards.

Why was there such a large descrepancy for the Sawdust Pile? EPA's estimate of 6,111 cubic yards for the volume of the sawdust pile had been based upon an April 1985 memorandum from Doice Hughes, a geologist with ADPC&E, to Tim Perdue in the EPA Region VI Office. MMI discussed its photograph and survey with Mr. Hughes.

*The documentation Record of EPA's HRS scoring indicates that the sawdust pile was included in the calculation of waste quantity because two 1979 soil and sawdust samples taken by the ADPC & E showed pentachlorophenol contamination at levels of 30,000 and 23,000 ppm. MMI questioned the levels of pentachlorophenol reported in these samples and they took three samples from three different portions of the sawdust pile for independent verification. The samples taken by MMI were analyzed by the McKesson Environmental Services Laboratory in Dublin, CA. The analytical results showed penrachlorophenol at 0.5 ppm, 2.1 ppm, and 170 ppm.

Mr. Hughes indicated that the dimensions he originally reported to EPA were only an estimate later indicated that he did not question the accuracy of MMI's measurements.

MMI, via its attorney, Alan Gates, suggested that elimination of Item No. 2, the railroad ditch, and Item No. 3, the sawdust pile should result in a HRS scoring value of 2 for quantity of wastes. 47 Fed. Reg. 31187, at 31229 (published July 16, 1982). This new scoring value for waste quantity resulted in the final HRS score for the Site being reduced from 34.21 to 26.32.

Three major areas of pollution have existed at the Site; 1) surface, 2) subsurface, and 3) dump sites.

Some surface contamination remains at the Site. Most of this contamination is a heavy black solid resembling road tar. This surface contamination can be easily removed, is insoluble and presents no risk to groundwater. There is also an area covered by the remains of a sawdust pile. Surface contamination by PCP or the soluble components of creosote, except in newly eroded areas, is not very likely. An explanation for this statement follows.

The Site is approximately 20 acres or 860,000 sq ft in area and receives 45 inches of rainfall per year. Therefore, about 25,000,000 gallons of water falls directly on the Site each year. The Site ceased operations in 1984. Therefore, approximately 75,000,000 gallons of water has substantially washed away most surface contamination. If one assumes that 500 gallons of waste was present on the surface in 1984, any waste component with an average solubility of 7 ppm would have been completely dissolved and washed away. The solubilities of creosote and PCP exceed this level. A total of 1,050 gallons of pure PCP (only 190 gallons have been estimated to have been released from 1968 to 1984) could have dissolved in 75,000,000 gallons of water. Over 20,000 gallons of 5% PCP treatment solution could be formulated from 1050 gallons of PCP. In addition, the water exits the Site rapidly, causing erosion and carrying with it surface particles.

The Site sawdust pile is steadily shrinking. It is unlikely that PCP or any water soluble contaminant remains in the sawdust above 1 ppm for the same reasons discussed for the Site in general. Assume that the sawdust is one foot thick and that for each sq ft of sawdust, 10-12 cu ft of water has penetrated since the plant closing. If PCP is soluble at 14 ppm in water, the sawdust would have been cleansed of 140 ppm of PCP. The sawdust pile was analyzed in 1986 and found to have 0.5, 2.1 amd 170 ppm of PCP present at the surface.

Sub-Surface - General

If we assume that ground-water moves linearly at a rate of 1 ft/hr, the Site would have been transversed by about 20 complete changes of water since the closing of the plant in 1984. Any dissolved contaminant in solution should have moved form the Site if the groundwater moved as little as 1 foot per day.

Sub-Surface - Specific

If, for example, we consider a 500 foot wide column of ground water starting 20' below the surface (bsl) and extending to 70' bsl which made up 1% of the volume and moved at a rate of 1 ft/hr, about 500 X 50 X 0.01 X 20,000 = 5 X 10^6 cuft or about 4 X 10^7 gallons would have passed through the Site since it was closed. This amount of water could displace 560 galons of PCP at 14 ppm or 21,400 gallons of toluene at 535 ppm or 71,000 gallons of benzene at 1,770 ppm. These figures suggest that if Site pollutants were equally distributed and available to be solubilized by subsurface water, the residues should already have been below detection limits. Such is not the case. Clearly the Site pollutants are not equally distributed and in solution in the ground-water underlying the Site.

What then is the explanantion of the continued detection of Site pollutants off-Site? The underlying rock forms channels which create small underground streams. When these streams contact large sources, exchange based on relative solubility occurs. This process results in the slow dissolving of components based on their relative solubilitities in water versus oil. It is likely that such factors are responsible for the pollution of Cricket Spring and vicinity wells. It is unlikely that a plume exists under the Site since the underlying geologic formation forms a series of vertical and horizontal aquitards and movement of the aquifer is largely by channel.

An attempt has been made to estimate the quantities of waste released at the Site. Several assumptions need to be made prior to initiation of calculations.

1. No PCP was used until 1968.

2. After 1968, the average split between PCP and creosote was 50%.

3. Sales for 1984 were estimated for 6 months of operation.

4. Sale dollars are related to production volume after adjustments for inflation which was estimated at 5% per year.

5. The creosote:oil mix ratio was 1:1.

6. The PCP:oil mix ratio was 1:19.

7. 500 gallons of waste was released in 1981.

The following table provides the details. It has been estimated that approximately 2,400 gallons of creosote and 190 gallons of of PCP were released on the Site over a 20 year period. A considerable portion of this material has been lost from the Site by the processes of rainwater scouring, burning and volatilization.

Cranmer and Associates, Inc.

Year	Value of 1984 Dollar*	Sales ($)	Conver. to 1984 Dollars (X)	Creosote Waste (gallons)	PCP Waste (gallons)	Total (gallons)
1965	0.38	384,210	2.63	120	—	120
1966	0.40	1,030,000	2.5	400	—	400
1967	0.42	1,400,000	2.4	410	—	410
1968	0.44	1,104,545	2.3	155	155	310
1969	0.46	1,215,217	2.2	160	160	320
1970	0.49	1,440,816	2.0	175	175	350
1971	0.51	1,717,647	2.0	205	205	410
1972	0.54	2,103,704	1.9	245	245	490
1973	0.57	3,378,947	1.8	375	375	750
1974	0.60	4,890,000	1.7	510	510	1,020
1975	0.63	2,371,428	1.6	235	235	470
1976	0.67	3,088,059	1.5	285	285	570
1977	0.70	2,714,285	1.4	230	230	460
1978	0.84	3,513,513	1.4	300	300	600
1979	0.77	3,506,493	1.3	280	280	560
1980	0.81	3,456,790	1.2	230	230	460
1981	0.86	3,516,279**	1.2	250	250	500
1982	0.90	2,368,888	1.1	160	160	320
1983	0.95	1,578,947***	1.1 x 0.2	20	20	40
1984	1.00	750,000***	1.0 x 0.2	10	10	20
Total				4,750	3,825	8,575
				x 0.5†	x 0.05††	
Amount of Pure Chemical (gallons)				2,375	190	

* Assume 5% inflation rate as average between 1965 - 1985.
** Loss estimated as 500 gallons.
*** Loss reduced by 80% due to operational charges.
† Mix was 50% creosote:50% oil.
†† Mix was 5% PCP:95% oil.

Predictions

The majority of surface pollution was due to product loss due to excess treatment chemicals dripping from stored posts and convenience spraying in the storage yard. The vast majority of this material was lost continuously from the Site over the years with little chance of concentrating in the environment.

Waste confined in Sinkholes and Pits has been concentrated and protected from rain water runoff. Areas of concentrated waste remain at the Site. The wastes in these areas is contained, concentrated and a large portion can be effectively and efficiently removed and properly disposed of.

Minor dispersed pockets exist in the microcaverns underlying the Site. Some connection between channels are possible, even likely, but the pockets are not practical targets for remedial action and do not represent imminent and substantial hazards to man or the environment.

Maximum concentrations of pollutants in groundwater surrounding the Site are limited to the solubility of the pollutant in the water. It should also be appreciated that minor constituents of PCP will not be found in the water in the same ratios as in the commercial product. This is especially important when it comes to dibenzodioxins and dibenzofurans which are nearly insoluble in water. Health risks based on technical products and their contaminants are not appropriately applied to groundwater. The EPA considered a No Observable Effect Level (NOEL) of 3 mg/kg/day to be appropriate of PCP. For a 150 pound adult, thiis is 210 mg/day. If a person were to drink two quarts of water containing 1ppm of PCP, there would be a 100 fold safety factor. It is very unlikely that anyone would consume 2 quarts of water every day for a lifetime.

Quantity

PCP levels as high as 1.6% have been reported in the Sinkhole. The volume has been reported to be 4 cubic yards. Therefore, approximately 12 gallons of PCP may be in the Sinkhole. The railroad Ditch Pit area has had quantities between 1 and 5% PCP reported. If one assumes that the volume is 68 cubic yards, then up to 125 gallons of PCP may be present. There could be up to 10 gallons of PCP in the Ash Pile.

If we assume that a 10,000 square feet area around the Trolley/Treatment Cylinder Area is contaminated to a depth of 3 feet at an average of 100 ppm, a total of 40 gallons of PCP could be recovered.

If 500 gallons of wood treating chemicals were lost in 1981 and if PCP were used for 16 years (1968-1984) and if 5% PCP solutions represented 50% of sales, then 190 gallons of PCP was released at the Site. This is inexcellent agreement with the estimates of PCP remaining on the Site.

Estimates of PCP

Sinkhole	12 gallons
Railroad Ditch Pit	125 gallons
Ash Pile	10 gallons
Trolley/Treatment Area	40 gallons
Total 187 gallons	

2. Development of Alternatives

Based on the information already obtained from the CAI-RI, a list of general response actions for site remediation was developed. A response action list was used to identify potentially applicable technologies. Table 2.1 presents some general response actions which have been considered together with their associated remedial technologies.

Table 2.1. Actions and Associated Preliminary Remedial Technologies.

General Response	Technologies

Action	
No Action	Some monitoring and analyses may be performed.
Containment	Capping; ground water containment barrier walls; bulkheads; gas barriers.
Pumping	Ground-water pumping; liquid removal; dredging.
Collection	Sedimentation basins; French drains.
Diversion	Grading; dikes and berms; stream diversion ditches; trenches; terraces and benches; chutes and downpipes; levees; seepage basins.
Complete Removal	Tanks; drums; soils; sediments; liquid wastes; contaminated structures; sewers and water pipes.
Partial Removal	Tanks; drums; soils; sediments; liquid wastes.
On-Site Treatment	Incineration; solidification; land treatment; biological, chemical and physical treatment.
Off-Site Treatment	Incineration; biological, chemical and physical treatment.
In Situ Treatment	Permeable treatment beds; bioreclamation; soil flushing; neutralization; land farming.
Storage	Temporary storage structures.
On-Site Disposal	Landfills, land application vaults.
Off-Site Disposal	Landfills, vaults, surface impoundments; land application.
Alternative Water	Cisterns; above ground tanks; deeper or upgradient supply wells; municipal water system; relocation of intake structure; individual treatment devices.

At this point in the CAI-FS, feasible technologies for the general response actions have been identified recognizing that there may be combinations of source control and management of migration that are compatible and incompatible. The remedial technologies have been classified according to the kinds of site problems they intend to mitigate.

Site data from the CAI-RI have been, and will continue to be, reviewed to identify conditions that may limit or promote the use of certain remedial technologies. Technologies whose use is clearly precluded by site characteristics have been eliminated from further consideration. The feasibility of the remedial technologies depends on the characteristics of the wastes.

The remedial technologies proposed evaluation based on status of performance record, and construction, operation and maintenance problems. Technologies that are unreliable, not fully demonstrated, or expected to perform poorly have been eliminated from further consideration.

Remedial response objectives for the Site have assisted in determining public health and environmental concerns and structuring of potential remedial alternatives. This was accomplished by consideration of a combination of the following:

- Description of the current site conditions;
- Data collected during the remedial investigations;
- Federal regulations cited in 40 CFR, Section 300.68;
- Applicable published EPA interim guidance documents; and
- Other applicable published EPA, Federal and State environmental standards, guidance advisories as defined under EPA's CERCLA compliance policy.

The goals were to achieve source control and management of migration. Controls and management should mitigate to the extent possible impacts caused by current and future contaminant migration.

2.2 Synthesis of Alternatives

Site-specific remedial alternatives were developed using the remedial technologies identified during the previous task. As part of the FS, at least one alternative for each of the following categories remains to be evaluated.

Factors that were considered during the development of site-specific remedial alternatives consist of:

- Treatment or disposal both on at an off-site facility approved by EPA (including RCRA, TSCA, CWA, CAA, MPRSA, and SDWA approved facilities), as appropriate;
- Applicable and relevant Federal or State public health or environmental standards;
- A no action alternative.

The technologies relevant to the Site were applicable to several different alternatives. Alternatives which minimized risk to receptor(s) were considered whenever possible.

Alternatives obtained by combining technologies have been prepared. Technologies that are most appropriate for the site include recycling, reuse, waste minimization and destruction.

An interim report has been prepared documenting the data needs before further consideration of alternatives. The interim report includes: (1) documentation for the rationale used to exclude certain technologies; (2) development of preliminary

cleanup objectives; and (3) assembling the remaining technologies used to develop the proposed remediation alternatives.

3. Evaluation of Alternatives

3.1 Technical Criteria

The alternatives selected emerged after elimination of the unfeasible or inappropriate. This selection was prior to undertaking detailed evaluations of the remaining alternatives. Technical, environmental, and economic criteria assisted in performing the review of the remedial alternatives including: (1) cost estimates consisting of capital and lifetime operational and maintenance costs and the present-worth value of these costs; (2) resulting adverse public health or environmental effects from implementation of the alternative; (3) reliability, effectiveness, implementability (including public acceptance, legal and institutional issues), and technical feasibility in meeting the defined objectives.

Three broad considerations were used as a basis for the initial screening: cost, public health, and the environment. More specifically, the following factors were considered:

1. Environmental Protection. Only those alternatives that satisfy the response objectives and contribute substantially to the protection of public health, welfare, or the environment have been considered. Source control alternatives achieve adequate control of source materials. Management of migration alternatives minimize or mitigate the threat of harm to public health, welfare, or the environment.

2. Environmental Effects. Alternatives posing significant adverse environmental effects have been excluded.

3. Technical Feasibility. Technologies that might prove extremely difficult to implement, or may not achieve the remedial objectives in a reasonable time period, or are unproven technology were modified or eliminated.

4. Cost. Alternatives whose costs far exceeded that of other alternatives were eliminated unless other significant benefits were to be realized.

3.2 Environmental and Public Health Criteria

Environmental and public health criteria were evaluated first followed by cost. This two-step screening process allowed for an initial assessment of the applicability of each alternative relative to the others and eliminated alternatives that did not provide adequate protection of public health, welfare, and the environment, and those that are much more costly than others without providing significantly greater protection.

5. Remedial Action Alternatives

5.1 Non-Cost Criteria Analysis

The objective of this task was to perform a comparative technical assessment the most feasible remaining alternatives and to use this assessment to determine if the most likely alternative has been evaluated. If unacceptable performance is demonstrated systematically, each remaining alternative will be developed in sufficient detail to allow comparative technical assessment.

This task includes the following components: (1) refine the alternatives and specify major logistic, equipment and utility requirements. Use of established technologies will be emphasized; (2) prepare a basic component diagram; (3) define operation and maintenance/monitoring requirements; (4) define implementation requirements including safety considerations, regulatory and permit requirements, temporary storage, off-site disposal and transportation; (5) prepare a conceptual site layout drawing; (6) develop a schedule for implementation and address phasing and segmenting options; (7) list potential adverse environmental impacts, describe methods to mitigate those impacts and costs of mitigation; and (8) prepare a preliminary estimate of probable costs associated with the alternative including distribution of cost over time.

After development of the alternatives, the evaluation of the alternatives will proceed with analysis of technical, environmental, public health, institutional and cost feasibility of the alternative in light of the remediation criteria established in previous tasks.

5.1.1. Technical Analysis

Technical analysis of alternatives involved the evaluation of remedial alternatives for performance, reliability, implementability, and safety. Desirability is defined on the basis of performance: effectiveness and useful life. Effectiveness refers to the degree to which an action will prevent or minimize substantial danger to public health, welfare, or the environment. The useful life is the length of time this level of effectiveness can be maintained. Because of the importance of implementing a remedial action which is protective of human health and the environment, reliability of the alternative is of serious concern. Remedial alternatives must be implementable. The relative ease of installation and the time required to achieve a given level of response is very important. Finally, each alternative was evaluated to assess the short and long-term threat to the safety of Omaha and nearby residents and environments as well as those to workers during implementation. Evaluation of these aspects resulted in an estimate of each alternative's technical feasibility.

In addition to the above technical feasibility considerations, the technical analysis considered the following elements, where applicable:

- Did the alternative comply with specific requirements of other environmental programs. Did the alternative prevent or minimize the migration of wastes and public health or environmental impacts. If not, were special designs available that could be implemented to achieve compliance.

- Operation, maintenance, and monitoring requirements of the remedy.

- Identify and review potential off-site disposal facilities to ensure compliance with applicable RCRA and other EPA environmental program requirements, both current and proposed. Potential disposal facilities should be evaluated to determine whether off-site management of site wastes could result in a potential for a future release from the disposal facility.

- Identify temporary storage requirements, off-site disposal needs, and transportation plans.

- Describe whether the alternative results in permanent treatment or destruction of the wastes, and, if not, the potential for future release to the environment.

- Outline safety requirements for remedial implementation (including both on-site and off-site health and safety considerations).

- Describe how the alternative could be segmented into areas to allow implementation in differing phases.

- Describe special engineering requirements or site preparation considerations regarding the remedy.

5.1.2. Environmental Analysis

The environmental analysis involved the preparation of an Environmental Assessment (EA) for the alternative under consideration. The EA focuses on the site problems and pathways of contamination actually addressed by the selected alternative. The EA includes an evaluation of beneficial effects of the response, adverse effects of the response, and an analysis of measures to mitigate adverse effects.

5.1.3. Public Health Analysis

The selected alternative was assessed in terms of the extent to which it mitigates long-term exposure to any residual contamination and protects public health both during and after completion of the remedial action. The assessment will describe the levels and characterizations of contaminants on-site, potential exposure routes, and potentially affected population.

The selected remedial alternative was evaluated to determine the level of exposure to contaminants and the reduction over time.

For management of migration measures, the relative reduction in impact was determined by comparing residual level for the selected alternative with existing criteria, standards, or guidelines acceptable to EPA. For source control measures or when criteria, standards or guidelines were not available, the comparison should be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

5.1.4. Institutional Analysis

The selected alternative will be evaluated based on relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participating agency coordination will be assessed.

5.2. Cost Analysis

The cost of each feasible remedial action alternative (and for each phase or segment of the alternative) will be evaluated. The cost will be presented as a present worth cost and will include the total capital cost and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of costs over time will be provided.

6. SUMMARY OF ALTERNATIVES

Finally, the individual analyses presented above will be compiled and a decision matrix constructed to compare data if it is determined that the selected alternative is not feasible and it was necessary to develop more than one alternative. This process will aid in the selection of the most appropriate remedial action alternative.

Alternatives will be compared using technical, environmental, and economic criteria. The following areas will be used to compare alternatives:

- Present Worth of Total Costs. The net present value of capital and operating and maintenance costs.

- Health Information. For the no-action alternative, prepare a quantitative statement including a range estimate of maximum individual risks. Where quantification was not possible, a qualitative analysis must suffice. For source control options, a quantitative risk assessment was not required For management of migration measures, a quantitative risk assessment including a range estimate of maximum individual risks is provided.

- Environmental Effects. Only the most important effects or impacts have been summarized. Reference has been made to supplemental information.

- Technical Aspects of the Remedial Alternatives. The technical aspects of each remedial alternative relative to the others should be clearly delineated. Such information generally will be based on the professional opinions regarding the site and the technologies comprising the remedial alternative.

- Extent of Compliance with Applicable Environmental Regulations. This information should be arrayed so that differences in how remedial alternatives satisfy such standards are readily apparent. The general types of standards that may be applicable at the site include:

  - RCRA design and operating standards; and

- Drinking water standards and criteria.

- Information on Community Effects. The type of information provided includes the extent to which implementation of a remedial alternative disrupts the community (e.g., traffic, temporary health risks, and relocation).

CHAPTER 8. REPORTING REQUIREMENTS

The CAI-FS scope of work for the Site requires quality control over reporting of the data, assessments, and conclusions. The remedial action must protect human health, welfare, and the environment and be cost effective. Proper reporting will help achieve this goal by:

- Ensuring that the major issues are addressed adequately;
- Tracking project progress;
- Consolidating data;
- Recording the methods used and the results of the work done; and
- Supporting the decisions made and conclusions drawn during the feasibility study.

Reporting during the implementation of this Work Plan will involve the monthly reporting of the technical status of the CAI-FS interim reports and the preparation of a preliminary and final report presenting the results of the CAI-FS.

Monthly project status reports will be prepared to assist in managing and evaluating the progress of the CAI-FS. The reports will consist of a technical status report which will identify and/or summarize: (1) activities conducted during this reporting period; (2) work progress, during this reporting period and to date, and percent complete; (3) work planned for next reporting period; (4) work revisions; (5) schedule status; (6) testing/data results; and (7) support activities. These reports will be prepared by the Site FS Officer and Project Manager and appended to the monthly CAI-RI report.

Quarterly reports documenting the decision making process used to evaluate and develop the most feasible, or if necessary, other alternative will be prepared, and appended to the quarterly CAI-RI reports. The quarterly reports will document: the initial technologies considered; evaluation of the technologies applicable to remediating the Site; cleanup objectives and a definition of the emediation categories; and rationale for selection or deletion of technologies (based on effectiveness, performance, reliability development status, and other related characteristics). At the conclusion, the following quarterly report will identify potentially applicable technologies for source and management of migration controls and their

ability to meet the requirements of the categories for Site specific remedial alternatives.

At the conclusion of the FS, a preliminary report will be prepared that documents the procedures used in assessing the most feasible technologies, cleanup objectives, and criteria, alternatives, and the detailed evaluation results. Documents will be submitted to EPA and the ADPC&E upon approval by the responsible party(s).

The last step of the CAI-FS involves the preparation of a final report which documents and summarizes the evaluation of the remedial action alternatives and presents the recommendations resulting from these evaluations. Comments made by EPA and the ADPC&E will be considered and addressed in the final CAI-FS report as appropriate.

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Endangerment Assessment

A Draft Endangerment Assessment (DEA) for the Site has been performed by CAI to evaluate the environmental hazards posed by residues of the wood treatment pesticides pentachlorophenol (PCP) and creosote. Several reservoirs of PCP and creosote are currently uncontrolled at the Site and could pose a threat to the environment if released. Residues have migrated from an as yet undetermined reservoir on the Site via groundwater. The DEA for the Site includes a pollutant migration pathway evaluation, identification of potential environmental receptors, and a preliminary hazard analysis. Formulation of the CAI-DEA followed guidelines consistent with the National Oil and Hazardous Substances Contingency Plan (NCP).

The objective of the CAI-DEA for the Site was to determine if there is a probability of actual or potential harm to the public health and welfare, and the environment, and if so to estimate the magnitude of risk. Risk may be estimated as either the threatened or actual release of pentachlorophenol or creosote. The CAI-DEA for the Site identifies and characterizes:

1. Concentrations of PCP and creosote present in relevant environmental compartments;

2. Environmental fate and transport mechanisms of PCP and creosote relevant to the Site;

3. Intrinic toxicological properties of PCP and creosote;

4. Pathways and extent of expected human exposure;

5. Human populations at risk; and

6. The likelihood and extent of harm due to exposure to PCP and creosote.

The CAI-DEA has weighed the accuracy, precision, comprehensiveness, reliability, and overall quality of available information and data relevant to the Site. The following outline identifies the major areas addressed by the CAI-DEA.

1. Physical Description of the Site and Site History

   a. Geographic location
   b. Management practices/Site use/Site modifications
   c. Chronological survey
   d. Facility descriptions/containment systems
   e. Substances on-Site (identity, quantity, form, and manner of disposal or holding

2. Site Contamination/Off-Site Contamination

   a. Identity of substances detected
   b. Concentration of substances detected

c. Survey of environmental monitoring studies (detailed discussion of environmental media and contamination levels)

3. Environmental Fate and Transport

a. Physical-chemical properties of specified chemicals/substances (e.g., soil/sediment adsorption coefficients, vapor pressures, solubility, etc.)
b. Photodegradation rates, decomposition rates, hydrolysis rates, chemical transformations, etc.
c. Local topography
d. Description of the hydrological setting and flow system
e. Climatic factors, other factors affecting fate and transport
f. Prediction of fate and transport (where necessary using modeling methods)

4. Toxicological Properties (hazard identification)

PCP

a. Metabolism
b. Acute toxicity
c. Subchronic toxicity
d. Chronic toxicity
e. Carcinogenicity
f. Mutagenicity
g. Teratogenicity/reproductive effects
h. Other health effects; including neurotoxicity, immuno-depressant activity, allergic reactions, etc.
i. Epidemiological evidence (chemical-specific or Site-specific)
j. Aquatic/non-human terrestrial species toxicity/environmental quality impairment

Creosote

5. Exposure Assessment

World Wide Comparison

a. Demographic profiles of populations at risk including subpopulation at special risk
b. Background chemical exposures
c. Lifestyle and occupation histories
d. Population macro- and micro-environments
e. Exposure route

6. Risk Assessment and Impact Evaluation

a. Carcinogenic risk assessment
b. Probability of non-carcinogenic human health effects
c. Non-human species risk assessment
d. Environmental impacts/ecosystem alterations

7. Conclusions

8. Support documentation (appendices)

The Final Endangerment Assessment (FEA) will be issued as a discrete document. Updates of the CAI-DEA will be performed concurrently with the RI activities and the initial stages of the Feasibility Study.

The completed draft FEA will be submitted to ADPC&E and the EPA for review and comment. Ten copies of the draft FEA shall be submitted to ADPC&E and the EPA for review and approval. The draft FEA shall be revised in response to ADPC&E and the EPA's comments and 10 copies of the FEA shall be submitted to ADPC&E and the EPA.

1. Physical Description of the Site and Site History

1.a Geographic Location

The Site occupies part of Section 27, T21N 421W located on the Omaha, Arkansas-Missouri Quadrant Map west of U.S. Highway 65, one-half mile southwest of the city of Omaha, Boone County, Arkansas. The Site is located at the head of a valley west of U.S. Highway 65, as shown in Figure 1.a.1. The Site covers a total of 15 - 20 acres that were used for treating wood with PCP and creosote and storage of treated posts. The total contiguous acreage of the Site owned by Mary Bank was 83 acres. A branch line of the Missouri Pacific Railroad (MPR) tracks are adjacent to the northern edge of the Site. To the south and west the Site is bounded by the unpaved Cricket Road. An aerial photograph of the Site in operation by Mass Merchanisers, Inc. (MMI) in February, 1984, is shown in Figure 1.a.2. The acreage was developed in the early 1900's when the Missouri Pacific Railroad (MPR) excavated to a depth of 40 to 50 feet below natural grade to obtain fill dirt for the construction of railroad embankments

The Site elevation falls from south-east to north-west along a smooth surface which resulted when the MPR removed the topsoil and after owner/tennant improvements. The Site falls approximately 100 feet in elevation from south-east to north-west. The Site surface has been channeled and little water flows from south to north, although this would have been the case prior to excavation. Excavation resulted in exposing the porous and occasionally cavernous underlying limestone to surface water entrainment. Several sinkholes are evident on the Site. Numerous aquifer channels exist immediately below the Site. A deep cased well with the well pump set at 920 feet is located on the south-west side of the northern end of the Site.

A steep bluff approximately 50' high exists on the lower one half of the north eastern boundary of the Site. A disposal area (pit) on the north-eastern boundary of the Site and next to the railroad tracks was covered with fill dirt in 1986.

1.B Management Practices/Site Use/Site Modification

Techniques of Treatment

The following discussion is offered as an explanation of the processes utilized by the wood treating industry in general and Arkwood, Inc. (AI) and MMI in specifics. The discussion is relevant to Site practices through 1984 when MMI discontinued operations.

Wood preservatives used at the Site were oil-based mixtures of either pentachlorophenol or creosote. These mixtures were used to treat wood for the prevention of decay and deterioration which occurs as a result of weather, soil conditions, or the infestation by organisms such as insects and fungi.

Creosote was not new when AI began operating the Site. Creosote had come into use for wood treatment in 1839 with the development of the Bethell full cell pressure treatment (FCT) process. Lumber or posts are enclosed in a cylinder and subjected to an initial vacuum to remove air and water from the wood cells. This step was followed by injecting creosote into the wood under pressures varying from 125-200 pounds per square inch (PSI) at temperatures of 180-210°F. Treatment continued until the wood was saturated with creosote or PCP. Pressure was then released, the cylinder drained, and the wood removed.

Treatment processes relevant to the Site (the Lowry and the Reuping) were developed in the early years of the 20th century. These processes are referred to as empty cell treatments (ECT) in which the excess preservative is removed from the wood cells when a final vacuum phase was added to the process, leaving the wood cells coated rather than filled with treatment solution. The ECT process was popular because less preservative was used and the cost of chemicals was significantly reduced.

In the Lowry Process, the preservative penetrated into the wood due to the high pressure and temperature of the treatment cylinder. The air naturally present in the wood was compressed during the pressurization process. The treatment process was completed when the pressure was released and the cylinder drained. The excess preservative was forced out of the wood cells by expansion of the compressed air. The only major variation in the Reuping Process was an initial application of pressure in the range of 25-75 psi prior to flooding the cylinder with creosote or PCP.

Solutions of creosote and crude coal tar or petroleum oils were effective and less costly for wood treating. As a result, creosote pressure applications by the empty cell method had predominated in the railroad industry since the 1920's. a 1:1 mixture of creosote and oil was used at the Site.

Pentachlorophenol (PCP) was available for use as a bulk wood preservative in 1947, however, its use at the Site began in approximately 1968. PCP was applied in heavy to light petroleum carriers or solvents by pressure methods similar to those used for creosote treament. A 5% PCP solution was used at the Site.

Operations Resulting in Contamination with PCP and Creosote

When the treated wood was removed from the pressure cylinder and transported to the yard for storage or shipment, it dripped. This was especially true in hot weather when maximum treatment (FCT) had been effected, for example to meet Federal specifications. This dripping and exposure to dust and rain would be expected by CAI to result in general contamination of the area. Process related contamination would be expected to be highest in the Trolley/Treatment Area.

The treatment room contained a recessed work area around the treatment cylinder. The recessed area drained into a sump. The sump contained waste from the treatment cylinder, sludge drained from the recessed work area, and water from leaking pipes. The wastes were pumped from the sump into the top of a separation tank east of the treatment room, see Figure 1.b.1.

The treatment room was washed down periodically to remove any oil film or residue on the floor. This wash water drained into the sump from which it was pumped into a wastewater holding tank. When full, the holding tank was set on a forklift or trailer and emptied as the tank was driven around the yard. Dust control was a source of general contamination and the most likely source of contamination in the wood chip pile. Dust control with process waste was discontinued by MMI in 1982 at the direction of MCE and ADPC&E.

Waste oil from clean-up operations in the treatment area was periodically deposited in a "Sinkhole" located near the treating cylinder room. Disposal in the Sinkhole was discontinued when the walls collapsed and it would no longer receive material. The Sinkhole was concreted over in 1982 at the direction of MCE and ADPC&E.

Contamination also occurred in non-treatment areas. Oil sludge was dumped into a "Railroad Ditch Pit" located in the railroad right-of-way north of the treatment cylinder and treating room. Periodically the oily sludge in the ditch would be burned. Other areas included the "Ash Pile" (ashes from a wood-fired boiler located in the treatment room), the trolley tracks leading away from the treatment cylinder and in yard areas used to store treated wood products. See 1.d. for additional details.

Steam condensate was contaminated with PCP and discharged by pipe over the side of the embankment and into the railroad ditch. Sludge was collected and deposited in various areas including sinkholes on the south east end of the Site.

1.C Chronology of Events at Arkwood Plant, Omaha, Arkansas.

Early 1900's

Site was developed as an open pit mine for railroad ballast to construct railbeds for the Missouri Pacific Railroad.

1961

February 22 — Hallie C. Ormond acquires the land from the railroad that will eventually become the Site.

1962

H.C. Ormond constructs treating plant on-Site. C.C. "Bud" Grisham supervises operations of the treating facility on the Site as C.C. and Mary Jo Grisham , d/b/a as Arkwood Treatment Company.

1965

June 16 — Arkwood, Inc. (AI) incorporated to operate the Site. Initial shareholders include: Hallie C. Ormond, C.C. Grisham, Mary Jo Grisham, and Ina Ann Farmer.

1967 or 1968

PCP use begins.

1969-1970

Piping used to transfer boiler blowdown waste.

1970

Bob Barker hired as Plant Manager.

1972

MMI funds expansion of AI and encourages purchase of Reese Tie Company.

Bob Barker becomes General Manager. Devoe Gregory becomes Plant Manager.

1973

January 11 — Hallie C. and Jean Ormond lease the Site to Mountain Enterprises, Inc. (MEI), a wholly-owned subsidiary of Mass Merchandisers, Inc. (MMI) for twelve years. MMI assumes operation of the treatment facility.

March 29 — AI conveys all corporate assets to MEI in exchange for MMI stock.

1974

August 13 — AI is dissolved by MMI.

1980

May 1	Missouri-Pacific (MP) train derailment near the east end of railroad tunnel.
1981	
Jan - Feb	MP railroad initiates new construction on railroad tunnel, including blasting.
May 19	Arkansas Department of Pollution Control and Ecology (ADPC&E) field inspector and Boone County Sanitarian conduct inspection of the MMI operation at the Site (As a result of a complaint received of contamination inside the railroad tunnel).
October 6	ADPC&E collects sediment and surface water samples at the Site, including samples from railway tunnel in Walnut Creek.
October 22	Meeting was held between ADPC&E, MMI - Wood Products Division, and McClelland Consulting Engineers (MCE) (MMI's consultants) to discuss problems at the Site. ADPC&E requests sampling and surface housekeeping.
Dec. 16	MMI submits A Site Correction Schedule to ADPC&E.
1982	
Winter	MPR concludes railroad tunnel construction.
January 25	Inspection of the Site by D. Hughes and M. Bates from the ADPC&E.
Feb 11	MCE obtains soil permeability tests.
April 14, 15	MCE conducts soil, surface and ground-water sampling to determine the extent of the contamination.
May 26	MCE updates ADPC&E on Site Activities. Production at MMI Site is down by 50%.
June 3	MMI asks the ADPC&E to withdraw Part A of the RCRA permit application for the Site.
June 29	MCE conducts soil, surface and ground-water sampling to determine the extent of the contamination.
July 26	Tom Millard, an independent consultant specializing in natural resource inventories, prepares a report on the geology of the Site.
July 26	MCE collected water samples for pentachlorophenol (PCP) analysis.

August 23	MCE collected surface and ground-water samples for analysis of PCP.
October 9	MCE collected surface and ground-water samples for analysis of PCP.
October 30	MCE collected surface and ground-water samples for analysis of PCP.
December 14	MCE collected surface and ground-water samples for analysis of PCP.
1983	
January 15	MCE collected surface and ground-water samples for analysis of PCP.
January 31	MCE collected surface and ground-water samples for analysis of PCP.
February 23	MCE collected surface and ground-water samples for analysis of PCP.
April 1	MCE collected surface and ground-water samples for analysis of PCP.
May 3	MCE collected surface and ground-water samples for analysis of PCP.
May 27	MCE collected surface and ground-water samples for analysis of PCP.
June 28	MCE collected surface and ground-water samples for analysis of PCP.
August 1	Samples taken.
September 7	MCE collected surface and ground-water samples for analysis of PCP.
September 30	MCE collected surface and ground-water samples for analysis of PCP.
October 31	MCE collected surface and ground-water samples for analysis of PCP.
November 30	MCE collected surface and ground-water samples for analysis of PCP.

1984

January 6	MCE collected surface and ground-water samples for analysis of PCP.
February 3	MCE collected surface and ground-water samples for analysis of PCP.
February 20	MCE collected surface and ground-water samples for analysis of PCP.
February 28	MCE collected surface and ground-water samples for analysis of PCP.
March 5	Meeting held between MMI (Erwin, Conner, and Barker) and Bob Behrens (whose well water was contaminated by PCP), where the subject of MMI buying his land was discussed.
March 12	MMI tenders an offer to purchase farm from Bob Behrens.
March 23	MCE collectedsurface and ground-water samples for analysis of PCP.
May 11	MCE collected surface and ground-water samples for analysis of PCP.
June 1	MCE collected surface and ground-water samples for analysis of PCP.
June 14	MMI ceases wood treatment operations.
August 24	MCE collects one water sample for analysis of PCP content.
Fall	MMI sells and removes remaining inventory of treated wood and treating materials from the Site.
October 7	MCE collect additional surface and ground-water samples for analysis of PCP content.
December 7-19	MCE collected surface and ground-water samples for analysis of PCP.

1985

January 11	Twelve-year lease to MMI from Hallie C. and Jean Ormond expires.
April 14-17	Geraghty & Miller, Inc. (GMI) collects water samples from springs and wells, and performs initial soils boring program.

April 29	C.R. barker filed a Certificate of Exemption and stated that the Site was complying with 40 CFR 261.5.
June 4-5	GMI, IT Corporation (IT), McKesson Environmental Services (MES) collect water samples from wells and springs, soil samples, and samples of sludge for waste characterization, preliminary hydrogeologic investigation.
September 18	The Site is proposed for addition to the National Priorities List in EPA's Update No. 4, published in 50 Federal Register 37950 (date of publication September 18, 1985), (based on a Hazardous Ranking System score of 34.21).
September	A meeting was held between MMI, MES and the ADPC&E to present status of site investigation and present remedial action plans.
1986	
May 15	MMI and Region VI Environmental Protection Agency (EPA) sign Administrative Order on Consent for Remedial Investigation/ Feasibility Study (RI/FS) for the Site.
August 15	Arkansas files suit in State Court against PRP's.
September 20	Mary Burke becomes owner
December 1	GMI submits RI/FS Plan
1987	
March 1	CAI begins work on RI/FS Plan
April 28	EPA sues for access on behalf of MMI.
May 1	EPA writes letter threatening penalty if access is not granted to MMI.
May 6	CAI visits Site and takes water samples.
May 15	CAI visits Site and begins Alternate Plan
May 29	CAI submits Draft Report
June 1	CAI submits RI/FS Plan Hearing - Boone County Chancery Court.

1.D Facility Description/Containment Systems

The current Site improvements include no intact buildings, several foundations, one shed structure, one deep well, a fence with gate, underground pipes and power poles. Several small areas show surface tar and discarded steel band scraps are found on the embankment overlooking the railroad. A sawdust pile is located in the most southeastern extremity of the excavated area. A quantity of tires and residue after burning (steel belts) are located on the southeast extremity of the Site.

Detailed insight into the Site condition in 1981 is provided by the study of reports of ADPC&E. R. David Orr of ADPC&E arrived at the Site on June 19, 1981 accompanied by Mike Youngblood, Boone County Sanitarian, of the Arkansas Department of Health. They met Mr. Roy Horn of MMI and informed Mr. Horn of the complaint that had been received concerning bad looking water coming from a spring inside a railroad tunnel adjacent to the Site. Mr's Orr and Youngblood asked for a brief tour of the Site.

The treatment process at the Site was observed by ADPC&E to involve steam pressure treatment of wood posts with pentachlorophenol and creosote on a four-day cycle. After treatment, the wood posts were piled in small groups to cure. Mr.'s Orr and Youngblood observed no means of containment of excess wood treatment chemicals below the piles of wood posts. Several pools of blackish water were reported as observed on the Site and adjacent to the Site along a railroad right-of-way.

After the tour of the treatment process, Mr.'s Orr and Youngblood drove along the railroad tracks to a tunnel where a repair crew was repairing tracks and were met by Mr. Gary Benham, MPC Motor Car Operator. Inside the tunnel, Orr and Youngblood reported observing a spring flowing from the north side which discharged through metal pipes. The water appeared clear. Further inside the tunnel, another spring flowed about 30 feet above the tracks. The water appeared somewhat clear but further down the ditch, it formed an oil film on the surface and stained the walls and dirt surfaces. On the east side of the tunnel, more oil film was observed which collected in pools. The drainage flowed off the railroad track right-of-way into a large pool of water with a thick brownish oil film on top. Further study showed that this drainage flowed into Barren Creek.

Samples were taken by Orr on the east side of the tunnel (sample #1), inside the tunnel at the west end below westside spring on the south side (sample #2) and at the spring on the north side of the tunnel (sample #3). The following are the results of analysis of these samples for pentachlorophenol:

Sample #	Log #	Description	Pentachlorophenol
1	24503	East Side of Tunnel	8.56 mg/l
2	24504	Inside Tunnel at Westend	2.1 mg/l
3	24505	North Side Spring	not detected

MMI had notified ADPC&E that the Site, under RCRA, was a generator of hazardous waste. Mike Bates of ADPC&E visited the site on October 5 and 6, 1981, for the purpose of conducting an interim RCRA status standards inspection and to follow-up the initial complaint and visit by Mr.'s Orr and Youngblood of June, 19th. Bob Barker and Devoe Gregory of MMI Wood Products Group supplied background information for the Site visit during a meeting with Mike Bates on October 6, 1981.

Mr. Mike Bates reported that according to Mr. Barker and Mr. Devoe of MMI, waste from the wood treating operation had been placed into the Sinkhole at the Site from the beginning of the operation until around 1970. The Sinkhole was then covered by boarding the entrance and covering it with a layer of dirt. The entrance was flush with the ground surface as of Mr. Bates' visit on October 6, 1981. As of October 6, 1981, process waste resulted from the wash down of the treatment room floor and residues from cleaning of the treatment cylinder between the use of pentachlorophenol and creosote. These wastes were accumulated in a tank and then sprayed over the storage yard for dust control. Mr. Barker estimated that MMI generated approximately 500 gallons/year of these wastes. Steam was also used in the treatment process, the steam was said to be reused in the process. Some of the steam was bled off to discharge behind the office building adjacent to the Missouri Pacific railroad tracks.

Mr. Bates reported that the Site could have been classified as a Small Quantity Generator under RCRA, according to the generation amounts furnished by Mr. Barker, if MMI had disposed of their waste properly. As of October 5, 1981, Mr. Bates reported that MMI was disposing of waste improperly at the Site by spreading the material for dust control and by dumping it in several places at the northeastern end of their property near Highway 65. The frequency of these "dumpings" were approximately every three weeks according to a Roy Horn, treatment plant manager. The area around the treatment plant was saturated with the treatment chemicals. There were pools of oily material around the treatment cylinder and the storage tanks. The tanks were not diked (with the exception of the raw pentachlorophenol storage tank) nor was there any type of containment to prevent the washing of the oily substances off-Site during rains. The storage yard where the treated wood products were taken to "cure" was saturated in many areas with what appeared to be the treatment chemicals leaching from the wood products. Mr. Horn indicated to Mr. Bates that this saturated soil was scooped out periodically and piled up along the entrance road when the storage areas got too mushy to operate the machinery.

Mr. Bates reported that signs of the steam bleed-off discharge mentioned previously existed on the slope behind the office building. The slope below the

discharge pipes was oil stained; at the base of the stained area there was an impoundment which contained a black oily looking liquid. Mr. Horn had said to Mr. Bates that nothing had been discharged through the pipes except steam and that nothing had been put in the impoundment for years. The impoundment was approximately 15' X 40', depth unknown. There was approximately 2' of freeboard with no evidence of overtopping. The impoundment was located adjacent to the Missouri Pacific railroad approximately 400' northwest of the railroad tunnel mentioned in the initial complaint.

At the time of Mr. Bates' visit, the railroad tunnel was situated in a northwest/southeast line and is approximately 1/2 - 3/4 of a mile in length. There had been a construction crew working on the northwest entrance of the tunnel to widen it. Their work had reportedly involved a considerable amount of blasting. Gary Benham with the construction crew accompanied Mike Bates into the tunnel on October 5, 1981. There were three springs inside the tunnel; the first of which (approaching from the northwest) was located about halfway through the tunnel on the northern side. The other two were located in the southeast one third of the tunnel, discharging from the south side of the tunnel. The first two springs discharged through pipes imbedded in the tunnel wall approximately 20-30' above the tracks. The southeastern most spring broke out near the roof. Mr. Benham stated that the crew complained that the spray from the springs burned their eyes.

The water in the ditches along the tracks was brown in color and had a dark brown to black film on the surface. The tunnel walls and sides of the ditches were oil stained. Both ditches showed signs of contamination, however, the southern ditch appeared to be more heavily contaminated.

The southern ditch flowed southeasterly from the tunnel for about 1000' before it dropped off into a depression formed by the points of two ridges intersecting the railroad. The trees growing in the bottom of this depression had oil stains on them up to 12" above the present level of the water (with oil film). This depression was the receiving point of three drainage patterns. Mike Bates did not observe a drainage point under the railroad. This depression could possibly have been a sinkhole. Mark Witherspoon of ADPC&E agreed with Mike Bates about the possibility of a sinkhole but indicated that a closer study would be needed to confirm it.

The northern ditch also flowed in a southeasterly direction for about 1000' before turning north and dropping sharply to intersect Walnut Creek on the eastern side of the railroad. The tunnel springs appeared to be supplying most of the water in Walnut Creek as of October 5, 1981. The creek bed was dry approximately 600' downstream from the point where the tunnel spring water intersected with the creek. The rocks in the dry bed of Walnut Creek were tinted brown whereas the rocks of an intersecting intermittently wet stream from the northeast (dry also) were not. This could have been an indication of the past flow of contaminants down Walnut Creek.

Mr. Bates determined that there were approximately 14 homes which used individual wells as drinking water within a mile radius of the Site, assuming that all of the residences within the city limits of Omaha were on city water and discounting the homes along Highway 65 which should also have been on city water.

The Omaha city water supply is a well located in the NE1/4, NE1/4 Sec. 27T21NR21W, inside the city limits near the Post Office. This well is also within one mile of the Site, the total depth of the well is 1315' with a casing depth of 60'. A well water sample was taken from the Site. The depth of the Site well was unknown, however, Mr. Horn stated that the pump (submergable) was set at 920'.

ADPC&E received another complaint from a representative of the railroad who charged that the Site was releasing liquid wood preservatives out of a holding area and that the material was getting into a railroad tunnel. The complaint also stated that railroad personnel were getting sick from the fumes in the tunnel. This complaint was considered by Mike Bates to have some validity. Mr. Bates believed that wood treating chemicals were in fact getting into the tunnel, however, as stated earlier, Mike Bates did not observe any discharge or evidence of the overtopping of the dikes of the impoundment below the Site. The railroad personnel may have been getting sick from fumes inside the tunnel, but Mike Bates thought that the fumes most likely came from the train engine exhaust, especially since the trains had to travel at a slow speed through the tunnel (complaint reported 10 mph).

Mike Bates considered the Site as operated by MMI in 1981 to be a serious threat to the groundwater and surface water quality in the area. The representatives of MMI were said to have voiced their willingness to cooperate and do what was necessary, within their means, to alleviate any environmental damage stemming from their operation. In Mike Bates' opinion, there were several things that needed to be accomplished.

1. Seal the Sinkhole, with concrete or other water tight material, to prevent any contaminants from entering it.

2. Cease the on-Site dumping or spreading of wastes fom the treatment process.

3. Clean up all contaminated soil on-Site and properly dispose of it.

4. Establish drip pads and runoff containment from the treated wood products storage area.

5. Eliminate any oily discharge and close out or maintain the impoundment according to RCRA.

6. Determine the source of contamination inside tunnel and implement measures to correct it.

7. Clean up all off-Site contamination.

8. Sample residential wells in the area for presence of contaminants.

1.E Substances on Site

Identity

Two wood preservative mixtures were used at the Site. The wood preservative used from 1962-1965 was exclusively a mixture of 50% creosote and 50% No. 6 road oil. Beginning in 1968, a sizeable percentage of posts were treated with pentachlorophenol (PCP) mixed with wood treating oil (#3 diesel fuel with a suspension additive) to give a 5% wood treating solution (5% PCP and 95% oil). Both preservative mixtures were applied in the same manner in the wood treatment process. The treatment process consisted of a single pressure-cylinder in which the wood was treated.

Creosote

Creosote remains the primary wood preservative used in the United States. It is defined by the industry today as a distillation product of coal tar produced by the high temperature carbonization of bituminous coal. It has a boiling range of 390°F to approximately 750°F. Other quality control specifications such as specific gravity, water content, etc. have been established by the industry. Creosote is composed principally of higher molecular weight aromatic hydrocarbons in addition to tar acids and bases. This preservative has 200 or more identified components, but less than 20 are present in amounts exceeding 1%. It is estimated that 10,000 or more compounds are present in creosote. Compositions vary with batch lots, depending on the coal source and production conditions. The major components of typical samples are phenanthrene (21%), fluorene and fluoranthrene (each 10%) and acenaphthene and pyrene (each about 9%).

Creosote is used directly or in combination with coal tar or petroleum oil. Commonly, it is mixed with a "topped" coal tar to increase the heavy aromatic content and toxicity to soil or marine organisms in addition to other physical or chemical properties desired of wood treatment. "Topped" coal tar has had the light boiling fraction removed by distillation. The percentage of "topped" coal tar used varies from 20-50% to the final product blend. Higher costs of petroleum and related products have affected blends of creosote/coal tar or petroleum solutions are blended to meet the AWPA specifications. It can be done at the treatment plant, but typically is purchased premixed.

The quantities and types of wood products treated nationwide in 1981 with creosote solutions are as follows:

Poles	1,129,000 number
Crossties	32,862,000 number
Lumber and Timbers	113,048,000 board feet
Fence posts	6,568,000 number

Pilings	18,422,000 linear feet
Switchties	76,757,000 board feet
Crossarms	93,000 number

In the late 70's methods were developed for pressure treatment which utilized volatile solvent-carriers. The Cellon® Process is done with liquified petroleum gas (LPG) extraction followed by pressure application of PCP on diisopropyl ether. The Dow® Process used methylene chloride as the solvent-carrier for pentachlorophenol. Both provide a cleaner non-oily surface lighter in color and more aesthetically acceptable.

Creosote solutions are usually applied alone. However, they may be used as part of a dual treatment system where specific additional preservative properties are needed. Mixtures of creosote and other preservatives have been used in the past, but are not currently used in commercial operations. Creosote containing 2% PCP has increased toxicity to soil organisms, but creates corrosion problems with treating equipment. As a result, its use is very limited.

Pentachlorophenol

Pentachlorophenol use became popular in the mid 1960's and became the second most commonly used wood preservative in the United States by the 1980's. Records indicate that 39,730,000 pounds of dry PCP was used in 1979. This does not include the sodium salt form used for dip and spray applications to green lumber. PCP is used primarily as a 5% solution in petroleum solvent carriers to treat poles, crossarms, lumber, timbers, fence posts, and other applications where a clean, paintable surface is not required. The petroleum carriers most commonly used for these purposes are the P-9 Type A or Type C oils. Type A is a light oil similar to diesel fuel. Type C solvent is a petroleum fraction with a boiling range comparable to mineral spirits. In a few specialized applications, a wax water-repellent has been added with PCP in a solvent carrier, such as Type C oil.

In the early 1980's use of PCP with more volatile solvents, which quickly evaporated from the wood after impregnation, gave a cleaner, less colored, and paintable treated surface. The most common of these is a combination of LPG and ether, licensed by Koppers Company as the Cellon Process. Another volatile solvent system, P-9 Type D uses methylene chloride by the Dow Process. Both of these processes, while providing excellent results for ground contact application uses, accounted for only a very small fraction of the total PCP treatments.

Only three companies manufactured PCP in the United States in 1981. They were Dow, Reichhold, and Vulcan Chemical. PCP was produced in flake form or as 1,000- and 2,000-pound (cylinder shaped) blocks. Some commercial sources also supplied PCP already dissolved in oil solutions delivered by tank truck to treating plants. MMI purchased PCP as oil solutions.

At larger plants, the block PCP is typically dissolved in oil or solvent in the treating cylinder or tank, diluted to the final use concentration, and then pumped to storage. Automated feed hopper silo systems are available for flaked PCP. It is fed from bulk storage mechanically to the mix tank, oil is added, and the mixture heated to dissolve the PCP. After Quality Control checks, it is pumped to storage for use as needed. Manual dumping and mixing of flake PCP from bags only occurs at smaller treatment operations for limited additions to solutions to bring PCP concentration up to the required minimum strength. Al only used sacks of flaked PCP.

Commercial PCP manufacturing results in the formation of secondary reaction contaminants such as the tri- and tetra- chlorophenol isomers, chlorinated dibenzodioxins, dibenzofurans, and phenoxyphenols. To a much lesser extent, this is also true of the Dow Chemical, Dowicide EC-7. This has been specifically processed to remove most of the side reaction dioxin compounds of environmental and occupational concern. Compositional data on PCP and the Dowicide EC-7 are shown in the table below.

COMPARISON OF COMPOSITION OF COMMERCIAL GRADE AND PURIFIED GRADE PENTACHLOROPHENOL (PCP)

Component	Commercial[a] (Dowicide 7)	Purified[b] (Dowicide EC-7)
Pentachlorphenol	88.4 %	89.8 %
Tetrachlorophenol	4.4 %	10.1 %
Trichlorophenol	0.1 %	0.1 %
Chlorinated phenoxyphenols	6.2 %	---
Octachlorodioxins	2500 ppm	15.0 ppm
Heptachlorodioxins	125 ppm	6.5 ppm
Hexachlorodioxins	4 ppm	1.0 ppm
Octachlorodibenzofurans	80 ppm	1.0 ppm
Heptachlorodibenzofurans	80 ppm	1.8 ppm
Hexachlorodibenzofurans	30 ppm	1.0 ppm

[a]Sample 9522 A
[b]Technical grade PCP reduced by distillation

The Dow product was more expensive due to the increased complexity of the distillation process. The increased costs hampered sales and Dow Chemical discontinued the manufacturing of the EC-7 product line. The EPA Position Document-4 on Wood Preservative Pesticides (July 1984) discusses the chemical industry's ability, but resistance to producing an environmentally safe product. This reluctance has indirectly but obviously contributed to the potential problems at the Site.

The product mix at the Site (creosote-treated products versus PCP-treated products) varied from year to year depending upon consumer demand. Both treatment products are major sources of the Site contamination.

Data are available for 1981 for the amount of chemicals purchased by MMI: (1) 52,595 gallons of creosote; (2) 217,900 gallons of wood treating oil; and (3) 159,500 pounds of PCP. Mr. Barker has estimated that 500 gallons of uncontrolled waste were generated in 1981 by MMI at the Site. This represents about 0.2% loss rate. PCP would then represent 73% of the treatment and creosote, 27%.

The following are the descriptions and results from analysis of samples taken at the Site on October 6, 1981.

DESCRIPTION OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample No.	Description
1	Dump area - sawdust and oily material - black - approximately 350' NW of Highway 65 near NE property.
2	Dump are - sawdust and oil material - black - approximately 100" SW of Site Sample no. 1.
3	Water from drainage pipe leaving property NW of office - light brown - foamy.
4	Water from office - (well on Site) - pump set at 920'.
5	Water from Walnut Creek.
6	North RR ditch (SE of tunnel) where it drops to Walnut Creek - water
7	South RR ditch directly across from Site Sample no. 6 - water.
8	Discharge behind Arkwood office - water.
9	SE corner of impoundment below Site Sample no. 8 - sediment.

RESULTS OF SAMPLES TAKEN ON OCTOBER 6, 1981

Sample Description	Pentachlorophenol detected (ppm)
#1: On-site dump - sediment	30,000
#2: On-site dump- sediment	23,000
#3: Discharge pipe - water	18
#4: On-site well - water	<0.01
#5: Walnut Creek - water	2.8
#6: Railroad ditch - water	3.4
#7: Railroad ditch - water	2.0
#8: Steam discharge - water	21
#9: Impoundment - sediment	5600

Waste Quantity Calculation

The quantity of PCP and creosote derived waste at the Site has been controversial.

Update No. 4 to the NPL propsed an HRS score of 34.21 for the Site. This calculation was based, in part on an estimated total quantity of waste of 6,234 tons. This estimated quantity of waste was grossly overestimated. The quantity cited by EPA was based on three separate items:

1. Estimates Bob Barker of MMI stated to ADPC&E representatives in 1981 that the plant produced a total of 500 gallons of waste per year during his tenure. The HRS calculation in Update No. 4 multiplied this 500 gallon per year figure by the 22 years that the plant was in operation, for a total of 11,000 gallons. CAI has estimated the total waste to be 8,600 gallons, if the oil is included, or 148 gallons of PCP and 1,771 gallons of creosote.

2. The Railroad Ditch Pit contains sludge and soil contaminated with creosote and pentachlorophenol. The volume of the Railroad Ditch Pit was estimated to be 67 cubic yards (40 feet long, 15 feet wide, and 3 feet deep). CAI has estimated that 1.5 cubic yards of PCP exists in the Railroad Ditch Pit.

3. The Sawdust Pile at the east end of the Site was estimated to be 6,111 cubic yards (275 feet long, 150 feet wide and 4 feet deep). CAI estimates that less than 1 lb of PCP remains in the sawdust.

MMI, via its attorney Alan Gates, took issue with EPA and correctly commented that the waste quantity calculations for the Site improperly recorded wastes more than once and consequently, overstated the value used in the HRS scoring for total quantity of waste.

Additional important points were made in a letter from Alan Gates, attorney for MMI, to EPA. Gates pointed out that the first item in EPA's calculations represented an estimate of waste generated over the operating life of the plant. The second item, the railroad ditch, is one of the areas where these same wastes were placed. Thus, all of the wastes placed in the railroad ditch were already counted once as part of Item No. 1. It was inappropriate to count the wastes a second time as part of Item No. 2. The total volume of the contaminated soil in the railroad ditch is undoubtedly larger than the volume of waste which is contaminating the soil. Gates' point was that under the Hazard Ranking System, it is inappropriate to base a score on the total volume of contaminate soil or other contaminated matrix at a Site. Only the amount of the contaminating hazardous substance is to be included in the waste quantity calculation. Uncontrolled Hazardous Waste Site Ranking Users Manual. 47 Federal Register 31187, at 31229 (published July 16, 1982). CAI calculated the PCP in the Railroad Ditch Pit to be 1.5 cubic yards.

Item No. 3 in the calculation of total waste represented another significant error in the estimate of waste quantity. The pile of sawdust and shavings at the east end of the Site had been generated by wood planing equipment and had been used exclusively on untreated wood. The sawdust and shavings themselves originally contained no treatment chemicals. Evidence obtained by MMI indicated, however, that the sawdust pile,in 1986, was only contaminated with pentachlorophenol in the low parts per million range.* The most reasonable source of the pentachlorophenol observed in the sawdust pile was derived from Bob Barker's statement that MMI's used the liquid wastes included on Item No. 1, above, for dust control purposes.

The wastes in the sawdust pile, just as in the case of the Railroad Ditch Pit, were counted twice; by EPA first as part of Item No. 1, and second as part of the sawdust pile. Inclusion of the entire volume of the sawdust pile improperly added a substantial volume of soil and sawdust.

MMI, via its attorney, Alan Gates, noted that the dimensions attributed to the sawdust pile by EPA overstated its volume by more than two orders of magnitude. MMI photographed and surveyed the sawdust pile. MMI's measurements indicated

*The documentation Record of EPA's HRS scoring indicates that the sawdust pile was included in the calculation of waste quantity because two 1979 soil and sawdust samples taken by the ADPC & E showed pentachlorophenol contamination at levels of 30,000 and 23,000 ppm. MMI questioned the levels of pentachlorophenol reported in these samples and they took three samples from three different portions of the sawdust pile for independent verification. The samples taken by MMI were analyzed by the McKesson Environmental Services Laboratory in Dublin, CA. The analytical results showed penrachlorophenol at 0.5 ppm, 2.1 ppm, and 170 ppm.

that the sawdust pile had a surface area of 2,108 square feet and an average depth of six to nine inches. These dimensions resulted in a total volume of less than 60 cubic yards. CAI estimated that in May 1987, the volume of the Sawdust Pile was less than 40 cubic yards.

Why was there such a large descrepancy for the Sawdust Pile? EPA's estimate of 6,111 cubic yards for the volume of the sawdust pile had been based upon an April 1985 memorandum from Doice Hughes, a geologist with ADPC&E, to Tim Perdue in the EPA Region VI Office. MMI discussed its photograph and survey with Mr. Hughes. Mr. Hughes indicated that the dimensions he originally reported to EPA were only an estimate later indicated that he did not question the accuracy of MMI's measurements.

MMI, via its attorney, Alan Gates, suggested that elimination of Item No. 2, the railroad ditch, and Item No. 3, the sawdust pile should result in a HRS scoring value of 2 for quantity of wastes. 47 Fed. Reg. 31187, at 31229 (published July 16, 1982). This new scoring value for waste quantity resulted in the final HRS score for the Site being reduced from 34.21 to 26.32.

Three major areas of pollution have existed at the Site; 1) surface, 2) subsurface, and 3) dump sites.

Some surface contamination remains at the Site. Most of this contamination is a heavy black solid resembling road tar. This surface contamination can be easily removed, is insoluble and presents no risk to groundwater. There is also an area covered by the remains of a sawdust pile. Surface contamination by PCP or the soluble components of creosote, except in newly eroded areas, is not very likely. An explanation for this statement follows.

The Site is approximately 20 acres or 860,000 sq ft in area and receives 45 inches of rainfall per year. Therefore, about 25,000,000 gallons of water falls directly on the Site each year. The Site ceased operations in 1984. Therefore, approximately 75,000,000 gallons of water has substantially washed away most surface contamination. If one assumes that 500 gallons of waste was present on the surface in 1984, any waste component with an average solubility of 7 ppm would have been completely dissolved and washed away. The solubilities of creosote and PCP exceed this level. A total of 1,050 gallons of pure PCP (only 190 gallons have been estimated to have been released from 1968 to 1984) could have dissolved in 75,000,000 gallons of water. Over 20,000 gallons of 5% PCP treatment solution could be formulated from 1050 gallons of PCP. In addition, the water exits the Site rapidly, causing erosion and carrying with it surface particles.

The Site sawdust pile is steadily shrinking. It is unlikely that PCP or any water soluble contaminant remains in the sawdust above 1 ppm for the same reasons discussed for the Site in general. Assume that the sawdust is one foot thick and that for each sq ft of sawdust, 10-12 cu ft of water has penetrated since the plant closing. If PCP is soluble at 14 ppm in water, the sawdust would have been cleansed of 140 ppm of PCP. The sawdust pile was analyzed in 1986 and found to have 0.5, 2.1 amd 170 ppm of PCP present at the surface.

Sub-Surface - General

If we assume that ground-water moves linearly at a rate of 1 ft/hr, the Site would have been transversed by about 20 complete changes of water since the closing of the plant in 1984. Any dissolved contaminant in solution should have moved form the Site if the groundwater moved as little as 1 foot per day.

Sub-Surface - Specific

If, for example, we consider a 500 foot wide column of ground water starting 20' below the surface (bsl) and extending to 70' bsl which made up 1% of the volume and moved at a rate of 1 ft/hr, about $500 \times 50 \times 0.01 \times 20{,}000 = 5 \times 10^6$ cuft or about 4×10^7 gallons would have passed through the Site since it was closed. This amount of water could displace 560 galons of PCP at 14 ppm or 21,400 gallons of toluene at 535 ppm or 71,000 gallons of benzene at 1,770 ppm. These figures suggest that if Site pollutants were equally distributed and available to be solubilized by subsurface water, the residues should already have been below detection limits. Such is not the case. Clearly the Site pollutants are not equally distributed and in solution in the ground-water underlying the Site.

What then is the explanantion of the continued detection of Site pollutants off-Site? The underlying rock forms channels which create small underground streams. When these streams contact large sources, exchange based on relative solubility occurs. This process results in the slow dissolving of components based on their relative solubilitities in water versus oil. It is likely that such factors are responsible for the pollution of Cricket Spring and vicinity wells. It is unlikely that a plume exists under the Site since the underlying geologic formation forms a series of vertical and horizontal aquitards and movement of the aquifer is largely by channel.

An attempt has been made to estimate the quantities of waste released at the Site. Several assumptions need to be made prior to initiation of calculations.

1. No PCP was used until 1968.

2. After 1968, the average split between PCP and creosote was 50%.

3. Sales for 1984 were estimated for 6 months of operation.

4. Sale dollars are related to production volume after adjustments for inflation which was estimated at 5% per year.

5. The creosote:oil mix ratio was 1:1.

6. The PCP:oil mix ratio was 1:19.

7. 500 gallons of waste was released in 1981.

The following table provides the details. It has been estimated that approximately 2,400 gallons of creosote and 190 gallons of of PCP were released on the Site over a

20 year period. A considerable portion of this material has been lost from the Site by the processes of rainwater scouring, burning and volatilization.

Year	Value of 1984 Dollar*	Sales ($)	Conver. to 1984 Dollars (X)	Creosote Waste (gallons)	PCP Waste (gallons)	Total (gallons)
1965	0.38	384,210	2.63	120	—	120
1966	0.40	1,030,000	2.5	400	—	400
1967	0.42	1,400,000	2.4	410	—	410
1968	0.44	1,104,545	2.3	155	155	310
1969	0.46	1,215,217	2.2	160	160	320
1970	0.49	1,440,816	2.0	175	175	350
1971	0.51	1,717,647	2.0	205	205	410
1972	0.54	2,103,704	1.9	245	245	490
1973	0.57	3,378,947	1.8	375	375	750
1974	0.60	4,890,000	1.7	510	510	1,020
1975	0.63	2,371,428	1.6	235	235	470
1976	0.67	3,086,059	1.5	285	285	570
1977	0.70	2,714,285	1.4	230	230	460
1978	0.84	3,513,513	1.4	300	300	600
1979	0.77	3,506,493	1.3	280	280	560
1980	0.81	3,456,790	1.2	230	230	460
1981	0.86	3,516,279**	1.2	250	250	500
1982	0.90	2,368,888	1.1	160	160	320
1983	0.95	1,578,947***	1.1 x 0.2	20	20	40
1984	1.00	750,000***	1.0 x 0.2	10	10	20
Total				4,750 x 0.5†	3,825 x 0.05††	8,575
Amount of Pure Chemical (gallons)				2,375	190	

* Assume 5% inflation rate as average between 1965 - 1985.
** Loss estimated as 500 gallons.
*** Loss reduced by 80% due to operational changes.
† Mix was 50% creosote:50% oil.
†† Mix was 5% PCP:95% oil.

The majority of surface pollution was due to product loss due to excess treatment chemicals dripping from stored posts and convenience spraying in the storage yard. The vast majority of this material was lost continuously from the Site over the years with little chance of concentrating in the environment.

Waste confined in Sinkholes and Pits has been concentrated and protected from rain water runoff. Areas of concentrated waste remain at the Site. The wastes in these areas is contained, concentrated and a large portion can be effectively and efficiently removed and properly disposed of.

Minor dispersed micopockets exist in the microcaverns underlying the Site. Some connection between channels are possible, even likely, but the dispersed micropockets are not practical targets for remedial action and do not represent imminent and substantial hazards to man or the environment.

Maximum concentrations of pollutants in groundwater surrounding the Site are limited to the solubility of the pollutant in the water. It should also be appreciated that minor constituents of PCP will not be found in the water in the same ratios as in the commercial product. This is especially important when it comes to dibenzodioxins and dibenzofurans which are nearly insoluble in water. Health risks based on technical products and their contaminants are not appropriately applied to groundwater. The EPA considered a No Observable Effect Level (NOEL) of 3 mg/kg/day to be appropriate of PCP. For a 150 pound adult, this is 210 mg/day. If a person were to drink two quarts of water containing 0.01ppm of PCP, (only 1 sample from an abandoned well contained a greater quantity, 0.37 ppm) there would be a 10,000 fold safety factor. A cancer risk of less than 1/100,000,000 is estimated. It is very unlikely that anyone would consume 2 quarts of water every day for a lifetime.

Quantity

PCP levels as high as 1.6% have been reported in the Sinkhole. The volume has been reported to be 4 cubic yards. Therefore, approximately 12 gallons of PCP may be in the Sinkhole. The railroad Ditch Pit area has had quantities between 1 and 5% PCP reported. If one assumes that the volume is 68 cubic yards, then up to 125 gallons of PCP may be present. There could be up to 10 gallons of PCP in the Ash Pile.

If we assume that a 10,000 square feet area around the Trolley/Treatment Cylinder Area is contaminated to a depth of 3 feet at an average of 100 ppm, a total of 40 gallons of PCP could be recovered.

If 500 gallons of wood treating chemicals were lost in 1981 and if PCP were used for 16 years (1968-1984) and if 5% PCP solutions represented 50% of sales, then 190 gallons of PCP was released at the Site. This is inexcellent agreement with the estimates, based on analytical chemistry, of PCP remaining on the Site.

Estimates of PCP by Analytical Chemistry		By Bob Barker
Sinkhole	12 gallons	
Railroad Ditch Pit	125 gallons	
Ash Pile	10 gallons	
Trolley/Treatment Area	40 gallons	
Total	187 gallons	190 gallons

2. ON-SITE CONTAMINATION/OFF-SITE CONTAMINATION

2.A Identification of Substances Expected* to be Detected

Table 2.A.1 . Components of Creosote and PCF Used for Wood Protection.

Creosote Components	Solubility in Water (ppm)	Density
Naphthalene	33.1	1.1621
2-methyl naphthalene		
Acenaphthene	3.42	1.024
Fluoranthene	0.26	1.252
Fluorene	1.84	1.203
Acenaphthylene	3.93	0.8988
Phenanthrene	1.15	1.182
Anthracene	0.59	1.24
Chyrsene	0.002	1.274
Pyrene	0.136	1.271
Benzo (a) anthracene	0.012	
Commercial PCP Components		
Pentachlorophenol	14	1.978
Toluene	535	0.866
2,4,6-Trichlorophenol	800	1.490
2,4-Dichlorophenol	4500	1.383
2-Chlorophenol	28,500	1.256
Phenol	93,000	1.072
2,4-Dinitrophenol	5,600	1.683
2-Nitrophenol	2,100	1.495
4-nitrophenol	16,000	1.270
2,4-Dimethylphenol	17,000	1.023
4,6-Dinitro-o-cresol		6.82
p-Chloro-m-cresol	3,850	
Benzene	1,770	0.879
Ethylbenzene	152	0.867
Acetone	Soluble	0.792
Xylene		0.861

* Compounds detected at the Site are in bold type.

Most of the components of creosote are only sparingly soluble in water. While PCP is not very soluble, once the sodium salt is formed, PCP becomes very soluble in water as are most phenolic PCP contaminants. Oil solutions of these compounds can separate into three phases. First, there can be a lighter-than-water (floating) phase containing light oil, as well as creosote compounds and PCP dissolved in the oil. Second, there can be a water phase, which will contain those contaminants that have become dissolved in water or have the same density as water. Thirdly, there can be a heavier-than-water (sinking) phase, consisting primarily of the dense free phase organics (PCP, aromatics associated with creosote compounds, and heavier fractions of the wood treatment oil).

Analytical Data from Site Samples

Date Sampled	Sampling Location	Sample Description	Analyses Performed	Results (ppm) PCP	PNA	VOA-Cl	VOA-ARO
5-21-85	Railroad Ditch Disposal Area Standing Water	MES#22461 Matrix: Liquid	EPA624 EPA625 EPA610	—	Total 3.4	—	—
5-21-85	Railroad Ditch Disposal Area	MES#22468 Matrix: Waste	EPA624 EPA625	10,400	Total 4000	—	—
5-21-85	Soil in Yard between Product and Water Tank	MES#22464 Matrix: Soil Discrete	EPA8250 for PCP only	8200	N/A	N/A	N/A
6-3-85	B-1 Concrete Pad Boring 1.5' bls	MES#22833 Matrix: Soil, Discrete	EPA8340 EPA8270	7000	Total 1660	—	41
6-3-85	Sinkhole Fluid	MES#22834 Matrix: Waste Water	EPA8240 EPA8270	200	Total 131	—	2.3
6-3-85	B-2, 3' bls Near Concrete Pad	MES#22835 Matrix: Soil, Discrete	EPA8250 for PCP only EPA8270	56	—	N/A	N/A
6-3-85	B-3, 5' bls	MES#22839 Matrix: Soil, Discrete	EPA8270	830	200	N/A	N/A
6-4-85	B-4, 2'bls Wood Chip Pile	MES#22843 Matrix: Soil, Discrete	EPA8250 for PCP only	1.1	N/A	N/A	N/A
10-16-85	Ash Pile	MES#851049-1 Matrix: Soil, Discrete	EPA8240 EPA8270	2600	550	—	—
11-25-85	Railroad Tunnel† Spring, South Side	MES#851186-5 Matrix: Water	EPA624 EPA625	0.11	—	—	—
3-19-86	Railroad Tunnel Spring, South Side	MES#8603108.1 Matrix: Waste Water	EPA624 EPA625	0.010	—	Chloromethane* 0.006	—

- below detection limits
NA not analyzed
* Likely a laboratory or sampling error
† selected for off-Site monitoring

Railroad Ditch Disposal Area, Surface Samples (above 1ppm)

Date Sampling Performed	Analyses Performed	Results		
		Compound	Concentration (ppm) at Center*	East Edge*
6-4-85	Volatile Priority Pollutants	ethylbenzene	3.2	ND
		toluene	1.8	ND
	Volatile Non-priority Pollutants	acetone	3.1	1.4
		total xylenes	3.1	3.1
	Base-neutral Extractable Priority Pollutants	acenaphthylene	6	NA
		naphthalene	930	NA
		acenaphthene	NA	170/230
		fluoranthene	NA	680 /520
		fluorene	NA	840/710
		phenanthrene	NA	3600/3100
	Acid-Extractable Priority Pollutants	pentachlorophenol	31,000	50,000/47,000
	Non-priority Pollutants	2-methylnaphthalene	2000	NA
		2-nitroaniline	150	NA
		dibenzofuran	NA	730/670

* Physical Characteristics observed: sludge mixed with soil, deep brown yellow in color

Analytical Data for Polychlorinated Dioxin/Furan Analysis (ppm)

FURANS	SINK HOLE[3] CAL ANALYTICAL[2]	SINK HOLE[3] IT[1]	WOODCHIP PILE[1] DUPLICATE		RAIL ROAD DITCH[1] CENTER	RAIL ROAD DITCH[1] EDGE
tetra (total)	0.0015	ND	ND	ND	ND	ND
2,3,7,8-TCDD	0.00037					
penta	0.0098	ND	ND	ND	ND	ND
hexa	0.97	ND	ND	ND	ND	ND
hepta	10	0.15	ND	ND	ND	0.070
octa	4.34	0.38	ND	ND	0.26	0.51
DIOXINS						
tetra (total)	0.005	ND	ND	ND	ND	ND
2,3,7,8-TCDD	ND					
penta	0.11	ND	ND	ND	ND	ND
hexa	0.83	0.0075	ND	ND	0.039	0.071
hepta	13	1.1	0.0055	0.0036	0.94	2
octa	1.8	1	0.1	0.077	32	40

Notes to Table:

1 Collected and analyzed by IT Analytical Services, collected 6-2-85,analyzed, June 1985.
2 Collected by MES and analyzed by California Analytical Laboratories, analyzed June 1985.
ND = Not detected at level specified in parenthesis.
3 Samples were grab samples collected from the top phase.

Ash Pile, Surface Sample* (ppm)

Date of Sampling	Analyses Performed	Results	
		Compound	Concentration
10-16-85	EPA 8240, 8270	pentachlorophenol	2,600
		total PNA	550

Treatment Areas Surface Sample* *(ppm)

Date of Samplig	Analyses Performed	Results	
		Compound	Concentration
5-21-85	EPA 8250 for PCP only	pentachlorophenol	8,200

* Physical Characteristics observed: fine gray ash
** Physical Characteristics observed: black rocky clay with evidence of oil

Sinkhole Grab Sample From Top of Sinkhole (ppm)

Compound	Concentration
pentachlorophenol	16,000
ethylbenzene	13,000
2-methylnaphthalene	3,600
benzene	1,300
naphthalene	1,100
n-nitrosodiphenylamine	1,000
dibenzofuran	800
fluorene	790
fluoranthene	370
acenaphthene	300
2-nitroaniline	210
toluene	12
acetone	6.4
styrene	1.7

Analytical Data from Well Water Samples

Data Sampled	Sample Description	Analyses Performed	Results (ppm) PCP	PNA	VOA-Cl	VOA-ARO	Others
Birmingham - Old Well							
05-21-85	MES#22465 Matrix: Water	EPA 624 EPA 625	—	Naphthelene 0.026 Flucrene 0.031	—	—	
06-05-85	MES#22831 Matrix: Water	EPA 624 EPA 625	—	Total 0.023	—	—	
11-25-85	MES#851186-1 Matrix: Water	EPA 624 EPA 625	—	Total 0.005	—	—	
03-04-86	MES#860340-6 Matrix: Water	EPA 625	—	—	NA	NA	
03-31-86	MES#860403-3 Matrix: Water	EPA 624	NA	NA	—	—	
06-24-86	MES#8606141-2,12 Matrix: Water	EPA 624 EPA 625	—	—	—	—	
Birmingham - New Well							
05-20-85	MES#22456 Matrix: Water	EPA 624 EPA 625	—	— 0.10	—	—	
06-05-85	MES#22832 Matrix: Water	EPA 624 EPA 625	NA	NA	Total 0.037	—	
11-25-85	MES#851186-3 Matrix: Water	EPA 624	—	—	—		
03-19-86	MES#8603108.2 Matrix: Water	EPA 624 EPA 625	—	—	Total 0.01	—	
06-24-86	8606141-3, 13 Matrix: Water	EPA 624 EPA 625	—	—	—	—	
Birnam Well†							
05-21-85	MES#22466 Matrix: Water	EPA 610	NA	—	NA	NA	
06-05-85	MES#22830 Matrix: Water	EPA 624 EPA 625	—	—	—	—	
03-04-86	MES#860340-2 Matrix: Water	EPA 625	—	—	NA	NA	
06-24-86	MES#8606141-1 Matrix: Water	EPA 624 EPA 625	—	—	—	—	

\- below detection limits
NA not analyzed
† selected for off-Site monitoring

Analytical Data from Cricket Spring† Samples

Data Sampled	Sample Description	Analyses Performed	Results (ppm) PCP	PNA	VOA-Cl	VOA-ARO	Others
05-20-85	MES#22457 Matrix: Water	EPA624 EPA625 EPA610	1.9	—	—	—	
06-04-85	MES#22829 Matrix: Water	EPA625	4.5	—	N/A	N/A	
11-25-85	MES#851186-6 Matrix: Water	EPA624 EPA625	1.8	Total 0.028	—	—	
03-31-86	MES#860403-5 Matrix: Water	EPA624 EPA625	1.4	Total 0.016	—	—	
06-24-86	MES#8606141-8, 18 Matrix: Water	EPA624 EPA625	—	Phenanthrene 0.008	—	—	

- below detection limits
NA not analyzed
† Selected for off-Site monitoring
* Not from Site

PENTACHLOROPHENOL ANALYSIS

Date	Cricket Spring	Behren Cistern	Behren Well	RR Spring South	Canning Fact. Spring	Miles Well	Birmingham Old Well	Birmingham New Well	Binam Well	RR Civt. Sludge	RR Ditch Runoff	Site
1982												
04-14	8.3	5.6		5.6	0.005				ND	0.005		
06-29	2.7	0.48		0.004					0.004			
07-26	0.013		0.0003	0.0002					0.0001		0.24	
08-23												0.037
10-09	0.004		0.001	0.046					ND			
10-30	0.002		ND	0.0002								0.010
12-14	0.002		ND	0.0002								0.004
1983												
01-05	0.002		0.0009	0.0015								
01-31	0.006		0.00009									
02-23	0.001		0.0005	ND								
04-01	0.003		0.0001	0.0003								
05-03	0.0006		0.00008	0.0003								0.002
05-27	4.0		0.0006	0.0004					0.0001			
06-28	10.0		ND	0.03								0.87
08-01	4.2		ND	0.011								
09-07	9.0		0.0033	0.029								
09-30	97.0		0.0002									
10-31	15.0		0.0011	0.0046								2.0
11-30	10.0		0.0002	0.14								2.6
1984												
01-06	5.7		0.0031	0.012								
02-03	11.0		0.37	0.002					ND			
02-20				0.012								0.28
02-28	7.4		0.0019	0.28					0.0028			
03-13	0.023										7.7	10.6
03-23	5.6		ND	0.100								
05-15	4.6		0.0002	0.057						0.57		4.2
06-01	5.7		0.0005	0.051					0.0081			
08-24	54.0			0.0039					4 tests			
10-07	9.2			0.0099					in '85 &			
12-07	5.5								'86 no			0.28
12-19	3.7			0.017		0.011			PCP			
1985												
05-20	1.9			ND	ND	ND	ND	ND				
06-04	4.5			ND			ND					
11-25				ND								
1986												
03-04	ND		ND			ND	ND					
03-19		ND		0.01			ND	ND				
03-31	1.4				ND							
06-24	ND	ND	ND	ND	ND	ND	ND	ND				
09-24	5.1											
1987												
01-16	0.83	ND	ND	ND	ND		ND	ND	ND	(Also Duggan Well		
03-24	3.6											
05-15	2.31											tests ND)

Omaha City wells: No PCP in NUmerous 1982-1987 tests
Arkwood 1000' Site well: No PCP in numerous 1982-1987 tests
Walnut Creek: No PCP in numerous 1982-1987 tests
Cricket Creek: No PCP in numerous 1982-1987 tests

3. ENVIRONMENTAL FATE AND TRANSPORT

3.A Photodegradation Rates, Decomposition Rates, Hydrolysis Rates, Chemical Transformations, etc.

Degradation of PCP in Soil

The degradation and persistence of PCP in soil was first based on determining the toxicity and biocidal activity of soil at various times after PCP treatment. Lousalot and Ferrer (1950) examined the persistence of PCP in soil treated with 0, 30, 60 and 90 lbs/acre* and stored for 0, 1/2, 1 and 2 months before being bioassayed with corn and cucumbers. The data obtained demonstrated that, in general, the toxicity to soil organisms decreased with the passage of time. Water played an essential role since There was no appreciable inactivation of PCP after two months when applied to air-dried soil. PCP persisted somewhat longer in soil with medium moisture content than in saturated soil. Toxicity appeared to persist longer when applied to a heavy clay soil than when applied to a sandy or sandy-clay mixture (Lousalot and Ferrer, 1950). Young and Carroll (1951) also observed that PCP decomposed more rapidly in soils containing a higher content of organic matter. The rate of dissipation was greater when soils were near saturation point and when the soil temperature approached the optimum for microbiological activity.

Lousalot and Ferrer (1950) demonstrated that PCP persistence varied from 15 to more than 60 days and was dependent upon soil conditions and application rate. Young and Carroll (1951) observed PCP to persist in detectable quantities for as long as 49 days. When applied at 7.5 lbs/acre, Alban and McCombs (1949) observed residual effects of Na-PCP for as long as 12 weeks after application of 7.2 lbs/acre to muck soils. Taylor (1950) observed no residual toxicity in soil after 100 days from 25 lbs/acre applications of Na-PCP, but did find residual activity after 100 days from 5 lbs/acre applications of PCP in 50 gallons of Stoddard solvent. Thus, formulation, as well as soil type, organic matter and moisture contents, and temperature will affect PCP persistence in soil.

The effect of numerous factors on the degradation of PCP in soil was discussed by Tsunoda (1965), Kuwatsuka (1972) and Aso and Sakamoto (1962). The rate of PCP dissipation from soil was closely related to temperature, aeration and organic matter. The degradation of PCP is partially dependent on cation exchange capacity and soil pH, whereas soil texture, clay content, degree of base saturation, and free iron

*If all the PCP waste reported as released (250 gallons of a 5% solution per year) at the Site were distributed equally on the Site (20 acres), it would equal 10 lbs/acre/year.

oxides did not influence the rate of PCP degradation. At higher temperatures, PCP disappeared more rapidly from soils under anaerobic (flooded) conditions than under aerobic conditions. A more rapid degradation of PCP in paddy soil under flooded conditions than in previously aerobic soils placed under anaerobic conditions indicates the importance of an established anaerobic population. The half-life of PCP at an initial soil concentration of 100 ppm was 10-40 days at 30 ° C under flooded conditions, whereas almost 100 % was detected in aerobic soil after two months. PCP degraded more rapidly in high organic matter soils than in soils with low organic matter content. In subsequent investigations Kuwatsuka and Igarashi (1975) further indicated a slight correlation of PCP degradation with free iron content and phosphate adsorption coefficent, but little little correlation with available phosphorus content.

The effect of flooding or anaerobic conditions on PCP degradation in 11 different rice paddy soils was examined by Kuwatsuka and Igarashi (1975). The half-life of PCP varied from 10 to 70 days (average 30 days) in the arable soils under flooded conditions, and from 20 to 120 days (average 50 days) under upland conditions. The period of time required to degrade 90 % of the PCP present was 30 days or more under flooded conditions, and 50 days or more under upland conditions. Almost 100% of the PCP remained even after 50 days when applied to a forest subsoil which contained only trace amounts of organic matter, and submitted to both water conditions. Similar results were obtained by Watanabe (1973) and Ide *et al.* (1972) who reported that PCP disappeared rapidly in mature paddy fields, but very slowly in a newly reclaimed field and in soil collected from an immature paddy field. In other investigations the rate of PCP degradation varied among farm soils and was influenced by the presence of certain fungicides (Suzuki and Nose, 1970); repeated applications of PCP to paddy fields resulted in accelerated degradation (Watanabe and Hayashi, 1972) and no PCP degradation occurred in submerged soils which had been sterilized (Kuwatsuka, 1972; Igarashi and Kuwatsuki, 1972). These results suggest that PCP degradation is related to microbial activity in the soil.

Numerous degradation products have been isolated from PCP treated soil. Ide *et al.* (1972) examined PCP degradation in sterile and nonsterile paddy soil. PCP was stable in sterilized soil, but was degraded in nonsterile soil. Decomposition products isolated from soil included 2,3,4,5-, 2,3,5,6-, and 2,3,4,6-tetrachlorophenols; 2,4,5- and 2,3,5-trichlorophenols; 3,4- and 3,5-dichlorophenols; and 3-chlorophenol. Time course investigations were also conducted with the three tetrachlorophenols. Of these, 2,3,4,6-tetrachlorophenol was the most rapidly degraded. It was concluded that the chlorines *ortho* and *para* to the hydroxyl group underwent reductive dechlorination more easily than the *meta* chlorine.

Similar results were obtained by Kuwatsuki and Igarashi (1975) who also identified pentachloroanisole as a PCP degradation product. Pentachloroanisole formation and its subsequent degradation back to PCP was reported by Igarashi and Kuwaysuki (1971, 1972, 1973). Demethylation and methylation of phenolic groups in biological systems is well known (Williams, 1959). Ide *et al.* (1972) also found 2,3,4,5-, 2,3,5,6-, and 2,3,4,6-tetrachloroanisoles, 2,3,5- and 2,4,5-trichloroanisoles and 3-chloroanisole as methylated products of PCP in incubated soil, but not 2,3,6-, 2,5,6- and 2,4,6-trichloroanisoles. Based on the results obtained in these investigations,

Igarashi and Kuwatsuki (1975) propose a soil degradation pathway in which the initial degradative mechanism in soil is either methylation or reductive dechlorination.

Photolytic degradation of PCP influences the fate of PCP in soil, as observed in paddy fields. The photodegradation products were isolated and identified by Munakata and Kuwahara (1969). 1,2,3,4,6,7,8,9-octachlorodibenzo-*p*-dioxin was identified later as a photodegradation product of PCP by Crosby et al. (1972). Others have also noted that photochemical decomposition is at least partially responsible for PCP dissipation (Kuwahara *et al.*, 1966).

In considering the biodegradation of PCP in soils and other environments it is also important to consider which products are actually degradation products as opposed to contaminants in the original formulation. Typical commercial PCP contains a variety of substances such as tetrachlorophenols, trichlorophenols, hexachlorobenzene, chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans (Johnson *et al.*,1973; Schwetz *et al.*). The degree of contamination seems to vary with the commercial preparations examined (Johnson *et al.*, 1973; Nilsson *et al.*).

Investigations which have involved the use of commercial formulations (other than the analytically pure ^{14}C-PCP formulations) have reported a wide variety of tetra- and trichlorophenols as PCP degradation products. The predominant tetrachlorophenol in technical PCP samples is the 2,3,4,6-tetra isomer. It seems reasonable, therefore, to question which compounds are actually degradation products and whiich may be contaminants. From a chemical synthesis point of view, placement of *meta* substituents is somewhat difficult. Similarly, from a biochemical point of view, abstraction of a substituent from a *meta* position is most difficult. Soil microorganisms have traditionally shown a preference for removing substituents which are either ortho or para to reactive sites, or both. For these reasons it seems logical to question whether tetra- or trichlorophenols with only a missing *meta* substituent are actually degradation products or contaminants in the original formulation. The results of the few investigations with ^{14}C-PCP would support pathways, either in soil or with isolated microorganisms, which involve dehalogenation in either the *ortho* or *para* positions, or both. However, these observations would not apply to the formation of methyl esters of any of the tetra- or trichlorophenols in soil. Methylation is common phenomenon in the soil metabolism of phenolic moieties.

Murthy *et al.* (1977) examined the degradation of ^{14}C-PCP in both aerobic and anaerobic moist soil with and without cellulose amendents. The anaerobic soil was aerated with nitrogen. In anaerobic soil, PCP reduced soil respiration in the presence of celllulose. Losses by volitalization accounted for only 0.5% of the PCP added to the soil. No $^{14}CO_2$ was detected. Organic solvent extractable radioactivity was the same from all anaerobic treatments. Gas chromatographic analysis of the soil extracts showed the presence of the methylether of PCP (0.7%). 2,3,5,6- and 2,3,4,5-tetrachlorophenols and 2,3,6-trichlorophenol were also detected as degradation products by gas chromatography after methylation. Total ^{14}C- recoveries from unamended and cellulose amended soils were 95.7 and 93.5%, respectively. Similar results were obtained in aerobic soils with regard to product formation. 2,3,4,5- and 2,3,5,6-tetrachlorophenol and 2,3,6-trichlorophenol were detected in extracts from

aerobic soils. The principle product (51.5%) however, was the methylether of PCP, or pentachloroanisole.

Further degradation of the pentachloroanisole was examined in both aerobic and anaerobic soils. In aerobic soils, only 5.6% of the pentachloroanisole was reduced back to the PCP in 24 days, whereas in anaerobic soil, 42.1% was reduced to PCP. These results indicate that while some interconversion of pentachloroanisole and PCP occurs in both aerobic and anaerobic soil, the reactions involved in the degradation of these compounds are reductive in anaerobic soil, and both reductive and oxidative in aerobic soils.

The results of the preceding investigation indicate that degradation of PCP in soil occurs primarily by reductive dehalogenation. This degradation pathway results in the formation of progressively simpler chlorophenols, i.e., tetrachlorophenols, trichlorophenols and dichlorophenols. Investigations conducted with ^{14}C-PCP indicate that this proceeds through a logical sequence with the initial dehalogenation reactions occurring at either *ortho* or *para* positions. Methylation of the phenol group also appears to be a common reaction in PCP degradation as well as its tetra- and trichlorophenolic products.

In summary, pentachlorophenol (PCP) readily degrades in the environment by chemical, microbiological and photochemical processes. Degradation in soil is affected by numerous chemical, physical and biological factors. PCP degrades more rapidly in flooded or anaerobic soil than in aerobic moist soil. Several pathways of degradation have been identified. The degradation of PCP in soil is primarily by reductive dehalogenation to simpler tetra-, tri- and dichlorophenols. Methylation of PCP to pentachloroanisole and liberation of $^{14}CO_2$ from ^{14}C-PCP have also been observed. Isolated soil microorganisms metabolize ^{14}C-PCP by methylation, dehalogenation, and ring cleavage with the ultimate conversion of the ^{14}C to $^{14}CO_2$ and normal ^{14}C-cell constituents.

Degradation of Pentachlorophenol in Water

A two year study of the fate of pentachlorophenol in outdoor artificial streams focused on details of microbial degradation by a combination of *in situ* and laboratory measurements (Pignatello, *et al.*, 1985). Replicate streams were dosed constantly at pentachlorophenol concentrations of 0, 48, and 144 µg/L, respectively, for an 88 day period during the summer of 1983. Pentachlorophenol was degraded both aerobically and anaerobically. Aerobic degradation was more rapid than anaerobic degradation. Mineralization of pentachlorophenol was concomminant with pentachlorophenol disappearance under aerobic conditions, but lagged behind the loss of the parent molecule under anaerobic conditions. Biodegradationin the streams, or in specific stream compartments such as the sediment or water column, was characterized by an adaptation period (3-5 weeks for the streams as a whole, and reproducible from the previous year), which was inversely dependent on the concentration of pentachlorophenol and microbial biomass. The adaptation in the streams could be attributed to the time necessary for selective enrichment of an initially low population of pentachlorophenol degraders on surface compartments. The extent of biodegradation in the streams (percent loss of the initial concentration of pentachlorophenol)

increased with increasing pentachlorophenol output, which was explicable by an increase in the pentachlorophenol degrader population with increasing pentachlorophenol concentration. The sediment zone most significant to overall pentachlorophenol biodegradation was the top 0.5- to 1-cm layer as shown by pentachlorophenol migration rates and depth profiles of degrader density within the sediment. Pentachlorophenol profiles in sediment cores taken during and after the adaptation period for degradation showed that diffusion of pentachlorophenol into the sediment was rate limiting to degradation in this compartment. Degradation rates were independent of temperature within the temperature range of the streams during the dosing season (19-30°C), but became increasingly slower below 19°C. The impact of sudden increases in toxicant level (to 10 or 100 mg/L) on degradation was significant (negative), and was assessed by laboratory experiments with sediments. Total heterotrophic activity of sedimentary communities over a major part of the season was unaffected by pentachlorophenol at all stream concentrations tested.

Degradation of Dibenzodioxins in Soil

The persistence of dibenzodioxins in the environment is a primary concern since dibenzodidioxins have been detected as a contaminant of PCP. Several studies on the biodegradability of dibenzodioxins are described in the literature. The investigations show that dibenzodioxins exhibit relatively strong resistance to biodegradation, though they may not necessarily be totally recalcitrant. Most of the work has focused on 2,3,7,8-TCDD because of its extreme toxicity. Poiger and Schlatter (1980) noted that 2,3,7,8-TCDD absorbs strongly onto soil particles, thereby reducing its bioavailability. Young (1983) also noted that 2,3,7,8-TCDD is not likely to be metabolized readily by soil microorganisms. Approximately 100 strains of microbes that have previously shown the ability to degrade persistent pesticides were tested for their ability to degrade 2,3,7,8-TCDD. After incubation, extracts from microorganisms were prepared and analyzed for metabolites by thin-layer chromatography. Of the strains tested, five showed some ability to degrade dibenzodioxins. Only one (Kearney *et al.*, 1973) has examined the biodegradability of another dibenzodioxin, 2,7-DCDD. Data from this study indicate that this dibenzodioxin can at least be partially degraded in soils.

The photodecomposition of 2,3,7,8-TCDD on wet or dry soil under artificial and natural sunlight was studied by Crosby *et al.* (1971). The photodecomposition was found to be negligible in soils. Similarly, Plimmer *et al.* (1973) determined that photodecomposition if TCDD on soils was too slow to be detected. In a later experiment, Plimmer (1978) found that although TCDD decomposed significantly from precoated silica plate (~22%) in 8 hours of sunlight irradiation, practically no decomposition of TCDD was observed from TCDD sorbed on soil under similar conditions.

The photodegradation of TCDD in combination with other pesticide mixtures was studied by Crosby and Wong (1977). When Agent Orange containing 15 ppm of TCDD was applied on the surface of glass plates (5 mg/cm^2), rubber plant, Hevea brasiliensis (6.7 mg/cm^2) and on the surface of sieved Sacramento loam soil (10 mg/cm^2) and exposed to sunlight, TCDD was found to photodecompose. The loss of TCDD in 6 hours was >50% from glass plate, ~100% from the surface of leaves and

~10% from the surface of soil. The rapid photolysis of TCDD from these surfaces indicates that the herbicide formulation provided a hydrogen donor that probably allowed the photolysis to occur. The authors attributed the slower photolysis of 2,3,7,8-TCDD in soil to a shading effect by lower layers of soil particles.

Many studies have addressed the mobility of dibenzodioxins, especially 2,3,7,8-TCDD , in soils. Generally, it has been found that dibenzodioxins are more tightly bound to soils having relatively higher organic content. Dibenzodioxins applied to the surface of such soils generally remain in the upper 6 to 12 inches. They migrate more deeply into more sandy soils, to depths of 3 feet or more. In areas of heavy rainfall, not only is vertical migration enhanced but lateral displacement also occurs by soil erosion with runoff and/or flooding. Dibenzodioxins may appear in normal water leachate from soils that have received several dibenzodioxin applications.

Kearney *et al.* studied the mobility of 2,7-DCDD and 2,3,7,8-TCDD in five different types of soil. They observed that the mobility of both dibenzodioxins decreased with increasing organic content in the soil. Matsumura and Benezet (1973) showed that mobility of 2,3,7,8-TCDD is relatively slow, much slower than that of DDT. It was concluded that any movement of 2,3,7,8-TCDD in the soil environment would be by horizontal transfer of soil and dust particles or by biological transfer (other than by plants).

The U.S. Air Force studied test plots in Utah, Kansas and Florida to determine the overall soil degradation rate of 2,3,7,8-TCDD under field conditons (Young *et al.*, 1976). The three test plots were considered representative of various climatic conditions and soil types. Herbicide Agent Orange, containing 3700 ppb of 2,3,7,8-TCDD, was applied to all three plots at a rate of 4480 kg/hectare. Initial soil concentrations of the dibenzodioxin were not reported for any of these sites. Composite samples from upper 15 cm of each soil were taken from time to time after the initial herbicide application, and analyzed for both the herbicide and 2,3,7,8-TCDD.

From these data and other leaching data, the Air Force concluded that the disappearance of 2,3,7,8-TCDD was most likely due to degradation by soil microbes, because dioxin concentrations in the 15 to 30 cm layer indicated that leaching was insignificant. The Air Force report further stated that dioxin degradation was most rapid in the Kansas soil, followed by the Florida soil and finally the Utah soil, but that variations in soil and climate had little overall influence on dioxin persistence. It was also reported that the initial breakdown rate was rapid, but decreased substantially over the test period. On the basis of this observation, the investigators speculated that microbial enzymes responsible for herbicde metabolism and possibly dioxin metabolism are inducible.

The overall half-life of 2,3,7,8-TCDD in soil has been reported to be 1 to 3 years by Kearney *et al.* (1972). The half-life of this chemical in soils under relatively dry conditions (Utah test area) was found to be ~330 days and in more moist soils and under warm conditions (Florida test area) was found to be ~190 days. This is consistent with the biodegradation half-life of ~0.5 year for TCDD determined by Commoner and Scott from the soil in rural Missouri after the accidental spraying of

TCDD-contaminated oil (IARC, 1977). However, these half-life estimates may greatly underestimate the true value, since it has recently been shown that radiolabeled TCDD adsorbed in soil becomes progressively more resistant to extraction (Philippi, *et al.*, 1981; Huetter and Philippi, 1982).

The rate of disappearance of 2,3,7,8-TCDD following an accidental 2,3,7,8-TCDD release from a trichlorophenol manufacturing plant at Seveso, Italy, was studied by DiDomenico *et al* (1980, 1982). The disappearanceof 2,3,7,8-TCDD from the topmost soil layer after 1 year was speculated to be due to photodegradation, volatilization or vertical movement through the soil. These investigators estimated the initial half-life of 2,3,7,8-TCDD in the soil at the time of its release to be 5 months. One month after release, the rate of disappearance of 2,3,7,8-TCDD slowed down to the equivalent of 1 year in apparent half-life. By the 17th month, the rate declined to an extremely slow level; the apparent half-life figure for this phase was calculated to be >10 years. More recent data (Young, 1983; Wipf and Schmid, 1983) indicate that the half-life if 2,3,7,8-TCDD in soil is about 10-12 years. Since most of the other poly chlorinated dibenzo dioxins (PCDDs) are no more susceptible to transformation/degradation than TCDDs, their half lives in soil are presumed to be similar to that postulated for TCDDs.

In summary, PCDDs are resistant toward photochemical and biodegradation reactions in soil. The half-life of 2,3,7,8-TCDD in soils may be >10 years. These compounds are likely ro be transported from soil through movement of articulate matter containing sorbed PCDDs. The most probable transport of these compounds to the atmosphere by contaminated airborne dust particles, evaporation, and transport to surface water via eroded soil transported by water. Leaching is usually a less likely transport process for these chemicals except for very sandy soils.

3.C Local Topography

The Site is located on an excavated area in rolling pine-covered hills that are characteristic of the Ozark Mountain chain. The surficial cover derived from cherty clay residuum is readily visible from past Site excavations. The Site is flat, with the area surrounding the Site featuring a considerable amount of relief, including a steep drop down an embankment towards the railroad tracks on the north-eastern edge of the property. Land use in the area is primarily for grazing.

Characteristic of the Site and Ozark Mountains in general is the "karst" topography and hydrology. Groundwater flow in karst terrain is typically through fractured limestone. These fractures dissolve to create channel flow condition, accompanied by the creation of sinkholes. This factor is of prime importance when evaluating potential migration pathways for polluted groundwater.

A regional generalized hydrogeologic column for the Omaha, Arkansas, area is provided in Figure ( ), and provides descriptions of lithology and estimates for the thicknesses of individual geologic formations. It should be noted that the various formations vary in thickness and some may be absent within the Site area. Figure ( ) shows a generalized stratigraphic cross-section for the area of the Site. Figure ( ) shows the trace of this cross-section and indicates which wells were used to develop the cross-section.

Figure ( ) is an hypothetical cross-section because conflicting information exists on the elevation of the Chattanooga Shale (if present). The figure respresents the hypotheses in which the Chattanooga Shale is around 900 feet above sea level in the Site area. This hypothesis is based on driller logs and correlated with information of Purdue & Miser. On the other hand, according to Mr. O. A. Wise the Chattanooga Shale would be at a higher elevation and could outcrop in the studied area.

Regionally, the surficial cover is a cherty clay residuum derived from the Boone Formation. At the Site, the surficial materials are classified as cherty silty loams which are partly by-products of the blasting related to railroad construction and operation of machinary.

Below the residuum is the Boone Formation, which consists of varying amounts of chert and limestone. The thickness of the formation at the Site is reported to be approximately 120 ft to 250 ft, excluding the St. Joe Member. Limestone in the formation is nearly pure calcium carbonate. Limestones are very soluble in ground water and subsurface cracks, joints and fissures are visible at several locations on the Site. Sinkholes are common where limestone is present at the surface. Many of the large joints and fissures are filled are filled with red clay and debris. Chert (a very dense, microcrystalline siliceous rock) occurs frequently in the Boone Formation and is the principal rock in the basal section. The distribution of chert is the limestone varies from scattered nodules to sheet-like masses in excess fo 100 feet in thickness.

The St. Joe member of the Boone Formation is regionally the most laterally persistent and conspicuous beds present. The thickness of this unit is approximately 50 feet. The rocks of the St. Joe member are composed of crystalline limestone. At the base of the unit , immediately above the Chattanooga Shale (where this formation is present), fractures have been widened extensively by solution.

The Devonian-aged Chattanooga Shale may or may not be present in the vicinity of the Site. The basal section is generally a black, carbonaceous, thinly fissile (tendency to form thin sheets) shale which weathers into flakes. It contains numerous vertical joints. The upper section is black to brown, with occasional phospatic sandy streaks. The upper section is less fissile than the basal part and weathers into prismatic blocks irrespective of bedding. Total thickness of the shale varies from 0 to 50 feet. This layer may act as an aquitard between the Boone Formation and the underlying carbonate units.

Where the lower section of the Chattanooga Shale is absent, the upper section typically overlies the Sylamore member. The Sylamore member is composed of sandstone generally 2 to 5 feet thick and consists of one or more massive (without stratification) beds, although it may be locally thin-bedded.

The Ordovician-aged Powell Formation underlies the Chattanooga Formation. The formation consists primarily of crystalline dolomite, with minor amounts of green, carbonaceous shale containing chert congomerate. The thickness of the unit ranges from 0 to several hundred feet. The formation weathers rather easily. In the upper part of the formation, numerous veins and masses of sandstone are present. The

veins range from approximately one-half inch to six inches in thickness and extend downward 20 feet from the top of the dolomite. The largest of the masses are 75 feet in diameter and 40 feet in height. Horizontal joints and vertical slickensides (grooved and striated surfaces produced on rocks by movement along a fault) are found at many locations.

The Cotter Formation dolomite underlies the Powell Formation. It contains minor amounts of shale, chert and sandstone. The formation consist primarily of two types of dolomite; a fine-grained, argillaceous (clay containing), relsatively soft variety and a more massive medium-grained variety. The two varieties are generally interbedded with thinner layers of sandstone, shale and chert. The total thickness of this formation is estimated to be more than 500 feet.

The Roubidoux Formation underlies the Cotter Formation. The Roubidoux consists of dolomite, sandstone and minor amounts of chert. The dolomite is mostly lightly colored, and is finely granular to medium crystalline. Light colored sandstones are present throughout the Roubidoux Formation. The sandstones are composed of loosely to well cemented (siliceous or calcareous cement), fine to medium grained, angular to rounded, frosted quartz grains. Cherts in the formation are generally dense and light colored, and may be considered representative of the Roubidoux. In northern Arkansas, thickness of the formation ranges between 130 ft to 455 ft.

The Gasconade-Van Buren Formations (underlying the Roubidoux) are undifferentiated in northern Arkansas. The Gasconade-Van Buren Formations (excluding the Gunter member) are generally light colored, finely granular to medium crystalline, containing light colored dense cherts. The cherts in the lowere section occasionally are slightly sandy or contain minor amounts of dolomite. The thickness of this undifferentiated unit ranges between 320 to 600 ft.

At the base of the Gasconade-Van Buren unit, the Gunter member is found. Generally, the Gunter is described as a sandstone which may contains few thin sandy or silty dolomite beds. The sandstone is loosely cemented by siliceous or calcareous material. Thickness of the Gunter ranges upwards to 40 feet.

3.D Description of the Hydrological Setting and Flow System

The Site surficial clay deposits may be somewhat impervious due to compaction by heavy yard machinary. The vertical coefficient of permeability of a compacted clay sample was measured in the laboratory to be 4.5×10^{-6} cm/sec (September 29, 1982 correspondence from Tom Millard to MCE, Appendix E). Permeability of the in-situ material may vary from this value. A very wide range of permeabilities was observed across the Site during percolation tests run by Millard. These percolation tests ranges from 2 minutes per inch of infiltration to 8 hours for less than one inch of infiltration.

Below the surficial residuum, the Site hydrogeology is believed to be similar to the regional hydrogeology described below.

The Chattanooga Shale, where present, may or may not act as a low permeability layer (aquitard). If the Chattanooga Shale acts as an aquitard, ground

water may be present in three aquifer (water bearing) systems: (1) a shallow aquifer system above the Chattanooga Shale; (2) an upper deep aquifer system directly below the Chattanooga Shale; and (3) a lower deep aquifer system. If the Chattanooga Shale is not present or does not act as an aquitard, the ground water may be present in two aquifer systems. These systems could have highly heterogeneous vertical permeabilities.

Shallow Aquifer System

The shallow (unconfined) aquifer system consists primarily of deeply weathered cherty limestones of the Boone Formation. The limestone of the Boone Formation has undergone extensive solution on the Omaha area resulting in what is commonly referred to as "karst" topography and hydrology. Karst topography is characterized by vast numbers of depressions of all sizes, dolines, sinks and other solution features, an almost total lack of surface streams (sinking streams), and large springs in deeper valleys.

Typically, rainfall which is normally mildly acidic, percolates through the carbon dioxide-rich organic soil, further lowering the pH of the infiltrating rainfall. Entering the limestone strata, the moving water enlarges joints and fractures in the bedrock by dissolving the bedrock, producing solution channels along which ground-water flow can occur. The ease by which percolating surface water can move through the unsaturated zone increases the potential for ground-water contamination.

Local ground-water patterns (especially in the shallow aquifer system) are difficult to determine because of the nature of karst hydrology. In general, depending on the location of recharge and discharge zones, as well as the karst influences, the static water table in the shallow aquifer will follow (in a subdued manner) the topography. Deviations from this general pattern can be expected to be observed during seasonal variations in precipitation.

There is some contamination of the shallow aquifer as best evidenced by Cricket Spring. Minute pollution at other wells in the general pathway from the Site, to Cricket Spring and beyond, has occurred. Only Cricket Spring has contained pollutant levels representing health concerns.

Deep Aquifer System

The deep aquifer system surrounding the Site may be divided into an upper group and a lower group. The upper group would consist of the Powell and Cotter Formations. The lower group would consist of the Roubidoux Formation, the Gasconade-Van Buren Formations, and the Gunter member.

The upper-deep aquifer system consists mainly of limestones and dolomites of the Powell and Cotter Formations. This aquifer system commonly supports wells which yield 5 to 10 gpm (gallons per minute) from solution channels, bedding planes and fractures.

The lower-deep aquifer system consists mainly of sandstones and dolomites of the Roubidoux Formation, the Gasconade-Van Buren Formations, and the Gunter member. Sandstones are generally more productive water-bearing rocks than dolomites. The sandstones of the Roubidoux Formation can average up to 150 gpm and yields of as much as 450 gpm can be obtained from some wells. The Gunter member of the most productive waterbearing rock of this lower group. Wells that tap this sandstone commonly yield 150 to 300 gpm and may yield as much as 500 gpm. The Omaha city well appears to be pumping from the lower-deep aquifer system.

Ground-water hydraulic heads in the lower-deep aquifer system could be higher than those in the upper-deep and shallow aquifer systems (Arkansas Geological Commission). This head distribution may act to create an upward ground-water flow potential from the deep to the shallow systems. Therefore, even if the Chattanooga Shale is not present or does not act as an aquitard, this head distribution suggests that dissolved contaminants in the shallow aquifer sysyem would be unable to hydraulically migrate to the lower deep aquifer system. However, the lower aquifers could conceivably be contaminated by heavier-than-water contaminants coming from shallow aquifers through uncased wells. It is for this reason that CAI opposes additional wells being drilled on the Site.

Site Surface Hydrology

Surface drainage at the Site is primarily to the northwest by a tributary of Cricket Creek. Cricket Creek is several thousand feet west of the Site and flows in a generally northwesternly direction. Some of the drainage from the"Railroad Ditch Pit" Site could conceivably drain to the east along the railroad tracks into the Walnut Creek basin under heavy rain conditions. Walnut Creek lies approximately 3/4 of a mile to the south and east of U.S. Highway 65, and flows to the southeast. The karst topography present in the area is typified at the Site by an absence of perennial surface streams.

Concerns have been expressed by ADPC&E that residue from the Site may affect ground-water supplies and surface water quality via Cricket Spring Channel (which discharges into Cricket Creek). No data available to date demonstrate any impact on Cricket Creek below the confluence with Cricket Spring Channel. Additional, theoretically possible but unlikely. Impacts which may have occurred during actual Site operation include effects on soils, biota, and ambient air quality.

Several springs and domestic wells, as well as the community water supply well for Omaha, Arkansas are located within three miles of the site. In all, approximately 660 persons live within three miles of the site and depend primarily upon ground water from the deep aquifer systems as a source of drinking water.

An inventory of all the registered water supply wells within a three mile radius of the site is provided in the following table. This table tabulates construction details of some of the wells, including well depths. The data has been compiled from all available well completion forms submitted to the State by drilling contractors. No completion data were available for the Site well or the Omaha City Well.

Water Well Inventory and Construction Details of Wells Within Three Mile Radius of the Arkwood Plant, Omaha, Arkansas.

Well Owner	Use of Well	Date Well Completed	Depth Interval of Water Producing Formation (ft)	Type of Formation	Depth to Water (ft-bls)	Total Depth of Well (ft-bls)
Omaha City Well*	Municipal			Dolomite		2100
John Atchison	Domestic	09-08-80	780-785	Limestone	400	795
Frank Atchison	Domestic	09-08-78	525-530	Limestone	380	550
Robert Behrens	Domestic	07-17-82	274-274.5	Limestone	240	565
Robert Behrens	Domestic	01-26-80	280-300	Limestone	350	400
Robert Behrens - abandoned	Domestic	01-26-80	280-300	Limestone	350	496
Dean Curhow	Domestic	10-20-78	664-670	Limestone	410	775
Mildred Davidson	Domestic	10-20-78	660-665	Limestone	–	687
Bud Essary	Domestic	07-15-76	210-215	Limestone	160	300
Bud Essary	Domestic	07-20-81	640-650	Limestone	300	688
Clifford Ford	Domestic	10-02-75	384-385	Limestone	250	415
Clinton Hicks	Domestic	09-18-72	470-480	Limestone	360	650
John Huston	Domestic	12-10-79	441-445	Limestone	350	496
Farnam Jones	Domestic	03-15-79	520-530	Limestone	450	550
Norman Klasener	Domestic	10-30-77	450-470	Sandstone	375	505
James Lovell	Domestic	11-20-74	400-440	Limestone	300	480
Leonard Matlock	Domestic	08-20-76	645-690	Sandstone	430	705
McGinnis	Domestic	07-29-75	593-594	Limestone	400	6[illegible]
Charles McMahon, Jr.	Domestic	06-15-77	348-352	Limestone	—	[illegible]12
Don Moore	Domestic	07-28-75	519.5-520	Limestone	350	550
New Hope Baptist Church	Domestic	05-17-71	190-195	Sandstone	330	555
Nelson Rice	Domestic	09-74	—	—	—	783
Sid Richardson	Domestic	01-08-77	770-772	Limestone	375	775
John Robinson*	Domestic	07-15-73	600-610	Limestone	480	640
T.C. Sallee	Domestic	08-01-73	580-690	Limestone	430	710
Cam Tong	Domestic	05-17-71	725-730	Limestone	380	735
John Wood, Sr.	Domestic	02-23-73	145-253	Limestone	—	253
Nelson Rice	Domestic	09-74	—	—	—	783
Omaha School Well	Domestic	—	—	—	—	—
Cathy Duggan	Domestic	—	—	—	—	—
Biram	Domestic	—	—	—	—	—
Birmingham	Domestic	—	—	—	—	—
Birmingham - abandoned	Domestic	—	—	—	—	—
David Miles	Domestic	—	—	—	—	—
O.C. White	Domestic	—	—	—	—	—
O.C. White	Domestic	—	—	—	—	—
Tate	Domestic	—	—	—	—	—
Site*	Industrial	—	—	—	—	—
House w/ Satellite Dish	Domestic	—	—	—	—	—
Turney	Domestic	—	—	—	—	—

*The Omaha City water supply is located within one mile of the Site. The total depth of the well has also been reported as 1315' with a casing depth of 60'. The depth of the Site well is unknown, however, the pump (submergable) was set at 920'.

GMI and CAI share the belief that the 2100-foot Omaha municipal water well is not threatened by PCP and creosote released from the Site. Several hydrogeologic reasons supported this conclusion:

1. The hydraulic gradient at Arkwood had been determined to be northwestward (the Omaha well was located to the northeast);

2. The distance between the Site and the Omaha well was about one mile;

3. Several domestic water wells were located between the Site and the Omaha well that had not been found to be contaminated and , if designated as such, could act as an early warning system;

4. Several thick aquicludes existed between the shallow zone in which contamination had been observed and the aquifer that was tapped by the Omaha well; and

5. A properly cased 900-foot well that was located on the Site itself had been sampled repeatedly and was free of any contamination.

3.E Omaha City Well

There are several techniques available which permit the estimation of risk to the Omaha City well. First, we will identify several assumptions.

1. The distance from the well to the Site is one mile.

2. The production of the well is 70 GPM.

3. The well is 2,000 feet deep.

4. The furthest boundary of the recharge areas is one mile and is composed of 1% groundwater on the average.

5. The Site area is 0.03 square mile.

6. The recharge area is 3 square miles.

7. The maximum solubility of PCP is 14 ppm.

General Plume

If the probability of contamination is proportional to charge-recharge areas, there would be a 1% chance of pollution occurring. The dilution would be expected to be 100 fold resulting in 0.14 ppm as the maximum PCP concentration.

The estimated volume of water would be:

$1{,}000 \times 5{,}280 \times 5{,}280 \times 3 \times 0.01 \times 7 = 6 \times 10^9$ gallons.

The 190 gallons of PCP will produce $= 1.9 \times 10^8$ gallons of 1 ppm. The quantity of PCP available is 50 times less than that needed. Obviously a general plume poses no risk.

Direct Channel

A direct channel of 3 feet in width is modeled as exiting the Site. The probability of it intersecting the Omaha City well bore hole is about one in 10,000. If one requires an intersection at below 1,000 feet, the chances are one in 10 million.

If one assumes that the Omaha City well produces 70 GPM and the maximum amount of PCP lost in any year is 15 gallons, then at 1 ppm, the PCP supply would be exhausted in:

$$\frac{15}{70 \times 24 \times 60 \times 1 \text{ ppm}} = 150 \text{ days}$$

or the average PCP concentration could not exceed 0.4 ppm.

Absolutely the worst case would be that: (1) a direct channel connected the Site to the Omaha City well; (2) no pollutant PCP could be lost in transit; and (3) all the water migrating in the channel was pumped from the well. Even given the worst case, the maximum concentration of PCP that could be maintained would be 0.4 ppm.

A reasonable person would exclude this possibility as being too remote to merit consideration. Finally, 20 years after pollution of groundwater began, no PCP or creosote has ever been detected in the Omaha City well.

Let us now assume that Cricket Spring was directly mixed with the Omaha City well water. A dilution of at least 70 fold would occur. This would result in maximum PCP concentrations of 0.2 ppm. Again even this exaggeration falls short of producing a level of contamination with any significant health importance.

3.F Climatic Factors

The Site receives approximately 45 inches of precipitation per year. December, January and February are the driest months. The wettest months are from April to June. Precipitation is generally well distributed throughout the year as shown in Figure ( ). Precipitation if a tenth of an inch or more generally occurs on an average of one day out of five. One or more snowstorms occur every winter, but the snow cover generally does not remain for more than a few days. On an average, from 9 to 10 inches of snow falls each season.

The summers are long and warm, with minimum nighttime temperatures in the mid 60's (degrees Fahrenheit). The daytime temperatures reach 100 degrees in most summers, with average maximum temperatures in the high 80's and 90's. The winters are generally mild, with the temperatures falling to below zero about every other year. Daily maximum temperatures have never been as low as 0°. Minimum temperatures of 0° or below on any season do not prevail for more than a few days.

4. TOXICOLOGICAL PROPERTIES (HAZARD IDENTIFICATION)

4.A Creosote, Solutions of Creosote and PCP Toxicities

Creosote is a distillate fraction from coal tar, a by-product in the conversion of coal to coke, which is used in the manufacture of steel. However, the chemical distillate creosote is a coal-derived product with a specific boiling range of 300° to 700°F.

In commercial wood treatment plants, the distillate material can be used solely but, in most treating operations, creosote is blended with coal tar, tar bottoms, and/or heavy oils; these may be of coal or petroleum origin. Although all are referred to as creosote, there are significant compositional variations between plants. The coal utilized in the coking process can also affect both the composition of the coal tar and creosote derived. No specific details are available through the literature or industry sources.

There is a substantial body of compositional and general information available on creosote distillates and commercial blends used in wood treatment processes (Lorenz and Gjovik, 1972 as cited in EPA PD-2/3 on Wood Preservative Pesticides, 1981). It is known that they contain some of the aromatic amines and nitrogen compounds of occupational concern for latent health effects, such as skin, lung or bladder carcinomas. Sulfur compounds are also present, but little data is available on concentrations in creosote. These have been shown by some investigations to act as accelerators or promoters of the carcinogenic process in laboratory animal studies (Norton, 1961; Lijinsky, 1957).

Data on the composition and distribution of aromatic and polynuclear hydrocarbons indicates a significant percentage of the 3 to 5-ring fused compounds (Lorenz and Gjovik, 1972; Combes, 1954). While many have been specifically identified, there is a paucity of quantitative data on the two most potent carcinogens of these chemical groups; i.e., benz (a) pyrene and dibenzanthracene.

The variety of blended materials used for creosote treating would realistically preclude quantifying the range of these specific known carcinogenic compounds in the commercial mixtures. More importantly, this type of specific PNA analysis in the past has not provided a more reliable index of potential skin contact or inhalation hazard than total benzene extractable organics because individual compounds in the creosote mixtures, independently or in combination, can act as carcinogens directly, or as accelerators, promoters, and carcinogenic inhibitors.

Direct skin contact with creosote, if not properly removed, results in chemical burns (NIOSH, 1977a). The Pesticide Exposure Response System of EPA contains a number of reports of skin erythema and frequent burns in personnel handling creosote-treated wood products. Skin burns and allergic reactions from creosote contact have also been reported in a survey of the accident history of fifty pressure treating plants (Johnson, 1978a; McMillan, 1976).

The occupational limits in use as a guide for health risk control purposes are based on composition and uses, boiling range and plant experience. This conservative approach is based, in part, on historic human experience related to the

compounds and mixtures present in creosote, and on slack wax and other industries and occupations (Mauro, 1951; Shambaugh, 1935; Combes, 1954).

A number of occupational exposure surveys to creosote materials in wood treating operations have been conducted. Some were NIOSH Health Hazard Evaluations (Markel *et al.*, 1975, 1977). Others done in late 1978 and 1979 by the wood treating industry were in response to the EPA-RPAR on the wood preservative pesticides. Generally, the data indicate that most personal exposures do not routinely exceed the current coal tar pitch volatile (CTPV) occupational standard of 0.2 mg/m3. There were a few high values reported which the investigators felt were due to sample contamination. All the creosote exposure data generated in both the Health Hazard Evaluations and industry studies utilized the NIOSH cyclohexane extraction gravimetric procedure. That data indicates the personnel most exposed are those working adjacent to the pressure cylinders during the opening, wood removal, and refilling tasks. Other more remote personnel assisting in loading and unloading, sorting timber, etc., appeared to have less exposure, and these were consistently well below the limits for benzene soluble airborne particulates.

Creosote is commonly handled and controlled occupationally as though similar to coal tar in health effects as a contact irritant, photosensitizer, and potential carcinogen with routine, prolonged contact or inhalation. There is neither positive nor negative human experience data in the wood treating industry to indicate that additional or less restrictive exposure control is appropriate.

4.B PCP Metabolism

Weinbach ushered in the era of molecular toxicology of pentachlorophenol in 1954 when he studied the effects of pentachlorophenol on oxidative phosphorylation. This work was followed by papers in 1956 on the effects of pentachlorophenol on mitochondrial adenosinetriphosphatase and the biochemical bases of toxicity of pentachlorophenol in the Proceedings of the National Academy of Sciences in 1957. In 1958, Parker reported on the enzymatic activity of rat liver mitochondria and Farquharson, Gage and Northover published on the biological reactions of pentachlorophenol.

Weinbach and Garbus published a series of papers in 1964, 1965 and 1968 on the ability of pentachlorophenol to uncouple mitochondrial phosphorylation.

The effects of PCP on the oxidative phosphorylation in the mitochondria were studied by several authors and is important in understanding effects observed in the human kidney. At higher concentrations of 1-50 mM PCP ATPase activity is inhibited; and depending on the substrate, the uptake of inorganic phosphate and oxygen is suppressed either partially or completely. Buffa *et al.* found that the behavior of the ATPase activity in the course of intoxication and the effect of PCP upon this activity when added *in vitro* to injured mitochondria, were indicative of the presence of the inhibitor in the particles isolated from the PCP-injected animal. They concluded that PCP acts on mitochondria *in vivo* as well as *in vitro*.

After administration of a low oral dose of pentachlorophenol (0.1 mg/kg bw) to volunteers, the kinetics fitted an open one-compartment model, with extensive enterohepatic circulation. In the urine, 86% of the dose was excreted in seven days; the half-times for elimination of pentachlorophenol and pentachlorophenyl glucuronide were 33 and 13 h, respectively (Braun *et al.*, 1979). After repeated occupational exposures, slower urinary elimination of pentachlorophenol has been reported (Begley *et al.*, 1977). In an abstract, the half-lives for the urinary excretion of 2,4,6-tri-, 2,3,4,5-tetra- and pentachlorophenol were reported to average 18 h, 5.1 days and 16 days, respectively (Pekari *et al.*, 1985). Kalman and Horstman (1983) reported that the minimum estimated half-time for urinary elimination of 2,3,4,6-tetrachlorophenol in two occupationally exposed workers was approximately two days.

Of total urinary pentachlorophenol, 40% or more has been found to be in the form of conjugates (Edgerton & Moseman, 1979; Needham *et al.*, 1981). Human liver microsomes metabolize pentachlorophenol to the glucuronide conjugate (Lilienblum, 1985). In an abstract, it was reported that 2,3,4,6-tetrachlorophenol and 2,4,6-trichlorophenol occur in the urine almost exclusively as conjugates (Pekari *et al.*, 1985).

With the exception of conjugates, the only other metabolite of pentachlorophenol detected in humans is tetrachlorohydroquinone (Ahlborg *et al.*, 1974). Human liver microsomes metabolize pentachlorophenol to this compound (Juhl *et al.*, 1985).

2,4-Dichlorophenol, 2,4,6-trichlorophenol (Judis, 1982) and pentachlorophenol (Hoben *et al.*, 1976) have been shown to bind reversibly to human serum albumin. The binding affinity appears to be related to lipophilicity (Judis, 1982).

4.C PCP Acute Toxicity

In 1906, Bechold and Ehrlick first called attention to the toxicity of pentachlorophenol. Their work was followed by toxicological studies on pentachlorophenol by Bayle in 1924. Kehoe, Deichman and Kitzmiller conducted a comprehensive study in 1939. Boyd, McGavock, Terranova and Piccione published papers in 1940 and 1941 on the acute and chronic intoxications with pentachlorophenol in rabbits. In 1941, Adams and co-workers studied the response of rabbit skin to pentachlorophenol as a number of compounds reported to cause Acneform dermatitis.

By the beginning of World War II, research was plentiful and publications had appeared in several countries, covering several different routes of exposure, durations of exposure and levels of exposure with at least five species of experimental animals. In 1948, Monsanto Chemical Co. published the Toxicology and Dermatology of Pentachlorophenol and Sodium Pentachlorophenate.

Acute toxicity studies have been performed in several species. The acute symptoms of intoxication are vomiting, hyperpyrexia, elevated blood pressure, increased respiration rate and amplitude, tachycardia and hyperglycemia. Later, frequent defecation, weakened eye reflex and developing motor weakness are seen.

Animal data and human studies of exposures after 1977 are of little value in predicting the effects of exposures to PCP manufactured in the 50's and 60's since the commercial product had been improved upon the removal of toxic contaminants. Several papers appeared in the 1970's demonstrating that much of the toxicity expressed by technical PCP was not present in purified PCP.

The toxicological effects of occupational exposure to chlorophenols have been reviewed (IARC, 1979A; Ahlborg and Thunberg, 1980; Sterling *et al.*, 1982). The acute toxicity of chlorophenols, especially pentachlorophenol, is manifested by hyperthermia, convulsions and rapid death. Most data on the toxicity of chlorophenols come from studies in occupational environments, and the effects described include skin irritation, rashes and sometimes chloracne, indications of liver damage and neurological effects (Fielder *et al.*, 1982).

In 1942, Deichmann, Machle, Kitzmiller and Thomas studied the acute effects; local and systemic effects resulting from repeated cutaneous applications; cumulative effects of small oral doses; distribution of pentachlorophenol in tissues; detoxification of pentachlorophenol by conjugation; and removal of pentachlorophenol accidentally spilled on the skin. These authors conducted detailed histopathological examinations. Dogs, cats, rabbits, rats and guinea pigs were studied. In 1943, Mackle, Deichmann and Thomas reported on the fate of pentachlorophenol in experimental animals.

4.D PCP Carcinogenicity

In 1959, a paper of special note appeared in Cancer Research. This report was authored by Boutwell and Bosch. The topic was tumor-promoting action of phenolic compounds including pentachlorophenol. This paper documents the concerns about cancer being known to researchers as early as 1957 when the project was conceived.

The symptoms observed in man from excessive acute or chronic occupational exposures and accidental poisoning have basically been duplicated in animals (Deichman, 1942; Knudson, 1974; Goldstein, 1977). The commercial product has been shown to be highly toxic by ingestion, inhalation, skin contact, and absorption for several species. There are no animal data indicating that technical grade PCP is carcinogenic. Studies have been done at dietary levels of up to 30 mg/kg per day for rodents with no significant increase in the incidence of tumors for the full lifetime of the animals (Schwetz, 1973; Johnson, 1978c). Similar results were obtained with mice.

Dermal applications did not promote tumorigenic activity when used in conjunction with a known carcinogen in a single application (Boutwell and Bosch, 1959).

Pentachlorophenol was included in the NCI Bio-assay Program. No data indicating that PCP or the predominant secondary reactions products have significant biological activity (NCI, 1978) has been received.

4.E PCP Mutagenicity

The genetic effects of chlorophenols have been reviewed (Wassom *et al.*, 1977/1978; Exon, 1984).

Peripheral blood lymphocytes were taken each month from January to May from six workers exposed to pentachlorophenol in a wood treatment plant in Idaho, USA and from four control subjects. During this time, exposure varied considerably. Levels of pentachlorophenol residues in the serum and urine were one to two orders of magnitude higher in the exposed individuals than in the single control measured (serum: 348-3963 *versus* 38-68 µg/l; urine: 41-760 *versus* 3-4 µg/l). Lymphocytes were cultured for 48 hours and only 25 cells were examined from each person. The incidence of chromosomal aberrations (breaks and gaps) was not statistically different in the two groups (Wyllie *et al.*, 1975). [The Working Group noted the small number of workers and the small sample size of cells].

Bauchinger *et al.* (1982) examined lymphocyte chromosomes from 22 male workers employed at two plants of a pentachlorophenol-producing factory in the Federal Republic of Germany. The mean concentrations of pentachlorophenol in the blood and urine of workers at one plant (producing pentachlorophenol) was 4.73 and 2.38 µg/ml, and in the second plant (producing the sodium salt), 2.23 and 0.84 µg/ml, respectively. A small, but significant increase in the frequency of dicentrics (0.0016 *versus* 0.0005 per cell) and acentrics (0.0057 *versus* 0.0022 per cell) was observed in exposed workers as compared with a group of 22 matched controls (300 cells were examined from each worker and 500 from each control). No difference was found for other categories of damage (gaps, chromatid breaks and chromatid exchanges). No significant increase in the incidence of sister chromatid exchanges (SCEs) was found in pentachlorophenol-exposed workers who smoked as compared with smoking controls (9.41 *versus* 8.89 per cell). Within the control group, smokers had a higher incidence of SCEs than nonsmokers (8.89 *versus* 7.60). [The Working Group noted that the unusual pattern of chromosomal damage in the exposed groups, similar to that after exposure to radiation.]

Chromosome studies were made on a group of workers in England ten years after accidental exposure to crude 2,4,5-trichlorophenol in which TCDD was a trace contaminant (Blank *et al.*, 1983). Group A was the control, group B had 'possibly been exposed', and Group C was 'known to be exposed' (with chloracne). Fifty cells were examined from each subject. Chromosomal aberrations (in preparations from 48-h cultures) were scored in 124 individuals (31 in group A, 55 in group B, and 38 in group C). No significant difference was found between the groups either as regards chromosomal damage or SCEs. The mean number of chromosomal aberrations per cell was 0.0755 in group A, 0.0807 in group B and 0.0858 in Group C. The mean number of SCEs per cell was 8.0 in group A, 8.5 in Group B and 8.1 in Group C. [The Working Group noted that the number of aberrant cells was not given nor was the type of aberration described.]

4.F PCP Teratogenicity/Reproductive Effects

In contrast, it has been demonstrated to be fetotoxic, causing significant anomalies (Schwetz, 1974b; Hinkle, 1973). This data is from studies of pregnant rats fed the material at different levels during the critical stages of gestation. Some of the

minor side reaction products in PCP are known to be embryotoxic and possibly teratogenic when administered orally to rodents (Schwetz *et al.*, 1973).

4.G PCP Other Health Effects; Including Neurotoxicity, Immuno-Depressant Activity, Allergic Reactions, Etc.

Severe dermatitis and neurological disturbances have been noted in humans from chronic skin or inhalation exposure. Typically, the first symptoms are bronchitis and/or chloracne. Generally, when chronic symptoms occur, the recovery time is lengthy and can require up to a year (Baader and Bauer, 1951). Other medical problems which have been reported in man are reduction in libido and central nervous system effects. The latter are somewhat less certain since, in most instances, the exposures were not exclusively to PCP (Campbell, 1952).

Zober *et al.* (1981) have reported immunological changes in woodworkers exposed to pentachlorophenol, and McGovern (1982) observed marked T-cell suppression in several persons exposed to chlorophenols. Aplastic anaemia has been associated with exposure to pentachlorophenol (Roberts, 1981). Baader and Bauer (1951) mentioned haematological changes in workers in a plant manufacturing pentachlorophenol.

Chloracne - similar to acne vulgaris in appearance - is seen in some heavily exposed workers (see Kimming and Schulz, 1957; Arsenault, 1976; Suskind, 1985). It is one of the most prominent features of exposure to TCDD, which occurs as an impurity in commerical chlorophenol preparations.

4.H PCP Epidemiological Evidence (Chemical-Specific or Site-Specific)

There were many reports in the toxicological and industrial health and hygiene literature during the 1950's concerning pentachlorophenol toxicity. Three papers appeared in 1951. Baader and Bauer published on the intoxications of German workers where chloracne (Acneform dermatitis) was observed. (It is noteworthy that in 1957, Kimming and Schulz reported that technical pentachlorophenol produced in a factory in Germany produced hyperkeratosis in the ear of rabbits whereas pure pentachlorophenol did not, suggesting the presence of dibenzo-p-dioxins.) Stohman published on the general toxicity of pentachlorophenol and Herdt, Loomis and Nolan reported on the effects of oral administration to experimental animals.

These reports were quickly followed by two additional reports in 1952. Truhaut, L'Epee and Boussemart studied occupational intoxications in France and Campbell reported on neurological deficits in persons occupationally exposed to pentachlorophenol in Britain.

In 1953, the World Health Organization Monograph Series included a paper by Barnes on the toxic hazards of pentachlorophenol.

Three additional papers were published between 1956 and 1959 on the toxicity of pentachlorophenol to humans. In 1956, Bordon asked "How dangerous is pentachlorophenol?". In 1958, Menon published in the British Medical Journal on the

tropical hazards of pentachlorophenol. In 1959, Shirakawa, Nagatoshi and Hirakawa conducted studies on workers exposed to pentachlorophenol in the Asian rubber manufacturing industry. In 1959, Pleskova and Benege also published on the toxic properties of pentachlorophenol and Harrison reported on toxic effects on stock in New Zealand.

In 1961, Blair published in the Bulletin of the World Health Organization on the dangers of the use and handling of pentachlorophenol.

In 1963, Buffa, Carafoli and Muscatello described mitochondrial biochemical lesions and pyrogenic effects due to pentachlorophenol; Roberts first reported aplastic anemia due to pentachlorophenol; and Viniegra, Maguez and Saraboso reported human intoxications in Mexico.

Two reports of human poisoning appeared in 1965. Bergner, Constantindis and Martin published about an industrial pentachlorophenol poisoning in Winnipeg, Canada in 1965 and Chapman and Robson reported on pentachlorophenol poisoning from bath water.

In 1967, Bevenue and Beckman discussed the properties and residues of pentachlorophenol in human and animal tissue.

In 1969, Robson, Kissane, Elvick and Pundevela expanded on Robson's report of 1965 and described pentachlorophenol poisoning of newborn infants after exposure in a nursery.

In 1969, Casarett, Bevenue, Hauger and Whalen reported levels of pentachlorophenol in human blood and urine.

The Dow Chemical Company's product literature of 1969 warned that frequent skin contact with pentachlorophenol may result in Acneform dermatitis.

The acute toxicity effects reported from plant experience with PCP exposure are basically attributable to the pentachlorophenol and the tri- and tetrachloro isomer secondary reaction products rather than the dioxins or dibenzofurans (Menon, 1958; Robson *et al.*, 1969). The material used in the treatment plant has been shown to be toxic by both inhalation and dermal absorption in addition to its skin irritating and photosensitizing properties.

A number of acute occupational and non-occupational cases of poisoning have occurred, several of which have been fatal (Gordon, 1956; Menon, 1958). The acute cases documented have occurred in applications where there was significant contact and/or close proximity to obvious airborne sources such as when spraying solutions of pentachlorophenol for wood preservative surface treatment and in dipping operations. Most incidents predate the mid 1960's. A later documented acute epidemic also occurred when the material was inadvertently used as a disinfectant (Armstrong, 1969). In that instance, the symptoms which occurred were from skin absorption and resulted in the death of two infants. Other short term effects published include eye and upper respiratory irritation from the emissions of hot treating solutions.

A New Zealand study of soft-tissue sarcoma (referred to in the IARC Monograph on Occupational Exposures to Chlorophenoxy Herbicides, p. 391) found an odds ratio of 1.6 (90% CI, 0.5-5.2) for potential exposure to chlorophenols for five days or more, more than ten years prior to diagnosis (Smith *et al.*, 1984). Work in pelt-treatment departments (where 2,4,6-trichlorophenol has been used) or in tanneries (where pentachlorophenol and 2,4,6-trichlorophenol are used) yielded an odds ratio of 7.2 (six exposed cases; p = 0.04). When meat works and tanneries were contacted, it was found that two of the cases could not have been exposed to chlorophenols and exposure of a third was unlikely, while two could have been exposed to 2,4,6-trichlorophenol and one to pentachlorophenol.

Hardell *et al.* studied 44 cases of nasal cancer and 27 cases of nasopharyngeal cancer in northern Sweden and compared the reported frequency of exposure to chlorophenol (and other chemicals) with that of the combined 541 referents from earlier studies (Hardell and Sandström, 1979; Eriksson *et al.*, 1981) from the Umea region. Exposure was assessed in the same way as in the previous studies (see above). A relative risk estimate of 6.7 (95% CI, 2.8-16.2) was found for exposure to chlorophenols of more than one week, continuously or intermittently for more than one month. The most frequent occupations in which exposure occurred were sawmilling and carpentry. After controlling for exposure to wood dust, an odds ratio of 6.7 (95% CI, 2.9-15.6) was obtained.

A study of 167 sinonasal cancer cases and 167 colorectal cancer controls carried out in Denmark, Finland and Sweden found an association with woodwork (Hernberg *et al.*, 1983). Two cases and no referent had probably been exposed to chlorophenols in addition to wood dust. A study of 839 cases of sinonasal cancer and 2465 controls from the Danish Cancer Registry classified these according to wood dust and chlorophenol exposure. A relative risk of 0.6 (95% CI, 0.3-1.2) was seen after adjustment for exposure to wood dust (Olsen and Møller-Jensen, 1984). [The Working Group noted that classification of chlorophenol exposure was based on occupational title and might not have been accurate.]

Several cases of acute pentachlorophenol intoxication have resulted from dermal exposure (Truhaut *et al.*, 1952; Menon, 1958; Robson *et al.*, 1969). Among sawmill workers, the highest urinary concentrations of chlorophenols were found after dermal exposure (Kauppinen and Lindroos, 1985). Urine and serum concentrations of penta- and tetrachlorophenols were higher in workers exposed both dermally and by inhalation than in those exposed by inhalation only. However, in the absence of dermal exposure, workers exposed by inhalation were found to have higher serum chlorophenol levels than nonexposed workers, indicating that pulmonary absorption may also be important (Embree *et al.*, 1984). Absorption of pentachlorophenol from the gastrointestinal tract is rapid (Braun *et al.*, 1979).

In necropsy material from the general population, highest concentrations of pentachlorophenol were detected in the liver, brain and kidney (medians: 67, 47 and 43 ng/g, respectively) (Grimm *et al.*, 1981). The concentrations generally reported in fat are lower (range of median values, 10-23 ng/g) (Shafik, 1973; Ohe, 1979; Morgade *et al.*, 1980; Frimm *et al.*, 1981).

4.I. Aquatic/Non-Human Terrestrial Species Toxicity/Environmental Quality Impairment

Pentachlorophenol

Pentachlorophenol (PCP) and its salt, sodium pentachlorophenate (NaPCP) are two of the most widely used pesticides in the United States (Cirelli, 1978) because of their effectiveness against a wide spectrum of target organisms, PCP and NaPCP have been used extensively as fungicides, herbicides, insecticides, bacteriocides, and molluscicides in forest, agriculture, textile, and paint industries. As a result of its wide application, PCP has been detected in human and animal tissues (Bevenue and Beckman, 1967), in fishes (Landner, *et al.*, 1977), and other non-target organisms as well as in aquatic environments (Matsumoto, *et al.*, 1977) indicating PCP's wide distribution in the total environment.

A number of studies have been performed to determine the toxic effects of NaPCP on fresh water fishes.Hanumante and Kulkami (1979) studied the acute toxicity of PCP to an important fresh water food fish, *Channa gachua*. They reported the 96 hr LC_{50} to be 0.39 ppm. In comparison with other fresh water fishes, the toxicity value of NaPCP for a 96 hr exposure of Channa is critically higher. Reported 96 hr LC_{50} for blue gills was 0.02 ppm; for goldfish, 0.05 ppm (Inglis and Davis, 1972); and for sockeye salmon, 0.064 ppm (Webb and Brett, 1973).

A review of fish life-cycle toxicity tests suggests that embryo-larval and early juvenile stages are among the most sensitive for most toxicants (McKim, 1977). Johansen *et al.* (1985) reported on the toxicity of PCP to various life-cycle stages of a warm water species, the large-mouth bass (*Micropterus salmoides*). Also, using long term exposures to low concentrations of PCP these authors determined the highest PCP concentration which caused no significant increase in mortality. The LC_{50} data for fry at 14 and 28 days was 0.285 ppm. The LD50 for 49 and 84 day old fry was 0.159 ppm. They concluded that between 28 and 49 days of age, large-mouth bass fry became less tolerant to PCP poisoning. For both 1 and 2 year old bass, the LC_{50} was 0.194 ppm, not dissimilar from that of bass at 49 and 854 days of age.

Chronic exposure of bass to PCP was studied using a 120 day exposure period. The 120 day LC_{50} was calculated to be 0.054 ppm. This LC_{50} was roughly a third of the 96 hr LC_{50} for fry 49-84 days of age. The 120 day mortality data of the group treated with 0.083 ppm was significantly higher than that of the controls, whereas the other treatment groups, including thoses exposed to 0.041 ppm, showed no significant difference from the untreated group. Thus, the maximum acceptable toxicant concentration fell between the values of 0.041 and 0.83 ppm.

Owen and Rosso (1981) monitored the histological changes in the livers of blue gill sunfish exposed to a sublethal dose of PCP (0.1 ppm). They found that after 1 day of exposure, the liver still retained the normal sheet-type arrangement of hepatocytes, most of which contained notable glycogen reserves. The most obvious changes were increased numbers of nuclei with prominant nucleoli, an apparent increase in iron-positive macrophages in the vicinity of the veins, and a tendency of some peripheral

hepatocytes to become eosinophilic and for all cell boundaries to become less distinct. In specimens exposed for 2 days, peripheral eosinophilia was more accentuated and peripheral nuclei were basophilic, whereas centrally located cells had hypochromatic nuclei with distinct nucleoli. Glycogen was absent from practically all cells and cell boundaries were almost indistinguishable. Groups of cells, apparently multikaryotic, disrupted the cord-like oraganization of the hepatocytes.

After 4 days, the exposed livers resembled a more normal liver than did livers of fish exposed for 2 days. There was less clumping of cells, fewer pa[illegible] nuclei, and an apparent tendency for hepatocytes to reorganize into a sheet-type system. Iron-positive macrophages were still obvious; peripheral and central cells had similar staining affinities for H&E. At the end of 8 days of exposure, the overall liver organization was somewhat similar to that of the 4 day exposure interval; however, cytoplasmic dissociation and cellular hypertrophy were common, indicating that portions of the liver were undergoing piecemeal necrosis. By the end of the 16th day of exposure, a normal cord-like arrangement of hepatocytes occurred in various parts of the liver; other areas still exhibited foci of dying and regenerating cells. Aggregates of iron-positive macrophages were associated with most of the veins in any given tissue section. After 32 days of exposure, the entire livers were pale yellow when dissected, indicating a "fatty" condition. Lipid globules, apparently larger than those of specimens exposed for 16 days, occupied much of the cell volume. Lipid accumulation, however, had not proceeded to the point of displacing the nuclei from the cell center in most hepatocytes. Although there were liver areas with well organized hepatic cords, the overall organization of most liver hepatocytes had not improved over that of the 16 day exposure specimens.

Tagatz *et al.* (1981) studied the effects of PCP on already established aquatic communities, both in the laboroatory and in the field. Each of these communities was exposed to PCP concentrations of approximately 0.001, 0.013 and 0.14 ppm for 7 days. Community structures were significantly altered by 0.14 ppm PCP in both the laboratory and field systems. Mollusks, arthropods and annelids populations were significantly decreased in the systems exposed to the highest concentration of PCP.

Thomson and Strachan (1981) determined the rate of NaPCP biodegradation: (1) under aerobic/anaerobic condition, (2) with/without co-metabolites and, (3) with different nitrogen sources, in laboratory environmentally-controlled fermentors employing an acclimatized bacterial culture from activated sludge. Oxygenation in terms of aerobic or anaerobic condition in the growth medium was found to have a profound effect on the rate of PCP degradation. After 3 days, the concentration of PCP in an aerobic fermentor had decreased to a negligible amount, while 100% of the added PCP remained unchanged in the anaerobic fermentor. Further incubation of the latter for 28 days resulted in only 5% degradation, indicating the inherent persistence of PCP under anaerobic environments. The half-lives of PCP concentrations in aerobic and anaerobic metabolic fermentors were calculated to be 0.36 and 192 days, respectively.

During the process of PCP degradation, 4-chlorophenate (MCP), the co-metabolite was found to biodegrade under both aerobic (t_{50}=0.29 days) and anaerobic conditions (t_{50}=5.8 days). This observation indicated that even the low chlorinated

phenols were susceptible to conditions of oxygenation in the natural environment. To further investigate the impact of co-metabolism on PCP biodegradability, glucose (500 ppm) was added to to the aerobic fermentors as a co-metabolite. Both glucose and MCP were found to suupress the rate of PCP degradation. Glucose at 100 ppm had been reported to retard PCP biodegradation (Watanabe, 1973).

Thomson and Strachan also studied the effect of a nitrogen source in the growt medium on PCP degradation. Yeast extract was shown to have a distinct stimulating effect on PCP degradation; however, peptone tended to inhibit PCP degradation. Ammonium sulfate, ammonium nitrate and urea did not appear th exhibit any significant stimulatory or inhibitory effect on the rate of PCP degradation.

During recent years, an increasing number of cases of suspected PCP poisoning of farm animals has been reported. Diagnosis of PCP poisoning had been largely based on the statements of farmers that the animals had been exposed to PCP. Frequently, the exposure resulted from contact with buildings that had recently been treated with wood preservative. The affected animals were reported to look sickly, have skin lesions and poor weight gain (Thomas *et al.*, 1977). Necropsy of these animals showed no signs that could be specifically attributed to the effects of PCP. Greichus *et al.* (1979) performed clinical studies on young pigs in an attempt to find clinical signs which could be correlated to overt signs of PCP poisoning. In this study, 6 week old pigs were administered doses of 5, 10 and 15 mg/kg/day of purified PCP for 30 days. The animals were weighed and bled before the start of tresatment and then weighed weekly and bled at the middle and end of the study. At necropsy, livers kidneys brains and muscles were removed for light microscopy examination.

The results indicated no significant differences between the PCP-treated groups and the controls in total weight gains, kg of feed consumed per kg weight gain or weight if kidneys in g/kg body weight. The 10 and 15 Mg/kg treated groups had significantly larger livers on a g/kg weight basis than the controls. This result correlated with the reports of Kimbrough and Linder (1975) who observed enlargement of livers in rats fed 1,000 ppm of pure PCP for 3 months, with enlarged hepatocytes and inclusions in the cytoplasm of many cells.

Levels of PCP in the blood, muscles, kidneys and livers did not appear to increase with increasing doses. PCP levels increase only slightly in the plasma between the 15 day and the final 30 day bleeding.

Blood chemistry values for the 15 day and 30 day bleedings showed on significant differences between the controls and treatment groups or between PCP-treated groups for packed cell volume, hemoglobin, serum protein, serum glutamic oxalacetic transaminanse, and lactic dehydrogenase. The white blood cell counts were lower in the 15 mg/kg group than the controls at the 15 day bleeding and lower for the 10 and 15 mg/kg groups than controls at the final bleeding.

At the 15 day bleeding, the blood urea nitrogen values of the 10 and 15 mg/kg groups were significantly higher than the controls. The 15 mg/kg group continued to show this trend at the final bleeding.

The only histopathological finding observed in the PCP treated pigs was a nonspecific diffuse cloudy swelling of hepatocytes, characterized by enlarged cells whic has a finely vacuolated cytoplasm. Sinusoids in some cases were decreased in size, presumably due to encroachment by enlarged hepatocytes.

Creosote

Malins *et al.* (1985) studied the rate of occurrence of hepatic neoplasms and other hepatic lesions in English sole (Parophrys vetulus) exposed to creosote-contaminated bottom sediment. High prevalances of idiopathic hepatic lesions, including neoplasms (e.g. hepatocellular carcinomas, cholangiocellular carcinomas) (27%, 20 of 75 fish) and foci of cellular alteration (putative 'preneoplastic' lesions) (44%, 33 of 75), were found in English sole exposed to creosote-contaminated sediments in Eagle Harbor, Puget Sound, WA. Sediments from the contaminated region of the harbor contained particularly high concentrations of aromatic hydrocarbons (e.g., benzo [a] pyrene and benz [a] anthracene), and a variety of nitrogen-containing aromatic compounds (e.g., carbazole and acridine). The composition of the aromatic compounds was characteristic of creosote. Dramatically lower concentrations of aromatic compounds were found in sediments from a reference site in which the bottom-dwelling fish examined were free of detectable neoplastic or 'preneoplastic' hepatic lesions. Food organisms in the stomachs of the English sole from Eagle Harbor contained substantially higher concentrations of aromatic hydrocarbons than comparable organisms from the reference site. The concentrations of individual aromatic hydrocarbons in muscle and liver from the Eagle aHarbor fishh were low; however, high concentrations of metabolites of aromatic hydrocarbons were present in the bile. These findings strongly suggest an association between exposure to creosote and the prevalence of hepatic lesions.

5. EXPOSURE ASSESSMENT

5.A Exposure Route

The only route of human exposure from the Site is via consumption of groundwater. There is no danger of fire or explosion. Air pollution due to the emissions from the Site do not exist. Some minimal air pollution may occur on Site during remedial action.

5.B Occupational Exposure

Table 5a summarizes measurements made in the urine of exposed workers in various industries and occupations. Generally, no indication is given of when the samples were taken, but levels would be expected to be highest towards the end of a working week. Pentachlorophenol levels seen in urine after unspecified nonoccupational exposures are reported to vary considerably (< 0.01 - 1.8 mg/l), but, in general, are < 0.05 mg/l (Detrick, 1977). It should be noted that both analytical methods and timing of sample collection may differ in the listed studies; for example, the hydrolysis phase of the analytical procedure is decisive for comparability of results (Edgerton and Moseman, 1979).

Production Plants

In pentachlorophenol manufacture, mean urinary concentrations ranging from 0.11 to 2.38 mg/l have been reported (Table 5a). The average blood pentachlorophenol level of workers in a pentachlorophenol plant was 4.73 µg/ml, as compared to 2.23 µg/ml in a sodium chlorophenate plant; short-term levels of airborne pentachlorophenol exceeded 500 µg/m3 during some work-phases (Bauchinger *et al.*, 1982). In another pentachlorophenol plant, the highest airborne concentration was 50 µg/m3 (Zober *et al.*, 1981). In a plant manufacturing pentachlorophenol and its sodium salt, average airborne concentrations in the range of 0.5 to 16.5 mg/m3 were found, with short-term exposures up to 100 mg/m3 (Baxter, 1984).

Rappe and Nygren (1984) measured PCDD and PCDF levels in blood plasma of a group of workers manufacturing a chlorophenol formulation. Neither PCDDs nor octa-CDFs were found; levels of hepta-CDFs are shown in Table 5b. The highest levels were found for those workers with the longest exposure.

Wood Preservation and Other Industrial Uses

Urinary levels of pentachlorophenol in wood treatment workers have been studied in the USA, Canada, Sweden and Finland. In pressure and non-pressure treatment plants, the mean pentachlorophenol levels in urine ranged from 0.08 to 1.6 mg/l and from 0.02 to 2.8 mg/l, respectively. In sawmills, the corresponding concentrations varied from 0.20 to 3.2 mg/l among exposed workers. Values exceeding 1 mg/l have been reported during dipping and spraying and during loading of newly treated timber (Kauppinen and Lindroos, 1985). Embree *et al.* (1984) demonstrated a gradient of exposure from 0.230 mg/l in urine and 0.919 µg/l in serum in those directly handling wood, to 0.139 mg/l in urine and 0.354 µg/l in serum for those working in a sawmill but not in manual contact.

Table 5a. Concentrations of PCP in the Urine of Exposed Workers by Industry and Activity.

Industry and Activity (Country)	Substances Measured[a]	Concentration in Urine (mg/l) Mean (Range)	No. of samples (of Workers)	Reference
Production of pentachlorophenol (PCP) or its sodium salt (PCP-Na)				
PCP production plant (FRG)	PCP	0.11b(0.01-1.22)[c]	(18)	Triebig *et al.* (1981)
PCP and PCP-Na production plant (Brazil)	PCP	1.20 (0.35-3.40)[c]	9	Siqueira & Fernicola (1981)
PCP production plant (FRG)	PCP	2.38 (NS)[c]	(8)	Bauchinger *et al.* (1982)
PCP-Na production plant (FRG)	PCP	0.84 (NS)[c]	(14)	Bauchinger *et al.* (1982)
Pressure treatment of wood				
Pressure treatment plant (Hawaii, USA)	PCP	1.6 (NS)[c]	99(11)	Casarett *et al.* (1969)
Pressure treatment plant (USA)	PCP	0.14 (0.04-0.76)[c]	30(5)	Wylie *et al.* (1975)
Pressure treatment plant (USA)	PCP	1.24 (0.17-5.57)[c]	NS	Arsenault (1976)
Pressure treatment plant (Hawaii, USA)	PCP	0.27 (<0.01-2.40)[c]	(23)	Klemmer *et al.* (1980)
	PCP	0.08c (NS)		
Pressure treatment plant (Canada)		0.11c (NS)	8	Embree *et al.* (1984)
sawmill	PCP	0.08c (NS)	8	Embree *et al.* (1984)
Pressure treatment plant (Canada)	PCP	0.95 (< 0.01-5.2)[c]	11	Markel *et al.* (1977)
Non-pressure treatment of wood				
Wood treatment plant (Hawaii, USA) vat dipping	PCP	2.6 (NS)[c]	136(11)	Casarett *et al.* (1969)
Wood industry (USA)	PCP			Cranmer & Freal (1970)
carpentry		0.02[c] (NS)	(1)	
boat building		0.06 (NS)	(1)	
spraying		NS (0.13-0.27)[c]	(2)	
Spraying of timber (USA)	PCP	0.98 (0.13-2.58)[c]	NS	Arsenault (1976)
Dipping of timber (USA)	PCP	2.83 (0.12-9.68)[c]	NS	Arsenault (1976)
Wood treatment plant (Hawaii, USA) vat dipping, spraying, brushing	PCP	1.31 (0.09-3.3)[c]	(18)	Begley *et al.* (1977)
Wood treatment plant (Hawaii, USA) vat dipping	PCP	0.95 (<0.01-7.80)[c]	(18)	Klemmer *et al.* (1980)
manufacture (Finland)	PCP	≈0.3 (<0.3-1)	1376	Pekari & Alto (1982)
Sawmills (Sweden) CPs				Rappe *et al.* (1982)
loading of newly treated timber		3.2 (0.12-10.3)[c]	12	
handling of imported timber treated with chlorophenols		0.20 (0.03-0.50)[c]	22	
Other industries				
Pest control (Hawaii, USA)	PCP	1.6 (0.003-35.7)[c]	210(130)	Bevenue *et al.* (1967)
Pest control and farming (Hawaii, USA)	PCP	0.01 (<0.01-0.40)[c]	210	Klemmer *et al.* (1980)
Application of herbicides (USA)	PCP	0.01 (NS)	NS	Draper (1982)
Textile industry (Sweden)	CPs			Rappe *et al.* (1982)
impregnation of fabrics		0.30 (0.01-0.80)[c]	15	
sewing of impregnated fabrics		0.20 (0.01-0.35)[c]	20	

[a] PCP, pentachlorophenol; PCP-Na, pentachlorophenate sodium; CPs, chlorophenols; TeCP, 2,3,4,6-tetrachlorophenol; NS, not specified

[b] Median

[c] The Working Group noted that, as no acid hydrolysis of conjugates was included in these analyses, results probably underestimate total chlorophenol levels.

Table 5b. Occupational Exposure Limits for Pentachlorophenol[a]

Country	Year	Concentration (mg/m^3)	Interpretation[b]
Australia	1978	0.5	TWA
Belgium	1978	0.5	TWA
Finland	1981	0.5	TWA
		1.5	STEL
German Democratic Republic	1979	0.5	TWA
		1.0	STEL
Germany, Federal Republic of	1985	0.5	TWA
Hungary	1974	0.2	TWA
Italy	1978	0.5	TWA
Japan	1978	0.5	TWA
The Netherlands	1978	0.5	TWA
Norway	1981	0.5	TWA
Poland	1976	0.5	Ceiling
Romania	1975	0.5	TWA
		1.0	Ceiling
Sweden	1984	0.5	TWA
		1.5	STEL
Switzerland	1978	0.5	TWA
UK	1985	0.5	TWA
		1.5	STEL
USA	1985		
ACGIH		0.5	TWA
		1.5	STEL
OSHA		0.5	TWA
USSR	1977	0.1	TWA
Yugoslavia	1971	0.5	Ceiling

a From International Labour Office (1980); Directorate for Arbeidstilsynet (1981); Työsuojeluhallitus (1981); Arbetarskyydsstyrelsens Förgattningssamling (1984); Deutsche Forschungsgemeinschaft (1985); American Conference of Governmental Industrial Hygienists (ACGIH) (1985); Health and Safety Executive (1985); US Occupational Safety and Health Administration (OSHA) (1985)

b TWA, time-weighted average; STEL, short-term exposure limit

The risks to employees during cleanup at the Site should be negligible.

5.B Population Macro and Micro Environments

The macro-environment is defined by CAI to include all groundwater within a 3 mile radius. The only major vehicle of distribution of PCP and crosote with human exposure potential is the Omaha City well. There has never been any indication of contamination of the Omaha City well by PCP or creosote. In addition, several wells are located between the Site and the Omaha City well. Monitoring of these wells would provide an early warning system since any migrating PCP or creosote would be detected in these wells prior to polluting the Omaha City well.

Pentachlorophenol has been used as a pesticide against many organisms. PCP has been used as a pre and post plant herbicide in several crops, but its most extensive use as a herbicide has been in rice paddy fields. PCP has also been used extensively as a wood preservative against wood rotting and staining organisms, and for the control of powder post beetles, wood-boring insects, and termites. Other uses have been as a biocide in cellulose products, starches, adhesives, proteins, leather, oils, paints, rubber, rug shampoos, textiles, food processing plants, and the control of bacteria, fungi, insects, mollusks, and other nuisance biota.

PCP concentrations of 100 - 50,000 ppm are required to obtain pesticidal activity. There are no off-Site data reporting PCP at levels which would be toxic to either fauna or plant life. No adverse effect on the environment is anticipated to be due to PCP transported via groundwater. The limit of PCP solubility is 14 ppm, a non-toxic level.

There have been micro-environmental impacts due to pollutant release from the Site. Moderate to high PCP concentrations have been detected in Cricket Spring. Three wells near the Site have produced water containing low levels of PCP and occasionally detectable levels of PNA's. No well in current use contains levels of PCP or PNA's that represent a risk to human health.

5.C Lifestyle and Occupational History

The lifestyles and occupational histories of the residents in the near vicinity of the Site do not represent populations at special risk. Many persons in the Omaha vicinity worked at the Site over its 22 year history of operation.

5.D Background Chemical Exposures

Background exposures of the potentially exposed population offer no unusual circumstances with the exception of persons who once worked at the Site.

5.E Demographic Profiles of Populations at Risk Including Populations at Special Risk

There is no discernible demographic profile of any population at risk or at special risk due to future exposures. Persons previously consuming water from wells contaminated with PCP or creosote are the only off-Site population known to ever be at any risk.

6. RISK ASSESSMENT AND IMPACT EVALUATION

6.A Carcinogenic Risk Assessment

Cancer risk, just as any disease induced by chemicals is responsive to exposure. The greater the exposure the greater the risk. The only persons exposed to any of the compounds making up PCP and creosote residues escaping from the Site were those persons drinking well water. It is important to understand that the cancer risk associated with commercial PCP and crosote does not relate to the residues of PCP and creosote components found in vicinity well water. The reasons for this are that the carcinogenic risk associated with commercial PCP is due to its dibenzodioxin and dibenzofuran contaminants. Creosote is a complex mixture of at least 200 compounds. A small minority of the 200 have been found to produce cancer in experimental animals at high doses or by using processes which promote cancer. None of the known carcinogenic components of creosote have been found in well water in the vicinity of the Site.

To obtain a registration for a pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA"), as amended, an applicant for registration must show that the pesticide satisfies the statutory standard for registration. That standard requires, among other things, that the pesticide perform its intended function without causing "unreasonable adverse effects on the environment."

The term "unreasonable adverse effects on the environment" is defined by EPA as "any unreasonable risk to man or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide". To register a pesticide, EPA must find that the benefits of each use of the pesticide exceed the risks of use, when the pesticide is used in accordance with commonly recognized practice and in compliance with the terms and conditions of registration.

The burden of proving that a pesticide satisfies the registration standard is on the proponents of registration and continues as long as the registration remains in effect. Under section 6 of FIFRA, the EPA may cancel the registration of a pesticide or modify the terms and conditions of registration whenever it is determined that the pesticide causes unreasonable adverse effects on the environment. The EPA created the RPAR process to facilitate the identification of pesticide uses which may not satisfy the statutory standard for registration and to provide an informal procedure to gather and evaluate information about the risks and benefits of these uses.

The regulations governing the RPAR process are set forth in 40 CFR 162.11. Among other things, this section provides that a rebuttable presumption against registration shall arise if a pesticide meets or exceeds any of the risk criteria set out in the regulations. The EPA announces the commencement of the RPAR process by publishing a notice in the *Federal Register*. After an RPAR is issued, registrants and other interested persons are invited to review the data upon which the presumption is based and to submit data and information to rebut the presumption by showing that the EPA's initial determination of risk was in error, or by showing that use of the pesticide is not likely to result in any significant exposure to humans or the environment with regard to the adverse effects in question. In addition to submitting evidence to rebut the risk presumption, respondents may submit evidence as to whether the economic, social and environmental benefits of the use of the pesticide outweight the risks of use.

In determining whether the use of a pesticide poses risks which are greater than the benefits, the EPA considers possible changes to the terms and conditions of registration which can reduce risks, and the impacts of such modifications on the benefits of use. If the EPA determines that such changes sufficiently reduce risks to the level where the benefits outweigh the risks, it may conclude the RPAR process. The EPA announces this type of conclusion to an RPAR review by publication of a Notice of Determination in the *Federal Register*. That Notice states and explains the rationale for the Agency's regulatory position, provides that the registrant may avoid cancellation by implementing the modifications to the terms and conditions of registration set forth in the Notice, and sets forth the hearing rights of the affected parties.

Updated Risk and Benefit Information

After the publication of the PD 2/3, the EPA received additional information from the United States Department of Agriculture (USDA), the wood preserving industry, and published articles on risk and exposure to the wood preservatives.

As a result of the additional information received and evaluated by the EPA, the exposure and risk estimates for certain uses of the wood preservative chemicals were recalculated. In some instances the change in risk estimates caused the EPA to modify the regulatory proposals set forth in the PD 2/3.

Risk Information - Pentachlorophenol

Multi-stage Model for Estimating Oncogenic Risks

The pentachlorophenol risk estimates for oncogenicity presented in PD 4 varied slightly from the estimates derived in the PD 2/3, partly because the EPA refined its oncogenic risk assessment method to use the "multi-stage model" rather than the "one-hit" model. For similar exposure estimates, the estimated oncogenic risks for pentachlorophenol derived by this revised methodology fall essentially in the same range as the PD 2/3 estimates.

The EPA described the rationale for using the multi-stage model instead of the one-hit model in the "Water Quality Criteria Document" published in the *Federal Register*, November 28, 1980 (45 FR 79318). The multi-stage model is more appropriate based on mathematical, theoretical, and biological grounds, as summarized in the Appendix of that document. The "one-hit" model can be considered the first stage of the multi-stage model. The multi-stage model reduces to the one-hit model when there is only a control group and one active dose level. Most oncogenic studies include two or three active doses and thus the dose-response relationship is frequently more complex than suggested by the "one-hit" model.

To estimate the potential risk (R) to humans from exposure to the HxCDD contaminant in pentachlorophenol, the EPA used the following equation:

$$R = 6.2 \times \text{exposure}$$

where the exposure is expressed in ug/kg/day averaged over a lifetime. The Agency assumes that the average worklife is 30 years.

The human exposure estimates for the various use situations for pentachlorophenol with its HxCDD contaminant are summarized in Appendix C of PD 4; the human risk estimates are summarized in Appendix B.

For similar exposure estimates, the potential estimates for HxCDD would be of the same order of magnitude as those presented in the PD 2/3. Although the tumor incidences for female rats are lower than originally reported, it only takes a very small amount of HxCDD (5 ug/kg/week or less) to produce a positive tumorigenic effect, and thus the slope or Q1*, as an indicator of potency would not be expected to decrease appreciably.

When comparing the risk estimates calculated in the PD 2/3 with those calculated for the PD 4, it can be seen that for some uses the risk has increased by an order of magnitude or more. This is due mainly to the changes made in the exposure assumptions discussed in section II B of PD 4. Currently, the EPA has set 1 ppm as a level equaling a lifetime cancer risk of one in one million.

The best estimate of future carcinogenic risk to residents of the vicinity is zero. The opportunity for exposures can be maintained near zero via well monitoring. Estimates of past risk due to the consumption of well water are vanishingly small because, although not documented, exposures would have been minimal due to the sparing solubility of PCP and PNA's in water and the unpleasant tastes and odor associated with even moderate levels of pollution by PCP or PNA's.

When the EPA procedures for estimating carcinogenic risk outlined in PD-4 for Wood Treatment Pesticides are applied to persons who have consumed well water at 0.01 ppm, a maximum risk of:

$$\frac{(15 \text{ years} + 70 \text{ years}) \times (0.01 \text{ mg/L} + 1 \text{ mg/L})}{1{,}000{,}000} = \frac{2}{\text{billion}}$$

is calculated. A one in one million is the risk EPA sets as a level of concern for drinking water. The risk for drinking 2 quarts of Cricket Spring water each day for 70 years is somewhere between 0 and 4 per million. Since no one drinks the water, the risk is zero. The risk for creosote has not been calculated but it is far less than that for PCP.

Creosote

No new information was received which changed the EPA's position regarding the rebuttable presumptions for creosote. As summarized in the PD 2/3 (pp 36-46 and p 85), creosote and many of its component chemicals have been shown to cause cancer in laboratory animals; there have also been many case reports linking human cancer to exposure to creosote. These findings have been updated and supported by a recent review of polynuclear aromatic hydrocarbons. However, as stated in the PD 2/3 (p 85), the EPA still had no definitive data on the identity of the airborne component chemicals of creosote to which workers are exposed in wood treatment plants where creosote is used. Moreover, there were no quantitative data on dermal exposure to these workers. This lack of information precluded a quantitative assessment of risk of carcinogenicity in humans.

The EPA is aware that some researchers are studying the feasibility of interpolating results from skin painting studies which are validated against human carcinogens. However, creosote has not been tested or validated through this system.

Because the EPA continues to be concerned about the potential for cancer risk from exposure to creosote, the EPA, in a separate action apart from the requirements described in this PD 4, request registrants to submit a cross-sectional retrospective epidemiology study of creosote treatment plant workers to provide data with which to

quantitatively estimate the oncogenic risk to humans. Study parameters such as sample size, identification of appropriate treatment plants, identification of comparison or control populations and other study parameters were reviewed and accepted by the Agency prior to actual conduct of the study. Industrial hygiene air monitoring for exposure in creosote treatment plants will also be necessary and must include area and breathing zone data. The EPA believed the retrospective epidemiology study and creosote treatment plant monitoring survey would enable the Agency to quantitatively assess the potential human oncogenic risk from creosote exposure.

6.B Probability of Non-carcinogenic Human Health Effects

The possibility of adverse human health effects developing is limited to the extent of actual exposure. The only route of human exposure to PCP and creosote residues is via the groundwater. The following studies support the presumption that there is no risk of non-carcinogenic health effects due to the Site.

In 1976, Takahashi *et al.*, studied the effects of occupational exposure in the pesticides industry and gamma mobility C-reactive protein (CRP). Injury in a variety of forms is often accompanied by acute changes in plasma CRP, which is often elevated in acute stages of various inflammatory disorders or tissue changes caused by toxic chemicals. The presence of CRP in the sera of workers exposed to pentachlorophenol was approximately three (3) times higher than in controls and higher than in workers exposed to organochlorine insecticides, fungicides, herbicides or organophosphate pesticides. In addition, total bilirubin and CPK levels of the pentachlorophenol group were higher than the controls or the other groups.

In 1977, Begley *et al.*, studied the association between renal function tests and pentachlorophenol exposure before and after a 20 day vacation. Glomerular function as assessed by creatinine clearance was impaired in the study group at the time the vacation occurred, but then improved to essentially normal function during the 20 day period of nonexposure. There was a trend toward renewed-impairment following renewed work exposure. Similarly, tubular reabsorption of phosphorus was depressed in some individuals prior to vacation. Phosphorus clearence depression was accompanied in some individuals by a decrease in serum phosphorus levels. Recovery proceeded during vacation and deteriorated after reexposure.

In 1980, Klemmer *et al.*, reported on clinical findings in workers exposed to pentachlorophenol. PCP exposure was highly associated with increased numbers of bands, increased levels of blood plasma cholinesterase and alkaline phosphatase, gamma globulin, basophils, uric acid and reduced serum calcium. The prevalence rates for conjunctivitis, chronic sinusitis and chronic upper respiratory conditions were significantly higher among the PCP-exposed. Infections of the skin and subcutaneous tissue and hypertension were also increased.

These toxic effects are important when evaluating the chronic low level effects of PCP exposure since; none of the studied individuals died or were hospitalized; none suspected that their health was adversely affected by PCP; the observed adverse effects have been documented in animals; and adverse effects also required years to develop.

In past occupational exposure studies conducted at wood treatment plants, significant tasks of concern were typically identified as the short intervals of exposures occurring when opening pressure cylinders or emptying bags of PCP to make up treating solutions. None of the data, though relatively recent, describe possible contributions from skin contact. Some reports discuss work practices and skin protection and historic cases of skin problems, such as chloracne or photosensitization.

Some of the older operations such as Al utilized PCP received in bags for preparing treating solutions. By 1980, this was done only to a limited extent and primarily at plants with infrequent or minimal use. PCP in bags was used at a few plants to provide the additional poundage for one and two thousand blocks for making up a specific strength treating solution based on the volume of oil or solvent. Flaked material, now commonly available delivered in bulk truck-lots at commercial operations, is conveyed in essentially closed systems with appropriate dust collection, to mix tanks for bulk solution blending.

Several cases of human intoxication due to PCP and its sodium salt are known from the literature. Industrial intoxications have been described by Baader *et al.*, Truhaut *et al.*, Menon, Shirakawa *et al.*, Viniegra *et al.*, and Bergner *et al.* The general clinical symptoms are: loss of appetite and body weight, fever up to 43°C, excessive respiration, headache, congestion of ocular and nasal mucosae, irritation of respiratory organs, thorax constriction and weakness. After dermal contact, local skin irritation and acne are found. Cases of neuralgia have been described by Campbell and Barnes. Roberts describes one case of fatal aplastic anemia following continued dermal exposure for about 1 year. At least 24 fatalities in industry have been reported. At autopsy, the following changes are found: oedematous brain, heart dilatation, tubular degeneration of the kidneys, oedematous lungs with congestion and intra-alveolar hemorrhages, and a slightly congested liver with centrilobular degeneration.

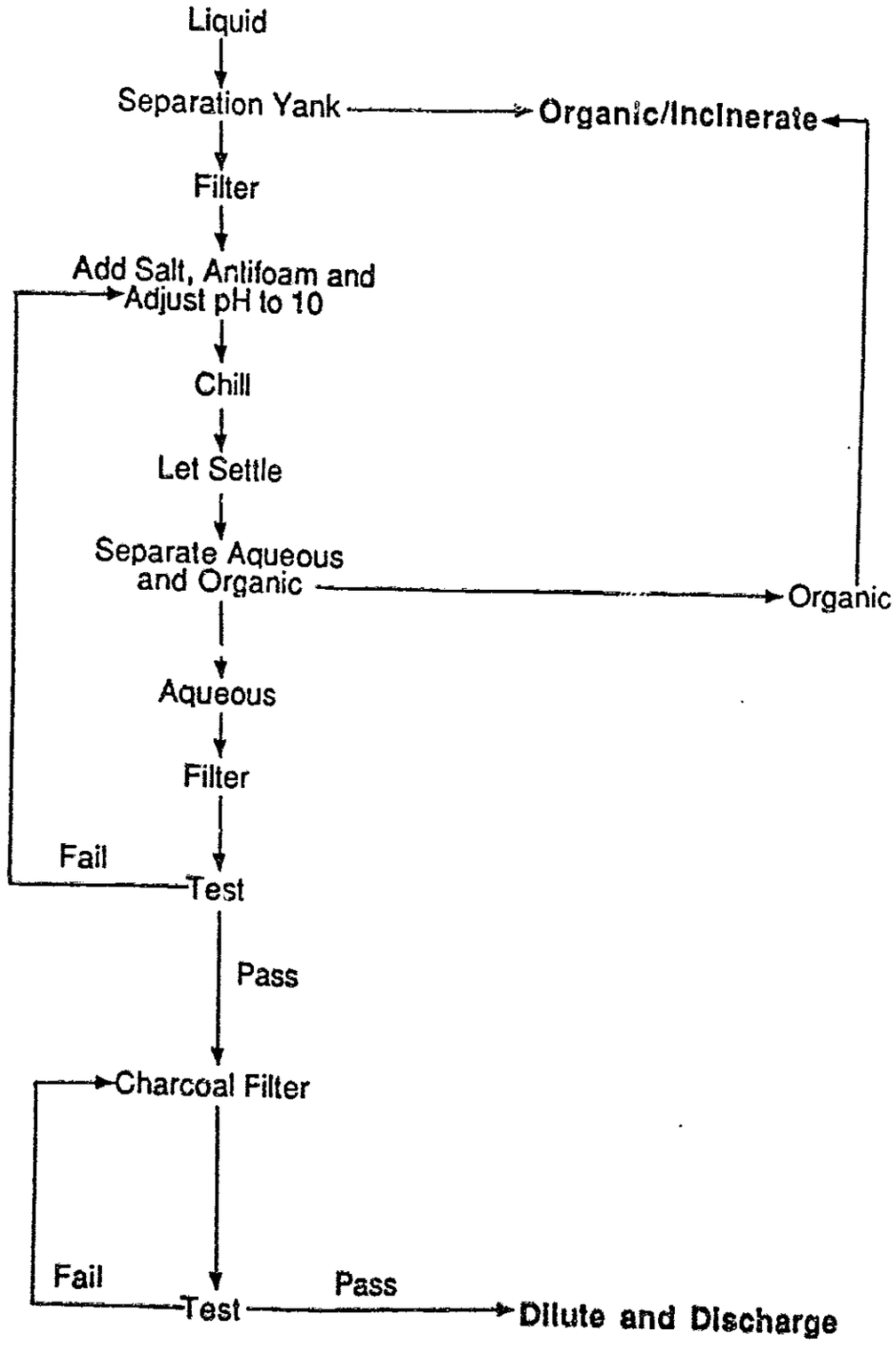
Robson describes the misuse of PCP in a laundry product. 20 of about 80 newborn infants developed signs of intoxication with 7 deaths.

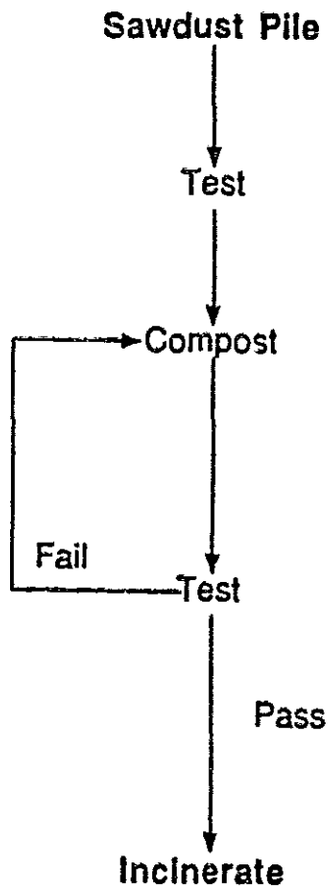
6.C Non-Human Species Risk Assessment

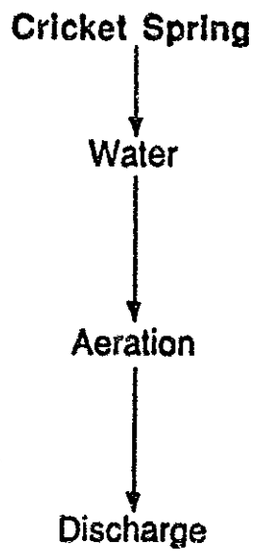
Certain areas on the Site have represented a risk to non-human species in the past. Recent modifications by the owner have greatly reduced this risk. PCP and creosote waste have been disposed of in open-exposed areas referred to as the Trolley-Treatment Area, the Ash Pile and the Railroad Ditch Pit. These areas contained high levels of PCP and creosote wastes. These levels could have been toxic to wildlife if contact had been made. These areas have been partially secured by the addition of a fill dirt covering.

FIGURES, REFERENCES AND CHARTS

001360

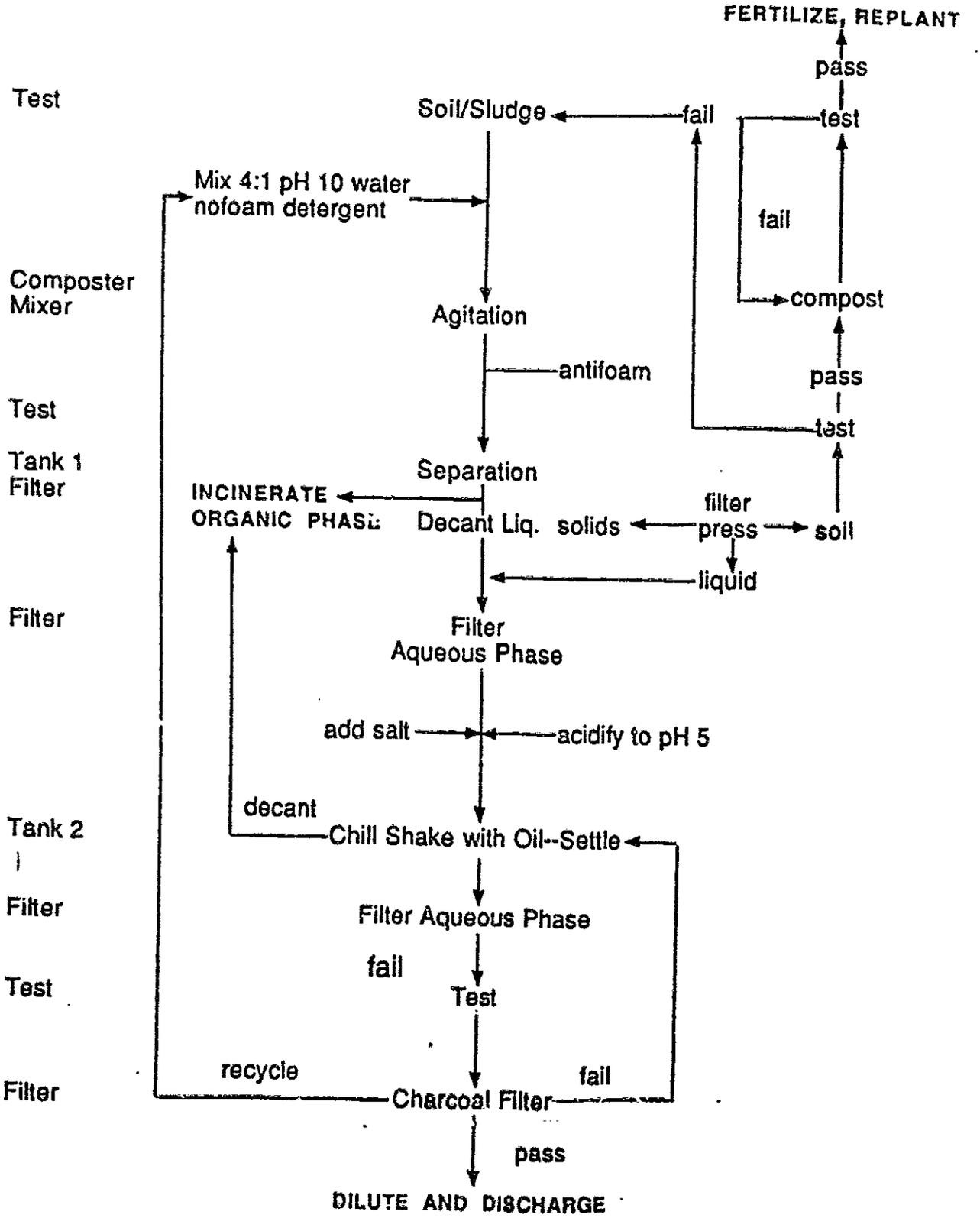

Liquid
Separation Yank
Organic/Incinerate
Filter
Add Salt, Antifoam and
Adjust pH to 10
Chill
Let Settle
Separate Aqueous
and Organic
Organic
Aqueous
Filter
Fail
Test
Pass
Charcoal Filter
Fail
Test
Pass
Dilute and Discharge

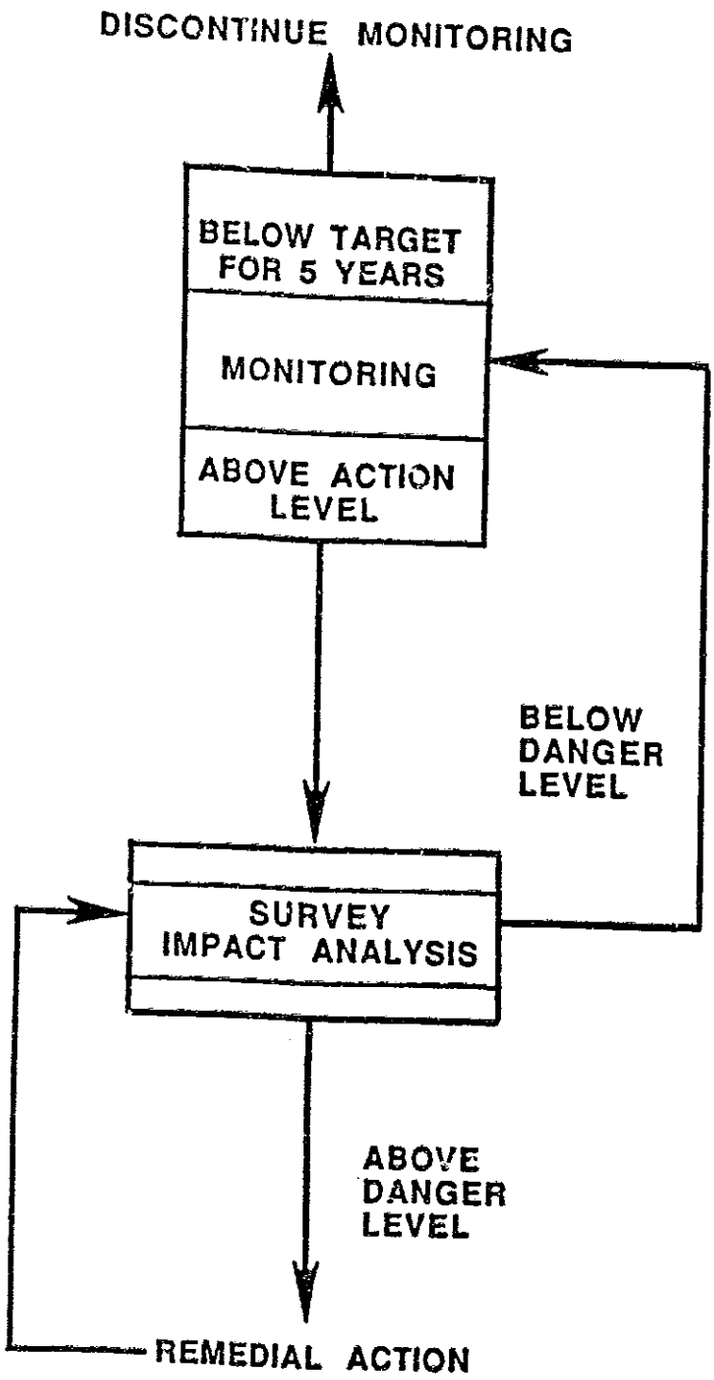

Sawdust Pile
Test
Compost
Fail
Test
Pass
Incinerate


Cricket Spring
Water
Aeration
Discharge

001362

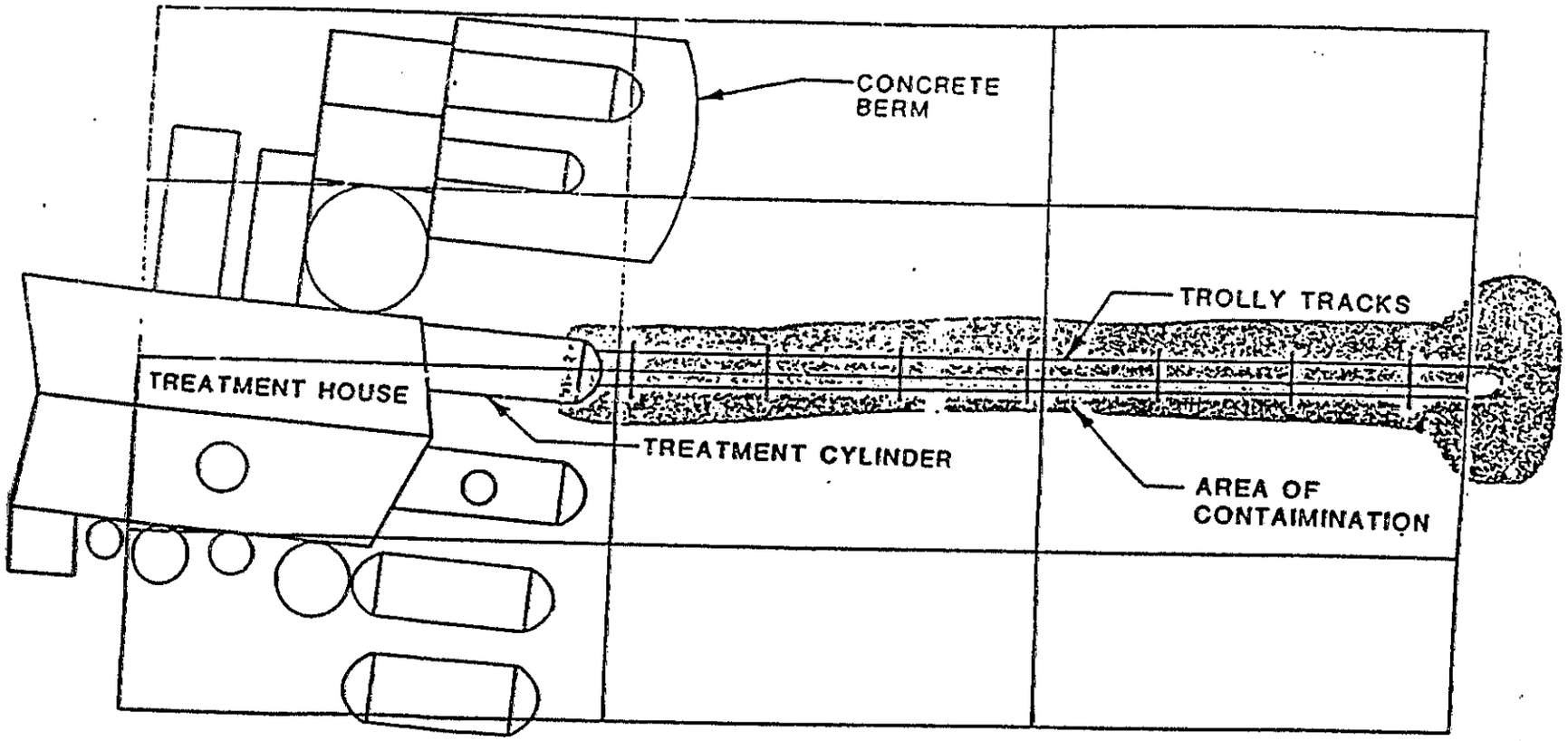
SOIL SLUDGE CLEANUP




DISCONTINUE MONITORING
BELOW TARGET FOR 5 YEARS
MONITORING
ABOVE ACTION LEVEL
BELOW DANGER LEVEL
SURVEY IMPACT ANALYSIS
ABOVE DANGER LEVEL
REMEDIAL ACTION

001364

NOTE: STRUCTURES ARE NO LONGER PRESENT



FIGURE

SAMPLING PLAN FOR TROLLY, TREATMENT AREA

RI/FS WORK PLAN

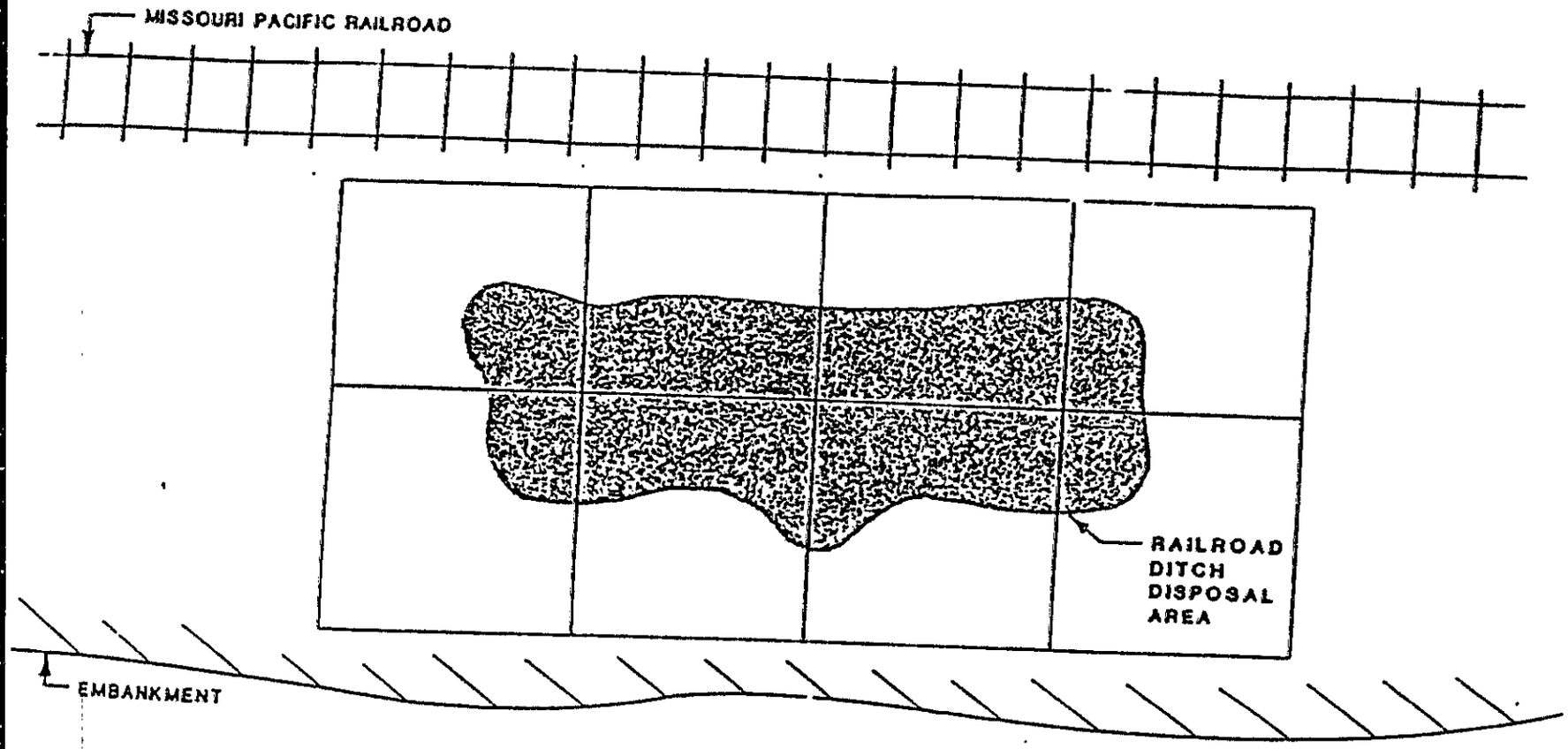


FIGURE
SAMPLING PLAN
FOR RAILROAD DITCH
DISPOSAL AREA
RI/FS WORK PLAN

0 10 FEET
SCALE

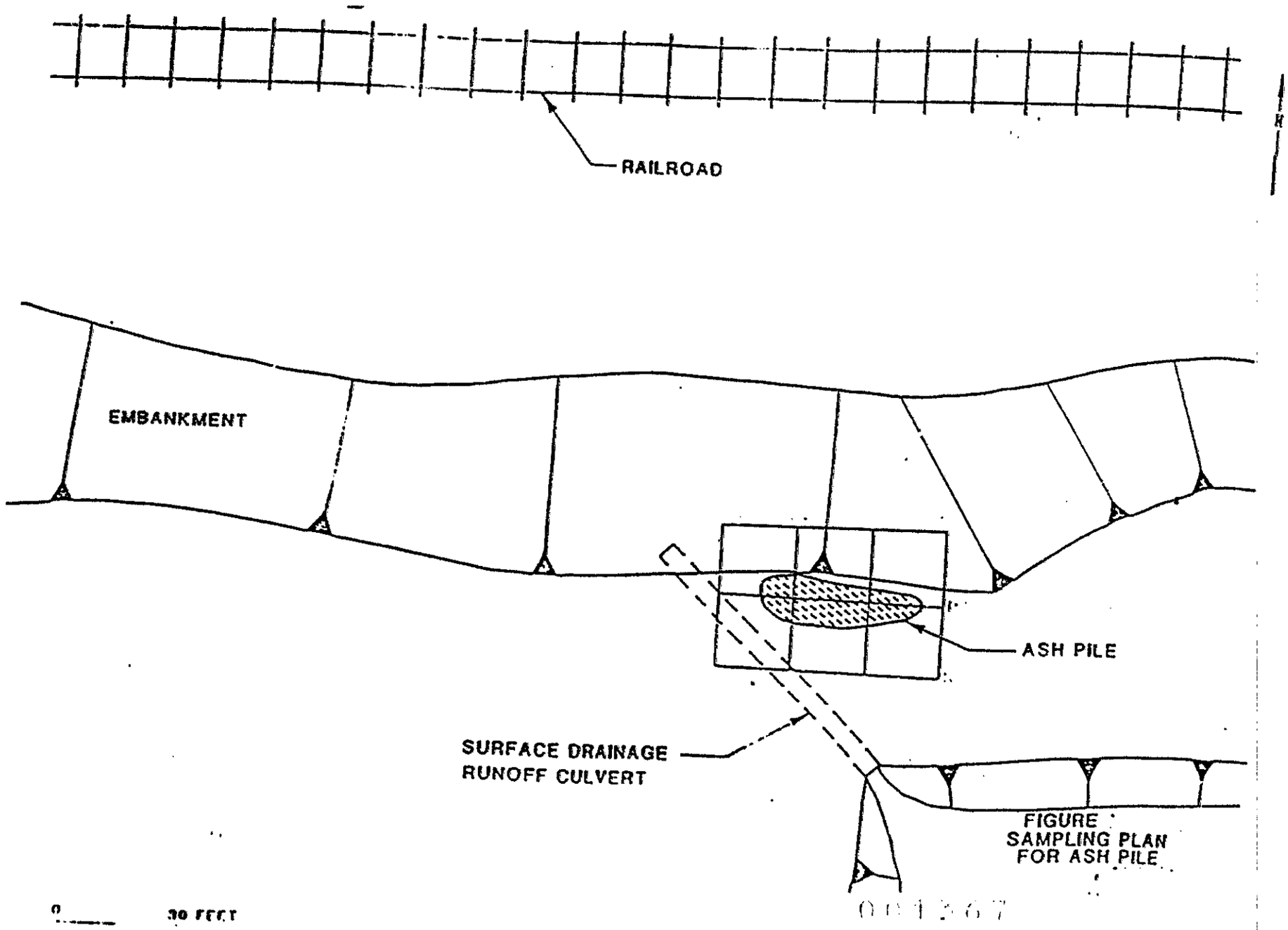
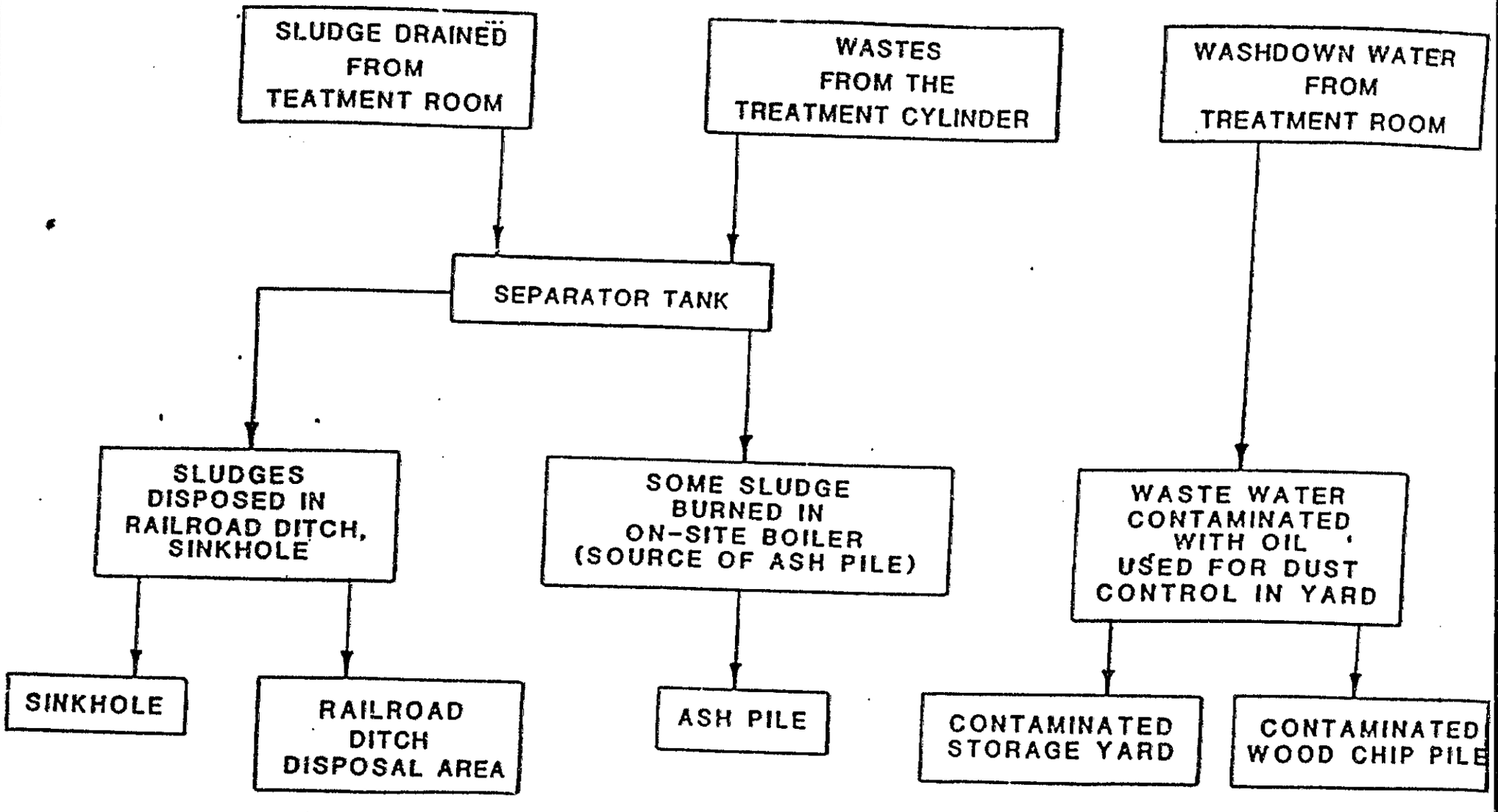


FIGURE
SAMPLING PLAN
FOR ASH PILE



WASTE STREAMS

RI/FS WORK PLAN

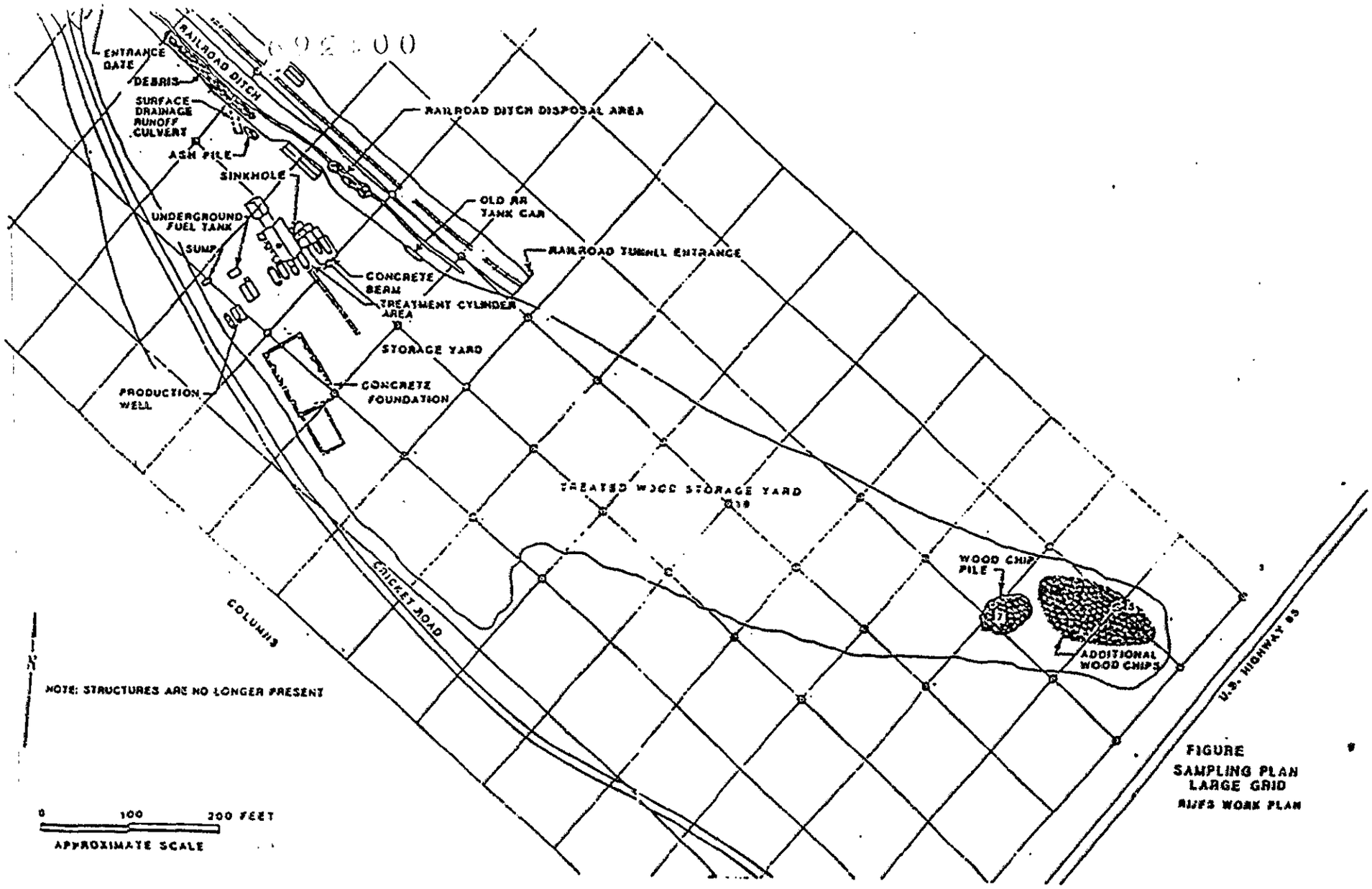


FIGURE
SAMPLING PLAN
LARGE GRID
RI/FS WORK PLAN

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001312

001573

APR 12 1985

Arkwood, Inc.
Omaha, Arkansas

Arkwood, Inc. is located at the Missouri-Pacific's Cricket Railroad siding, south of Omaha in Boone County, Arkansas. The site is approximately 20 acres in size, situated in Section 27,T21N R21W on the Omaha, Ark-Mo Quad map.

Arkwood was founded and originally operated by H.C. Ormand in the early 1960's. Mr. Ormand leased the process and land to Mass Merchandisers, Inc. of Harrison, Arkansas in the mid 1970's. Mass Merchandisers are the current operators of the site. Their representatives are Bob Barker and Devoe Gregory of the Wood Products Group. Mass Merchandisers's lease expired January 1, 1985 and was not renewed. The plant has not been operated since then.

The business consists of a millwork shop, a woodtreating operation using pentachlorophenol and creosote and a storage yard for the treated wood products before sale. The wastes from the wood treating operation, according to Mr. Barker and Mr. Gregory, were dumped into a cave at the treating plant from the beginning of the operation to around 1970 when the cost of the chemicals used in the treatment process forced a recovery system to be employed. The cave has been closed by boarding the entrance and covering it with a layer of dirt. (The entrance is flush with the ground surface). The wastes consist of the liquid from washing down of the treatment room floor and the cleaning of the treatment cylinder. These wastes were accumulated in a tank and then spread over the storage yard for dust control. Mr. Barker stated that, based on plant operation during 1970, a minimum of 6-7000lbs/yr of waste were generated over the 22 years of operation. However, prior to 1970 when recovery begun, the operation generated significantly more waste than minimum per year estimate. There are also a pit (40yd^3) containing waste adjacent to the site next to the railroad and a waste pile of sawdust and woodchips (5954 yd^3).

Arkwood, Inc. notified under RCRA as a generator of hazardous waste, but has never been issued and does not now hold any type of permit.

There are approximately 660 persons living within a 3 mile radius of the site whose water supply is groundwater. PCP has been detected in local water wells, natural springs in the area and in nearby Walnut Creek by State sampling. A new water well for a resident 400 feet west of the site has just been completed.

Gerraghaty-Miller has been retained by Mass Merchandisers for a geohydrological study. An Administrative Order is in the final phase of preparation by the State.

Facility name: Arkwood, Inc.

Location: Crickett, Boone County, Ark. South of Omaha

EPA Region: VI

Person(s) in charge of the facility: Bud Grisham

Hallie C. Ormand

Name of Reviewer: Tim Perdue, EPA, Doice Hughes, ADPCE Date: 3/26/85

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility, contamination route of major concern; types of information needed for rating; agency action, etc.)

The site is located on a 15-20 acre site in Section 27T21NR21W. South of Omaha in Boone County, Arkansas. The site has a Millwork Shop, pcp and creosote treatment process area, storage tanks and a storage yard. Wastes were dumped in a cave located onsite. PCP has been detected in groundwater and surface water.

Scores: S_M = 34.21 (S_{gw} = 59.18 S_{sw} = 0 S_a = 0)

S_{FE} = 0

S_{DC} = 25.0

FIGURE 1
HRS COVER SHEET

QA — R. Clearing Johnson 19 April 1985

Ground Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score		X	15	
3 Containment	0 1 2 3	1	X	3	3.3
4 Waste Characteristics					3.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	8	8	
	Total Waste Characteristics Score		26	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	9	9	
Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	20	40	
	Total Targets Score		29	49	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			33930	57,330	
7 Divide line 6 by 57,330 and multiply by 100		S_{gw} = 59.18			

FIGURE 2
GROUND WATER ROUTE WORK SHEET

RCJ
4/19/85

Surface Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	0	45	4.1
If observed release is given a value of 45, proceed to line 4. If observed release is given a value of 0, proceed to line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
Toxicity/Persistence	0 3 6 9 12 15 18	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
	Total Waste Characteristics Score			23	
5 Targets					4.5
Surface Water Use	0 1 2 3	3	0	9	
Distance to a Sensitive Environment	0 1 2 3	2	0	6	
Population Served/Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		0	55	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5				64,350	
7 Divide line 6 by 64,350 and multiply by 100		S_{sw} =	0		

FIGURE 7
SURFACE WATER ROUTE WORK SHEET

Ref
4/16/86

Air Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If line 1 is 0, the S_a = 0. Enter on line 5. If line 1 is 45, then proceed to line 2.					
2 Waste Characteristics					5.2
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
	Total Waste Characteristics Score			20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1	0	30	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Land Use	0 1 2 3	1	0	3	
	Total Targets Score		0	39	
4 Multiply 1 x 2 x 3				35,100	
5 Divide line 4 by 35,100 and multiply by 100	S_a = 0				

FIGURE 9
AIR ROUTE WORK SHEET

RCB 4/19/85

001578

	S	S^2
Groundwater Route Score (S_{gw})	59.18	3502.27
Surface Water Route Score (S_{sw})	0	0
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		3502.27
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		59.18
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		34.21

FIGURE 10
WORKSHEET FOR COMPUTING S_M

001377

R.C.J.
4/17/75

Fire and Explosion Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
Total Waste Characteristics Score				20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 x 2 x 3				1,440	
5 Divide line 4 by 1,440 and multiply by 100	S_{FE} =				

FIGURE 11
FIRE AND EXPLOSION WORK SHEET

RGA
4/19/85

Direct Contact Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	0 45	1	0	45	8.1
If line 1 is 45, proceed to line 4 If line 1 is 0, proceed to line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics Toxicity	0 1 2 (3)	5	15	15	8.4
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 (2) 3 4 5	4	8	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
Total Targets Score			8	32	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			5400	21,600	
7 Divide line 6 by 21,600 and multiply by 100		S_{DC} = 25.0			

FIGURE 12
DIRECT CONTACT WORK SHEET

KCJ
1/10/85

June 28, 1982

DOCUMENTATION RECORDS
FOR
HAZARD RANKING SYSTEM

INSTRUCTIONS: The purpose of these records is to provide a convenient way to prepare an auditable record of the data and documentation used to apply the Hazard Ranking System to a given facility. As briefly as possible summarize the information you used to assign the score for each factor (e.g., "Waste quantity = 4,230 drums plus 800 cubic yards of sludges"). The source of information should be provided for each entry and should be a bibliographic-type reference that will make the document used for a given data point easier to find. Include the location of the document and consider appending a copy of the relevant page(s) for ease in review.

FACILITY NAME: Arkwood

LOCATION: South of Omaha, Arkansas

QA — R. Manning Johnson 19 April 1985

GROUND WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected (5 maximum):
Natural spring to the west of plant shows pentachlorophenol (PCP) up to 10 mg/l (Ref. 3, 6). Behren wells #2 and #3 also show PCP contamination (Ref. 6)

Rationale for attributing the contaminants to the facility:
PCP wastes ~~was~~ WERE deposited in on-site cave, were spread on ground for dust-supression and were found in high concentration (30,000 ppm) in dump area saw dust (ref. 4,5).

HRS value = 45

* * *

2 ROUTE CHARACTERISTICS

Depth to Aquifer of Concern

Name/description of aquifers(s) of concern:
Most higher elevation wells in this area ARE in the Boone limestones although, valley wells may be in the underlying ordovician dolomite. No significant continuous aquatards appear to exist between these formations and the deeper Roubidoux sandstones (top at 200 MSL) and the gunter sandstone (top at -400 MSL) Ref. 7

Depth(s) from the ground surface to the highest seasonal level of the saturated zone [water table(s)] of the aquifer of concern:

Depth from the ground surface to the lowest point of waste ~~disposal~~ contamination ~~storage~~:

Ref
4/19/85

Net Precipitation

Mean annual or seasonal precipitation (list months for seasonal):

Mean annual lake or seasonal evaporation (list months for seasonal):

Net precipitation (subtract the above figures):

Permeability of Unsaturated Zone N/A

Soil type in unsaturated zone:

Permeability associated with soil type:

Physical State

Physical state of substances at time of disposal (or at present time for generated gases):

* * *

RCJ
4/19/85

3 CONTAINMENT

Containment N/A

Method(s) of waste or leachate containment evaluated:

Method with highest score:

4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated:

	Toxicity	Persistence
pentachlorophenol	3	3

Ref. 3,5,6

Compound with highest score:

PCP

Matrix value of 18 - Ref. 1

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

~~6071~~ 6237 Tons

Ref. 5 p. 1,2 and Attachment F

Ref. 9

Ref. 10 Ref. 4 HRS VALUE ~~Route score~~ is 8

Basis of estimating and/or computing waste quantity:

1) 500 gal/yr X 22 yrs ÷ 50 gal/drums = 220 drums or 55 tons
2) pit 15' X 40' X 3' = 68 cu.yd. once filled capacities = 68 Tons
3) pile 275' X 150' X 4' = 6111 cu.yd. = 6111 Tons/total = 6234 Tons-equivalents

* * *

RCA 4/17/85

5 TARGETS

Ground Water Use

Use(s) of aquifer(s) of concern within a 3-mile radius of the facility:
Drinking water. Individual well-owners do not have an alternative unthreatened supply and the Omaha well cased to 65' deep and extending to 1315' deep is also considered threatened and without an alternative supply.
HRS value = 3

Distance to Nearest Well

Location of nearest well drawing from aquifer of concern or occupied building not served by a public water supply:
Home located on road west of site

Ref. 2

Distance to above well or building:
400' HRS value = 4

Observation by T.C. Perdue, EPA, 3/25/85
Ref. 8 pg. 8

Population Served by Ground Water Wells Within a 3-Mile Radius

Identified water-supply well(s) drawing from aquifer(s) of concern within a 3-mile radius and populations served by each:
174 homes in area x 3.8 = 661
3 mile radius drawn on topo map Ref 2 and dwellings counted, total count 174.

Computation of land area irrigated by supply well(s) drawing from aquifer(s) of concern within a 3-mile radius, and conversion to population (1.5 people per acre):
None in area

Total population served by ground water within a 3-mile radius:
661 (HRS value = 2) HRS matrix = 20

RCJ 4/14/85

SURFACE WATER ROUTE

1 OBSERVED RELEASE

Contaminants detected in surface water at the facility or downhill from it (5 maximum):

Not evaluated. Distance to perennial water in Crickett Creek is 3.5 miles and in Barren Forks is 4.3 miles. Hence, there are no surface water targets for HRS purposes.

Rationale for attributing the contaminants to the facility:

* * *

2 ROUTE CHARACTERISTICS

Facility Slope and Intervening Terrain

Average slope of facility in percent:

Name/description of nearest downslope surface water:

Average slope of terrain between facility and above-cited surface water body in percent:

Is the facility located either totally or partially in surface water?

Is the facility completely surrounded by areas of higher elevation?

1-Year 24-Hour Rainfall in Inches

Distance to Nearest Downslope Surface Water

Physical State of Waste

* * *

3 CONTAINMENT

Containment

Method(s) of waste or leachate containment evaluated:

Method with highest score:

4 WASTE CHARACTERISTICS

Toxicity and Persistence

Compound(s) evaluated

Compound with highest score:

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

Basis of estimating and/or computing waste quantity:

* * *

5 TARGETS

Surface Water Use

Use(s) of surface water within 3 miles downstream of the hazardous substance:

Is there tidal influence?

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

Distance to critical habitat of an endangered species or national wildlife refuge, if 1 mile or less:

Population Served by Surface Water

Location(s) of water-supply intake(s) within 3 miles (free-flowing bodies) or 1 mile (static water bodies) downstream of the hazardous substance and population served by each intake:

Computation of land area irrigated by above-cited intake(s) and conversion to population (1.5 people per acre):

Total population served:

Name/description of nearest of above water bodies:

Distance to above-cited intakes, measured in stream miles:

AIR ROUTE

1 OBSERVED RELEASE

Contaminants detected:

No data to show air release.

Date and location of detection of contaminants

Methods used to detect the contaminants:

Rationale for attributing the contaminants to the site:

* * *

2 WASTE CHARACTERISTICS

Reactivity and Incompatibility

Most reactive compound:

Most incompatible pair of compounds:

Toxicity

Most toxic compound:

Hazardous Waste Quantity

Total quantity of hazardous waste:

Basis of estimating and/or computing waste quantity:

* * *

3 TARGETS

Population Within 4-Mile Radius

Circle radius used, give population, and indicate how determined:

0 to 4 mi 0 to 1 mi 0 to 1/2 mi 0 to 1/4 mi

Distance to a Sensitive Environment

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

Distance to critical habitat of an endangered species, if 1 mile or less:

Land Use

Distance to commercial/industrial area, if 1 mile or less:

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Distance to residential area, if 2 miles or less:

Distance to agricultural land in production within past 5 years, if 1 mile or less:

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site?

FIRE AND EXPLOSION

1 CONTAINMENT

Hazardous substances present:

Site not certified by Fire Marshall
or contaminant detected as fire hazard.
Route score is 0.

Type of containment, if applicable:

* * *

2 WASTE CHARACTERISTICS

Direct Evidence

Type of instrument and measurements:

Ignitability

Compound used:

Reactivity

Most reactive compound:

Incompatibility

Most incompatible pair of compounds:

* * *

Hazardous Waste Quantity

Total quantity of hazardous substances at the facility:

Basis of estimating and/or computing waste quantity:

* * *

3 TARGETS

Distance to Nearest Population

Distance to Nearest Building

Distance to Sensitive Environment

Distance to wetlands:

Distance to critical habitat:

Land Use

Distance to commercial/industrial area, if 1 mile or less:

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Distance to residential area, if 2 miles or less:

Distance to agricultural land in production within past 5 years, if 1 mile or less:

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

Is a historic or landmark site (National Register of Historic Places and National Natural Landmarks) within the view of the site?

<u>Population Within 2-Mile Radius</u>

<u>Buildings Within 2-Mile Radius</u>

DIRECT CONTACT

1 OBSERVED INCIDENT

Date, location, and pertinent details of incident:

None observed

* * *

2 ACCESSIBILITY

Describe type of barrier(s):

There is a front gate, but no complete barrier.

Visual observation during onsite visit on 3/25/85 by Tim Perdue, EPA and Doice Hughes, ADPCE

* * *

3 CONTAINMENT

Type of containment, if applicable:

Spill on ground, crew spread PCP sludges and waste oil on facility grounds to control dust

Ref. 5

* * *

4 WASTE CHARACTERISTICS

Toxicity

Compounds evaluated:

PCP . Ref. 3 & 4

See groundwater section

Compound with highest score:

PCP

* * *

5 TARGETS

Population within one-mile radius

101 homes x 3.8 =384
Ref. 2

Distance to critical habitat (of endangered species)

REFERENCES

If the entire reference is not available for public review in the EPA regional files on this site, indicate where the reference may be found:

Reference Number	Description of the Reference
1	Uncontrolled Hazardous Waste Site Ranking System: A Users Manual. 47 FR 31219-31243, 16 July 1982 (Appendix A, CERCLA).
2	Topographic maps Omaha, Ark-Mo. Quad. 1967, 7.5 min Denver, Ark-Mo. Quad. 1972, 7.5 min Omaha NE, Ark-Mo. Quad. 2966, 7.5 min
3	Letter from Charles McLaughton, McClelland Consulting Engineers, Inc. to Doice Hughes, ADPCE, July 12, 1983
4	APDCE Inspection Report to Mike Bates from Jay Justice, Nov. 5, 1981
5	Memorandum to Bob Blanz, from Mike Bates October 12, 1981
6	Letter McClelland Consulting Engineers, Inc. To: Doice Hughes, ADPCE: From Charles McLaughlin May 22, 1984
7	A.G. Lamonds. Water resources Reconnaissance of the Ozark Plateaus Province, Northern Arkansas, USGS; Hydrological Investigations, Atlas HA-383. 1972
8	EPA Site Inspection Report, Form 2070-3 prepared by Doice Hughes, ADPCE 3/27/85
9	Record of Communication from Doice Hughes, ADPCE to Tim Perdue, EPA 3/26/85
10	Memo to Doice Hughes, ADPCE to Tim Perdue, EPA Received 4/10/85. Sub Arkwood onsite well and demission of onsite drums

001400

KCJ
4/15/85

Reference 2

Topographic maps Omaha, Ark-Mo. Quad. 1967, 7.5 min
Denver, Ark-Mo. Quad. 1972, 7.5 min
Omana NE, Ark-Mo. Quad. 2966, 7.5 min

Reference 3

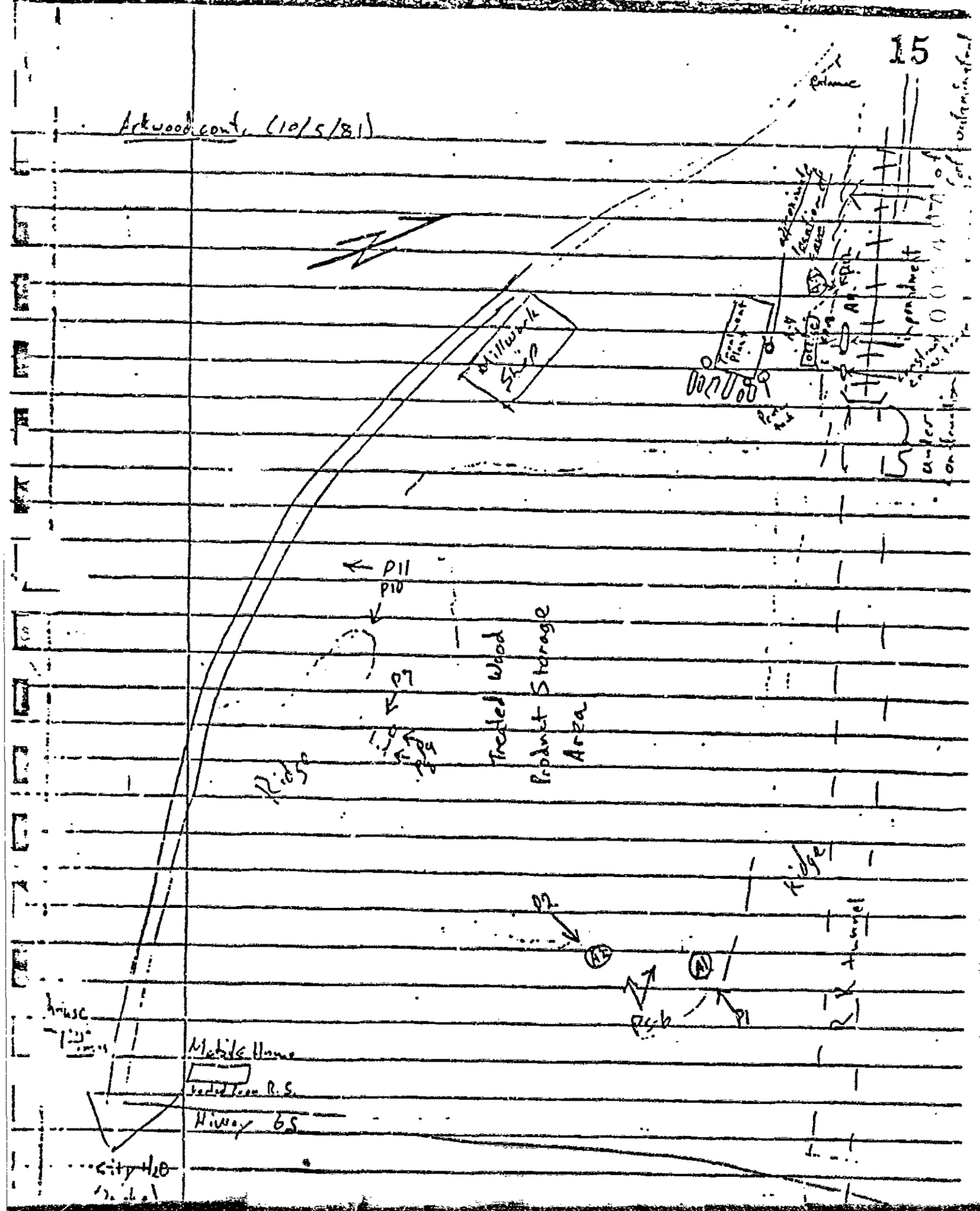
Letter from Charles McLaughton, McClelland Consulting Engineers, Inc. to Doice Hughes, ADPCE, July 12, 1983

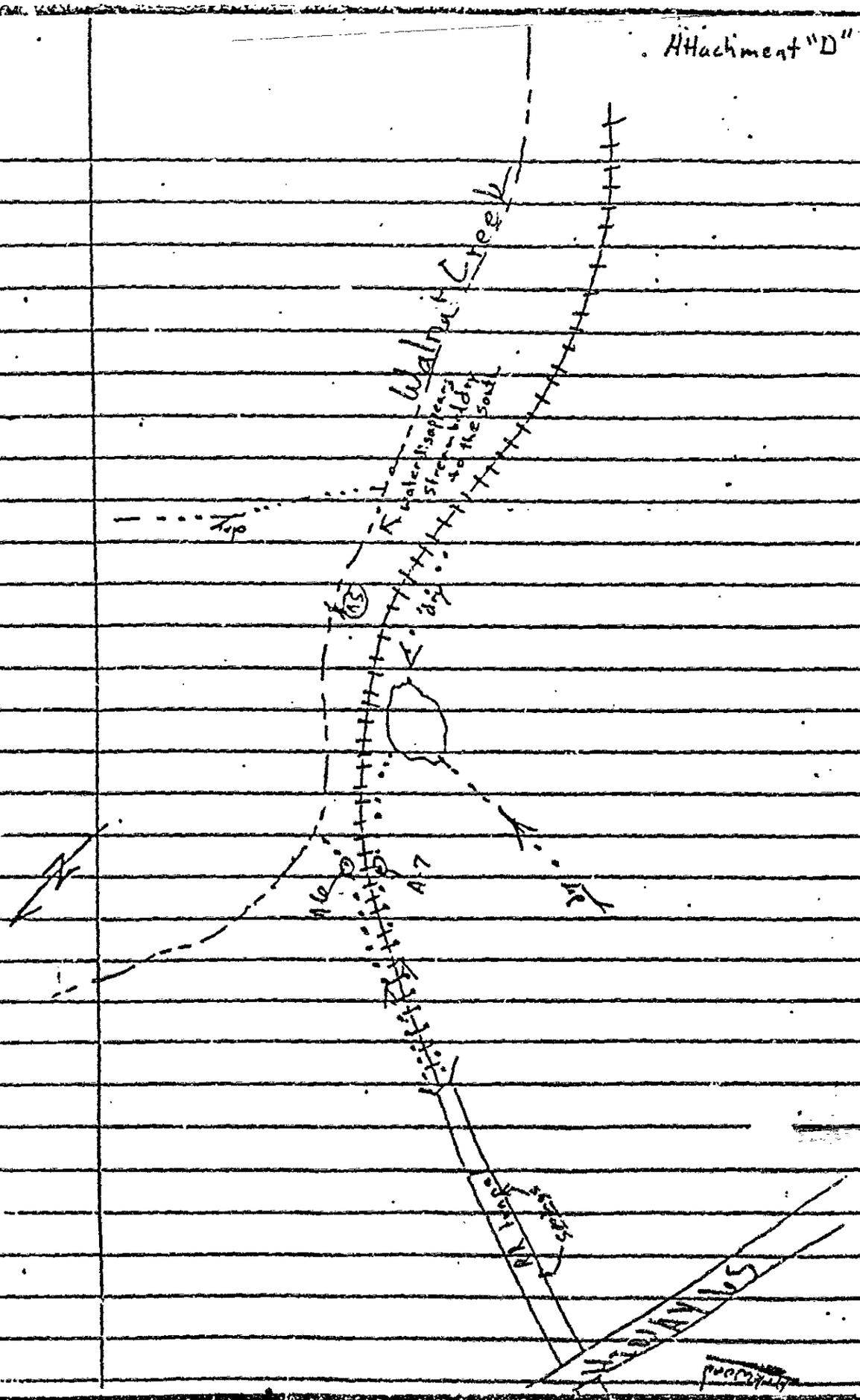
Reference 5

Memorandum to Bob Blanz, from Mike Bates October 12, 1981

Attachment C

Arkwood cont. (10/5/81)



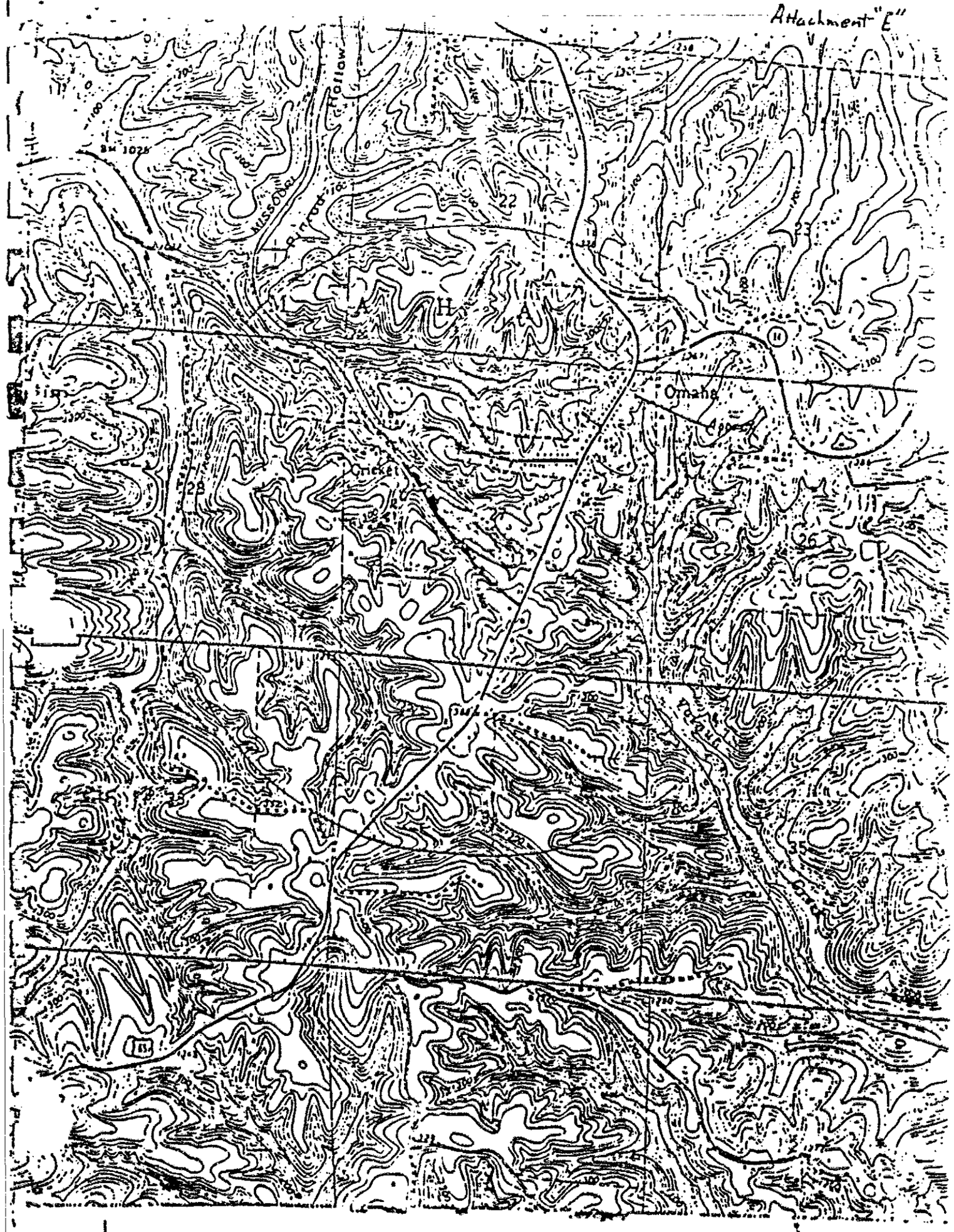

Walnut Creek
water disappears
streambed dry
to the south
dry
A-7
A-6
N

Reference 4

ADPCE Inspection Report to Mike Bates from Jay Justice, Nov. 5, 1981

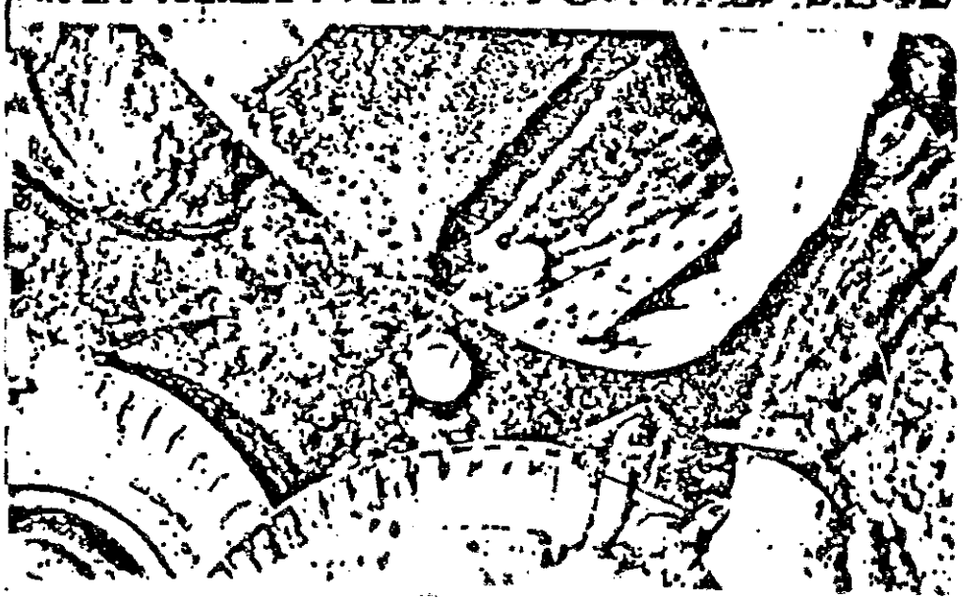
001406

Attachment "E"



SUBJECT: Ashwood, Inc. - Dump point
LOCATION: Sample pt. #1 (A1) L.E. co. Ashwood, looking West
CITY: Cricket COUNTY: Boone STATE:
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7S 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1:
NEGATIVE LOCATION: ADPC+E FILE #:
PROCESSED BY: KolacPrint
PHOTO #: 1 of 19

SUBJECT: Sample pt #2 (A2)
LOCATION: Approx. 75' SW of photo #1 Dump point looking SSW
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7S 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1:
NEGATIVE LOCATION: ADPC+E FILE #:
PROCESSED BY: KolacPrint
PHOTO #: 2 of 19



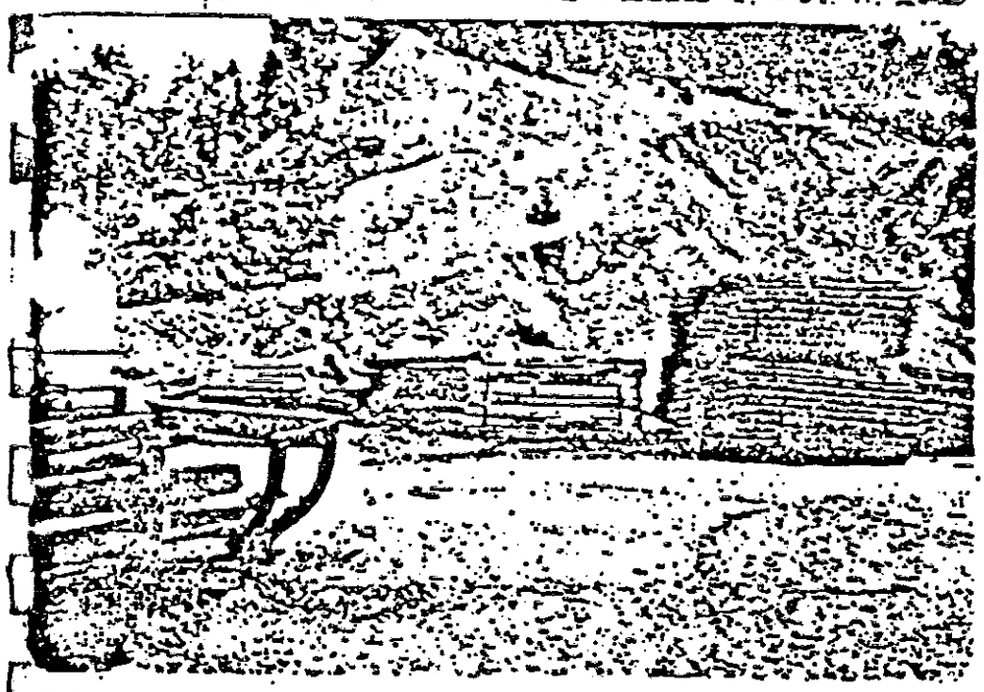
SUBJECT: Sample pt #3 (A3)
LOCATION: drainage pipe NW of Ashwood office
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7S 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1:
NEGATIVE LOCATION: ADPC+E FILE #:
PROCESSED BY: [illegible]

SUBJECT: Drainage ditch downgrad [illegible]
LOCATION: sample pt #2 (top left corner of [illegible] looking NNE
CITY: Cricket COUNTY: Boone STAT[illegible]
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAI[illegible]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/[illegible]
NEGATIVE LOCATION: ADPC+E FILE
PROCESSED BY: Kolor Print
PHOTO #: 4 of 19

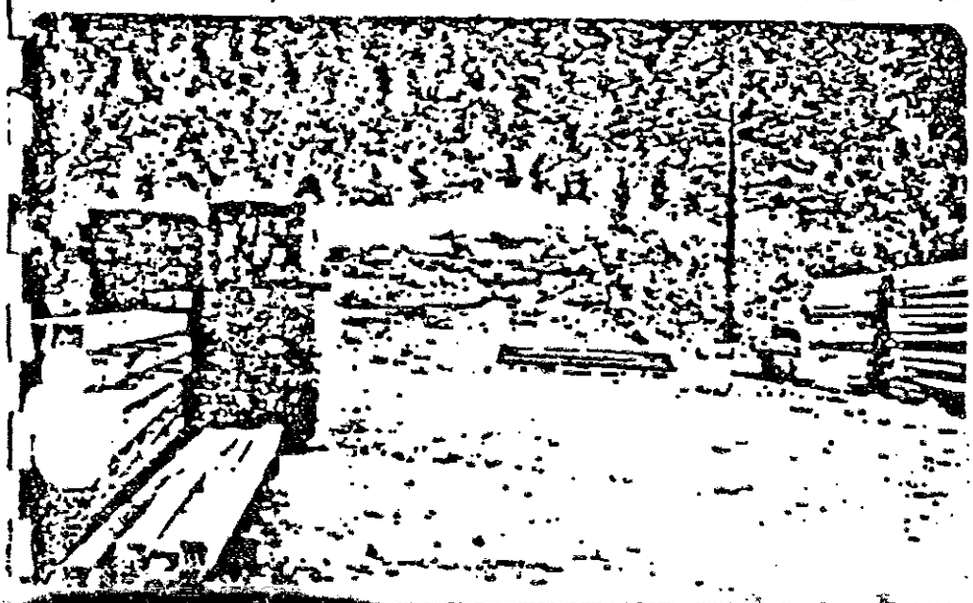
SUBJECT: Closer view of material in
LOCATION: ditch (photo #4)
CITY: Cricket COUNTY: Boone STATE: [illegible]
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SN[illegible]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/[illegible] f: [illegible]
NEGATIVE LOCATION: ADPC+E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 5 of 19

SUBJECT: End point of drainage pattern [illegible]
LOCATION: photo 4,5 looking east
CITY: Cricket COUNTY: Boone STATE: [illegible]
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SN[illegible]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/[illegible] f: [illegible]
NEGATIVE LOCATION: ADPC+E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 6 of 19

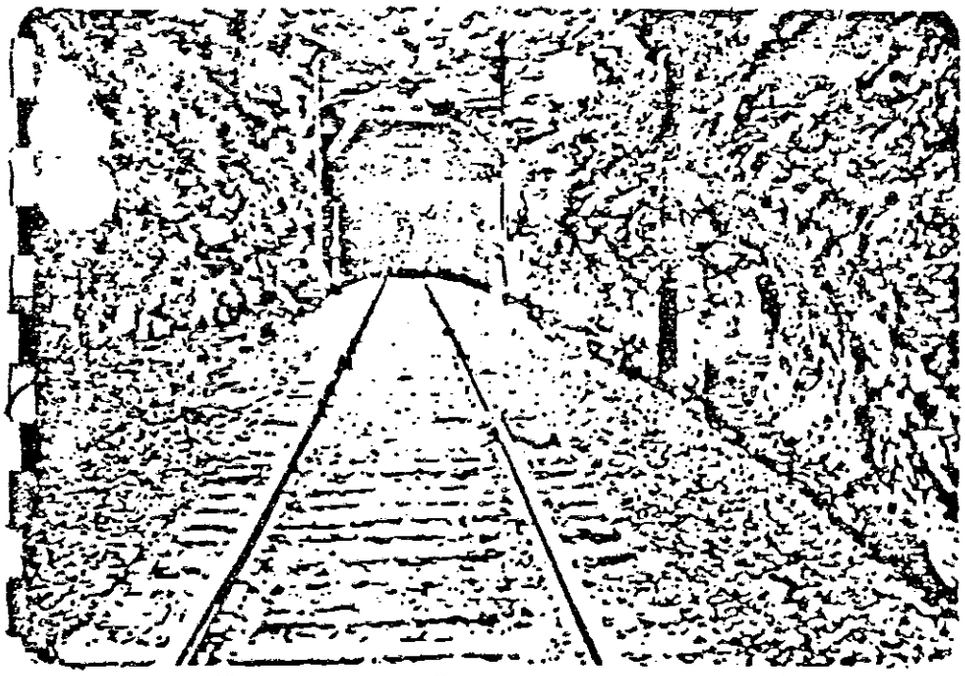
SUBJECT: Tank previously used to hand wa
LOCATION: from treating plant (note center-lo of photo catch basin of photo
CITY: Cricket COUNTY: Boone STATE:
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN]
PHOTOGRAPHER (Sig.) [signature]
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1:
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 7 of 19



SUBJECT: Soil of hillside - day/chest
LOCATION: Southern portion of Ashmead near County Road, looking SE
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNO
PHOTOGRAPHER (Sig.) [signature]
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 8 of 19



SUBJECT: Outcrop of bedrock (looking SW
LOCATION: Adjacent to county road at southern boundary of Ashmead
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 5, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNO
PHOTOGRAPHER (Sig.) [signature]
WITNESS:
CAMERA: Minolta 7s 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto 1: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 9 of 19



SUBJECT: Southeast entrance to RR tunnel
LOCATION: Adjacent to Ashwood (note: discoloration of ditch at water)
CITY: Cricket COUNTY: Boone STATE:
DATE: Oct. 6, 1981 TIME:
WEATHER: [SUN] [HAZE] ~~[CLOUDY]~~ [RAIN]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f:
NEGATIVE LOCATION: ADPC&E FILE #:
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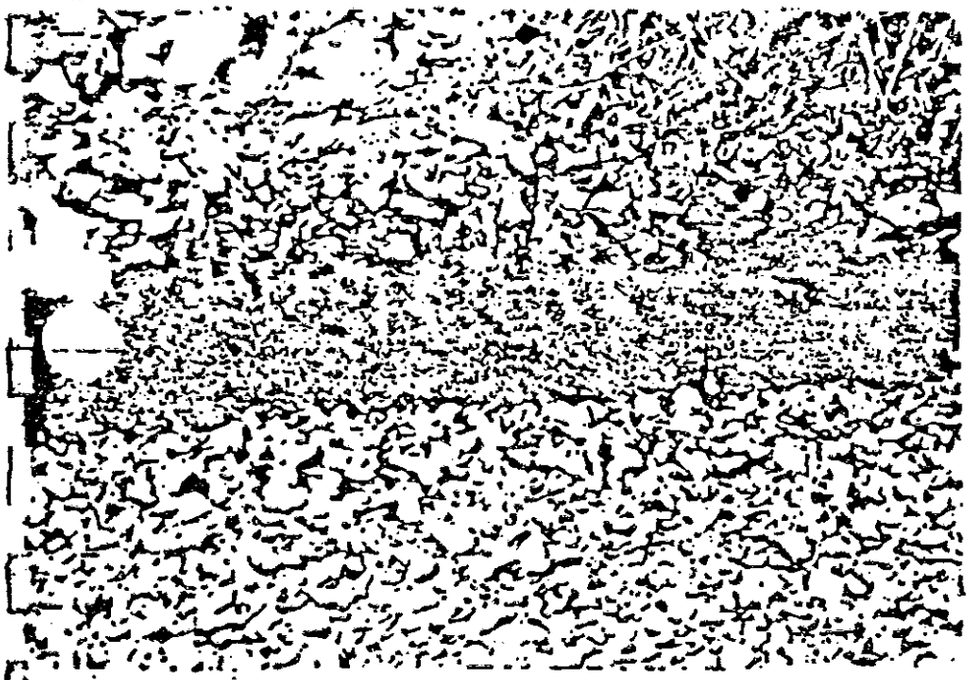
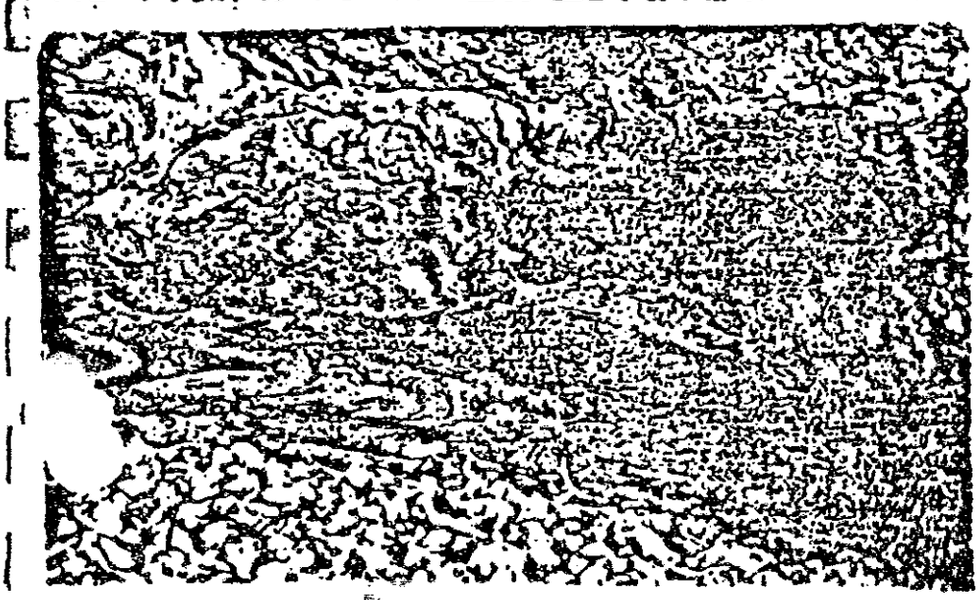
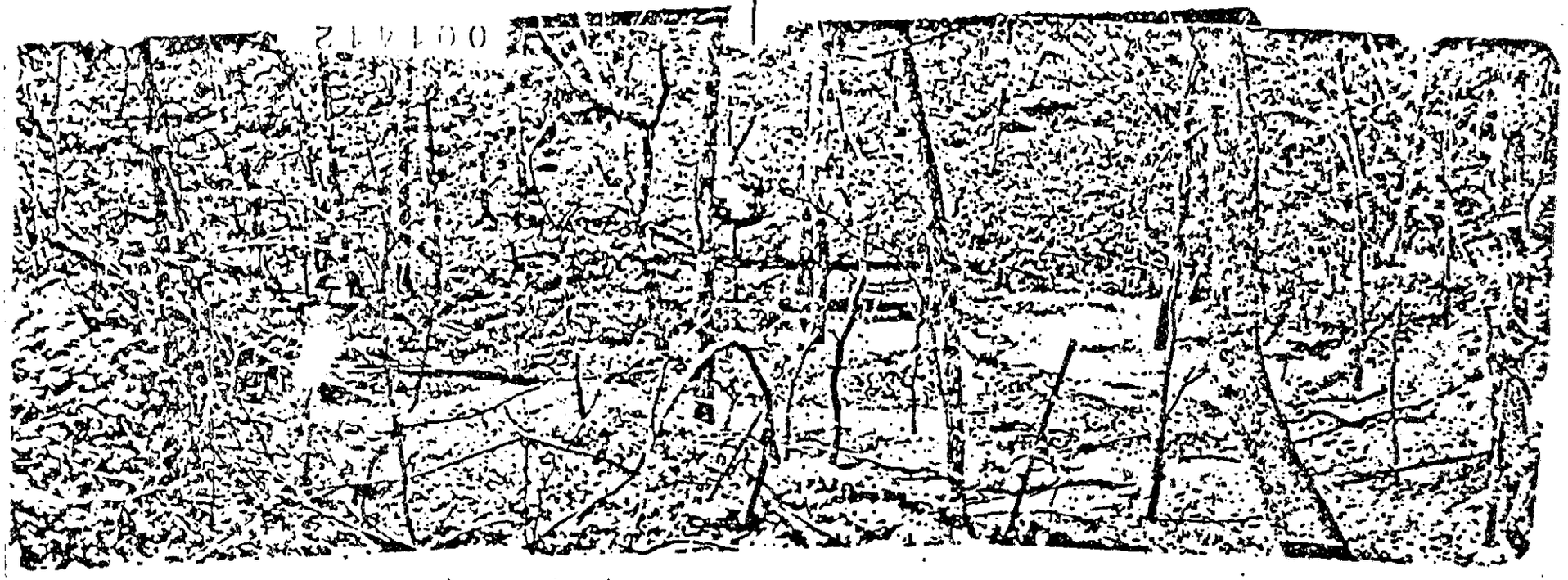
PHOTO #: 10 of 19



SUBJECT: RR ditch northern side (right
LOCATION: side of RR in photo #10)
looking NE
CITY: Cricket COUNTY: Boone STATE: Ln
DATE: Oct. 6, 1981 TIME:
WEATHER: [SUN] [HAZE] ~~[CLOUDY]~~ [RAIN] [SNO
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 11 of 19



SUBJECT: Southern RR ditch (left side
LOCATION: of RR in photo #10)
looking SW
CITY: Cricket COUNTY: Boone STATE: A
DATE: Oct. 6, 1981 TIME:
WEATHER: [SUN] [HAZE] ~~[CLOUDY]~~ [RAIN] [SN
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35 mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Au
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 12 of 19

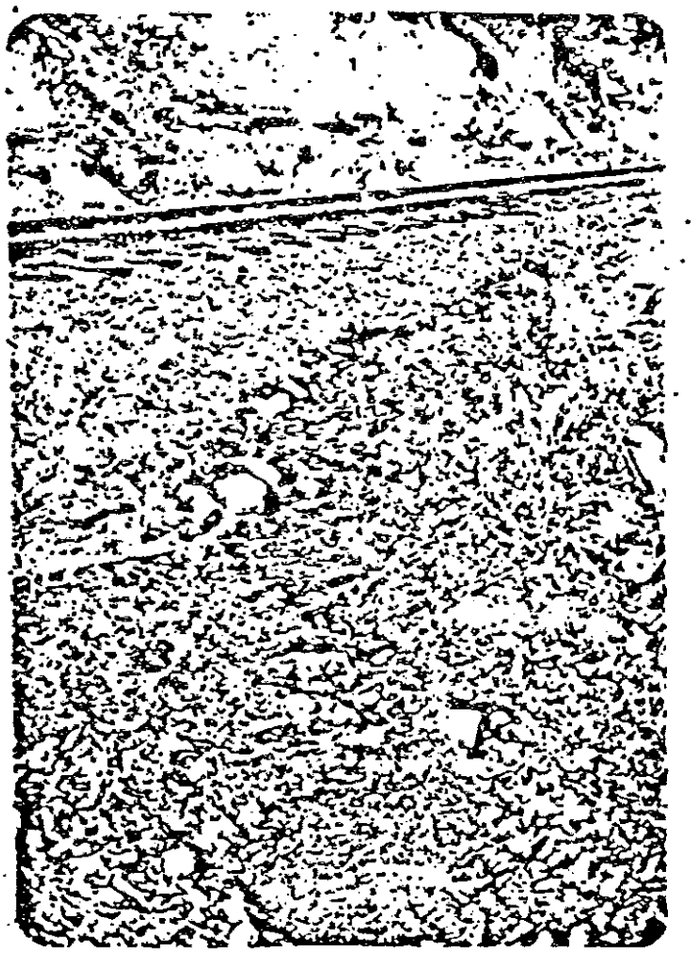


Panoramic View working South

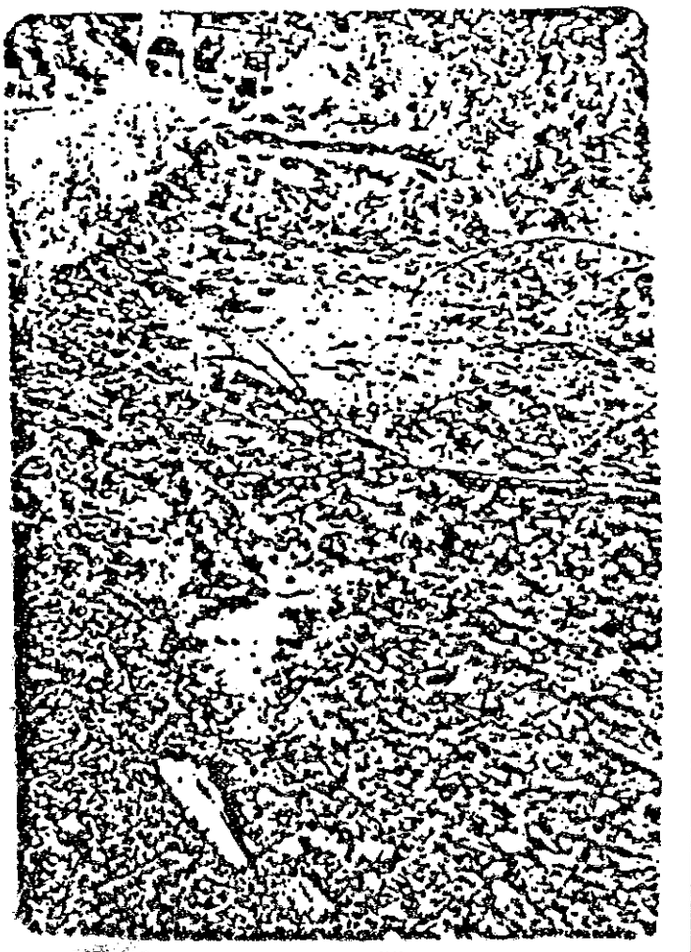
SUBJECT: End point of drainage from
LOCATION: Southern RR ditch (photo #13) - possible sinkhole - note stain on tree
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1987 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Rotter
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 13 of 19

(5)

(6)



SUBJECT: Nathan RR ditch as it turns
LOCATION: away from tracks - sample pt # 6(CO) looking SSW
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) [illegible]
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC-E FILE #:
PROCESSED BY: Kolor Point
PHOTO #: 14 of 19

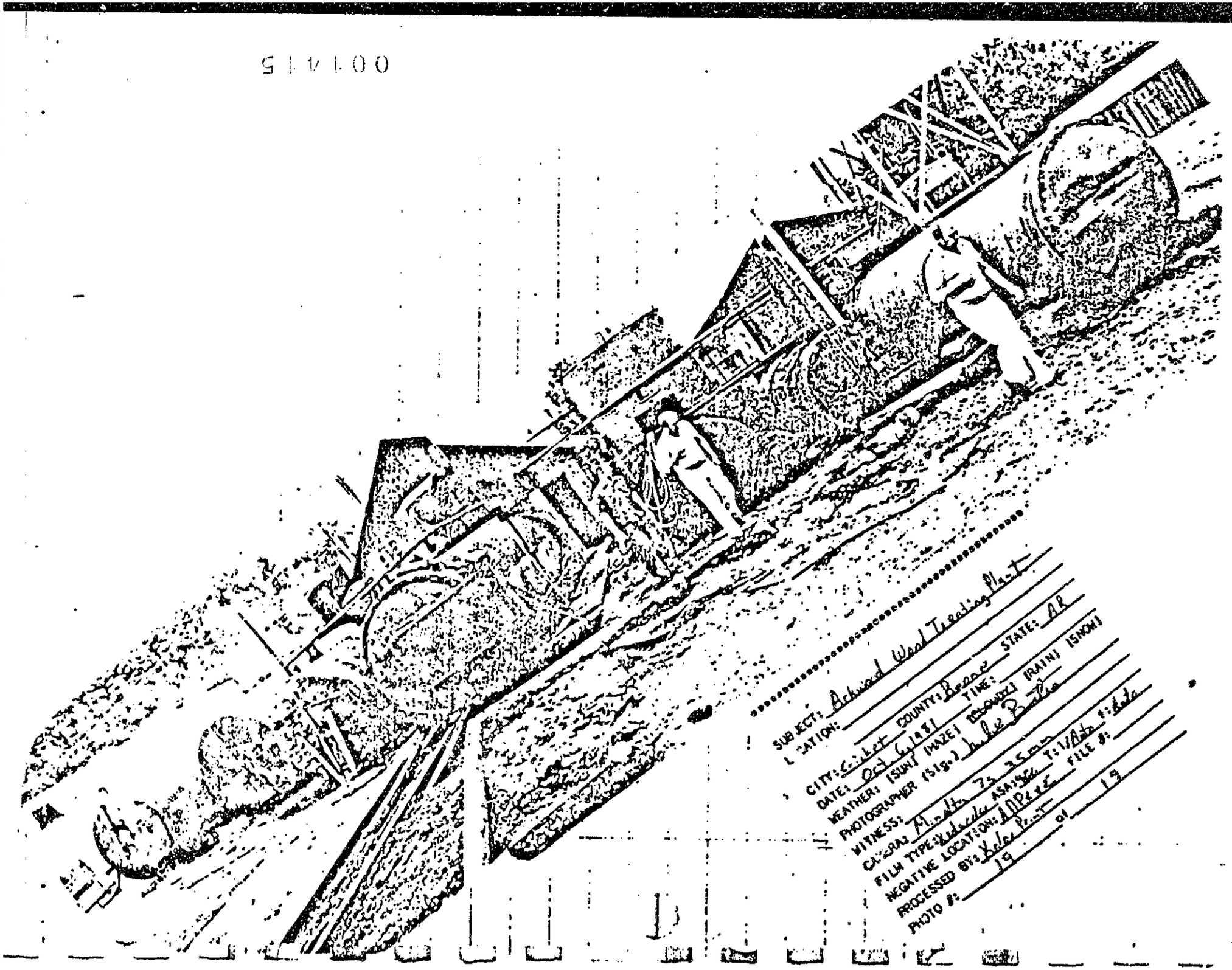


SUBJECT: Impoundment adjacent to RR below
LOCATION: discharge pipes behind Arkwood office, looking east
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1981 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) [illegible]
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC-E FILE #:
PROCESSED BY: Kolor Point
PHOTO #: 15 of 19

SUBJECT: Discharge behind Ackwood office
LOCATION: sample pt # 8 (A-8) (note stained slope below pipe) looking south
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1987 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Point
PHOTO #: 16 of 19

SUBJECT: Trend. up stream of sample pt # 5 (A-5)
LOCATION: wet discoloration of water and film on surface, looking south
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1987 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Point
PHOTO #: 17 of 19

SUBJECT: Sample pt. # 5 (A-5) - Walnut Grove
LOCATION: looking north
CITY: Cricket COUNTY: Boone STATE: AR
DATE: Oct. 6, 1987 TIME:
WEATHER: [SUN] [HAZE] [CLOUDY] [RAIN] [SNOW]
PHOTOGRAPHER (Sig.) Mike Bates
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 400 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Point
PHOTO #: 18 of 19


SUBJECT: Arkwood Wood Treating Plant
LOCATION:
CITY: Gilbert COUNTY: Boone STATE: AR
DATE: Oct 6, 1981 TIME:
WEATHER: (SUN) (HAZE) (CLOUDY) (RAIN) (SNOW)
PHOTOGRAPHER (Sig.) Julie Bratton
WITNESS:
CAMERA: Minolta 7s 35mm
FILM TYPE: Kodacolor ASA: 200 T: 1/Auto f: Auto
NEGATIVE LOCATION: ADPC&E FILE #:
PROCESSED BY: Kolor Print
PHOTO #: 19 of 19

Reference 6

Letter McClelland Consulting Engineers, Inc.
To: Doice Hughes, ADPCE: From Charles McLaughlin
May 22, 1984

Attachment "A"

STATE OF ARKANSAS

DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

8001 NATIONAL DRIVE
LITTLE ROCK, ARKANSAS 72209

501-371-1701 GEN OFFICE
501-371-1701 AIR DIVISION
501-371-1701 SOLID WASTE DIV
501-371-1701 WATER DIV
501-371-2130 BUS OFFICE

MEMORANDUM

TO: J. B. Jones

FROM: R. David Orr

DATE: July 29, 1981

SUBJECT: Arkwood Preservative Plant near Omaha

At approximately 10:09 a.m. on June 19, 1981, I arrived at Arkwood Preservative Plant near Cricket, approximately 16 miles northwest of Harrison on Highway 65. Accompanying me on the complaint inspection was Mike Youngblood, Boone County Sanitarian, Arkansas Department of Health. At the plant office, we met Mr. Roy Horn, Plant Manager. We told Mr. Horn about the complaint we received ("Bad looking water coming from a spring inside a railroad tunnel adjacent to the Arkwood property), and told him that we would like a short tour of the treatment process.

Their treatment process involves steam pressure treatment with pentachlorophenol and cresote on a four-day cycle. After treatment, the wood posts are piled in small groups to cure. No means of containment was observed below the piles. There was a level area of "clayish" gravel soil.

Mr. Youngblood and I both observed several pools of blackish water on the property and adjacent to the property along a railroad right of way.

After the tour of the treatment process, we drove along the railroad tracks to a tunnel where a repair crew was repairing tracks. There we met Mr. Gary Benham, Motor Car Operator. We told Mr. Benham why we were there and he said, "I'll show you some bad water on the far side of the tunnel."

Inside the tunnel we observed a spring flowing from the north side which discharged through metal pipes. The water appeared clear. Futher inside the tunnel we observed another spring flowing about 30 feet above the tracks. This water appeared somewhat clear but further down the ditch, it formed an oil film on the surface and stained the walls and dirt surfaces. On the east side of the tunnel, we observed more oil film which collected in pools. The drainage flowed off the railroad track right of way into a large pool of water with a thick brownish

oil film on top. Further study showed this creek to flow into Barren Creek, a tributary to Bull Shoals Lake.

Samples were taken on the east side of the tunnel (Special Ø1 at 10:45 a.m.), inside tunnel at west end below westside spring on southside (Special Ø2 at 10:53 a.m.), and at the spring on the north side of the tunnel (Special Ø3 at 11:01 a.m.). These samples were flown to Little Rock at 5:20 p.m.

I feel that the Arkwood Preservative Plant near Cricket has caused considerable environmental damage. Drinking water in the area and associated tributaries have been contaminated. I feel that this matter should be turned over to the legal section for review, and to the hazardous waste section for future sampling.

Since Bull Shoals Lake is affected, the Missouri Department of Natural Resources should be notified. The Corps of Engineers, Fish and Wildlife Service, and the Arkansas Game and Fish Commission should also be notified.

If I can be of assistance, please feel free to contact me.

RDO;vp

cc: Bob Blanz
Cheryl Terai
Jim Shell
Doice Hughes

Attachment "B"

ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

MEMORANDUM

TO : David Orr, Field Inspector, Compliance and T.A. Branch

FROM : Richard Thompson, Chemist Supervisor-Water, Technical Services

DATE : June 24, 1981

SUBJECT: Analysis of Samples From ArkWood Wood Treating Plant

The analysis of the samples you submitted on May 20, 1901, has been completed and the results are listed below.

Sample #	Log #	Description	Pentachlorophenol
1	24503	East Side of Tunnel	8.56 mg/l
2	24504	Inside Tunnel At Wastand	2.1 mg/l
3	24505		not detected

dp

ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

MEMORANDUM

TO: Bob Blanz, Deputy Director

FROM: Mike Bates, Hazardous Waste Inspector MB

DATE: October 12, 1981

SUBJECT: Arkwood, Inc. at Cricket (South of Omaha)

Arkwood, Inc. of Omaha is located on 15-20 acres in Sec. 27 T21NR21W in Boone County, Arkansas. The business consists of a millwork shop, a woodtreating operation using pentachlorophenol and cresote and the storage of the treated wood products before sale.

David Orr of our Fayetteville office received a complaint about "bad looking water coming from a spring inside a railroad tunnel adjacent to the Arkwood property" and made an inspection along with the Boone County Sanitarian, Mike Youngblood on June 19, 1981 (see Attachment "A"). David took three water samples at the railroad tunnel, please refer to attached analysis (Attachment "B").

Arkwood, Inc. notified under RCRA as a generator of hazardous waste. I visited the site on October 5 and 6, 1981, for the purpose of conducting an interim status standards inspection and to follow-up the initial complaint.

Arkwood was founded and originally operated by H. C. Ormand in the early 1960's (approximately 1962). Mr. Ormand leased the process and land to Mass Merchandisers, Inc. of Harrison in the mid 1970's. Mass Merchandisers are the current operators of the site. Their representatives, Bob Barker and Devoe Gregory of the Wood Products Group, supplied the background information for this report during a meeting on October 6, 1981.

The wastes from the wood treating operation, according to Mr. Barker and Mr. Gregory, were dumped into a cave at the treating plant from the beginning of the operation to around 1970 when the cost of the treatment chemicals forced a recovery system to be employed. The cave was covered by boarding the entrance up and covering it with a layer of dirt (the entrance is flush with the ground surface). Currently the wastes consists of the wash down of the treatment room floor and the cleaning of the treatment cylinder between the use of penta and cresote. These wastes are accumlated in a tank and then spread over the storage yard for use as dust control. Mr. Barker estimated they generate approximately 500 gallons/year (6-7000 lbs/year) of these wastes. Steam is also used in the treatment process, the steam is said to be reused in the process, some is bled off to discharge behind the office building adjacent to Missouri Pacfic railroad.

Arkwood could be classified as a Small Quantity Generator, according to the generation amounts furnished by Mr. Barker, if they dispose of their waste properly. Arkwood is presently disposing of their waste improperly by spreading the material for dust control and by dumping it in several places at the northeastern end of their property near Highway 65. The frequency of these "dumps" are approximately every three weeks according to a Roy Horn, treatment

plant manager. The area around the treatment plant is saturated with the treatment chemicals. There are pools of oily material around the treatment cylinder and the storage tanks. The tanks are not diked (with the exception of the raw penta storage tank) nor is there any other type of containment to prevent the washing of the oily substances off-site during rains. The storage yard where the treated wood products are taken to "cure" is saturated in many areas with what appears to be the treatment chemicals leaching from the wood products. Mr. Horn indicated that this saturated soil is scooped out periodically and piled up along the entrance road when the storage areas get too mushy to operate the machinery.

The steam bleed off discharge, as mentioned above, exists on the slope behind the office building. The slope below the discharge pipes is oil stained; at the base of the stained area there is an impoundment which contains a black oily looking liquid. Mr. Horn said that nothing was discharged through the pipes except steam and that nothing had been put in the impoundment for years. The impoundment is approximately 15'X40', depth unknown. There was approximately 2' of freeboard with no evidence of overtopping. The impoundment is located adjacent to the Missouri Pacific railroad and approximately 400' northwest of the railroad tunnel mentioned in the initial complaint.

The tunnel lies in a northwest/southeast line and is approximately 1/2-3/4 of a mile in length. There is a construction crew working on the northwest entrance of the tunnel to widen it. They have been working on the tunnel since the first of the year, the work has reportedly involved a considerable amount of blasting. Gary Benham, with the construction crew, accompained me into the tunnel on October 5, 1981. There are three springs inside the tunnel; the first of which (approaching from the northwest) is located about halfway through the tunnel on the northern side. The other two are located in the southeast one-third of the tunnel, discharging from the south side of the tunnel. The first two springs discharge through pipes imbedded in the tunnel wall approximately 20-30' above the tracks. The southeastern most spring breaks out near the roof. Mr. Benham stated that the crew complained that the spray from the springs burned their eyes.

The water in the ditches along the tracks was brown in color and had a dark brown to black film on the surface. The tunnel walls and sides of the ditches were oil stained. Both ditches showed signs of contamination, however, the southern ditch appears to be more heavily contaminated.

The southern ditch flows southeasterly from the tunnel for about 1000' before it drops off into a depression formed by the points of two ridges intersecting the railroad. The trees growing in the bottom of this depression had oil stains on them up to 12' above the present level of the water (with oil film). This depression is the receiving point of three drainage patterns (see Attachments "D" and "E"). I did not observe a drainage point out of the depression under the railroad. This depression could possibly be a sinkhole. Mark Witherspoon of our staff agrees with this possibility but indicated that a closer study would be needed to confirm it.

The northern ditch also flows in a southeasterly direction for about 1000' before turning north and dropping sharply to intersect Walnut Creek on the eastern side of the railroad. The tunnel springs appear to be supplying most of the water in Walnut Creek at the present time. The creek bed is dry approximately 600' downstream from the point where the tunnel spring water intersects the creek. The rocks in the dry bed of Walnut Creek are tinted brown whereas the rocks of an intersecting intermittent stream from the northeast (dry also) are not. This could be an indication of the past flow of contaminates down Walnut Creek.

Nine samples were taken during the inspection. Locations of the samples are shown in Attachments "C" and "D", sample description on Attachment "F". Sample analysis for pentachlorophenol and cresote should be available around October 14th. Numerous photographs were taken and will be furnished when processed. The Arkwood property lies on the Pitkin limestone formation. The contaminated water flows southeast from the railroad tunnel to an area underlain by the Powell Dolomite and the Cotter and Jefferson City Dolomites. These formations are typically intermittently solutionized along jointing patterns. Solutionization may be retarded due to the chert content.

Omaha city water extends along Highway 65 for about one mile south of Arkwood. This according to Ralph Scroggins who owns the house and mobile home at the intersection of Highway 65 and the road leading to Cricket. Mr. Scroggins also said the city lines do not extend off of Highway 65 very far. There are approximately 14 homes which use individual wells as drinking water within a mile radius of Arkwood, assuming that all of the residences within the city limits are on city water and discounting the homes along Highway 65 which should also be on city water.

The Omaha city water supply is a well located in the NE¼, NE¼ Sec. 27T21NR21W, inside the city limits near the Post Office. This well is also within one mile of the site, the total depth of the well is 1315' with a casing depth of 60'. The only water well sample taken was from Arkwood. The depth of the well is unknown, however, Mr. Horn stated that the pump (submergable) was set at 920'.

We have recently received another complaint from a representative of the railroad who charges that a wood treating plant near Cricket is letting liquid wood preservatives out of a holding area and that this material is getting into a railroad tunnel. The complainant also states that railroad people are getting sick from the fumes in the tunnel. This complaint does have some validity to it. There is definitely wood treating chemicals getting into the tunnel, however, as stated earlier I did not observe any discharge or evidence of the overtopping of the dikes of the impoundment below Arkwood. The railroad people may be getting sick from fumes inside the tunnel, but I think the fumes would more likely be coming from the train engine exhausts, especially since the trains have to travel at a slow speed through the tunnel (complainant reports 10 m.p.h.).

The Arkwood wood treating plant is a serious threat to the groundwater and surface water quality in the area. The representatives of Arkwood have voiced their willingness to cooperate and do what is necessary, within their means,

to alleviate any environmental damage stemming from their operation. There are several things, in my opinion, which should be accomplished.

1. Seal the on-site cave, with concrete or other water tight material, to prevent any contaminates from entering it.

2. Cease the on-site dumping or spreading of wastes from the treating process.

3. Clean-up of all contaminated soil on-site and properly disposal of it.

4. Establish dip pads and runoff containment for the treated wood products storage area.

5. Eliminate any oily discharge and close out or maintain the impoundment according to RCRA (if it contains a hazardous waste).

6. Determine source of contamination inside tunnel and implement measures to correct it.

7. Clean-up all off-site contamination.

8. Sample residential wells in area for presence of contaminantes.

Please advise as to what action should be taken.

MB/rlb

cc: Dolce Hughes
J.B. Jones

001423

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
ARKANSAS GEOLOGICAL COMMISSION

WATER-RESOURCES RECONNAISSANCE OF THE OZARK PLATEAUS PROVINCE, NORTHERN ARKANSAS

By
A. G. Lamonds

HYDROLOGIC INVESTIGATIONS
ATLAS HA-383

PUBLISHED BY THE U.S. GEOLOGICAL SURVEY
WASHINGTON D.C. 20242
1972

Reference 8

EPA Site Inspection Report, Form 2070-3 prepared by Doice Hughes, ADPCE
3/27/85

001425

RECEIVED
EPA ... 1985 APR -8 ... 54

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT

REGION VI | SITE NUMBER (to be assigned by HQ)

GENERAL INSTRUCTIONS: Complete Sections I and III through IV of this form as completely as possible. Then use the information on this form to develop a Tentative Disposition (Section II). File this form in its entirety in the regional Hazardous Waste Log File. Be sure to include all appropriate Supplemental Reports in the file. Submit a copy of the forms to: U.S. Environmental Protection Agency; Site Tracking System, Hazardous Waste Enforcement Task Force (EN-335), 401 M St., SW, Washington, DC 20460.

I. SITE IDENTIFICATION

A. SITE NAME: ARKWOOD PLANT

B. STREET (or other identifier):

C. CITY: Omaha | D. STATE: AR | E. ZIP CODE: 72662 | F. COUNTY NAME: Boone

G. SITE OPERATOR INFORMATION

1. NAME: Mass Merchandisers, Inc. | 2. TELEPHONE NUMBER: (501) 741-3425

3. STREET: Box 790 | 4. CITY: Harrison | 5. STATE: AR | 6. ZIP CODE: 72601

H. REALTY OWNER INFORMATION (if different from operator of site)

1. NAME: Bud Grisham (for H.C. Ormand) | 2. TELEPHONE NUMBER: (214) 521-9102

3. CITY: #3-C 3525 Turtle Creek Bldv., Dallas | 4. STATE: TX | 5. ZIP CODE: 78219

I. SITE DESCRIPTION: PCP wood treating plant

J. TYPE OF OWNERSHIP

☐ 1. FEDERAL ☐ 2. STATE ☐ 3. COUNTY ☐ 4. MUNICIPAL ☒ 5. PRIVATE

II. TENTATIVE DISPOSITION (complete this section last)

A. ESTIMATE DATE OF TENTATIVE DISPOSITION (mo., day, & yr.): 10/12/81

B. APPARENT SERIOUSNESS OF PROBLEM

☐ 1. HIGH ☒ 2. MEDIUM ☐ 3. LOW ☐ 4. NONE

C. PREPARER INFORMATION

1. NAME: D.L. Hughes | 2. TELEPHONE NUMBER: (501) 562-7444 | 3. DATE (mo., day, & yr.): 3/27/85

III. INSPECTION INFORMATION

A. PRINCIPAL INSPECTOR INFORMATION

1. NAME: Michael Bates | 2. TITLE: Hazardous Waste Inspector

3. ORGANIZATION: Arkansas Dept. of Pollution Control & Ecology | 4. TELEPHONE NO. (area code & no.): (501) 562-7444

B. INSPECTION PARTICIPANTS

1. NAME	2. ORGANIZATION	3. TELEPHONE NO.
Bob Blanz	AR Dept. of Pollution Control & Ecology	(501) 562-7444
Mike Bates	AR Dept. of Pollution Control & Ecology	(501) 562-7444
D. L. Hughes	Ar Dept. of Pollution Control & Ecology	(501) 562-7444

C. SITE REPRESENTATIVES INTERVIEWED (corporate officials, owners, residents)

1. NAME	2. TITLE & TELEPHONE NO.	3. ADDRESS
Roy Horn	Plant Manager (501) 741-3425	Bx 790, Harrison, AR 72601
Bob Barker	Vice President (501)741-3425	Bx 790, Harrison, AR 72601
Devoe Gregory	Purchas. Agent (501)741-3425	Bx 790, Harrison, AR 72601

Continued From Front

III. INSPECTION INFORMATION (continued)

D. GENERATOR INFORMATION (sources of waste)

1. NAME	2. TELEPHONE NO.	3. ADDRESS	4. WASTE TYPE GENERATED
Mass Merchandisers	501-741-3425	Bx 790, Harrison, AR 72601	PCP-Creosote

E. TRANSPORTER/HAULER INFORMATION

1. NAME	2. TELEPHONE NO.	3. ADDRESS	4. WASTE TYPE TRANSPORTED
N/A			

F. IF WASTE IS PROCESSED ON SITE AND ALSO SHIPPED TO OTHER SITES, IDENTIFY OFF-SITE FACILITIES USED FOR DISPOSAL.

1. NAME	2. TELEPHONE NO.	3. ADDRESS
N/A		

G. DATE OF INSPECTION (Mo., day, & yr.): 10/5/81

H. TIME OF INSPECTION: 9:00 a.m.

I. ACCESS GAINED BY: (Documentation must be shown in all cases) [X] 1. PERMISSION [ ] 2. WARRANT

J. WEATHER (Describe): Clear

IV. SAMPLING INFORMATION

A. Mark "X" for the types of samples taken and indicate where they have been sent e.g., regional lab, other EPA lab, contractor, etc. and estimate when the results will be available.

1. SAMPLE TYPE	2. SAMPLE TAKEN (Mark "X")	3. SAMPLE SENT TO:	4. DATE RESULTS AVAILABLE
a. GROUNDWATER	X	See attached analyses	4/4/85
b. SURFACE WATER	X	See attached analyses	
c. WASTE	X	See attached analyses	
d. AIR			
e. RUNOFF	X	See attached analyses	
f. SPILL			
g. SOIL			
h. VEGETATION			
i. OTHER (specify)			

B. FIELD MEASUREMENTS TAKEN (e.g., radiation, explosivity, pH, etc.)

1. TYPE	2. LOCATION OF MEASUREMENTS	3. RESULTS
NONE		

001427

Continued From Page 2

IV. SAMPLING INFORMATION (continued)

C. PHOTOS

1. TYPE OF PHOTOS: [X] a. GROUND [ ] b. AERIAL
2. PHOTOS IN CUSTODY OF: Mike Bates

D. SITE MAPPED?

[ ] YES, SPECIFY LOCATION OF MAPS: Not mapped.

E. COORDINATES

1. LATITUDE (deg.-min.-sec.): 36° 26' 45" North
2. LONGITUDE (deg.-min.-sec.): 93° 12' 0" West

V. SITE INFORMATION

A. SITE STATUS

[ ] 1. ACTIVE (These industrial or municipal sites which are being used for waste treatment, storage, or disposal on a continuing basis, even if infrequently.)

[X] 2. INACTIVE (These sites which no longer receive wastes.)

[ ] 3. OTHER (specify): _____ (These sites that include such incidents like "midnight dumping" where no regular or continuing use of the site for waste disposal has occurred.)

B. IS GENERATOR ON SITE?

[X] 1. NO [ ] 2. YES (specify generator's four-digit SIC Code): _____

C. AREA OF SITE (in acres): 20

D. ARE THERE BUILDINGS ON THE SITE?

[ ] 1. NO [X] 2. YES (specify): Plant and office buildings.

VI. CHARACTERIZATION OF SITE ACTIVITY

Indicate the major site activity(ies) and details re[illegible] to each activity by marking 'X' in the appropriate boxes.

X	A. TRANSPORTER	X	B. STORER	X	C. TREATER	X	D. DISPOSER
	1. RAIL		1. PILE		1. FILTRATION		1. LANDFILL
	2. SHIP		2. SURFACE IMPOUNDMENT		2. INCINERATION		2. LANDFARM
	3. BARGE	X	3. DRUMS	X	3. VOLUME REDUCTION	X	3. OPEN DUMP
	4. TRUCK	X	4. TANK, ABOVE GROUND		4. RECYCLING/RECOVERY	X	4. SURFACE IMPOUNDMENT
	5. PIPELINE	X	5. TANK, BELOW GROUND	X	5. CHEM./PHYS./TREATMENT		5. MIDNIGHT DUMPING
	6. OTHER (specify):		6. OTHER (specify):		6. BIOLOGICAL TREATMENT		6. INCINERATION
					7. WASTE OIL REPROCESSING	X	7. UNDERGROUND INJECTION
					8. SOLVENT RECOVERY	X	8. OTHER (specify):
					9. OTHER (specify):		Open burning

E. SUPPLEMENTAL REPORTS: If the site falls within any of the categories listed below, Supplemental Reports must be completed. Indicate which Supplemental Reports you have filled out and attached to this form.

[X] 1. STORAGE [ ] 2. INCINERATION [ ] 3. LANDFILL [X] 4. SURFACE IMPOUNDMENT [ ] 5. DEEP WELL

[X] 6. CHEM/BIO/PHYS TREATMENT [ ] 7. LANDFARM [ ] 8. OPEN DUMP [ ] 9. TRANSPORTER [ ] 10. RECYCLER/RECLAIMER

VII. WASTE RELATED INFORMATION

A. WASTE TYPE

[X] 1. LIQUID [X] 2. SOLID [X] 3. SLUDGE [ ] 4. GAS

B. WASTE CHARACTERISTICS

[ ] 1. CORROSIVE [ ] 2. IGNITABLE [ ] 3. RADIOACTIVE [ ] 4. HIGHLY VOLATILE

[X] 5. TOXIC [ ] 6. REACTIVE [ ] 7. INERT [ ] 8. FLAMMABLE

[ ] 9. OTHER (specify):

C. WASTE CATEGORIES

1. Are records of wastes available? Specify items such as manifests, inventories, etc. below.

NO

Continued From Front

VII. WASTE RELATED INFORMATION (continued)

2. Estimate the amount (specify unit of measure) of waste by category; mark "X" to indicate which wastes are present.

a. SLUDGE	b. OIL	c. SOLVENTS	d. CHEMICALS	e. SOLIDS	f. OTHER
AMOUNT 15	AMOUNT 25,000	AMOUNT	AMOUNT	AMOUNT 458	AMOUNT 10
UNIT OF MEASURE cu. yd.	UNIT OF MEASURE gal.	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE cu. yd.	UNIT OF MEASURE cu. yd.
X (1) PAINT, PIGMENTS	X (1) OILY WASTES	X (1) HALOGENATED SOLVENTS	X (1) ACIDS	X (1) FLYASH	X (1) LAGOON PHARMA
(2) METALS SLUDGES	(2) OTHER (specify): PCP & Creosote	(2) NON-HALOGENTD. SOLVENTS	(2) PICKLING LIQUORS	(2) ASBESTOS	(2) HOSPITAL
(3) POTW		(3) OTHER (specify):	(3) CAUSTICS	(3) MILLING/MINE TAILINGS	(3) RADIOA
(4) ALUMINUM SLUDGE			(4) PESTICIDES	(4) FERROUS SMELTING WASTES	(4) MUNICIP
X (5) OTHER (specify): PCP & Creosote			(5) DYES/INKS	(5) NON-FERROUS 2b CTS. WASTES	X (5) OTHER (specify): PCP & Creosote contaminated sawdust
			(6) CYANIDE	X (6) OTHER (specify): PCP & Creosote contaminated soil	
			(7) PHENOLS		
			(8) HALOGENS		
			(9) PCB		
			(10) METALS		
			(11) OTHER (specify):		

3. LIST SUBSTANCES OF GREATEST CONCERN WHICH ARE ON THE SITE (place in descending order of hazard)

1. SUBSTANCE	2. FORM (mark "X") a. SOLID	b. LIQ.	c. VAP.	3. TOXICITY (mark "X") a. HIGH	b. MED.	c. LOW	d. NONE	4. CAS NUMBER	5. AMOUNT	6. UNIT
PCP		X		X				SM6300000		
Creosote		X			X			GF8615000		

VIII. HAZARD DESCRIPTION

FIELD EVALUATION HAZARD DESCRIPTION: Place an "X" in the box to indicate that the listed hazard exists. Describe the hazard in the space provided.

XX A. HUMAN HEALTH HAZARDS

PCP was found in the water wells, springs and ditches.

EPA Form [illegible]

Continued From Page 4

VII. HAZARD DESCRIPTION (continued)

☐ B. NON-WORKER INJURY/EXPOSURE

☐ C. WORKER INJURY/EXPOSURE

☒ D. CONTAMINATION OF WATER SUPPLY

PCP was found in residential water wells.

☐ E. CONTAMINATION OF FOOD CHAIN

☒ F. CONTAMINATION OF GROUND WATER

PCP was found in ground water

☒ G. CONTAMINATION OF SURFACE WATER

PCP was found in water from ditches and springs.

Continued from Front

VII. HAZARD DESCRIPTION (Continued)

X H. DAMAGE TO FLORA/FAUNA

Dead areas were seen at the impoundment at east end of RR tunnel, in ditches, on slope above west RR impoundment.

I. FIRE HAZ

J. CONTAMINATION OF AIR

XX K. NOTICEABLE ODORS

Odors were detected in spring water, at the RR impoundment, in ditches, and at spill-drip areas near pressure tank.

XX L. CONTAMINATION OF SOIL

Contaminated soil was found at the RR impoundment, at the spill-drip area near pressure tank, across road from west spring, product storage area, and in big impoundment at east end of RR tunnel.

XX M. PROPERTY DAMAGE

Damage to water wells. Behren's property was purchased by Mass Merchandisers, Inc

001451

Continued From Page 5

VII. HAZARD DESCRIPTION (continued)

X N. FIRE OR EXPLOSION

When oil gathered on top of the west RR impoundment it was set on fire to burn it off.

X O. SPILLS/LEAKING CONTAINERS/RUNOFF/STANDING LIQUID

There was spillage and leakage near pressure tank, drip pad areas and in the product storage area. Runoff from plant area contained PCP. There was standing liquid in both RR impoundments.

P. SEWER, STORM DRAIN PROBLEMS

Q. EROSION PROBLEMS

XX R. INADEQUATE SECURITY

There is no fence around the impoundments, and fence to plant site is too low to prevent ingress.

S. INCOMPATIBLE WASTES

VII. HAZARD DESCRIPTION (continued)

[X] T. MIDNIGHT DUMPING

Waste oils and water were dumped into a hole near plant door.

[ ] U. OTHER (specify)

IX. POPULATION DIRECTLY AFFECTED BY SITE

A. LOCATION OF POPULATION	B. APPROX. NO. OF PEOPLE AFFECTED	C. APPROX. NO. OF PEOPLE AFFECTED WITHIN UNIT AREA	D. APPROX. NO. OF BUILDINGS AFFECTED	E. DISTANCE TO SITE (specify units)
1. IN RESIDENTIAL AREAS	5	5		400 feet
2. IN COMMERCIAL OR INDUSTRIAL AREAS				
3. IN PUBLICLY TRAVELLED AREAS	100	100		50 feet
4. PUBLIC USE AREAS (parks, schools, etc.)				

X. WATER AND HYDROLOGICAL DATA

A. DEPTH TO GROUNDWATER (specify unit) 150 feet	B. DIRECTION OF FLOW probably westward	C. GROUNDWATER USE IN VICINITY drinking water
D. POTENTIAL YIELD OF AQUIFER 25 gpm	E. DISTANCE TO DRINKING WATER SUPPLY (specify unit of measure) 400 feet	F. DIRECTION TO DRINKING WATER SUPPLY West

G. TYPE OF DRINKING WATER SUPPLY

[X] 1. NON-COMMUNITY (< 15 CONNECTIONS) [ ] 2. COMMUNITY (specify name) (> 15 CONNECTIONS) _____

[ ] 3. SURFACE WATER [X] 4. WELL

Continued From Page 8

X. WATER AND HYDROLOGICAL DATA (continued)

H. LIST ALL DRINKING WATER WELLS WITHIN A 1/4 MILE RADIUS OF SITE

1. WELL	2. DEPTH (specify unit)	3. LOCATION (proximity to population/buildings)	4. NONCOMMUNITY (mark 'X')	5. COMMUNITY (mark 'X')
Birmingham old well	78	30' N. old residence	X	
Birmingham old well	805	30' SW of trailer	X	
Binam Behren #1	? 150'	20' south of residence	X X	
Behren #2	420'	500' NW of residence	X	
Behren #3	580'	100' south of residence	X	
Plant well	980'	on plant site.	X	

I. RECEIVING WATER

1. NAME: Crickett Creek

980' clear

☐ 2. SEWERS ☐ 3. STREAMS/RIVERS ☐ 4. LAKES/RESERVOIRS ☐ 5. OTHER (specify):

J. SPECIFY USE AND CLASSIFICATION OF RECEIVING WATERS

Cool water fishery, primary & secondary contact recreation, public water supply, industrial & agricultural water supply.

XI. SOIL AND VEGITATION DATA

LOCATION OF SITE IS IN

☐ A. KNOWN FAULT ZONE ☒ B. KARST ZONE ☐ C. 100 YEAR FLOOD PLAIN ☐ D. WETLAND

☐ E. A REGULATED FLOODWAY ☐ F. CRITICAL HABITAT ☒ G. RECHARGE ZONE OR SOLE SOURCE AQUIFER

XII. TYPE OF GEOLOGICAL MATERIAL OBSERVED

Mark 'X' to indicate the type(s) of geological material observed and specify where necessary the component parts.

'X'	A. OVERBURDEN	'X'	B. BEDROCK (specify below)	'X'	C. OTHER (specify below)
	1. SAND	X	Limestone		
X	2. CLAY				
	3. GRAVEL				

XIII. SOIL PERMEABILITY

☐ A. UNKNOWN ☐ B. VERY HIGH (100,000 to 1000 cm/sec.) ☐ C. HIGH (1000 to 10 cm/sec.)

XX D. MODERATE (10 to .1 cm/sec.) ☐ E. LOW (.1 to .001 cm/sec.) ☐ F. VERY LOW (.001 to .00001 cm/sec.)

G. RECHARGE AREA

XX 1. YES ☐ 2. NO 3. COMMENTS:

H. DISCHARGE AREA

XX 1. YES ☐ 2. NO 3. COMMENTS:

I. SLOPE

1. ESTIMATE % OF SLOPE: 4%

2. SPECIFY DIRECTION OF SLOPE, CONDITION OF SLOPE, ETC.: Westward - uniform slope

J. OTHER GEOLOGICAL DATA

See Thomas T. Millard Report.

Continued From Front

XIV. PERMIT INFORMATION

List all applicable permits held by the site and provide the related information.

A. PERMIT TYPE (e.g., RCRA, State, NPDES, etc.)	B. ISSUING AGENCY	C. PERMIT NUMBER	D. DATE ISSUED (mo., day, & yr.)	E. EXPIRATION DATE (mo., day, & yr.)	F. IN COMPLIANCE (State X) 1. YES	2. NO	3. UNK.
NO PERMITS ISSUED							

XV. PAST REGULATORY OR ENFORCEMENT ACTIONS

☐ NONE ☒ YES (summarize in this space)

A. O. is in last phase of preparation.

NOTE: Based on the information in Sections III through XV, fill out the Tentative Disposition (Section II) information on the first page of this form.

Reference 9

Record of Communication from Doice Hughes, ADPCE to Tim Perdue, EPA
3/26/85

RECORD OF COMMUNICATION	☐ PHONE CALL ☑ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (Record of item checked above)

TO:	FROM:	DATE / TIME
Tim Perdue, EPA	Doice Hughes ADPCE	DATE 3/26/85 TIME A.M.

SUBJECT

Arkwood Ave, disposal pit

SUMMARY OF COMMUNICATION

Durning my site visit and discussions with Doice he informed me that the size of the pit on site was correct as reported in Mike Bates October 12, 1981 memo, p. 2. He also informed me that the dept was approximately 3'. Therefore the dimensions are 15' x 40' x 3' = 1800 ft³ or ~~40~~ 68 yd³ FW

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES

TO: File Ark

EPA Form 1300-4 (7-72) REPLACES EPA HQ FORM 1300-5 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Reference 10

Memo from Doice Hughes, ADPCE to Tim Perdue, EPA
Received 4/10/85. Sub. Arkwood onsite well and demissions of onsite dump

ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY

MEMORANDUM

TO : Mike Bates, Hazardous Waste Inspector, Air and Hazardous Waste

FROM : Jay Justice, Hazardous Waste Chemist, Technical Services JJ

DATE : November 5, 1981

SUBJECT: Results From Analysis of Samples Taken at Arkwood on October 6, 1981

Steam discharge

#8 Water

Pentachlorophenol 21 ppm

#4 Water on site well

Pentachlorophenol <0.01 ppm

#9 Sediment

Pentachlorophenol 5600 ppm

#1 Sediment on site dump

Pentachlorophenol 30,000 ppm

#5 Water

Pentachlorophenol 2.8 ppm

#2 Sediment on site dump

Pentachlorophenol 23,000 ppm

#6 Water

Pentachlorophenol 3.4 ppm

#3 Water

Pentachlorophenol 18 ppm

#7 Water

Pentachlorophenol 2.0 ppm

dp

RECEIVED
EPA REGION VI
1985 APR 10 PM 5:01
SUPERFUND BRANCH

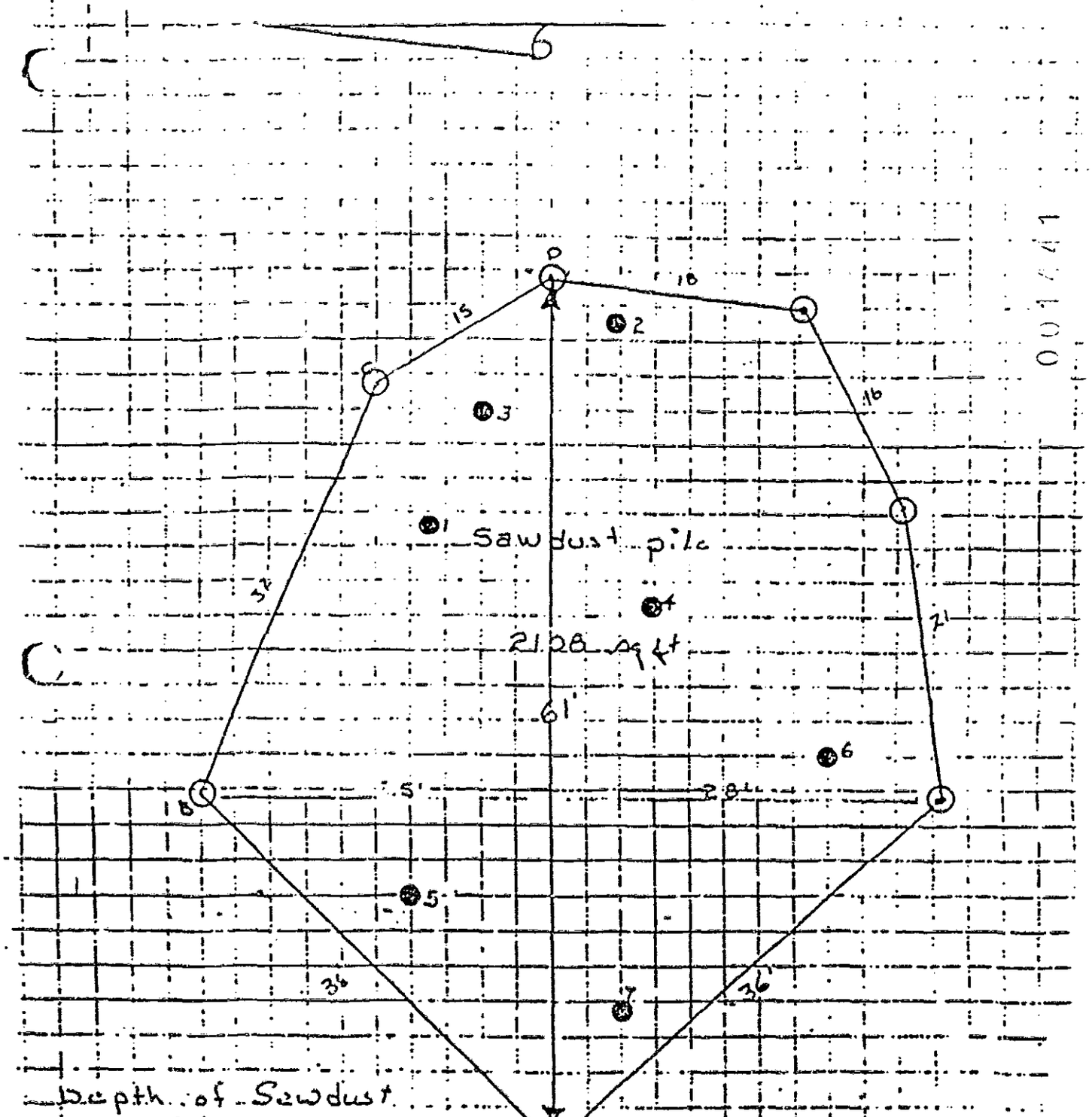
April 9, 1985

To: Tim Perdue
From: D L Hughes
Re: Ashwood

The on site water well did not show PCB at detection limit of .01. See Ashwood sample #9 on attached sheet.

The sawdust at Ashwood is contaminated - two samples were taken - 30,000 ppm & 23,000 ppm. See Ashwood sample #1 & 2 on attached sheet. The sawdust pile is approximately 275' x 150' x 4' (feet) i.e. 6,111 cu. yds.

D L Hughes



Depth of Sawdust

point #	
1	2 inches
2	27 "
3	6 "
4	18 "
5	4 "
6	7 "
7	4 "

Attachment "F"

Samples Taken During Inspection of Arkwood

Sample #	Description
Arkwood - 1	dump area - saw dust and oily material - black - approximately 350' NW of Highway 65 near NE property line
Arkwood - 2	dump area - sawdust and oil material - black - approximately 100' SW of Arkwood 1
Arkwood - 3 office -	water from drainage pipe leaving property NW of lightbrown - foamy
Arkwood - 4	water from office - (well on site) - pump set at 920'
Arkwood - 5	water from Walnut Creek
Arkwood - 6	North RR ditch (SE of tunnel) where it drops to Walnut Creek - water
Arkwood - 7	South RR ditch directly across from Arkwood - 6 - water
Arkwood - 8	discharge behind Arkwood office - water
Arkwood - 9	SE corner of impoundment below Arkwood - 8 - sediment

McCLELLAND CONSULTING ENGINEERS INC.

Environmental and Materials Testing
Civil, Environmental and Chemical Engineering Consulting

LITTLE ROCK
JAMES E. McCLELLAND, P.E.
FRED NIELSEN R.L.S.

FAYETTEVILLE
J.E. McCLELLAND, P.E.
VERNON E. [illegible], P.E.

July 12, 1983 81-161

Mr. Doice Hughes
Arkansas Department of Pollution
Control and Ecology
8001 National Drive
Little Rock, Arkansas 72209

Re: Arkwood
Omaha, Arkansas

Dear Mr. Hughes:

Six water samples were collected near the Arkwood Plant on June 28, 1983. The results of pentachlorophenol analyses on these samples are as follows:

Sample Description	PCP, mg/l
Railroad tunnel spring, south side, near east end	0.03
Spring west of plant, south of county road	10.0
Behren Well No. 2	< 0.00005
Behren Well No. 3	<0.00005
Run-off	0.87

The well samples have shown continued improvement with no PCP detected in these latest samples. However, during the last two sampling periods, the spring samples have had increased concentration of PCP. While we do not know what caused these increases, we can suggest two possible contributing factors:

Continued -

1010 N. COLLEGE AVE. P.O. BOX 1329 FAYETTEVILLE ARKANSAS 72702-1329 TELEPHONES (501) 443-4771/443-2577

(1) heavy rains and higher groundwater flows in the spring months may have "washed out" some of the waste material which had been deposited underground at the plant in years past; and (2) the very low spring flows on June 28th may have provided lower dilution volumes than in the past thereby resulting in higher PCP concentrations.

We plan to continue the sampling program at Arkwood over the next several months and will continue to inform you of the results. Meanwhile, please call if you have any questions.

Sincerely,

Charles McLaughlin, P.E.

CMcL/paa

cc: Mr. Bob Barker
Mr. Devoe Gregory

001444

McCLELLAND CONSULTING ENGINEERS INC.

Environmental and Materials Testing
Civil, Environmental and Chemical Engineering Consulting

ROCK
J.E. McCLELLAND, P.E.
FRED NIELSEN, R.L.S.

FAYETTEVILLE
J.E. McCLELLAND, P.E.
VERNON D. ROWE, P.

May 22, 1984 81-161

Mr. Doice Hughes
Arkansas Department of Pollution
Control and Ecology
8001 National Drive
Little Rock, Arkansas 72209

Re: Arkwood
Omaha, Arkansas

Dear Mr. Hughes:

Six water samples were collected near the Arkwood plant on May 11, 1984. The results of pentachlorophenol analyses on these samples are as follows:

Sample Description	PCP, mg/l
Railroad tunnel spring, south side, near east end	0.057
Spring west of plant, south of county road	4.6
Behren Well No. 2	0.00021
Behren Well No. 3	0.00024
Runoff No. 1	4.2
Runoff No. 2	0.85

Lt to DH/ADPC&E

Please advise if there are any questions at this time.

Sincerely,

Charles McLaughlin, P.E.

CMcL/paa

cc: Mr. Bob Barker
Mr. Devoe Gregory

Lt to DH/ADPC&E

REFERENCES 7

A.G. Lamonds. Water resources Reconnaissance of the Ozarks Plateaus Province, Northern Arkansas, USGS Hydrological Investigation, Atlas HA-3
1972.

BILL ASK DOE LOSS TO CALL ALAN G. FOR HIS COMPLETE FILE ON THIS. 2/25/87

COMMENTS OF

MASS MERCHANDISERS, INC.

REGARDING UPDATE NO. 4 TO THE

NATIONAL PRIORITIES LIST

ARKWOOD, INC. SITE (OMAHA, ARKANSAS)

I. INTRODUCTION

These comments are submitted on behalf of Mass Merchandisers, Inc. of Harrison, Arkansas ("MMI") in response to EPA's Update No. 4 to the National Priorities List. 50 Fed. Reg. 37950 (published September 18, 1985). MMI's comments are limited to the Hazardous Ranking System ("HRS") score proposed for the Arkwood, Inc. site in Omaha, Arkansas. As set forth more fully below, MMI believes that EPA's HRS calculations contain two errors that significantly affect the ultimate HRS score for the Arkwood site. First, EPA's estimate of the total quantity of waste erroneously counts the same waste more than once. Second, EPA's Groundwater Targets calculations are based on an erroneous assumption regarding the number of affected groundwater users and the availability of alternate, unthreatened supplies. When both of these errors are eliminated from the HRS calculations, the HRS score for the Arkwood site is reduced from 34.21 to 14.52.

II. BACKGROUND

The Arkwood site is the location of a small, single cylinder wood treating plant in north central Arkansas. The plant was constructed in 1962 and closed in 1984. MMI operated the plant from 1974 to 1984. In 1981, an off-site investigation revealed detectable levels of pen-

tachlorophenol in two springs and two inactive domestic wells in the immediate vicinity of the plant site. Since 1981, MMI has cooperated with the Arkansas Department of Pollution Control & Ecology ("ADPC&E") in voluntary efforts to investigate groundwater conditions and remove potential sources of contamination.

III. THE PROPOSED HRS WASTE QUANTITY CALCULATION

Update No. 4 to the NPL proposed an HRS score of 34.21 for the Arkwood site. This calculation was based, in part, on an estimated total quantity of waste of 6,234 tons. This estimated quantity of waste, in turn, is the total of three separate items:

1. Bob Barker, one of the Arkwood plant managers, estimated to ADPC&E inspectors in 1981 that the plant produced a total of 500 gallons of waste per year during his tenure. The HRS calculation in Update No. 4 multiplied this 500 gallon per year figure by the 22 years the plant was in operation, for a total of 11,000 gallons, or 220 fifty gallon drums, for a scoring equivalent of 55 tons.

2. A pit or ditch adjacent to the plant site, which contains sludge and soil contaminated with creosote and pentachlorophenol, was estimated to be 40 feet long, 15 feet wide, and 3 feet deep. These dimensions result in a total volume of 68 cubic yards, or a scoring equivalent of 68 tons.

3. A sawdust pile at the east end of the plant yard was estimated to be 275 feet long, 150 feet wide, and 4 feet deep. These dimensions result in a volume of 6,111 cubic yards, or a scoring equivalent of 6,111 tons.

MMI respectfully submits that these waste quantity calculations erroneously count the same wastes more than

once and, consequently, overstate the value used in the HRS scoring for total quantity of waste.

The first item in EPA's calculations represents estimate of waste generated over the operating life of the plant. The second item, the railroad ditch, is one of the areas where these wastes were placed. Thus, all of the wastes placed in the railroad ditch are counted once as part of Item No. 1, and a second time as part of Item No. 2. MMI concedes that the total volume of the contaminated soil in the railroad ditch is undoubtedly larger than the volume of waste which is contaminating the soil. Under the Hazard Ranking System, however, it is inappropriate to base a score on the total volume of contaminated soil or other contaminated matrix at a site. Only the amount of the contaminating hazardous substance is to be included in the waste quantity calculation. Uncontrolled Hazardous Waste Site Ranking System Users Manual. 47 Fed. Reg. 31187, at 31229 (published July 16, 1982).

Item No. 3 in the calculation of total waste represents an even more significant error in the estimate of waste quantity. The pile of sawdust and shavings at the east end of the plant yard was generated by wood planing equipment used in the manufacture of ties and posts. The planing equipment was used exclusively on untreated wood. Consequently, the sawdust and shavings themselves originally

contained no treatment chemicals. Sampling evidence indicates, however, that the sawdust pile is now contaminated with pentachlorophenol in the low parts per million range.* The only possible source of the pentachlorophenol observed in the sawdust pile is MMI's use of the liquid wastes included in Item No. 1, above, for dust control purposes. Consequently, as with the railroad ditch, all of the wastes in the sawdust pile are counted once by EPA as a part of Item No. 1, and once again as part of the sawdust pile. Furthermore, inclusion of the entire volume of the sawdust pile improperly adds to the waste calculations a substantial volume of soil and sawdust on top of the quantity of the wastes which have contaminated them.

If, for any reason, the sawdust pile is included in the calculation of hazardous waste, MMI also wishes to note that the dimensions attributed to the sawdust pile by EPA overstate its volume by more than two orders of magnitude. In order to establish more accurate dimensions, MMI photographed and surveyed the sawdust pile as it now exists. The photograph of the sawdust pile is reproduced as Appendix A of these Comments. A drawing with surface and depth measurements is reproduced as Appendix B. MMI's measurements indicate that the sawdust pile has a surface area of

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*The Documentation Record for EPA's HRS scoring indicates that the sawdust pile was included in the calculation of waste quantity because two 1979 soil and sawdust samples taken by the ADPC&E showed pentachlorophenol contamination

2108 square feet and an average depth of six to nine inches. These dimensions result in a total volume of less than 60 cubic yards.

EPA's estimate of 6,111 cubic yards for the volum of the sawdust pile was based upon an April 1985 memorandur from Doice Hughes, a geologist with ADPC&E, to Tim Perdue the Region VI Office. MMI discussed its photograph and survey with Mr. Hughes as part of its preparation of these Comments. Mr. Hughes indicated that the dimensions he originally reported to EPA were only an estimate, and that a subsequent visit to the site convinced him that his estimate significantly overstated the size of the sawdust pile. Mr. Hughes indicated that he did not question the accuracy of MMI's measurements.

In discussing the sawdust pile, MMI wishes to stress that there has been no alteration of the sawdust pile or removal of materials since the ranking process was initiated. The plant site is fenced in, with a locked gate.

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at levels of 30,000 and 23,000 parts per million. MMI questions the levels of pentachlorophenol reported for these samples and recently took three samples from three different portions of the sawdust pile for independent verification. The samples taken by MMI were analyzed by the McKesson Environmental Services Laboratory in Dublin, California. The analytical results showed pentachlorophenol at 0.5 ppm, 2.1 ppm, and 170 ppm. Splits of each sample were retained and will be made available to EPA if it wishes independent confirmation of the analyses.

To the best of MMI's knowledge, no sawdust or shavings have been added to or removed from the sawdust pile since the termination of treatment operations in 1984.

Based upon the foregoing facts, MMI believes that Item No. 2, the railroad ditch, and Item No. 3, the sawdust that is assigned an HRS scoring value of 2. 47 Fed. Reg. 31187, at 31229 (published July 16, 1982). When this new scoring value is substituted for the original waste quantity value, the final HRS score for the Arkwood site is reduced from 34.21 to a corrected score of 26.32. An itemized comparison of the original HRS calculation and the revised calculation for the Arkwood site is attached as Appendix C of these Comments.

IV. AFFECTED GROUNDWATER USE

EPA's HRS scoring sheets and Documentation Record assigned a Groundwater Targets value of 29 for the Arkwood site. This Groundwater Targets value was based, in part, on the assumption that there are "no significant aquatards" separating the shallow groundwater system in the immediate vicinity of the plant, which has shown trace contamination off-site, and the deep aquifer that supplies the Omaha municipal water system and other groundwater users within a three mile radius of the plant. MMI believes that EPA's assumption is mistaken and that there is a substantial

barrier between the shallow groundwater system affected by the plant site, and the deep aquifer supplying the Omaha municipal water system and other groundwater users in the area.

As part of its voluntary effort to deal with conditions at the site, MMI has retained Geraghty & Miller to conduct a geohydrologic investigation of the Arkwood site and the surrounding area. Although substantial additional work remains to be done by Geraghty & Miller, their initial site assessment and monitoring data indicate that the contaminants have been found to reside only in the shallow (less than fifty feet below land surface) interconnected solution cavities found at the base of the limestone formation. Water that enters the shallow drainage system flows laterally westward through the shallow solution features, emerging as springs along Cricket Creek about 400 yards from the Arkwood plant site. Most of the domestic wells within about a mile of the plant have been tested; only three wells located in a very small area between the plant and the spring contain the contaminants. It is believed that the contaminants enter the wells via the shallow solution channels because the wells are cased only into the top of the limestone (and not to the depth of the solution channels), and a 300-foot thick confining bed exists below the shallow water-bearing zone.

It is Geraghty & Miller's belief that the 2100-foot Omaha municipal water well is not in any way threatened by waste from the Arkwood site. Several hydrogeologic reasons support this conclusion:

1. The hydraulic gradient at Arkwood has been determined to be northwestward (the Omaha well is located to the northeast);

2. The distance between the Arkwood site and the Omaha well is about one mile;

3. Several domestic water wells are located between the Arkwood site and the Omaha well that have not been found to be contaminated and, if designated as such, can act as an early warning system;

4. Several thick aquicludes exist between the shallow zone in which contamination has been observed and the aquifer that is tapped by the Omaha well;

5. A properly cased 900-foot well that is located on the Arkwood plant site itself has been sampled repeatedly and is free of any contamination.

Based upon the data generated thus far by Geraghty & Miller, MMI believes that two corrections should be made in the Groundwater Targets value for the Arkwood site. First, the Groundwater Use factor should be reduced from 3 to 2, because users of domestic wells in the vicinity of the plant have a municipal water supply available nearby which draws from an alternate, unthreatened source. Second, the population served by domestic wells in the immediate vicinity of the plant which could be affected by contamination in the shallow groundwater system totals less than ten

houses or a scoring equivalent of 38 people. This population falls in the 1 to 100 population range that is assigned a scoring value of 1. Use of this revised population value together with the revised Groundwater Use factor, lowers the Groundwater Targets score from 29 to 16. The revision of the Groundwater Targets value, in turn, lowers the overall HRS score for the Arkwood site from 34.21 originally proposed by EPA to a corrected score of 18.87.

When the corrections suggested by these comments for total quantity of waste and Groundwater Targets are both included in the calculation, the final HRS score for the Arkwood site is reduced from 34.21 to a corrected score of 14.52. An itemized comparison of the original and revised HRS calculations is attached in Appendix C of these Comments.

VI. STATUS OF RESPONSE ACTIVITY

MMI recognizes that it is EPA policy not to consider the status of previous response or clean-up actions when scoring a potential NPL site. See 47 Fed. Reg. 31187 (July 16, 1982); 48 Fed. Reg. 40664 (September 8, 1983). Nevertheless, MMI believes that the current status of site investigation and remedial activity is relevant in considering the relative priority or need for Superfund attention at a given site.

The Arkwood site is not an orphaned or abandoned site. The owner and prior operators of the Arkwood site are known, and their financial resources are unquestionably adequate to address any foreseeable remedial contingency. More importantly, one of the responsible parties, MMI, has been cooperating with state officials for several years in remedial investigation and response activity. Finally, as noted by EPA in the Arkwood summary, a consent order addressing the site is nearing completion and should soon be entered.

Against this background, there is little reason to doubt that prompt and thorough investigation and remediation will take place at the Arkwood site without Superfund involvement.

VI. CONCLUSION

For the reasons set forth above, MMI respectfully submits that the HRS score proposed for the Arkwood site was based on an overestimate of the total quantity of waste and an erroneous assumption regarding the use of affected groundwater. As reflected in Appendix C, correction of either error significantly reduces the overall HRS score for the Arkwood site. When both errors are corrected, the revised HRS calculations reduce the overall score for the Arkwood site from 34.21 to a corrected score of 14.52.

MMI remains ready and willing to cooperate with EPA in any way it can in further consideration of the HRS scoring of the Arkwood site.

Respectfully submitted,

MITCHELL, WILLIAMS, SELIG,
JACKSON & TUCKER

By Allan Gates

Allan Gates

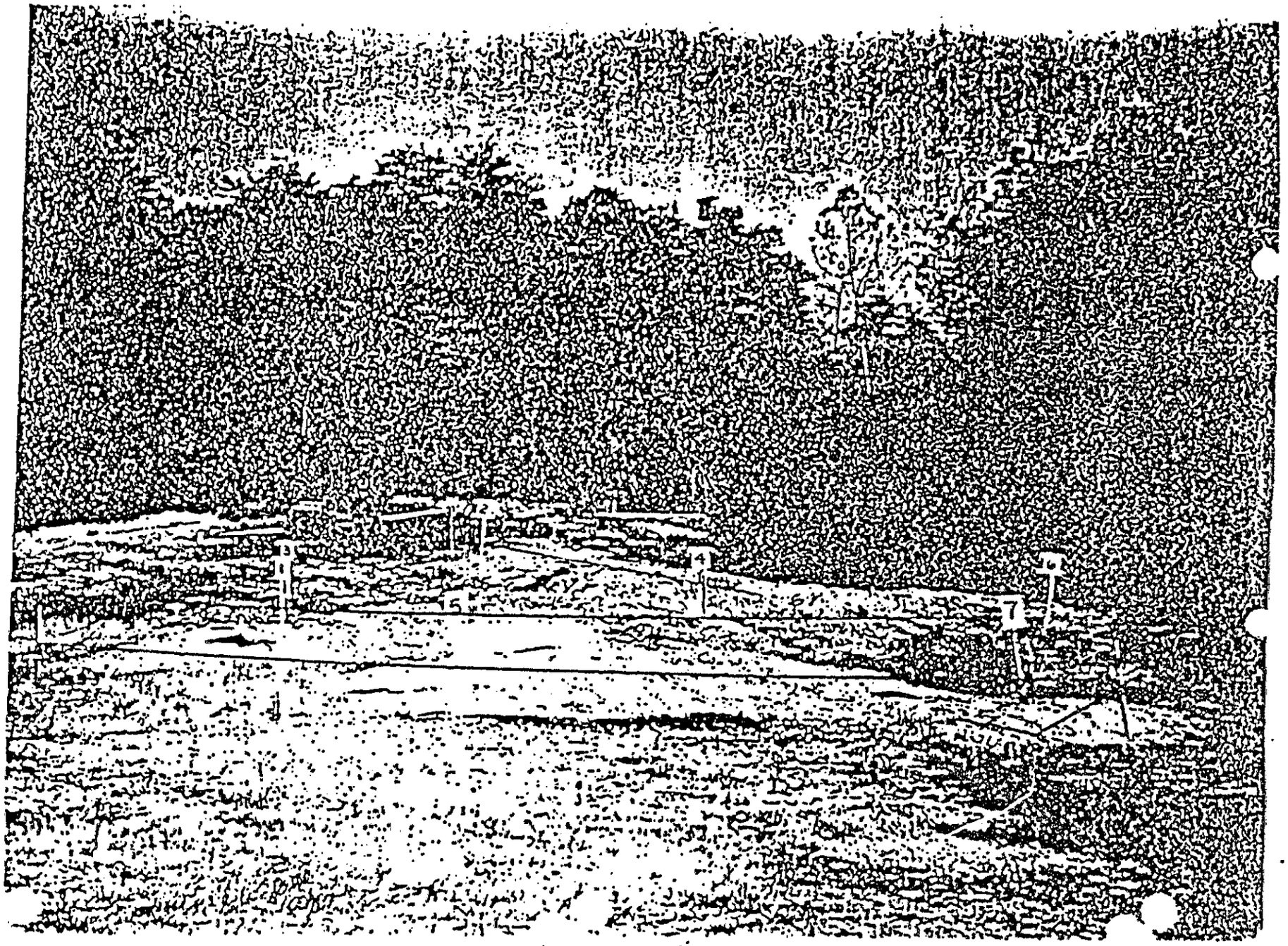
Attorneys for
Mass Merchandisers, Inc.

APPENDIX A

PHOTOGRAPH OF "SAWDUST PILE"

(EAST END ARKWOOD PLANT YARD)

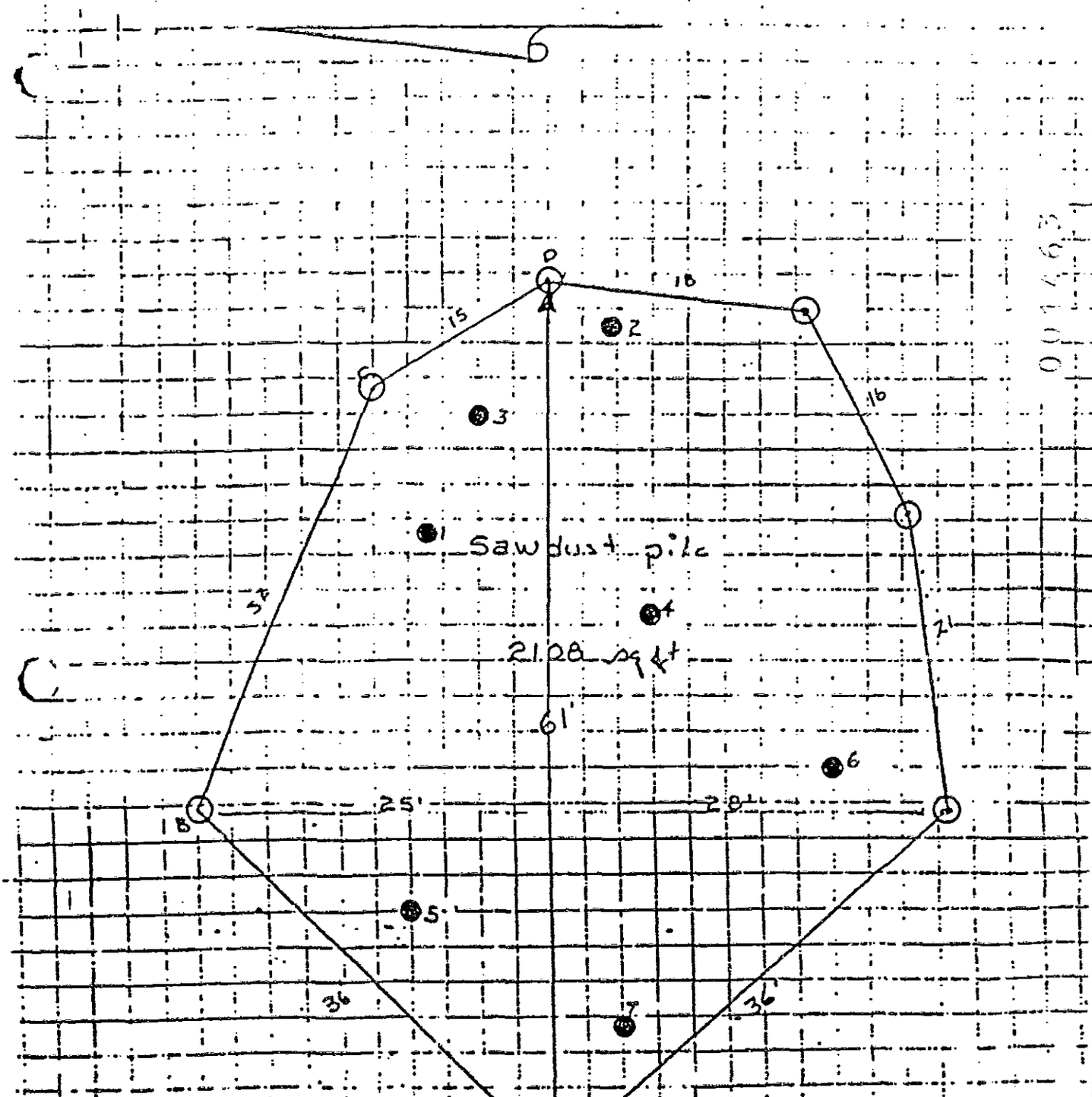
001450



APPENDIX B

DRAWING OF SAWDUST PILE DIMENSIONS

001162



Depth of Sawdust

point #	
1	2 inches
2	27 "
3	6 "
4	18 "
5	4 "
6	7 "
7	4 "

APPENDIX C

ORIGINAL AND REVISED HRS CALCULATIONS

001464

HRS CALCULATIONS

	Original EPA Proposed	Water Quality Revised	Groundwater Targets Revised	Both Revisions
Line 1 - Observed Release	45	45	45	45
Line 4 - Waste Characteristics				
Toxicity/Persistence	18	18	18	18
Hazardous Waste Quantity	8	2	8	2
	26	20	26	20
Line 5 - Targets				
Groundwater Use (Multiplied by 3)	9	9	6	6
Distance to Nearest Well/Population Served	20	20	10	10
	29	29	16	16
Lines 1 x 4 x 5	33,930	26,100	18,720	14,400
Divided by 57,330	0.5918367	0.455259	0.3265306	0.2511773
Multiplied by 100	59.18367	45.5259	32.65306	25.11773
Divided by 1.73	34.2	26.32	18.87	14.52