PADUCAH GASEOUS DIFFUSION PLANT
SITE SPECIFIC ADVISORY BOARD

Chartered under the Federal Advisory Committee Act

CO-CHAIRS
Mark Donham
Route 1
Brookport, Illinois 62910
mandk@midwest.net

Vicki Jones
1131 Hamburg Road
Kevil, Kentucky 42053
jonesvw@oml.gov

BOARD MEMBERS
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Linda Long
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Connie J. Sykes
705 N. 24th Street
Paducah, Kentucky 42001

Rev. Gregory Waldrop
701 Broadway
Paducah, Kentucky 42001

Meeting Minutes

June 19, 1997

The June 19, 1997, Site Specific Advisory Board (SSAB) meeting took place at Heath High School at 6:00 p.m.

The following board members were present: Mark Donham, David Fuller, W. G. Harvey, Sr., Vicki Jones, Ronald Lamb, and Linda Long. Ex Officio members present were: Carl Froede, and Tuss Taylor. Facilitator Present: Steve Kay. Also present were: Todd Adams, Carlos Alvarado, Jeannie Brandstetter, Bob Carson, Julia Carter, Raul Castañeda, Carol Connell, Anthony B. Davis, Dave Dollins, Teresa Fields, Bruce Ford, Clayton Gist, Shelley Hawkins, Dennis Hill, Norm Jetta, Chris Marshall, John Morgan, Ray McLennan, Todd Mullins, Myrna Redfield, Amy Shehee, Matt Vick, and Julie Watts.

The agenda was modified to allow the Agency for Toxic Substances and Disease Registry (ATSDR) presentation to be first, the presentation on Drum Mountain was last, and Waste Area Grouping (WAG) 23 presentation be added per a request from Mark Donham.

The minutes from the April 17, 1997, meeting were approved by consensus. The minutes from the May 22, 1997, informal informational meeting were approved for distribution through the Department of Energy (DOE). These minutes did not require board approval since there was not a quorum present.

The first presentation was made by Carol Connell, Health Physicist, of the ATSDR. Julie Watts with the Boston University also spoke. They spoke on the ongoing health assessment in the Paducah Gaseous Diffusion Plant (PGDP) area.

The second item on the agenda was a presentation on WAG 23. Carlos Alvarado presented a short introduction and introduced Amy Shehee and Julia Carter who presented the WAG 23 information. It was suggested that a presentation be made on Risk Assessments.

The next item on the agenda was the Northeast Plume presentation. Due to a miscommunication, this presentation will be delayed until the July meeting. Mark Donham stated that his questions had been deferred to this meeting. Carlos Alvarado stated that DOE will send the handouts to the board as soon as possible and at the next SSAB meeting the presentation would be made. Mark asked how a citizen was to get their comments in. Myrna Redfield stated that all comments were addressed in the document. Mark had some questions about the monitoring well report that he had requested and received. Carl Froede and Tuss Taylor agreed to review the information in the monitoring well report. It was agreed that a meeting or conference call would be arranged with Mark to discuss the concerns he has. Mark stated that in the past minutes that Jimmie Hodges had stated that if there was anything other than trichloroethylene (TCE) in the plume then it (the Northeast Plume System) would be shut down. Tuss Taylor stated that he would take it as an action to review the information that Mark had.

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Mark Donham requested comments on a draft letter to Al Alm he had written. There is a potential for a video conference with Al Alm on July 9, 1997. Mr. Alm will be in Oak Ridge that day and will have a public meeting that night. The board agreed that they wanted to participate. A notice will be sent to the board when final arrangement are available.

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The next meeting will be held on July 17, 1997, at the Heath High School at 6:00 p.m. The meeting was adjourned.

Tentative Agenda for the July 17, 1997, meeting:

Minutes
Discussion on the Northeast Plume
EMEF Project Updates
Review of the Accelerated Cleanup Plan (formerly the 10 Year Plan)
Review of the Community Relations Plan
Update on the SSAB Draft Work Plan

Action Items

Tuss Taylor will review the monitoring well data on the northeast plume
WAG 23 Risk Assessment to be provided to Board - DOE
Copy of Northeast Plume well data to Board - DOE
Copy of Northeast Plume presentation handouts to Board - DOE

MEMORANDUM
SITE SPECIFIC ADVISORY BOARD

TO: SSAB Members
Ex Officio Members

FROM: Mark Donham
Vicki Jones

DATE: June 6, 1997

SUBJECT: **MEETING REMINDER**

The next SSAB meeting will be June 19, 1997, at 6:00 p.m. in the Heath High School. The following is the tentative agenda and action items:

Tentative Agenda

Minutes
Northeast Plume Presentation
Presentation on Drum Mountain
Presentation by Julie Watts of the ATSDR
EMEF Project Updates
FFA Update
Membership Update
Review of the 10 Year Plan
Draft Work Plan

Action Items

Co-chairs will work on Workplan
Co-chairs will work on letter inviting Al Alm to come to Paducah
Jimmie Hodges will provide Executive Summary to WAG 6 and WAG 22 documents

PADUCAH GASEOUS DIFFUSION PLANT
SITE SPECIFIC ADVISORY BOARD
CONSENSUS RECOMMENDATION

DATE: June 20, 1997

NUMBER: 97-1

RESPONSE REQUESTED BY (date): June 27, 1997

REGARDING: Regarding the Federal Facilities Agreement

TO: Jimmie Hodges, DOE
Carl Froede Jr., EPA
Tuss Taylor, KDEP

CC: Dr. John Volpe, Radiation Control Branch
Wayne Davis, Kentucky Department of Fish & Wildlife Resources
Regular members — Nola Courtney, Tommy Fletcher, David Fuller, Rev. W. G. Harvey, William Kressenberg, Ronald Lamb, Linda Long, Connie Sykes, Rev. Gregory Waldrop,

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RECOMMENDATION:

The PGDP SSAB recommends that the parties to the Federal Facilities Agreement interpret the agreement to provide public participation in the planning process to the maximum extent possible.

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mandk@midwest.net

Vicki Jones
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MEMORANDUM
SITE SPECIFIC ADVISORY BOARD

TO: Distribution

FROM: Mark Donham
Vicki Jones

DATE: July 1, 1997

SUBJECT: **JUNE 19, 1997, MEETING MINUTES**

Attached are the subject meeting minutes. The next meeting will be held July 17, 1997, at the Heath High School at 6:00 p.m. Please review and provide comments or changes at the June meeting.

SSAB Distribution List
Nola Courtney
Mark Donham
Tommy Fletcher
David Fuller
W. G. Harvey, Sr.
Vicki Jones
William L. Kressenberg
Ronald Lamb
Linda Long
Connie J. Sykes
Gregory Waldrop

Ex Officio Distribution List
Wayne Davis
Carl Froede, Jr.
Jimmie C. Hodges
Tuss Taylor
John A. Volpe

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DRAFT

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PADUCAH GASEOUS DIFFUSION PLANT
SITE SPECIFIC ADVISORY BOARD
CONSENSUS RECOMMENDATION

DATE: June 20, 1997

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RESPONSE REQUESTED BY (date): June 27, 1997

REGARDING: Regarding the Federal Facilities Agreement

TO: Jimmie Hodges, DOE
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RECOMMENDATION:

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Paducah Gaseous Diffusion Plant (PGDP)
Site Specific Advisory Board (SSAB)
1997/1998 Work Plan

Issue	Expected Actions	Status/Approach	Jul 97	Aug 97	Sep 97	Oct 97	Nov 97	Dec 97	Jan 98	Feb 98	Mar 98	Apr 98	May 98	Jun 98
Waste Area Grouping (WAG) 6 On site source of contamination	D1 TSPP 11/22/96 D4 RI/FS WP 1/27/97													
WAG 22 Solid Waste Management Unit (SWMU) 7 & 30	D1 RI Report 7/28/97													
WAG 22 SWMU2 (Uranium Burial Ground)	PCSR Complete 2/19/97 D1 FS Due 8/29/97													
WAGs 9 & 11 Preliminary Assessment /Site Inspection (PA/SI) process Site Evaluation Report	SE Work Plan WAG 11 2/28/97 SE Report WAG 11 9/26/97													
Federal Facilities Agreement (FFA)	Complete pending agency signatures for release to public for comment													
Public Relations Plan														
Integrated Waste Management (IWMP)	IWMP Annual Report 12/97													
Vortec	RCRA RD&D Permit													
Site Treatment Plan (STP)	STP Annual Report 3/31/97 Waste Minimization Report 3/31/97 Quarterly Progress Report 6/30/97													

Acronym List:
RD&D--Research Demonstration & Development
TSPP--Treatability Study Program Plan
SE--Site Evaluation
RI/FS--Remedial Investigation/Feasibility Study
WP--Work Plan
PCSR--Preliminary Characterization Summary Report

paducah\ssab\work plan

WORKING DRAFT

1997 WORK PLAN

ISSUE	EXPECTED ACTIONS	STATUS/APPROACH
General Programs - Waste Management - Waste Minimization/Pollution Prevention - Transportation of wastes/hazardous materials - Decontamination & Decommissioning - Economic Impact on Community - Protection/Restoration of Natural Resources & Ecological Values - Protection of Workers, Public Health and Safety - Technology Development and Transfer - Strategies for effective and meaningfull Public Input - Cost Effectiveness	Review documents	Monitor & provide suggestions as appropriate
WAG 6	Review documents	Continue monitoring
WAG 22 (7 & 30)	Comment on D1 RI	
WAG 22 (2 & 3)	Comment on D1 FS	
WAG 17		
LASAGNA		
Drum Mountain (WAG 24)	Review documents	Provide recommendations
Site Treatment Plan Annual Report		

* SSAB will provide formal comments to DOE

WAGS 9 &11
WAG 3
WAGS 1 & 7
WAG 27
WAG 28
WAG 15
Groundwater Program

The scope of work for this project includes development of an SAP, field sampling and development of a Site Evaluation Report. Historical analytical data was transmitted electronically to the Kentucky Division for Waste Management, and the data assessment report completed and delivered to DOE and KDEP.

A new schedule has been established for the Site Evaluation, including field work in August and September 1997.

Waste Area Group 17/Rubble piles
The piles of concrete rubble that make up Waste Area Grouping 17 have been investigated for contamination. The rubble, derived from demolition of sidewalks, parking lots and other concrete structures at PGDP during the 1970s, was used as construction material in the Ballard County Wildlife Management area, McCracken County Wildlife Management Area and on Department of Energy property.

A small amount of contaminated material was removed from SWMU 124 in 1996. After further sampling, an additional removal action at this SWMU was planned for April 1997. Following that removal action, the state's Radiation Control Branch verified that no further action was needed at SWMU 124, and has issued a letter to that effect.

Waste Area Group 22/Burial grounds
This project includes the investigation of burial grounds in the northwest corner of the plant (SWMUs 7 & 30) and in the west-central portion of the plant (SWMU 2). Original plans included installation of a cap at SWMU 2, the C-749 Uranium Burial Ground, but investigation activities have determined that the buried material was saturated in the water table, indicating a cap would have limited effect.

A Data Summary Report, summarizing and evaluating data collected during investigation activities, is being prepared and was provided to the regulatory agencies in February.

The development of a Remedial Investigation Report is ongoing at SWMUs 7 & 30 (the C-747-A Uranium Burial Ground and C-747-A Burn Area). This RI report is to be submitted to the regulatory agencies in July, 1997.

Waste Area Group 23/Polychlorinated Biphenyls (PCBs) Spill Sites
Past use of PCBs and subsequent accidental spills and leaks of oils that contain PCBs caused surface soil contamination at several Solid Waste Management Units inside the PGDP security fence.

The preferred option in the original Proposed Plan was the excavation and treatment of the soil containing PCBs greater than 25 ppm using a thermal treatment technology known as vitrification. This process destroys organics, such as PCBs, and produces a glass which will bind any radioactive compounds.

The DOE is now seeking public comment on an Engineering Evaluation/Cost Analysis Summary (EE/CA Summary) for the cleanup of PCB sites. The summary describes the Non-Time-Critical Removal Action that DOE is considering to clean up the PCB contamination. DOE is proposing the excavation and temporary on-site storage of the contaminated soil. The focus of this removal action is the elimination of potential risk to workers from contact with contaminated soil. The final disposition of the contaminated soil would be determined at a later date, consistent with applicable laws and regulations, including appropriate public participation.

A 30-day public comment period on the EE/CA Summary began June 2, 1997. Following the

PADUCAH GASEOUS DIFFUSION PLANT SITE SPECIFIC ADVISORY BOARD
U.S. DEPARTMENT OF ENERGY
ENVIRONMENTAL MANAGEMENT & ENRICHMENT FACILITIES
PROJECT UPDATE
JUNE 19, 1997 — VERSION II

ENVIRONMENTAL RESTORATION

Northwest Plume Interim Remedial Action Pilot Plant

More than 168 million gallons of water have been treated at the Northwest Plume Groundwater Treatment Facility since operations began Sept. 1, 1995. The facility operates to contain a high contamination zone of the degreaser trichloroethylene and the man-made radionuclide technetium-99.

May activities include continued remedial operations (water extraction and treatment) and routine operation and maintenance of facility. The facility has been in operation 96 percent of the time from August '96 to December '96.

The Pilot Phase of operations ended per the project schedule on May 31, 1997. Lockheed Martin has proposed that pilot third quarter, fiscal year 98. DOE will determine the transition to ongoing operations.

Another carbon filter replacement is scheduled for June.

Northeast Plume Interim Containment System

The Northeast Plume project involves the installation of extraction wells in the northeast quadrant of DOE property with an underground pipeline running to the existing PGDP cooling towers as part of a newly completed treatment system.

This regional gravel aquifer's contamination comes solely from the degreaser trichloroethylene.

Routine operations began in March 1997, with more than 22 million gallons of groundwater treated to date.

On May 1, 1997, employees suspected a drip from the above ground piping insulation on the equalization tank effluent line. A catch bucket was installed. Initially, the drip was thought to be the result of rain water infiltrating into insulation and then slowly leaking out. After monitoring, it was determined to be water from condensation and rain accumulation, and not a leak.

Lasagna demonstration

The Lasagna soil remediation technology now being tested at PGDP works by using buried electrodes to move water through contaminated soil. Applied current drives the water an inch a day from a positive to a negative electrode. Along the way, the water picks up contaminants from the soil which are removed by treatment zones containing iron filings.

Phase IIA installation was completed in August 1996 and the process was operational through Feb. 26, 1997, with post-demonstration sampling completed the week of March 3, 1997.

DOE EM-50 has granted the Lasagna consortium another extension of the Phase IIA project and the system will operate until August 1997.

If full-scale remediation is undertaken, the remediation will be funded by EM-40 (the office of the Deputy Assistant Secretary for Environmental Restoration), which funds the remainder of Paducah's Environmental Restoration and Waste Management program. A Proposed Plan and Record of Decision schedule with a final ROD targeted for October 1997 has been postponed due

to the extension of the test. An overview of the schedule will be provided to the SSAB when finalized.

Waste Area Groups 1 & 7/C-746-K Landfill, Kentucky Ordnance Works
WAG 1 consists of a fire training area, the plant sewage treatment facility and a known trichloroethylene spill site inside the PGDP security fence. WAG 7 consists of five underground storage tanks at the plant water treatment facility, and an inactive sanitary landfill outside the security fence. Three SWMUs are connected with the former Kentucky Ordnance Works (KOW) and are located on the DOE reservation. They are the KOW sewage treatment facility, a known Toluene spill site and a burn area.

The current proposed plan includes continued controlled access, groundwater monitoring and deed restrictions in the preferred alternative.

The recent sluffing of the vegetative cover at the landfill requires a review of the Remedial Design, which will likely be modified to include the placement of an equal and similar clay patch over any original clay that may be removed during the construction of the proposed design, as well as the placement of additional rip-rap stone over a leachate seep location in the northwest drainage swale.

The sluffing has exposed the surface of the landfill cap in an area approximately seven feet tall by 32 feet wide. The integrity of the cap has been maintained. Geotechnical borings have been taken to determine the mateiral below the clay cap in this area, and in the entire proposed construciton area.

Waste Area Group 3/burial grounds
WAG 3 is composed of three burial grounds within the PGDP security fence. The FY 97 scope of this project include the development of a work plan scoping document and work plan. The draft scoping document was submitted to the regulators on March 27, 1997.

A meeting with regulators is scheduled for June 19.

Waste Area Group 6/Trichloroethylene spill site
The C-400 TCE spill site is a major source of TCE in the groundwater and soil. The Industrial Hydrogeologic Study focused on piping, utilities and building foundations in the C-400 building area to determine how these man-made structures and systems influence groundwater infiltration and flow.

The data from this investigation was used to prepare a WAG 6 Remedial Investigation Work Plan, which was submitted to the regulatory agencies in August, 1996. The plan focuses on contaminant distribution and movement. A Treatability Study Program Plan to identify needed treatability studies to collect data necessary to remediate contaminants expected to be found during the investigation is being developed, and was submitted to the regulatory agencies by Nov. 26, 1996.

Comments on the WAG 6 Remedial Investigation/Feasibility Study were received from the regulatory agencies in November, 1996, and resolution of those comments has been completed. A second draft work plan was submitted Jan. 20, 1997. Field work is being planned for summer 1997.

Based on conversations with the EPA and Kentucky Division for Waste Management , contaminated groundwater is not within the scope of the Feasibility Study, based on an assumption that a regional groundwater containment system will be approved and installed.

Waste Area Groups 9 & 11
WAGs 9 & 11 are composed of seven below ground liquid containment vessels.

public comment period, DOE will prepare an Action Memorandum for the selected action.

Waste Area Group 27/Potential trichloroethylene sources
WAG 27 consists of potential or known sources of TCE on the west side of the Paducah Gaseous Diffusion Plant. A second draft Remedial Investigation/Feasibility Study Work Plan is being developed for submittal to regulatory agencies on June 2, 1997.

Comments on the draft work plan have been received from the EPA, and a partial set of comments have been received from the Commonwealth of Kentucky. Resolution of comments is underway, with response due 60 days after receipt of final comments from the state.

Vortec Vitrification Project
The Vortec project is currently the subject of litigation.

Federal Facility Agreement (FFA)
Under CERCLA, a Federal Facility Agreement is required between the state, EPA and DOE to set forth guidelines on how the site cleanup is to be managed.

The FFA has been approved by DOE, state and federal regulators and has been issued for public comment.

Drum Mountain Scrap Removal
Drum Mountain must be moved from its present location before Oct. 1, 1998 to support Remedial Action activities at the Northwest Corner burial yards. Planning for this project consists of developing a project plan to identify the most cost-efficient method of packaging the wastestream.

After it is packaged, the waste will be moved to a staging area in preparation for future off-site shipment. Waste characterization will determine if the waste meets the acceptance criteria for Envirocare of Utah, the facility selected to receive the waste.

A project plan and statement of work have been drafted, and are under internal review and comment. A project plan is due to DOE for review on June 30, 1997. A cost benefit analysis and a Waste Characterization plan are being developed.

This approach will require $4 million in Fiscal Year 1998 not presently identified. DOE and LMES need to locate funding in the Oak Ridge program.

To: SSAB
From: Mark Donham & Kristi Hanson <mandk@midwest.net>
Subject: Alm visit letter
Cc:
Bcc:
X-Attachments:

Everyone, Here's an initial draft of a letter to Alm asking him to come. I'll bring it to the meeting. If you have any suggestions, let me know. Mark Donham

Mr. Al Alm
Asst. Sec. of Energy
1000 Independence Ave.
Washington, DC

Dear Asst. Sec. Alm,

This letter is on behalf of the Site Specific Advisory Board for the Paducah Gaseous Diffusion Plant. We have become aware of your plans to visit the "major" sites in the DOE complex this summer, and we want to extend and invitation and urge you to visit Paducah. As you know, Paducah has been identified as a major site in the WMPEIS. If you should come, we also would hope that you would meet with our SSAB.

We believe our site would benefit from a high level visit. This would help to bring attention to the serious problems at the site, and give you first hand input as to the community's concerns.

We would like to point out that the problems at the site range from extensive groundwater contamination which has moved offsite and has contaminated private wells, to the 40,000 cylinders of depleted uranium, to the largest inventory of contaminated scrap metal in the country, to the uranium burial grounds, where hundreds of tons of pyrophoric uranium are buried.

The sum total of the challenges facing the Paducah site are significant, and it will take a concerted effort on all levels to meet this challenge. A visit from someone of your rank could help in coordinating this, and would shine a needed spotlight on this site, giving it the national attention it needs to procure the necessary resources to meet these challenges.

We hope you will seriously consider this request. We look forward to hearing from you and hopefully meeting with you.

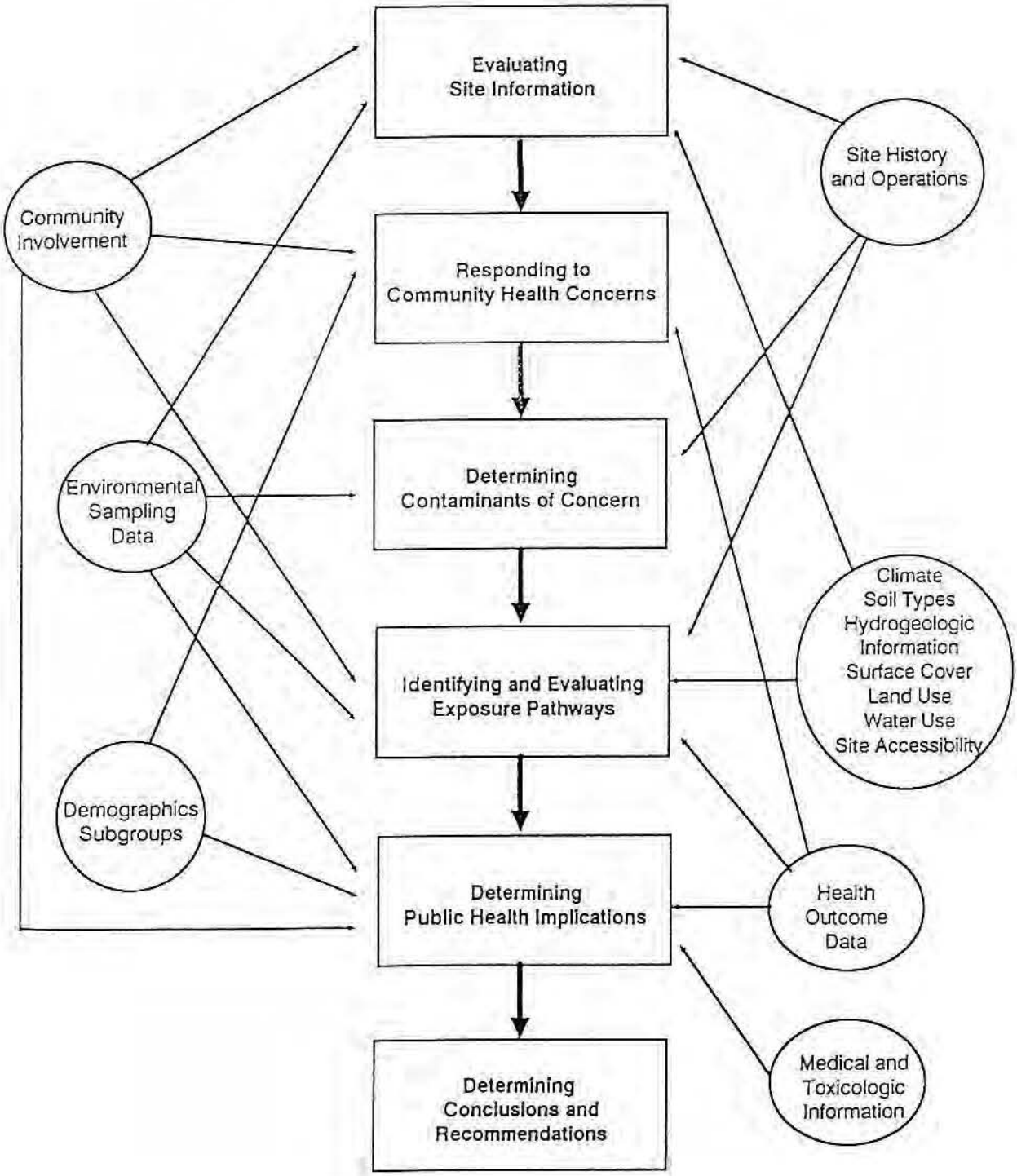
Sincerely,

Advantages of Removal Action

Advantages of implementing the removal action include:

- Timely elimination of potential risk to human health and the environment;
- Utilization of available fiscal year 1997 budget and resources;
- Use of streamlined/accelerated schedules and documentation;
- An action-oriented approach.

Figure 2.4. Factors Influencing the Health Assessment Process



U.S. Department of Energy
June 19, 1997

Solid Waste Management Unit 12

Site Background

- Solid Waste Management Unit 12, UF_4 Drum Storage Yard, is located in the Northwest area of the PGDP.
- It is comprised of approximately 251,000 cubic feet of empty, crushed drums that once contained UF_4.
- Drums were generated from 1952 to the mid 70's

Site Background, Sources

- **Original Feed Material and Natural Assay**
  - 55-gallon drums brought into plant and emptied into hoppers at C-420, Greensalt Plant
- **Other Source**
  - Recycled Material
- **Drum handling practices after emptying:**
  - Turned up side down, knocked, crushed
    - 60% of total drums
  - Turned up side down, knocked, washed, crushed
    - 40% of total drums
- **0.7% < Assay < 1.0%**
- **Low Level Waste**

Site Background, cont.

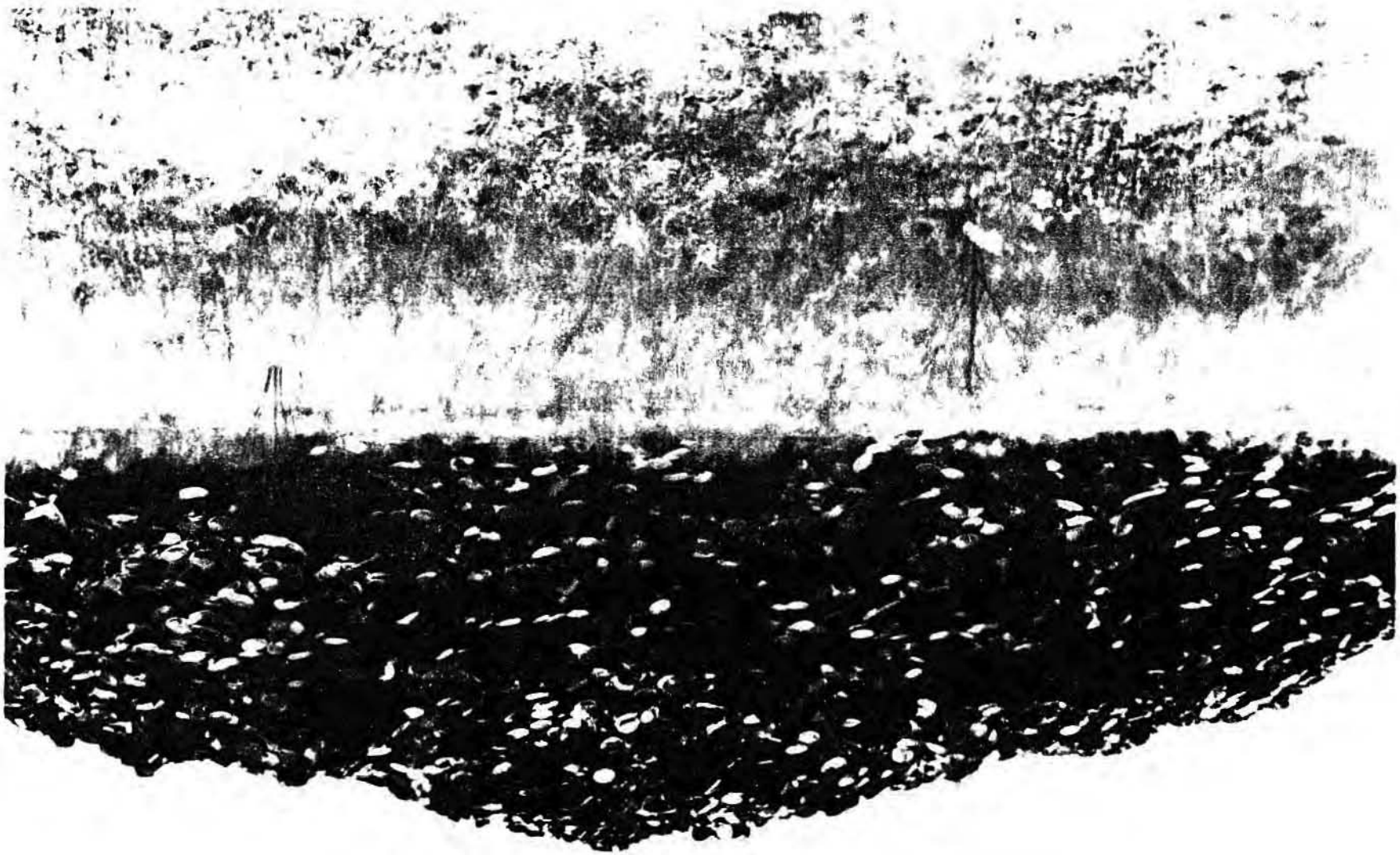
- When Drums were first brought into the yard, they were sent in one (1) truck load at a time.
- In the mid 70's, drums were consolidated and stacked in one big mountain.
- Samples taken to determine if drums could be sent to landfill revealed that drums did not meet our waste acceptance criteria.

Options

- The three options considered by DOE:
  - No Action.
  - Move the Drum Mountain to a different place inside the security fence.
  - Dispose of it by sending it to a long term disposal facility.
- There are two places presently licensed to accept long-term disposal of Low Level, bulk scrap metal waste:
  - Hanford
  - ENVIROCARE of Utah

Reasons for Disposal

- Facilitate Remedial Action on WAG 22
  - Drum Mountain needs to be removed by end of FY-'98 to facilitate the start of WAG 22 Remedial Action due in FY-'99.
- Although presently not fully funded, there is a high possibility of being fully funded in FY-'98.
- According to the Accelerated Cleanup Plan, funding for the removal of PGDP Scrapyards is not identified until FY-2002.



Waste Area Group 23 CERCLA Removal Action

presented to the

Site Specific Advisory Board

June 19, 1997

by the

U.S. Department of Energy

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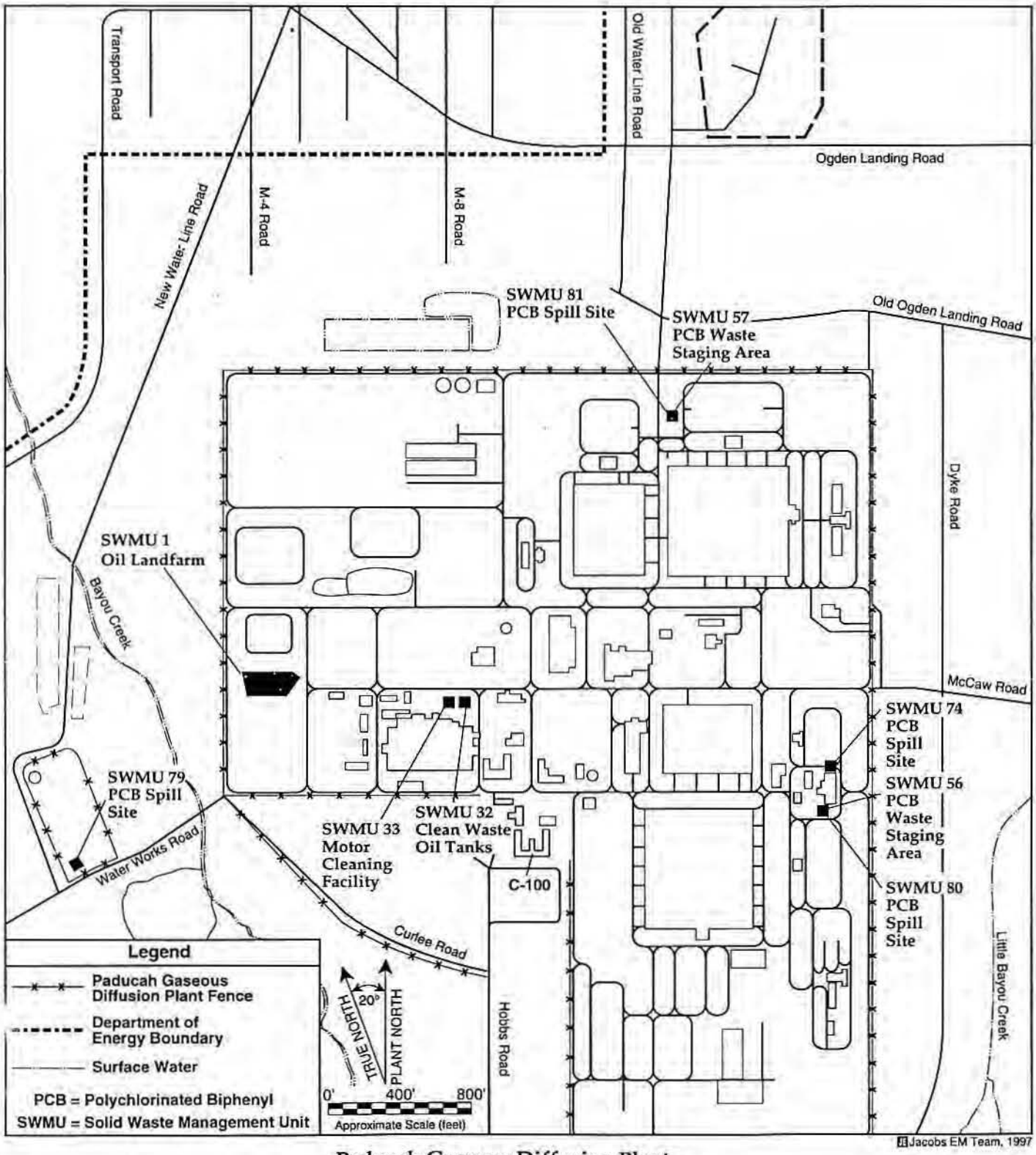
Site Background

Waste Area Group 23, the "PCB Sites":

- **Comprised of nine Solid Waste Management Units (SWMUs);**
- **Units are located throughout the PGDP;**
- **Each unit historically received/stored oils known to have contained polychlorinated biphenyls (PCBs).**



Paducah Gaseous Diffusion Plant

Chemicals of Concern

SWMU	PCBs	Dioxins	Tc-99
1		•	•
32 & 33			
56 & 80	•	•	
57 & 81	•	•	
74			
79			

Scope of the Removal Action

The action was originally evaluated as a CERCLA remedial action.

DOE will conduct a non-time critical removal action pursuant to Executive Order 12580.

DOE has determined that a removal action is necessary to achieve a more timely reduction of potential risk to human health and the environment.

Options Evaluated

The April 1996 *Feasibility Study Report*, which was approved by the EPA and the KDEP, evaluates six options:

- No action;
- Containment (capping);
- Excavation and treatment (using solvent extraction, thermal desorption, dechlorination, or vitrification).

Preferred Removal Option

Preferred removal option components include:

- Excavation of 260 cubic yards of soil, which contain chemicals of concern in excess of cleanup levels, from SWMUs 1, 56 and 80, and 57 and 81;
- Placement of clean soil in the excavations;
- Containerization and on-site storage of the excavated soils pending future treatment or disposal;

Preferred Removal Option
(continued)

- Additional sampling and testing of soils to verify that contaminants of concern exceeding the cleanup levels have been excavated.
- No action at SWMUs 32 and 33, 74, and 79, since these units do not present unacceptable risks or contain contaminants exceeding cleanup levels.

The preferred removal option will reduce risks to acceptable federal limits for industrial land use.

Community Participation

The September 1994 *Remedial Investigation Addendum* is available at the DOE's Environmental Information Center for public review.

The April 1996 *Feasibility Study Report*, also referred to as the "Engineering Evaluation/Cost Analysis-equivalent document," is also available at the Environmental Information Center for public review.

Community Participation
(continued)

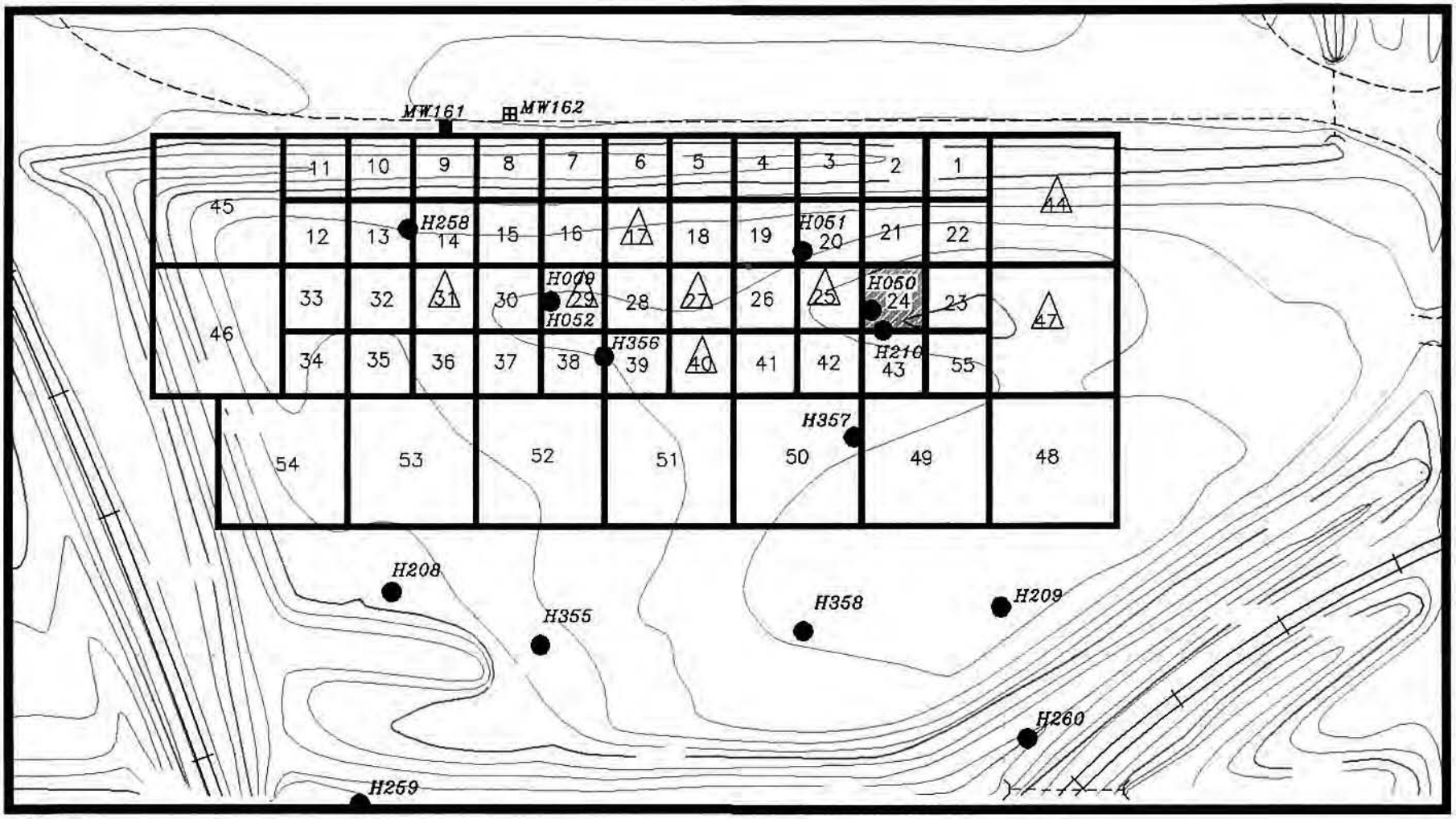
The DOE issued the *Engineering Evaluation/Cost Analysis Summary* to the public May 29, 1997. It is available for a 30-day public review period June 2 through July 1, 1997.

An *Action Memorandum* will address significant public comments received on the *Engineering Evaluation/Cost Analysis Summary.*

Projected Activities

- An *Action Memorandum* will be prepared by the DOE following the public comment period on the *Engineering Evaluation/Cost Analysis Summary*.

- The DOE will conduct the removal action field activities October through December 1997.



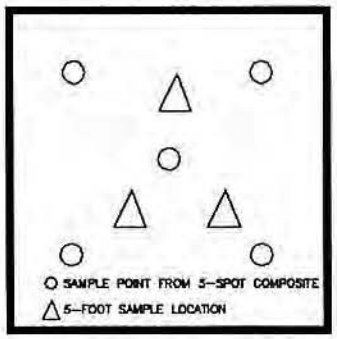
21 WAG 23 SWMU DELINEATION SAMPLING GRID

21 SWMU DELINEATION 5-FOOT SAMPLES

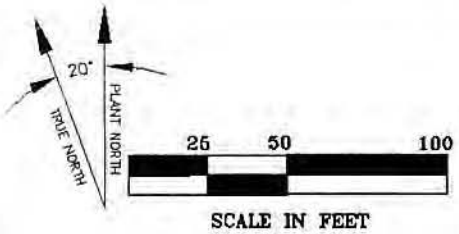
H355 SAMPLING POINT FROM RI ADDENDUM

TCDD

SWMU 1



EXAMPLE GRID LAYOUT



LOCKHEED MARTIN
1996

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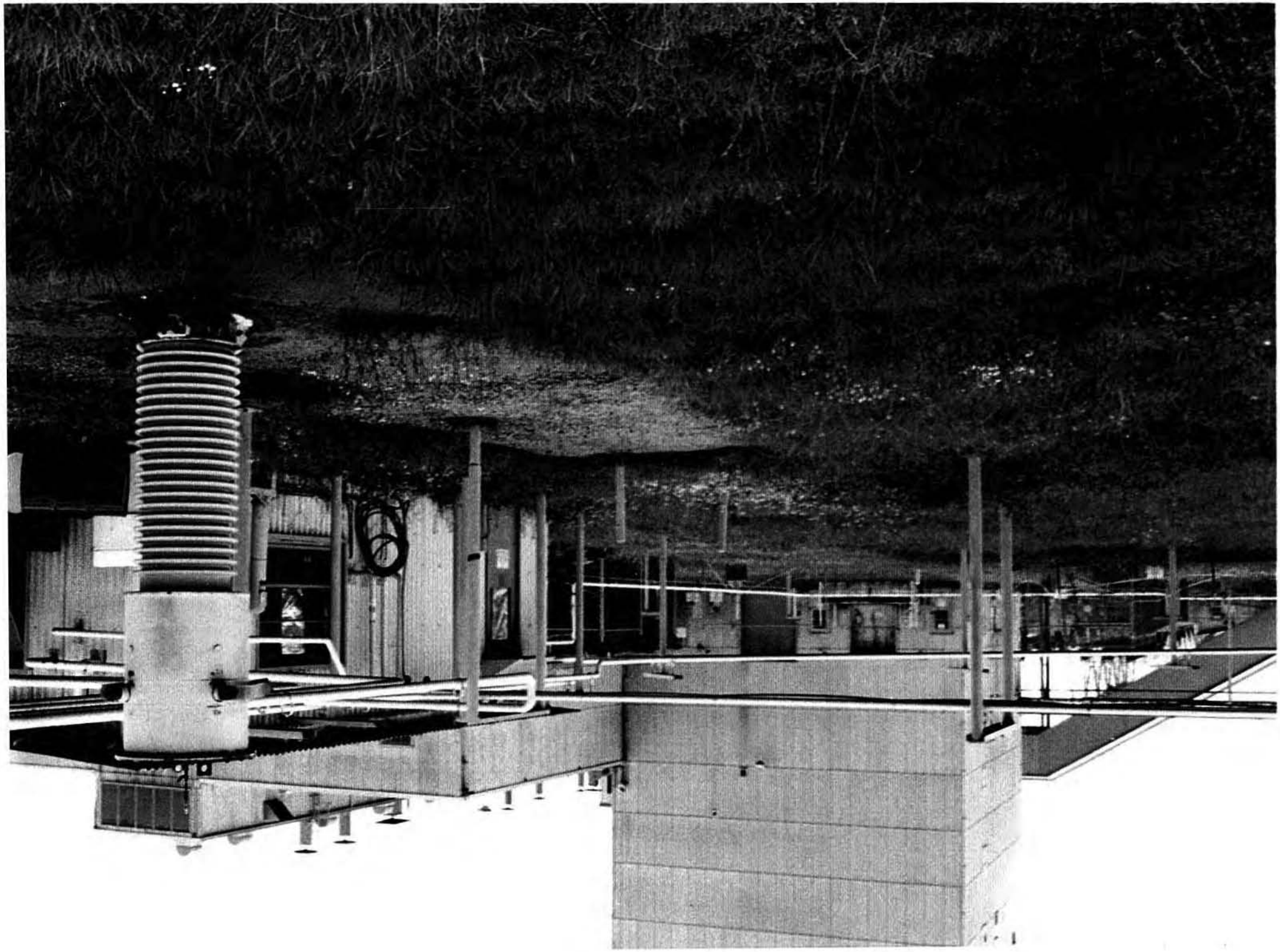
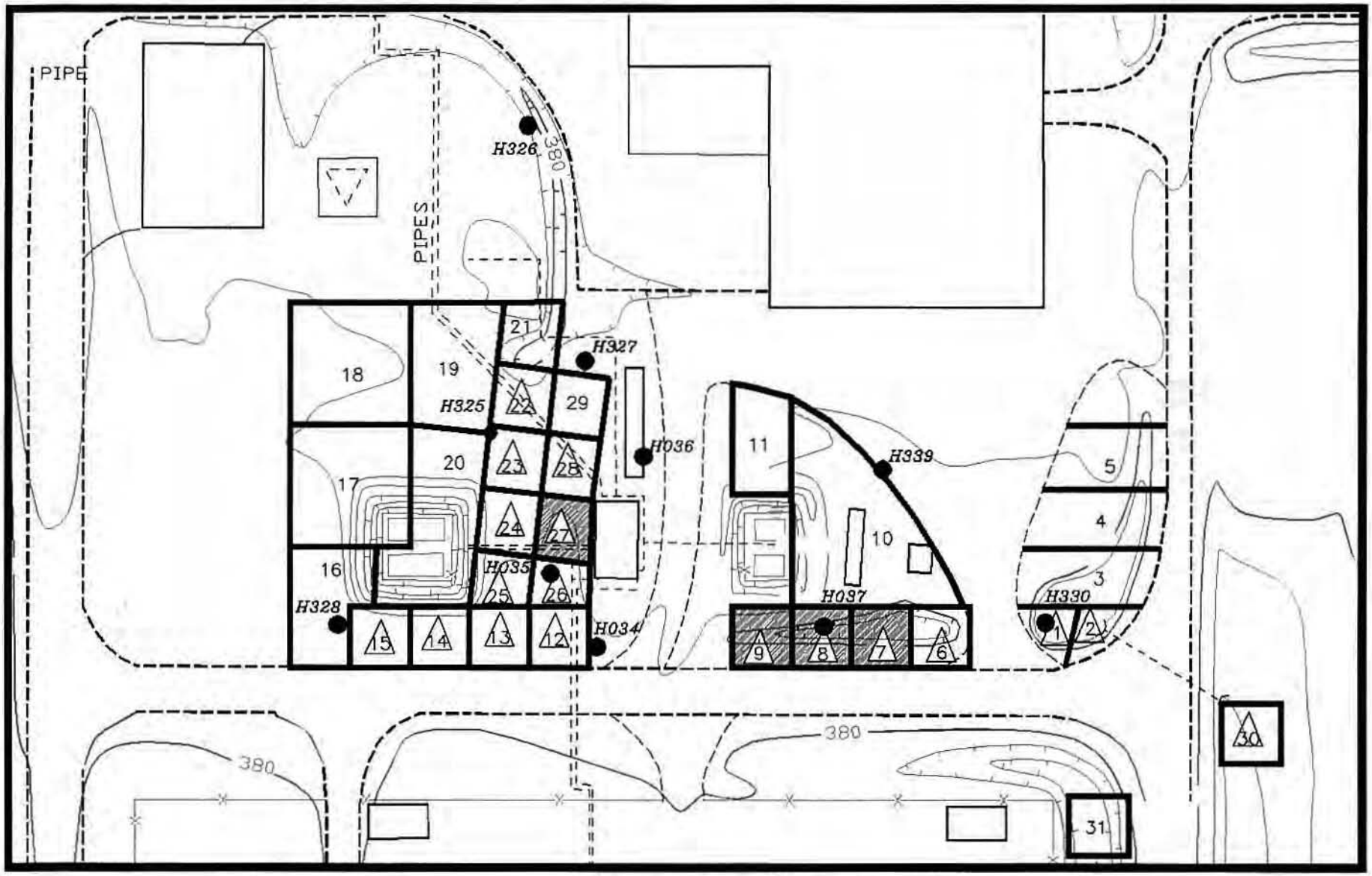


OIL

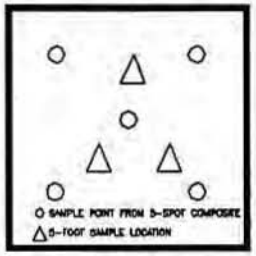


21 WAG 23 SWMU DELINEATION SAMPLING GRID

21 SWMU DELINEATION 5-FOOT SAMPLES

H330 SAMPLING POINT FROM RI ADDENDUM

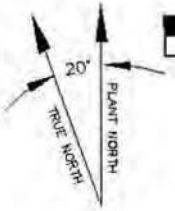
SWMUs 56 and 80

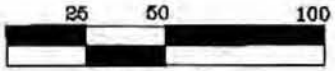


EXAMPLE GRID LAYOUT

TCDD

PCBs





SCALE IN FEET

LOCKHEED MARTIN

1996

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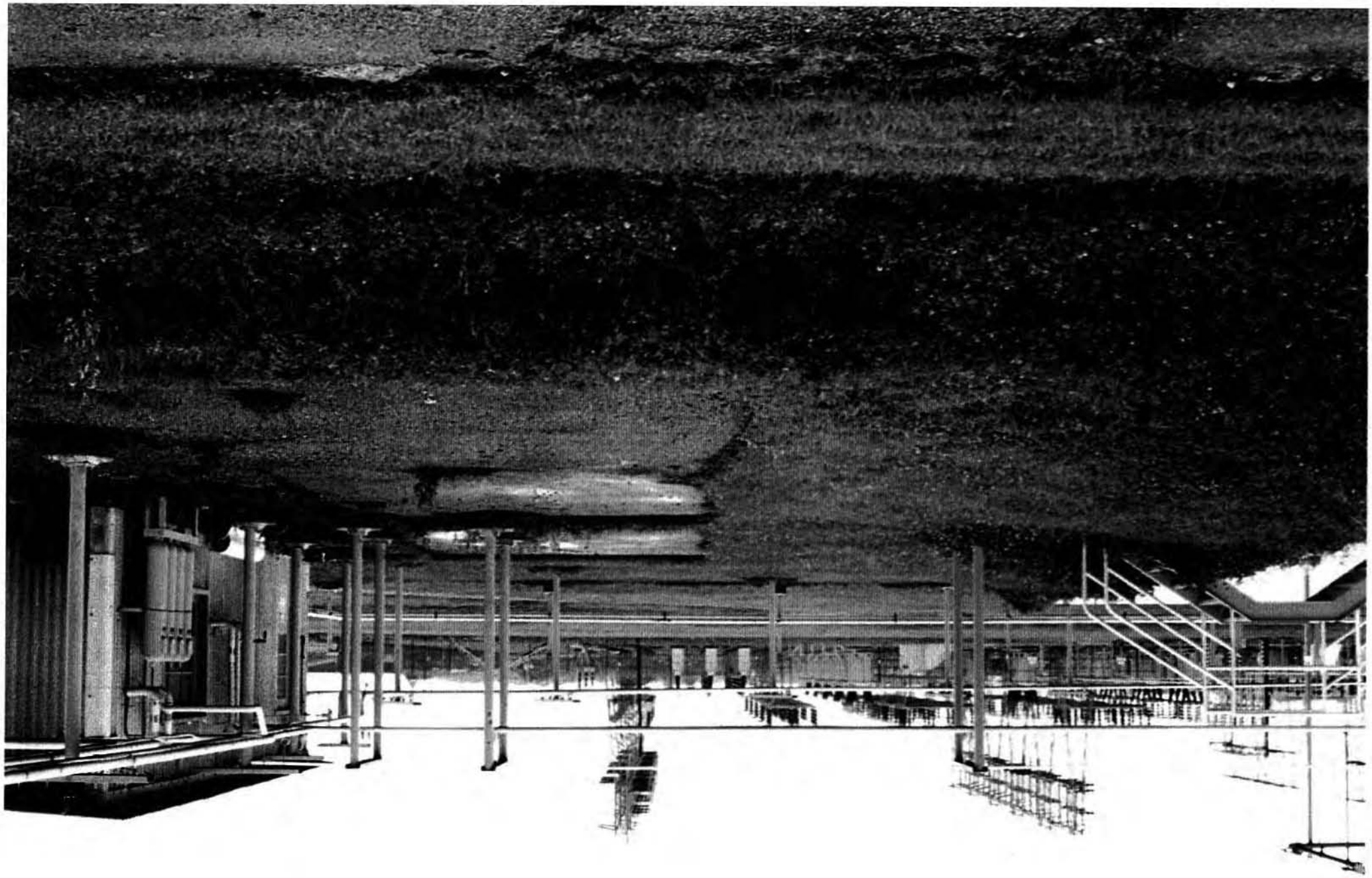
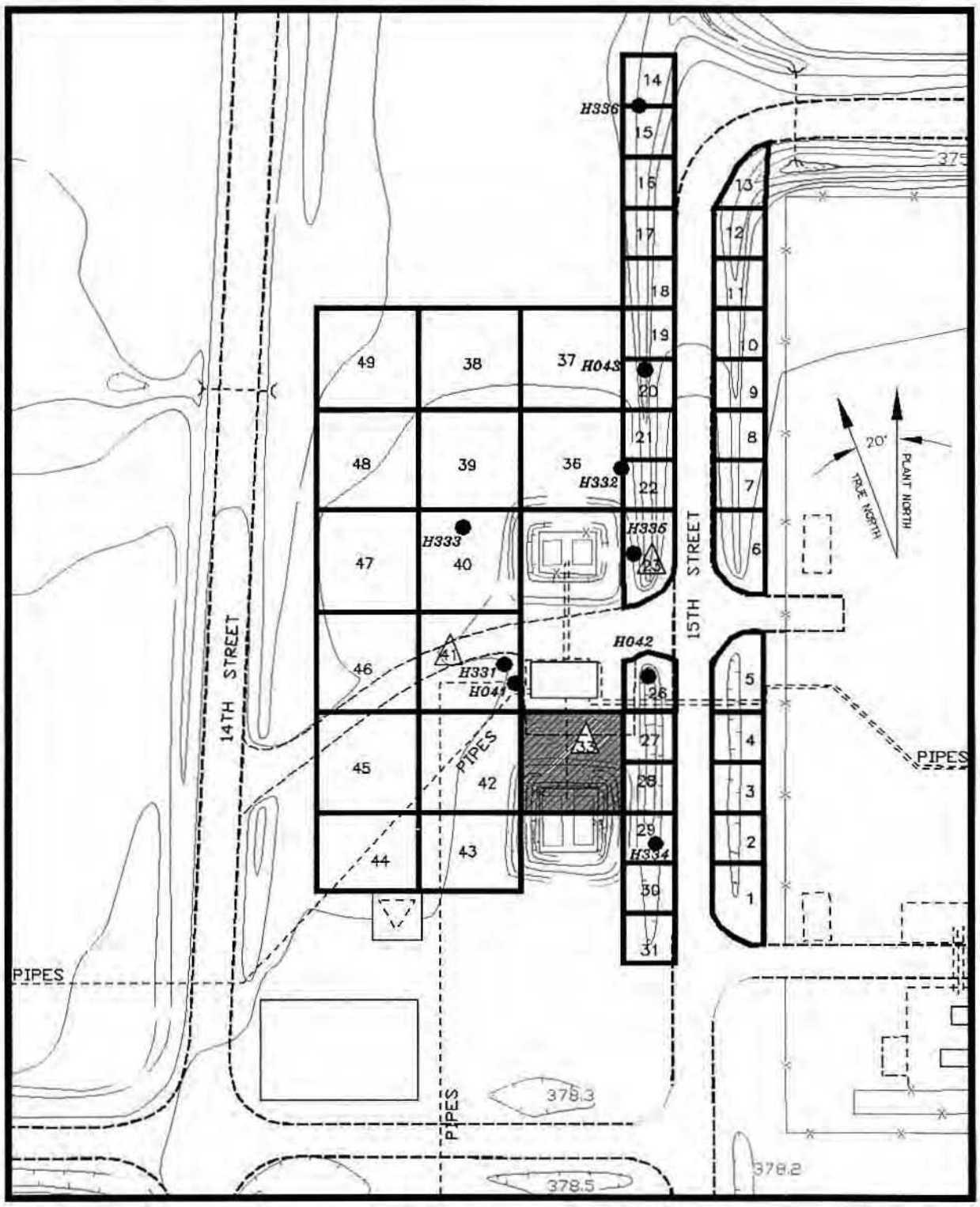


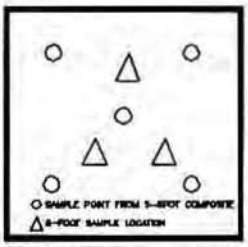


21 WAG 23 SWMU DELINEATION SAMPLING GRID

21 SWMU DELINEATION 5-FOOT SAMPLES

H334 SAMPLING POINT FROM RI ADDENDUM

SWMUs 57 and 81



EXAMPLE GRID LAYOUT

PCBs

25 50 100

SCALE IN FEET

LOCKHEED MARTIN

1996

Marshall

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEC 13 1994

MEMORANDUM

SUBJECT: Voluntary NEPA Review at Federal Facility CERCLA Sites

FROM: Steven A. Herman
Assistant Administrator for Enforcement and Compliance Assurance

Elliott Laws
Assistant Administrator for Solid Waste and Emergency Response

TO: Regional Administrators
Regional Counsels
Regional Waste Management Division Directors
OFA Regional Directors

The Department of Energy (DOE) and two services within the Department of Defense (DoD) -- the Army and Air Force -- have been applying the National Environmental Policy Act (NEPA) as a matter of policy at federal facility site cleanups being conducted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This memorandum clarifies the Agency's policy for cooperating with other federal agencies that follow NEPA procedures as a matter of policy when conducting CERCLA actions.

It is the policy of the Agency to cooperate with federal agencies that choose to apply NEPA to CERCLA activities as a matter of policy, but at the same time to ensure that the integration process does not delay CERCLA cleanups. Because the applicability of NEPA to CERCLA activities has not been definitively addressed judicially, agencies may have concerns -- including the need to avoid cleanup delays due to litigation -- that counsel in favor of full adherence to NEPA procedures as a matter of policy. Thus, in promoting expeditious cleanups, EPA should give due consideration to another agency's intention to apply NEPA fully to CERCLA activities. However, agencies deciding to follow NEPA procedures should be expected to raise the issue of NEPA review during negotiation of CERCLA cleanup timetables so that, as appropriate, the timetables reflect NEPA/CERCLA integration. Thereafter, delays due to NEPA do not excuse an agency's failure to adhere to negotiated CERCLA timetables. As the foregoing reflects, close coordination

between the federal agencies and EPA is essential to successful integration of NEPA and CERCLA review.

Attempts to integrate NEPA and CERCLA have had mixed success, and concern has been raised that NEPA/CERCLA integration will delay cleanups. However, in many cases, such integration is possible without significant cleanup delay. Indeed, because federal agencies incorporate NEPA review into the CERCLA process as a matter of policy only, agencies have considerable flexibility to find ways to do so without significantly delaying the cleanup process. For example, DOE has revised its policy so as to apply NEPA to a more limited set of CERCLA activities and to streamline its administrative procedures for integrating NEPA and CERCLA.

In sum, CERCLA cleanups at federal facilities must move forward in a timely manner whether or not the responsible federal agency chooses to work with NEPA as a framework. Where an agency integrates NEPA and CERCLA processes, it is critical that EPA work cooperatively to ensure effective decisionmaking and timely cleanups.

Close coordination between the federal facility and NEPA staffs at the regional level will aid successful implementation of this policy. Please address any questions you have about this policy clarification to Geoff Garver, OECA Senior Policy Counsel, at (202) 260-3914.

cc: General Counsel, EPA
Assistant Attorney General for Environment and Natural Resources, DOJ
Assistant Secretary for Environmental Restoration and Waste Management, DOE
General Counsel, DOE
Deputy Under Secretary for Environmental Security, DoD
General Counsel, DoD
Chairman, Council on Environmental Quality

DOE/OR/06-1529&D2

Treatability Study Program Plan for Waste Area Group 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

April 1997

CLEARED FOR PUBLIC RELEASE

EXECUTIVE SUMMARY

The United States Department of Energy (DOE) is conducting environmental remediation activities at the Paducah Gaseous Diffusion Plant (PGDP). Remedial efforts are required to address contamination which has resulted from historical waste handling and disposal practices at the site. The DOE is conducting these remedial activities in compliance with the regulatory requirements of the Commonwealth of Kentucky and the United States Environmental Protection Agency.

Source units at the PGDP have been combined into Waste Area Groups (WAGs). Waste Area Group 6 is composed of five solid waste management units (SWMUs), or source units. The primary contaminant of concern for WAG 6 is trichloroethene (TCE) which has been found in the soils and the ground water. Based on past sampling results at the C-400 Area, the presence of dense nonaqueous phase liquid is suspected. In addition, technetium-99 is a secondary contaminant.

Prior to conducting a feasibility study for WAG 6, treatability studies will be conducted to determine the effectiveness of treatment technologies on WAG 6 soils and ground water. The results of these treatability studies will be utilized during the remedial alternative development and screening phases of the WAG 6 FS. Also, these results may provide data that will facilitate and streamline the remedial design of the selected remedy. Additionally, the results of these treatability studies may provide pertinent information in the development and screening of remedial alternatives for other SWMUs and WAGs at the PGDP which also have soils and ground water contaminated with TCE.

This Treatability Study Program Plan (TSPP) identifies treatment technologies which may be applicable to WAG 6 soils and ground water contaminated with TCE, screens the technologies to eliminate those which do not meet the screening criteria for conducting treatability studies, and recommends a manageable number of technologies for treatability studies. This TSPP also provides essential site descriptions of the WAG 6 SWMUs, an overview of the treatability study process, and a tentative schedule to indicate the relative timing of this TSPP and the treatability studies prior to the initiation of an FS for WAG 6.

The following technologies are recommended for WAG 6 treatability studies:

- Regional Gravel Aquifer (RGA)
  - — Oxidation; and
  - — Cosolvent/surfactant.
- Upper Continental Recharge System (UCRS)
  - — 2-Phase Extraction; and
  - — 6-Phase Heating.

Because contamination exists in both the RGA and UCRS and since it is likely that a single remedial alternative may not be the most effective and/or applicable for both zones, treatability studies for both the RGA and UCRS are strongly recommended.

DOE/OR/07-1243&D4

Integrated Remedial Investigation/Feasibility Study Work Plan for Waste Area Grouping 6 at Paducah Gaseous Diffusion Plant Paducah, Kentucky

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PUBLIC RELEASE

are inadequate to complete the risk assessment and FS, then a Field Sampling Plan (FSP) Addendum will be submitted. The FSP Addendum will outline additional sampling for each SWMU and justify the additional sampling. After regulatory approval is granted, the FSP Addendum will be implemented and an RI Report will be prepared. As the FSP Addendum is implemented and the RI Report prepared, an FS will be completed. The FS Report will be submitted after the RI Report.

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP), located in Paducah, Kentucky, is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). Effective July 1, 1993, DOE leased the plant production operations facilities to the United States Enrichment Corporation, which contracted with Lockheed Martin Utility Services, Inc., to provide operations and maintenance services. Lockheed Martin Energy Systems, Inc., manages the environmental management activities for DOE.

On May 31, 1994, PGDP was placed on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA), as promulgated under Sect. 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and 40 CFR 300 (National Oil and Hazardous Substances Pollution Contingency Plan) (hereinafter referred to as the NCP). In addition, DOE, EPA, and the Kentucky Department for Environmental Protection have been negotiating a Federal Facilities Agreement (FFA). The draft FFA incorporates the site investigation (SI) process started at PGDP in accordance with a CERCLA Administrative Order by Consent and the requirements of the EPA Hazardous and Solid Waste Amendments Permit and the Kentucky Hazardous Waste Permit. The draft FFA sets forth requirements to address releases of hazardous or radioactive substances. Final approval of the draft FFA will subsequently require all solid waste management units (SWMUs) and areas of concern be investigated through an integrated remedial investigation/feasibility study (RI/FS) process.

A total of five SWMUs will be evaluated under this integrated RI/FS Work Plan. These SWMUs have been grouped into a single Waste Area Grouping (WAG) identified as WAG 6. Four of the five SWMUs are located in the central portion of the fenced security area near the C-400 Building which has been identified as a potential contributor to off-site groundwater contamination originating from PGDP. The fifth SWMU [C-401 Transfer Line (formerly C-400 to C-404) Underground Transfer Line)] is located within the west-central portion of the security area.

The goals of the integrated RI/FS for WAG 6 at PGDP are to collect sufficient information on each SWMU to evaluate the risk-based impact to human health and the environment, determine the nature and extent of contamination, and collect data for the support of the FS. A sampling strategy for each SWMU and the C-400 area has been developed in the WAG 6 area only, focusing sampling toward the efficient and cost-effective collection of data necessary to meet the objectives of the investigation.

The site priorities are to mitigate imminent threats, control hot spots as they are discovered, and address source units followed by final actions for groundwater and surface water. WAG 6 SWMUs are classified as source units and as secure on-site source control units, since they are located within the fenced security area.

After sampling activities outlined in this work plan have been implemented, a data evaluation meeting will be conducted with members of the regulatory community to evaluate sufficiency of collected data. If the data collected during the completion of the RI are of sufficient quantity and quality to satisfy the data gaps and complete the baseline risk assessment and FS for each of the SWMUs, the RI Report will be prepared. If the actual site conditions vary from the most probable site conditions identified during the preliminary data evaluation and/or if it is determined that data

SED28178.R

Document Number KY/ER-4

DRAFT

RESULTS OF THE SITE INVESTIGATION, PHASE I

at the
PADUCAH GASEOUS DIFFUSION PLANT
Paducah, Kentucky

owned and operated by the
U.S. DEPARTMENT OF ENERGY

and managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.

December 21, 1990

VOL. 1 OF 5

Chapter 1
INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

The United States Department of Energy (DOE) owns the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky, and Martin Marietta Energy Systems, Inc. (Energy Systems), manages the plant for DOE. In August 1988, contamination was found in private wells north of the PGDP. In the fall of 1988, the United States Environmental Protection Agency (EPA) and DOE entered into an "Administrative Order by Consent" (Consent Order) under Section 104 and Section 106 of the Comprehensive Environmental Response and Liability Act (CERCLA) to address the situation. The agreement is legally binding on both parties. The United States Department of Justice concurred in the Consent Order.

The contaminants that were found in groundwater and surface water off the site and whose presence led to the Consent Order are technetium-99 (Tc-99), a radionuclide; trichloroethene (TCE), an organic solvent (also known as "trichloroethylene"); and potential degradation products of TCE, such as trans-1,2-dichloroethene. Polychlorinated biphenyls (PCB) were found later downstream of the plant in sediment and fish. The contamination by PCBs is not specifically listed as part of the Consent Order.

The mutual objectives of EPA and DOE in entering the Consent Order were stated as follows: (1) to determine the nature and extent of the threat to human health and welfare and to the environment from the contamination of offsite groundwater caused by sources at the PGDP; (2) to see that the environmental effects associated with the releases and threatened releases of contaminants are thoroughly investigated and that appropriate action is taken as necessary to protect the public health and welfare and the environment; (3) to establish a work plan and schedules for developing, implementing, and monitoring necessary response actions at the site; and (4) to facilitate cooperation, exchange of information, and participation among the parties in meeting the mutual objectives of EPA and DOE.

The Commonwealth of Kentucky chose not to be a signatory to the Consent Order. They are, however, given copies of documents and sampling results.

DOE/Energy Systems, with EPA's concurrence, have undertaken a site investigation to meet the objectives of the Consent Order. The site investigation augments the continuing DOE/Energy Systems Environmental Restoration Program (ERP). CH2M HILL is conducting major parts of the site investigation for DOE/Energy Systems.

The investigation is being conducted in two phases. The purpose of Phase I is to evaluate the nature and extent of offsite contamination originating at the PGDP. The

3. PCB contamination of biota in the creeks may be a result of surface runoff from onsite surface or near-surface sources, such as the PGDP oil landfarm and the transformer areas.

4. The effect of groundwater and surface water contamination on human health can best be determined by sampling and measuring contaminant concentrations at the exposure points, such as private wells and local streams and ponds.

1.1.2 PHASE II

The purposes of Phase II are to:

1. Characterize the onsite sources of the contamination found in Phase I.

2. Further characterize the nature and extent of the offsite contamination that was found, including the contamination known to be present in surface water and groundwater.

3. Evaluate and recommend appropriate alternatives for remediating offsite contamination and onsite sources of the contamination.

The expected results of Phase II include a risk assessment of the "no action" alternative and comparisons of remedial alternatives. After Phase II is completed, the Consent Order will be amended by EPA and DOE to include actions for completing the proposed remediation.

DRAFT

1.2 REPORT ORGANIZATION

This report presents the results of Phase I of the investigation in seven chapters:

- Chapter 1, "Introduction," discusses the purpose and objectives of the site investigation; site background, including a description of the site; continuing environmental programs for collecting information pertinent to the investigation; waste management units (WMUs) that are potential sources of releases; environmental data from previous investigations and environmental programs at the PGDP; applicable or relevant and appropriate requirements (ARARs); and the QA/QC approach established for the site investigation.

- Chapter 2, "Summary of Site Investigation," describes the field activities in Phase I. They include investigating surface features, surface water, sediment, hydrogeology, ecology, and contaminant sources. Also included is a discussion of a survey that was conducted of the uses of the groundwater and the surface water in the study area.

mechanism for enrichment is based on the fact that a UF_6 molecule containing U-235 is slightly lighter than a UF_6 molecule containing U-238. As the UF_6 molecules move through the miles of tubing in a cascade system, slightly more U-235 than U-238 escapes through the small holes in the tubing. As this process is repeated (cascading), the U-235 concentration increases. About two-thirds of the U-235 in the natural ore are removed during enrichment, so there are two product streams: enriched uranium and depleted uranium.

Currently, uranium enriched at the PGDP is further enriched at another DOE gaseous diffusion plant, which is managed by Energy Systems in Portsmouth, Ohio. Most of the uranium from the PGDP is ultimately designated for the commercial sector as fuel for nuclear power reactors in the United States and abroad. For comparison, the fuel in commercial power reactors is about 3 percent U-235, fuel for the production reactor at the Savannah River site is typically 60 percent U-235, and naval reactor fuel is 97.3 percent U-235. Depleted uranium is used for components in both nuclear and conventional weapons.

1.3.2 FOCUS OF THE INVESTIGATION

During enriching operations from 1953 to 1975, feed material (called "reactor tails") from government reactors was used intermittently in addition to the UF_6 typically used. Reactor tails are the fuel from nuclear reactors that is no longer usable because of decreased radioactivity or because of "poisoning" of the fuel by fission products. The reactor fuel rods were processed at other DOE facilities (where much of the fission products were removed) and the enriched uranium and fission products were fed into the PGDP cascade system. Use of the reactor tails resulted in the introduction of Tc-99, a contaminant in the feed material, into the plant. Tc-99 is a man-made radioactive substance (radionuclide) having a half-life estimated at between 212,000 and 250,000 years. It decays by emitting beta radiation.

In addition to the radiological contamination, the PGDP used TCE, a volatile organic solvent, for industrial degreasing and cleaning. PCB, a chlorinated nonflammable material, was used at the plant as a lubricating oil, as a hydraulic fluid, and as a cooling fluid for electrical transformers.

Arsenic was a contaminant in the cascade feed material, probably from 1982 or 1983 to 1989. The waste solutions from cleaning HF_6 cylinders probably contained low levels of arsenic. The C-410 building contains 120 cells used in processing feed material from the mid-1950s to 1965 and from 1968 to 1975. Arsenic was present in the hydrofluoric acid purchased and used in electrolyte cells for generating fluorine for producing UF_6 in the feed plant from the mid-1950's to 1965 and from 1968 to 1975.

Arsenic amounted to between 2 and 15 pounds of the four electrolytes in the 120 large cells that were tested. The cells were routinely changed out. The sludge and solutions were sent to a neutralization pit behind the C-410 building; that practice has stopped, and the waste electrolytes are put in drums and stored. The sludge was tested by the

- The McNairy Formation, which is predominantly clay with layers of sand, underlies the regional gravel aquifer. Sand layers within the McNairy Formation are another potential aquifer in the vicinity of the PGDP.

- Clay layers in the McNairy Formation and in the Porters Creek Clay (where present) separate the regional gravel aquifer from the McNairy sands and may serve as vertical confining layers. In some locations beneath the plant, either the Porters Creek Clay or the McNairy Formation is overlain by Eocene sands, which may also serve as an aquifer.

- Above the gravel aquifer, sand lenses in clay may bear and transmit water. They do not serve as a major aquifer for the local water supply, but large-diameter hand-dug wells may be in the sand lenses.

1.3.4 ENVIRONMENTAL PROGRAMS

DOE/Energy Systems have established a series of environmental programs at the PGDP, including the Remedial Action Program (RAP), the Groundwater Monitoring Program, the Biological Monitoring Program, and the Ambient Environmental Monitoring Program. The programs are being conducted to (1) identify and assess sites that may contaminate the environment, (2) assess the effects of releases from the plant on the environment, (3) assess the effectiveness of the environmental monitoring program for detecting and monitoring releases, and (4) develop and implement remedial actions to control and minimize the release of contaminants from the site. Phase I of the PGDP site investigation was conducted in conjunction with these programs. The programs and the data generated to determine the extent of contamination in groundwater and surface water are discussed in subsequent sections of this report.

1.3.4.1 Remedial Action Program (Environmental Restoration Program)

The RAP is designed to define the extent of existing contamination. It will determine the proper corrective action for WMUs at the PGDP. WMUs include landfills, surface impoundments, treatment units, scrap yards, spill sites, and other units that have received waste at any time, regardless of the type of waste.

The specific objectives of the RAP include hydrogeological characterization of the plant site, development of work plans for investigating WMUs, evaluation of WMUs to determine necessary corrective actions, and identification of additional WMUs that may be at the facility. The discovery of offsite contamination of groundwater resulted in the expansion of the RAP's objectives to include determining the source and extent of offsite contamination, as required by the terms of the Consent Order. The RAP was renamed the "Environmental Restoration Program" (ERP) in October 1990.

1.3.4.4 Ambient Environmental Monitoring Program

Routine monitoring and sampling for radiation, radioactive materials, and chemical substances on and off the PGDP are used by DOE/Energy Systems to document compliance with appropriate standards, identify trends, provide information to the public, and contribute to general environmental knowledge. The surveillance program helps fulfill the DOE policy of (1) protecting the public, DOE employees, and the environment from the harm that could be caused by PGDP activities and (2) reducing negative environmental effects to the maximum extent practicable. Information from environmental monitoring complements data on specific releases, trends, and summaries.

Monitoring and sampling locations for various types of measurements are organized in three categories:

- Regional stations off the site, some distance from the PGDP in residential and community areas; they are used for documenting conditions in areas potentially affected by the PGDP that are occupied or that are visited by the public

- Perimeter stations on the boundaries of the PGDP; they are used for documenting conditions in the areas on the PGDP's boundaries

- Stations on the PGDP site

Typically, over 300,000 measurements are taken annually from air, groundwater, streams, lakes, drinking water, trees, grasses, wildlife tissues, garbage, sewage, soil, sediment, and sludge.

1.3.5 WASTE MANAGEMENT UNITS

Before the implementation of Phase I, DOE/Energy Systems identified 95 WMUs within the PGDP. Two additional WMUs, a scrap wood pile (WMU 96) and the site of a diesel-fuel spill (unnumbered WMU), were added during Phase I.

While the *Phase I Site Investigation Work Plan for Paducah Gaseous Diffusion Plant* (CH2M HILL, 1989) was being prepared, 32 WMUs and effluents from 2 process areas that are not WMUs (the C-310 purge cascade vent and the C-400 decontamination building) were identified as likely sources of Tc-99 or TCE contamination. Identified as likely sources of PCB contamination were 19 WMUs and 2 other areas--the C-340 building hydraulic system and the plant storm sewer system.

Appendix 1A contains a list of WMUs at the PGDP. Additional information on each of the potential sources of Tc-99, TCE, and PCB contamination is in the Phase I work plan.

1.3.6.3 Soil and Sediment

Samples of shallow soil are collected annually at 10 locations around the PGDP. Concentrations of uranium in samples from shallow soil at the PGDP have been reported from 1958 to the present. Tc-99 in soil was measured but was not reported in PGDP environmental surveillance documents until recently because no discernible differences in concentrations of Tc-99 in comparison to concentrations in previous years had been noted at any of the regular soil-sampling locations (Energy Systems, 1986f).

The results of analyses for Tc-99 and other radionuclide concentrations in sediment samples from creeks and ponds are available from 1977 to the present (Energy Systems, 1986f). Sediment samples are analyzed for PCBs, uranium, U-235 assay (percent U-235), Tc-99, neptunium-237 (Np-237), plutonium-239 (Pu-239), and thorium-230 (Th-230). Currently, sediment samples are taken annually from 21 locations in Big Bayou Creek, Little Bayou Creek, PGDP drainage ditches, and PGDP surface impoundments (see Figure 18-4 in Energy Systems, 1986f).

1.3.6.4 Biota

Biological sampling has been conducted at the PGDP since 1955, and the results have been reported in the annual environmental surveillance report since 1958. The program has largely consisted of sampling grasses at 16 to 18 locations near the plant boundary and at locations about 1 mile and 5 miles from the plant. The grass samples were analyzed for fluorides to determine compliance with Commonwealth of Kentucky requirements for fluoride concentrations in grasses eaten by grazing animals. In 1986 and 1987, DOE/Energy Systems personnel sampled various food crops found inside and outside the plant boundary for Tc-99 and other radionuclides.

The Biological Monitoring Program is designed to determine the adverse effects of liquid effluents on aquatic biota in receiving streams, the appropriateness of present effluent limits, and the effects of remedial actions taken by the PGDP for specific discharges. The program includes chemical monitoring, toxicity testing, ecological surveys, and bioaccumulation studies.

1.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Generally, remedial action at the PGDP is required to comply with federal and state environmental laws and with standards, requirements, criteria, and limits that are considered either legally applicable or relevant and appropriate for the circumstances created by the release or threatened release of hazardous substances, pollutants, or contaminants. Such laws, standards, requirements, criteria, and limits are known as "applicable or relevant and appropriate requirements" (ARARs).

1.5 QUALITY ASSURANCE AND QUALITY CONTROL

Phase I of the site investigation was performed in accordance with *Environmental Surveillance Procedures Quality Control Program*, ESH/Sub/87-21706/1, September 1, 1988 (Energy Systems, 1988r). This document has been approved by EPA for use in all environmental investigations conducted by DOE/Energy Systems in EPA Region IV.

The QA program complied with the criteria of *Quality Assurance Program Requirements for Nuclear Facilities*, ANSI/ASME NQA-1-1986, which is the predominant standard for DOE remedial investigations, and with the requirements of *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80, EPA/600/4-83/004. Compliance with these requirements and additional DOE Orders was accomplished by incorporating actions in the site-specific quality assurance project plan.

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RESULTS OF THE SITE INVESTIGATION, PHASE II

at the

Paducah Gaseous Diffusion Plant
Paducah, Kentucky

owned and operated by

U.S. Department of Energy

and managed by

Martin Marietta Energy Systems, Inc.

April 1992

Volume 1 of 6

EXECUTIVE SUMMARY

1.1 BACKGROUND

The Paducah Gaseous Diffusion Plant (PGDP) is a uranium-enrichment facility consisting of a diffusion cascade and extensive support facilities. Construction at the plant began in 1951, and by 1952 the plant was operating. The PGDP is owned and operated by the United States Department of Energy (DOE) and is currently managed by Martin Marietta Energy Systems, Inc. (Energy Systems).

The plant is located in northwestern Kentucky on a reservation of about 1,350 acres in western McCracken County, about 10 miles west of Paducah, Kentucky, and about 3 miles south of the Ohio River. Approximately 740 acres of the reservation are within a fenced security area. The raw-water treatment plant, the residential landfill, the inert landfill, and two industrial treatment lagoons are operating areas outside the security area. In addition, a former sanitary landfill and several concrete rubble piles are inactive waste management units (WMUs) outside the security fence. An uninhabited buffer zone surrounds the fenced area.

Beyond the DOE-owned buffer zone is an extensive wildlife management area of 2,100 acres deeded or leased to the Commonwealth of Kentucky. During World War II, the Kentucky Ordnance Works, a trinitrotoluene (TNT) production facility, operated in an area southwest of the plant on what is now part of the West Kentucky Wildlife Management Area (WKWMA).

The PGDP performs the first step in the uranium-enrichment process. The product from the PGDP must be further enriched before being used as nuclear fuel. The plant provides an enriched feed stream to the gaseous diffusion plant in Portsmouth, Ohio. It also provided a similar feed stream to the Oak Ridge Gaseous Diffusion Plant in Oak Ridge, Tennessee, before that plant ceased production.

The PGDP enriches the uranium-235 (U-235) radionuclide in a physical separation process. The separation is based on the faster rate at which U-235 diffuses through a membrane barrier in comparison to the heavier U-238. Extensive support facilities are required for maintaining the diffusion process. Some of the major support facilities include a steam plant, four major electrical switchyards, four sets of cooling towers, a building for chemical cleaning and decontamination, a water treatment plant, maintenance facilities, laboratory facilities, and two active landfills. Several inactive facilities are also located on the plant site.

Hazardous, nonhazardous, and radioactive wastes have been generated and disposed of as a result of PGDP operations. In August 1988, contamination was found in an offsite

Phase I report was approved as final by EPA in June 1991. Details of the Phase I activities can be found in that report.

Phase II of the investigation was conducted in 1990 and 1991 to further assess the nature, extent, and risk of offsite contamination; to characterize WMUs possibly contributing to offsite contamination; and to identify contaminant migration pathways contributing to offsite contamination.

This site investigation report presents the data collected during Phase II and summarizes the analytical results from both phases of the investigation. These findings provide the basis for the alternatives evaluation and the public health and environmental assessment, both of which were submitted to EPA and the State of Kentucky in December 1991.

1.3 SUMMARY OF SITE ACTIVITIES

The major accomplishments of the site investigation are the following:

- Installed 83 new water quality monitoring wells in clusters upgradient and downgradient of the plant
- Inspected and evaluated 80 monitoring wells previously installed by DOE/Energy Systems and selected about 40 wells for periodic monitoring of water quality during the investigation
- Conducted six rounds of sampling and analysis of selected residential and monitoring wells between June of 1989 and June of 1991; most wells that were selected were sampled in at least two of the six rounds
- Conducted four rounds of aquifer slug tests in selected wells to determine hydraulic conductivity of the primary aquifers beneath the site
- Measured water levels simultaneously over several days in wells and streams to evaluate the interconnection between groundwater and surface water
- Measured water levels in wells monthly over a one-year period to determine aquifer gradients
- Collected soil samples from 13 offsite and 44 onsite deep borings, from 20 shallow onsite borings, and from more than 100 surface borings both onsite and offsite

- Safely managed over 1,600 55-gallon drums and 50,000 gallons of investigation-derived waste generated during the 23 months of field investigations

- Collected samples, maintained chain-of-custody from collection through analyses, and returned to the PGDP more than 5,000 samples of various environmental media; screened each sample for radioactivity prior to shipping; and shipped samples and sample residuals without incident

- Submitted several thousand environmental samples for analyses, validated the data, and entered the information in an electronic database management system developed for the project

- Prepared 44 technical memoranda, the Phase I report (which included a preliminary assessment of offsite receptors), and the Phase II report

The overall result of these activities is a clearer understanding of the pattern of offsite contamination of groundwater, surface water, and sediment resulting from the plant's activities; a better concept of contamination patterns on the site and the contribution of each to the offsite contamination; and an estimate of the risks to offsite receptors.

1.4 AQUIFER CHARACTERISTICS

The PGDP site is underlain by the predominantly clay Coastal Plain Deposits. Overlapping scour channels from an ancient river eroded the top of the Coastal Plain Deposits to form a major subsurface feature near the southern part of the site, referred to as the Porters Creek Clay terrace. The Lower Continental Deposits were deposited in the old scour channels and were subsequently overlain by (in ascending order) sand and clay of the Upper Continental Deposits, loess, alluvium, and fill.

The deep groundwater system is within the Coastal Plain Deposits and represents the lowest vertical extent of this site investigation. The deep groundwater system is not typically used as a water supply in this area, but contamination of this system would be an indicator of continuing contaminant migration. The general absence of contamination in the deep groundwater system associated with PGDP activities is discussed in section 2.1 below.

The Regional Gravel Aquifer of the Lower Continental Deposits is the major water supply aquifer for this area. This aquifer is not homogeneous. Preferential pathways for more rapid groundwater movement apparently occur along the alignments of former river channels, which are oriented generally east-west beneath the plant. Even within these channels, preferential subpathways may be present. Aquifer tests indicate that conditions in these channels have resulted in a transmissivity parallel to the scour channels that is

Table ES-1
Contaminants Found Offsite in Assessed Media[a]
PGDP Phase II Site Investigation

Contaminants	Assessed Media					
	Groundwater	Surface Water	Sediment	Fish	Deer	Plants
PCBs			X	[a]	[b]	
Dioxins, Furans			X			
Pesticides		X				
Phenol	X					
PAHs			X			
Trichloroethene (TCE)	X	X	X			
BTEX	X	X	X			
Other VOCs	X	X	X			
Arsenic	X			X	X	X
Beryllium	X			X	X	
Lead	X			X	X	X
Nickel	X	X		X	X	X
Zinc	X	X	X	X		
Other Metals		X	X	X	X	X
Technetium-99	X	X	X	X	X	X
Uranium	X	X	X	[c]	X	
Other Radionuclides	X	X	X	[c]	X	

[a]Table summarizes data obtained during both Phase I and Phase II of the site investigation.
[b]Oak Ridge National Laboratory (ORNL) detected PCBs in one deer liver tissue.
[c]Not analyzed.

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2.1.1.2 Surface Water and Sediment

Chemical and radiological contamination associated with the PGDP was detected in Little Bayou Creek and the North-South Diversion Ditch in both surface water and sediment (see Table ES-1). The contamination consists primarily of uranium and PCBs, as depicted on Figures ES-5 and ES-6, respectively.

The low levels of chemical and radiological contamination found off the site in ponds, lakes, and marshes (see Table ES-1) could not be readily attributed to the PGDP. A direct pathway, for migration from the plant to those ponds where trace contamination was found, is not present. The marsh at the confluence of Big and Little Bayou Creeks is in direct communication with the creeks, and with the Ohio River, during flood stage.

2.1.1.3 Biota

Low levels of contaminants were detected in fish from both streams and ponds (see Table ES-1). Radionuclide values higher than reference values were detected in one fish sample at an estimated 5.95 pCi/g of Tc-99. PCB concentrations above the Food and Drug Administration's (FDA's) action level of 2 ppm were not found in any of the more than 30 fish collected as part of this site investigation, although the PGDP's Biological Monitoring Program (BMP) has reported such levels.

Analyses of radionuclides in edible parts of deer by both the Oak Ridge National Laboratory (ORNL) and subcontracted laboratories did not detect levels of radionuclides above reference (or background) levels. One deer liver tissue sample contained a detectable concentration of PCBs. Inorganic contaminants, primarily arsenic, were detected, but at levels below FDA action levels for meat to be used for human consumption.

The only crops found with radionuclides above reference values were some composite samples from whole (root, stem, and pod ground together) soybean plants.

2.1.1.4 Soil

No pattern of soil contamination associated with the PGDP, including air dispersion, was found in offsite soil.

2.1.2 SOURCES CONTRIBUTING TO OFFSITE CONTAMINATION

Forty-two onsite WMUs were investigated. Twenty-one were found to be contributing to contamination found off the site. Of these, 9 were identified as contributing to only offsite groundwater contamination, 9 were identified as contributing only to offsite surface-water contamination, and 3 were found to be contributing to both. These

Table ES-2
WMUs Contributing to Offsite Groundwater Contamination
PGDP Phase II Site Investigation

Waste Management Unit	Analyte		
	TCE	Tc-99	Comments
TCE Spill Sites			
C-747 Oil Landfarm (WMU 1)	B	C	
C-400 TCE Leak Site (WMU 11)	A	B	Likely source of other VOCs
UF_6 Cylinder Drop Test Area (WMU 91)	A	C	
Radioactive Burial Sites			
C-749 Uranium Burial Ground (WMU 2)	B	A	Major source of metals, likely source of uranium
C-404 Low-Level Radioactive Waste Burial Ground (WMU 3)	B	A	Major source of metals, likely source of uranium
C-747-A Burial Ground (WMU 7)	A	A	Major source of other VOCs and metals
C-747-A Burn Area (WMU 30)	B	B	Major source of metals and likely source of VOCs
Sanitary Landfills			
C-746-S Residential Landfill (WMU 9)	C	B	Major source of uranium, likely source of metals
C-746-T Inert Landfill (WMU 10)	C	B	Major source of uranium, likely source of metals
Lagoons			
C-616-E Sludge Lagoon (WMU 17)	D	C	
C-616-F Full-Flow Lagoon (WMU 18)	D	B	
Miscellaneous Structures			
C-403 Neutralization Tank (WMU 40)	A	A	
C-400 Basement Sump (WMU 98)			See WMU 11

NOTE:

Source contribution is based on relative concentration of contaminant at the source:

A = Major source of offsite contamination.
B = Likely source.
C = Possible source.
D = Not probable source.

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The soil properties that affect the potential reaction of soil with the dissolved components in the water include hydraulic conductivity, cation exchange capacity (CEC), mineral content, and organic carbon content. Hydraulic conductivity is a measure of the rate at which water flows through the soil under a specific pressure or head. Hydraulic conductivity is used to estimate flow velocities; lateral flow velocities calculated from aquifer tests ranged from 200 to 400 feet per year in the Regional Gravel Aquifer and from 0.0001 to 40 feet per year in the shallow groundwater system. The CEC of a soil is a measure of its capacity to immobilize positively charged ions, such as metals and radionuclides, by adsorption or exchange of those ions on the surface of the clayey soil particles. Soils analyzed during the PGDP site investigation typically showed low CEC values and, as a group, do not have a generally high capacity to adsorb metals or radionuclides. The amount of organic carbon present in a soil increases the amount of an organic compound that will be attenuated by that soil. The total organic carbon (TOC) content of subsurface soil was low, indicating that some contaminants (primarily organic compounds) are not likely to be adsorbed to the mineral surfaces of the soil particles. The sediment TOC content was somewhat higher, and some organic contaminants are expected to be retained by the sediments.

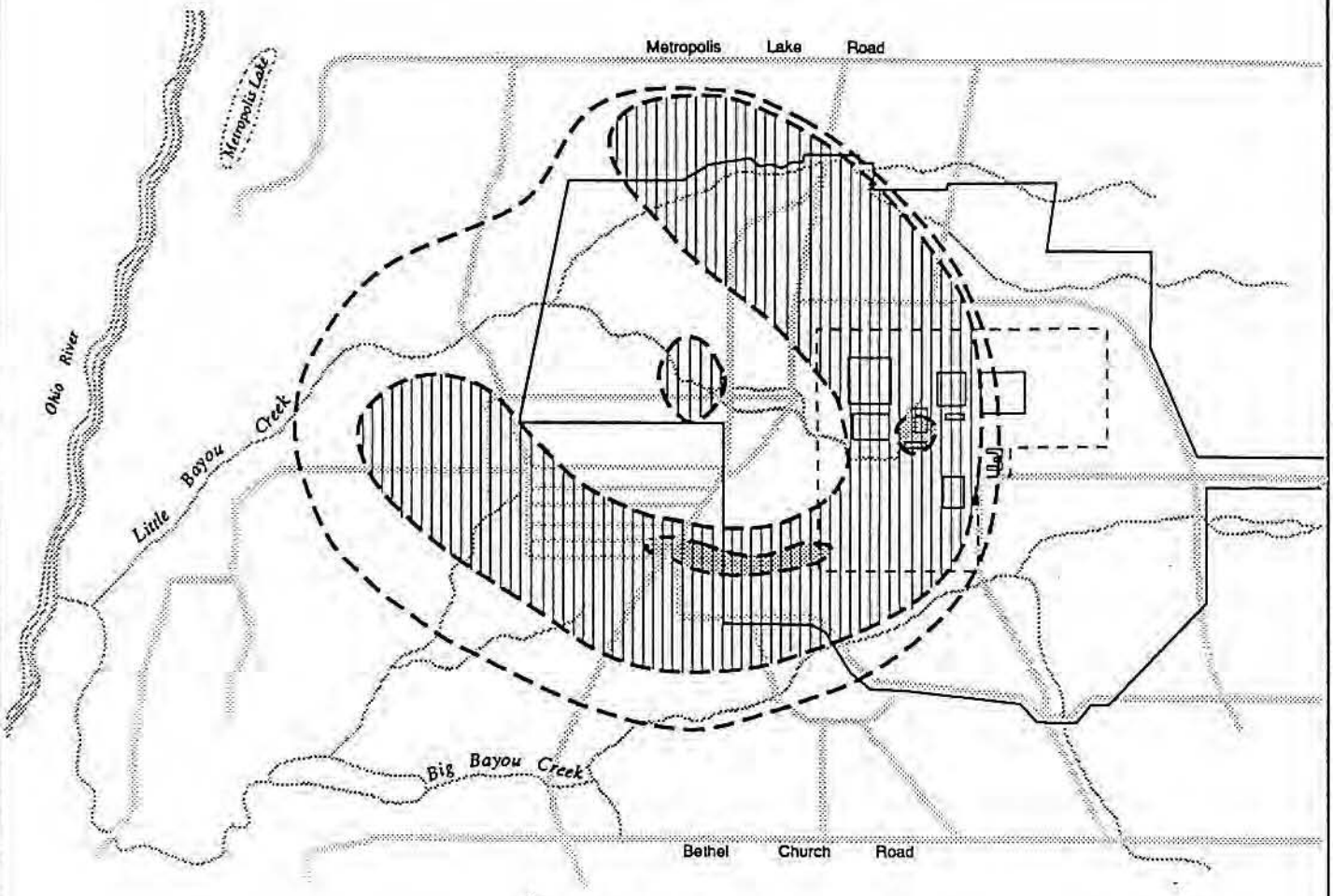
The four primary contaminants detected in this investigation are TCE and Tc-99 in groundwater and uranium and PCBs in surface water and sediment. TCE and Tc-99 are relatively mobile in the soil-groundwater system and do not tend to sorb to soil (or sediment). They tend to dissolve in water and move freely with it. TCE, if released in large quantities (such as those from the leaks associated with WMUs 11 and 91), can also migrate as a DNAPL (as discussed previously) and create new underground sources (or "pools" of TCE) from which TCE can continue to dissolve and be released to flow with the groundwater.

PCBs are a group of toxic, chlorinated organic components characterized by low water solubility, low volatility, a high affinity for organic matter, and high resistance to chemical and biological breakdown. As seen in the results of environmental sampling, PCBs have been found in creek sediments and in fish from the creeks and some ponds, but not in surface water or groundwater. This is because PCBs tend to sorb to sediment and migrate with the sediment in runoff, rather than by dissolving in the surface water or groundwater. Fish that ingest the contaminated sediment can accumulate PCBs in their body tissues.

Uranium is a radioactive contaminant found primarily in the sediment and not in the surface water or groundwater. Important factors controlling the mobility of uranium from soil to the water phase are oxidation-reduction potential of the water, pH of the water, complex formation, and adsorption of uranium to clay particles.

The Regional Gravel Aquifer is the primary transport route for contaminants found in the offsite groundwater. The shallow groundwater system does not appear to be a major

- Monitoring of surface water and suspended sediment in runoff from general plant areas during storm events
- The absence of contamination in marsh sediment near the confluence of Big Bayou and Little Bayou Creeks
- The sampling of crops or other foodstuffs over several growing seasons to identify spatial and temporal changes



TCE Contamination

Legend

- Area Where Maximum TCE Concentration > 1 µg/l [a]
- Area Where Maximum TCE Concentration > 5 µg/l [b]
- Area Where Maximum TCE Concentration >1,000 µg/l
- PGDP Site Boundary
- DOE Boundary

Plant North
True North

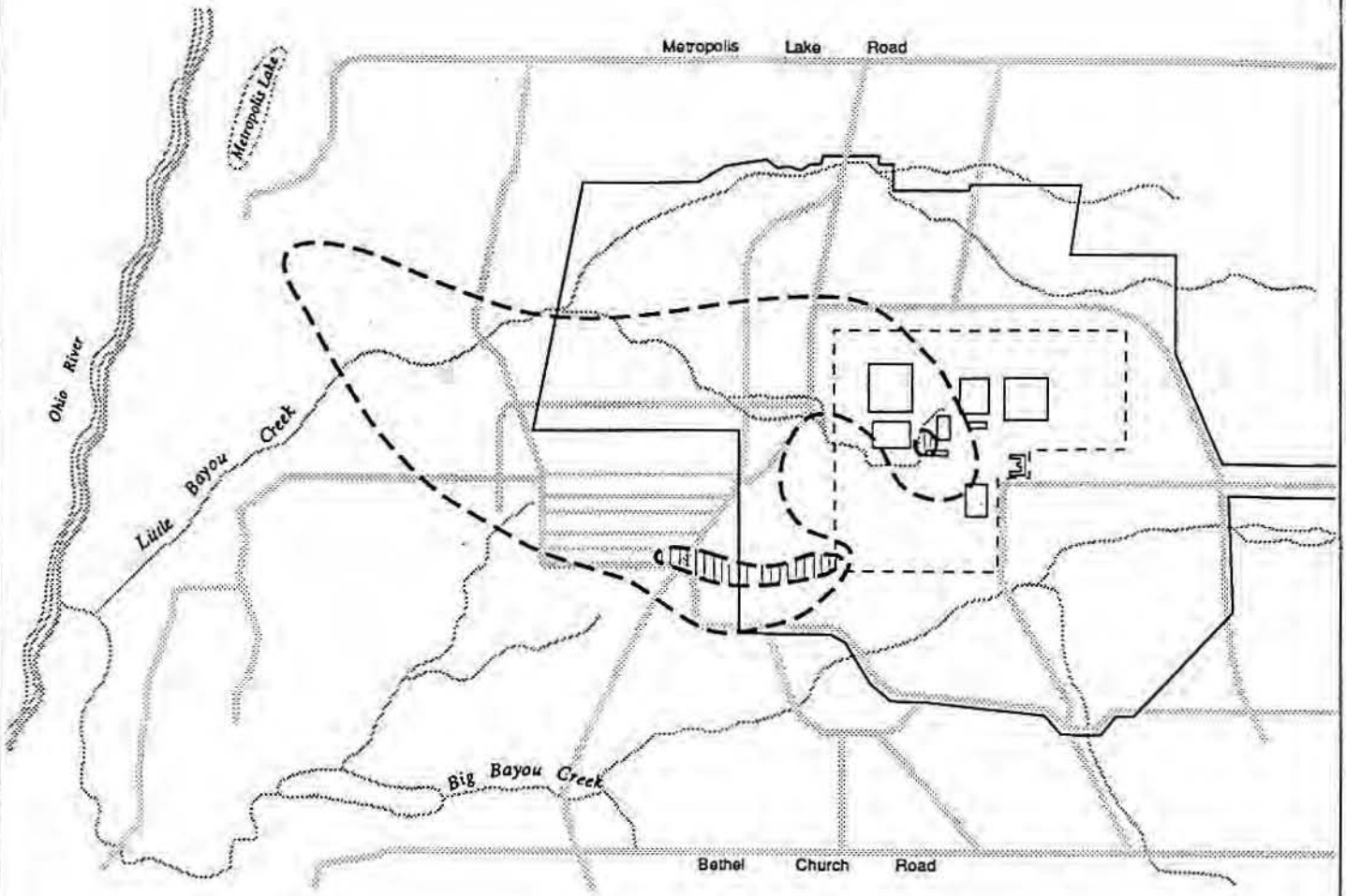
Approximate Scale (ft)
0 2000 4000

[a] *Lowest Practical Detection Limit*

[b] *Maximum Contaminant Level as defined by EPA in Safe Drinking Water Act*

Figure ES-1
EXTENT OF TCE CONTAMINATION IN THE REGIONAL GRAVEL AQUIFER

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



Tc-99 Contamination

Legend

- Area Where Maximum Tc-99 Concentration > 25 pCi/l [a]
- Area Where Maximum Tc-99 Concentration > 900 pCi/l [b]
- PGDP Site Boundary
- DOE Boundary

[a] *Action Level as defined by DOE/PGDP*

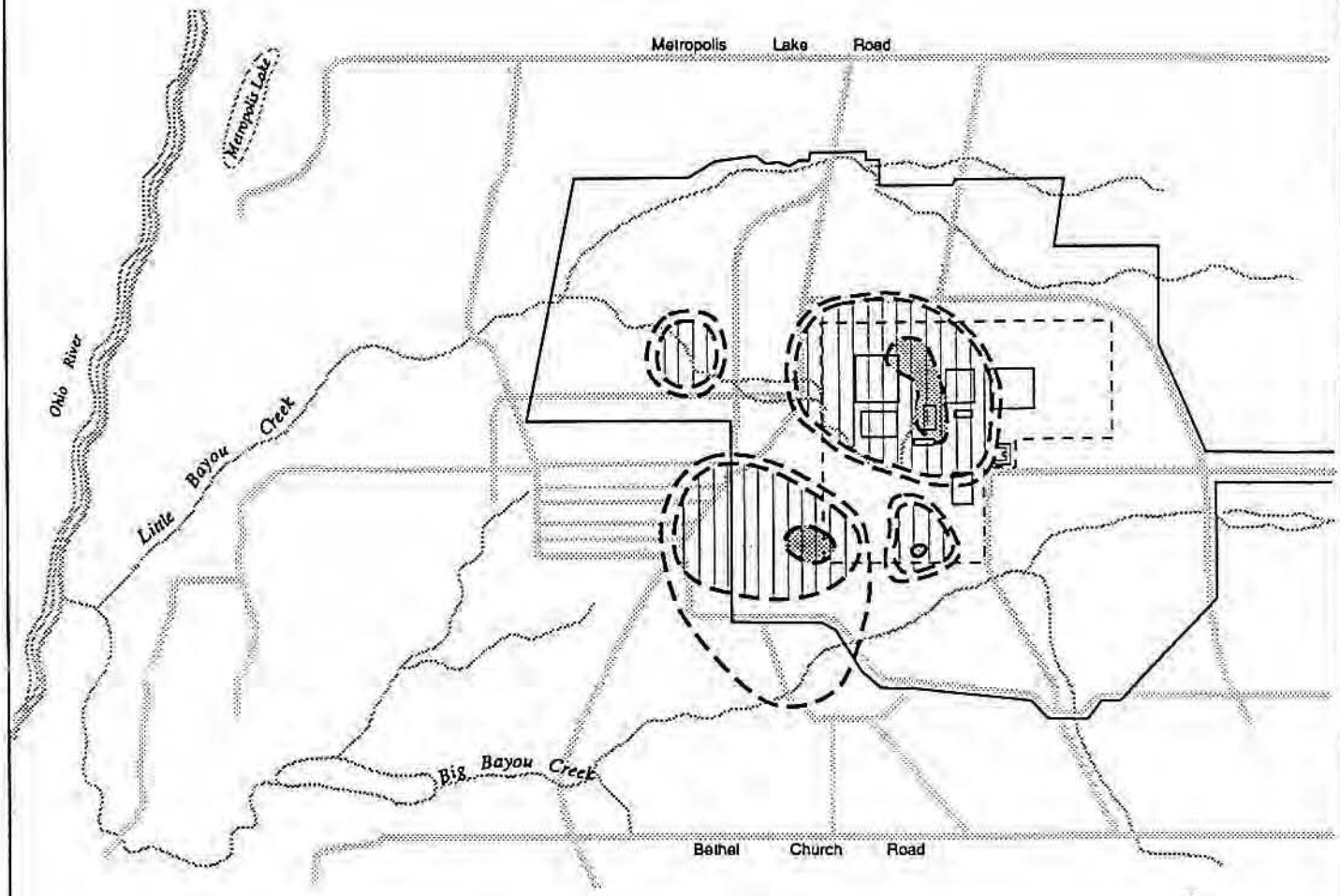
[b] *Maximum Contaminant Level as defined by EPA in Safe Drinking Water Act*

Plant North
True North

Approximate Scale (ft)
0 2000 4000

Figure ES-2
EXTENT OF Tc-99 CONTAMINATION IN THE REGIONAL GRAVEL AQUIFER

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



TCE Contamination

Legend

- Maximum TCE Concentration > 1 µg/l [a]
- Maximum TCE Concentration > 5 µg/l [b]
- Area Where Maximum TCE Concentration >1,000 µg/l
- PGDP Site Boundary
- DOE Boundary

[a] *Lowest Practical Detection Limit*

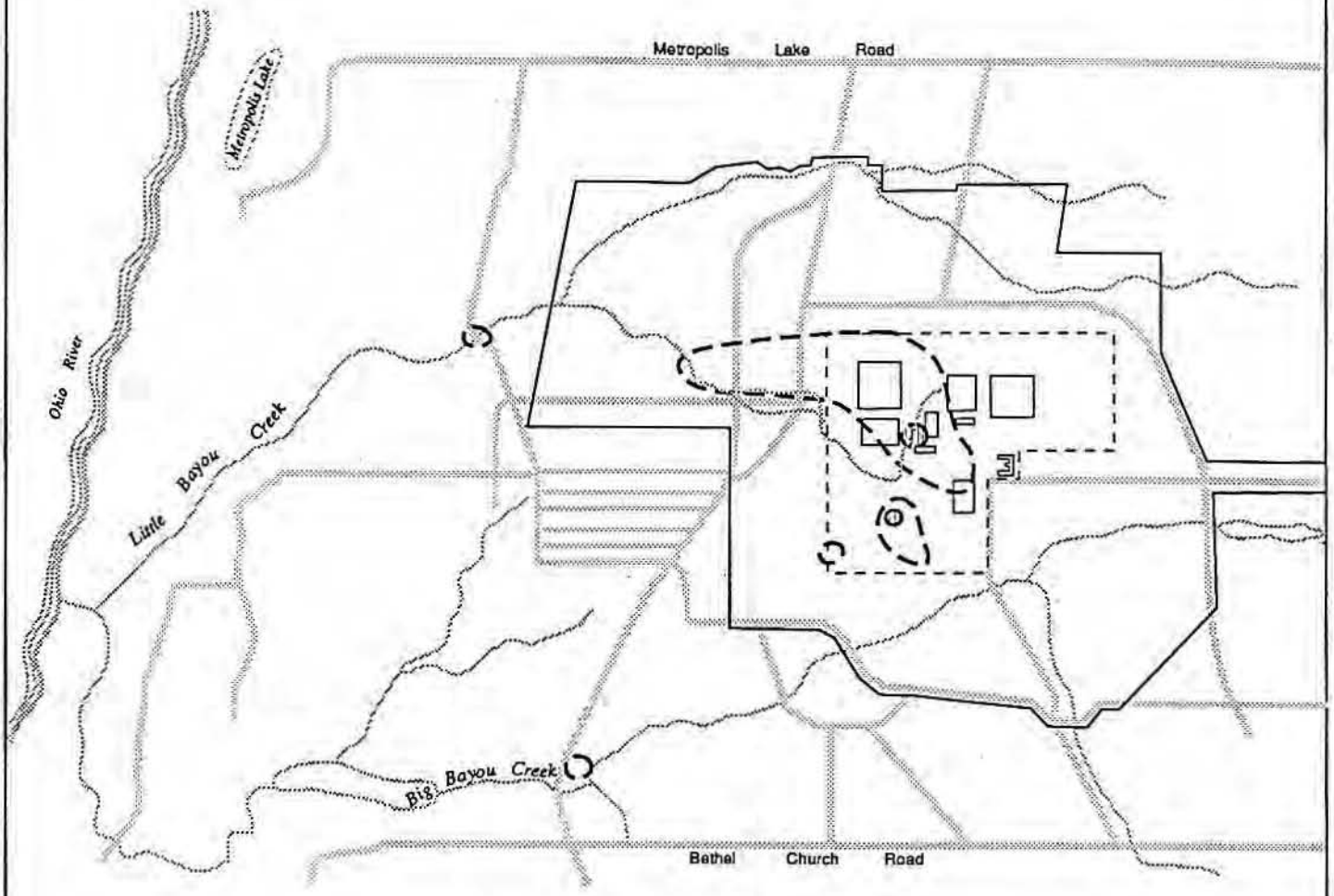
[b] *Maximum Contaminant Level as defined by EPA in Safe Drinking Water Act*

Plant North
True North

Approximate Scale (ft)
0 2000 4000

Figure ES-3
EXTENT OF TCE CONTAMINATION IN THE SHALLOW GROUNDWATER SYSTEM

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



Tc-99 Contamination

Legend

- Area Where Maximum Tc-99 Concentration > 25 pCi/l [a]
- Area Where Maximum Tc-99 Concentration > 900 pCi/l [b]
- PGDP Site Boundary
- DOE Boundary

Plant North
True North

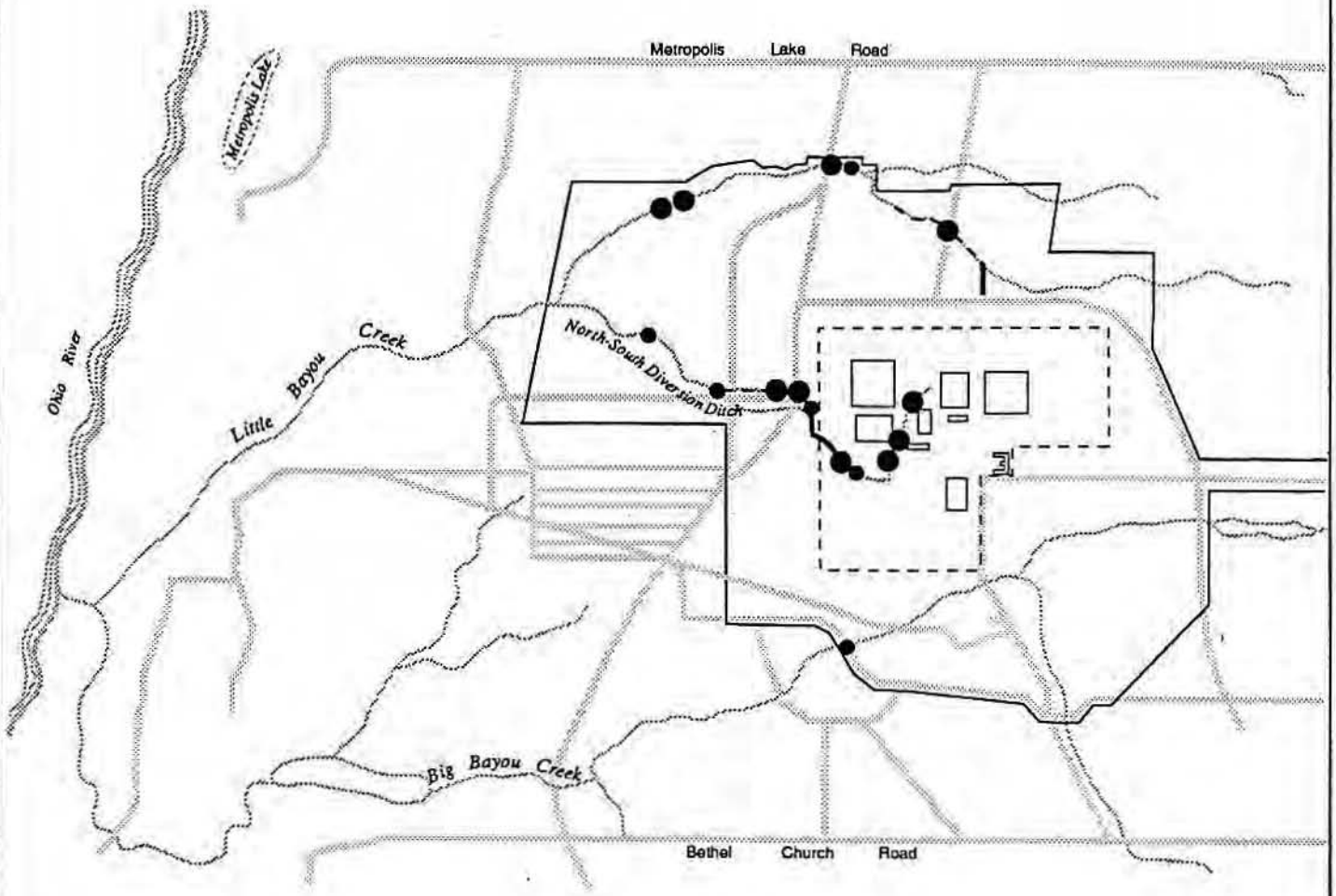
Approximate Scale (ft)
0 2000 4000

[a] *Action Level as defined by DOE/PGDP*

[b] *Maximum Contaminant Level as defined by EPA in Safe Drinking Water Act*

Figure ES-4
EXTENT OF Tc-99 CONTAMINATION IN THE SHALLOW GROUNDWATER SYSTEM

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



Uranium Contamination

Legend

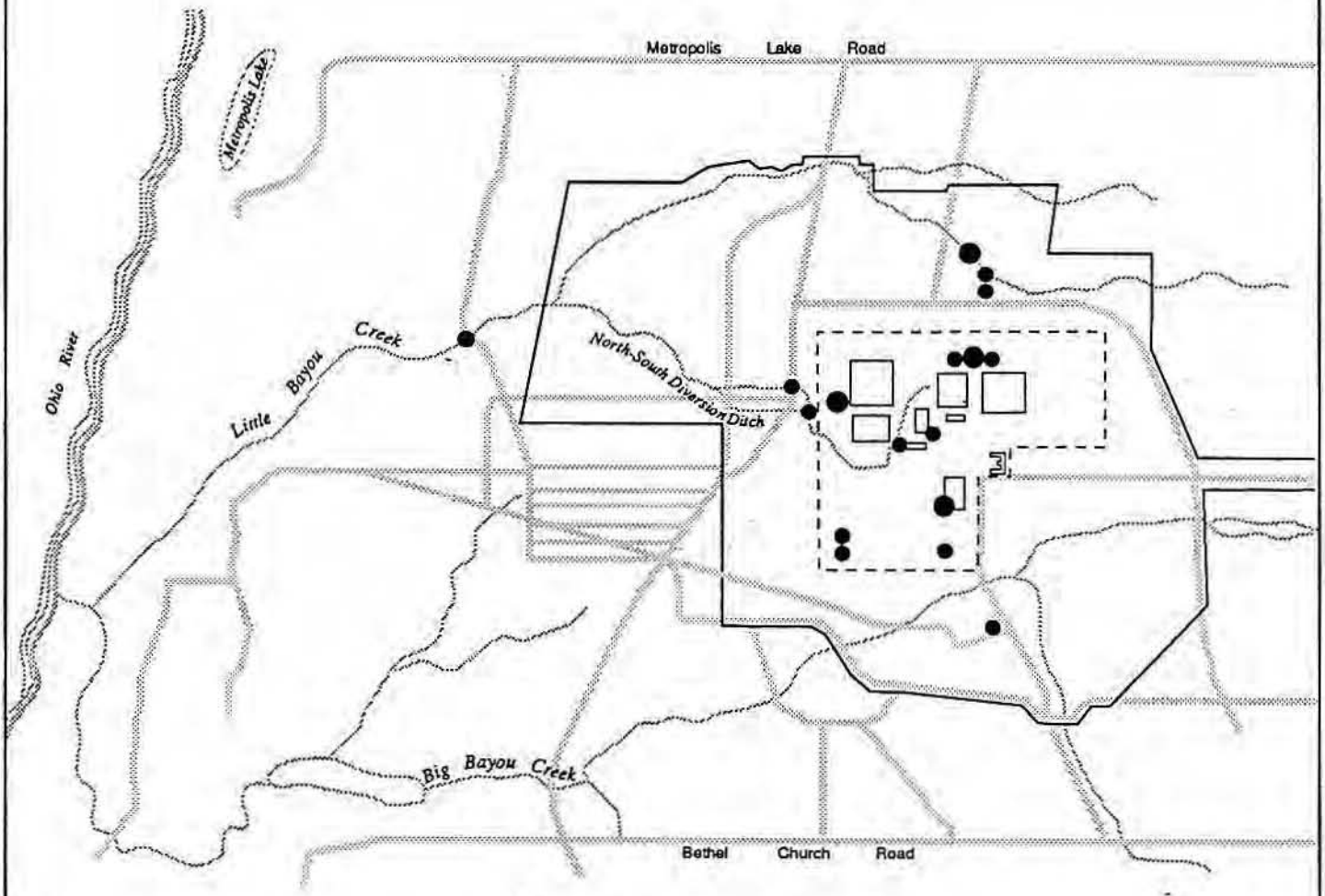
- Reach of Stream Where Gamma Radiation Dose > 2x Background
- Reach of Stream Where Gamma Radiation Dose > 1.5x Background
- Sample Location Where Total Uranium > 100 pCi/g
- Sample Location WhereTotal Uranium > 10 pCi/g
- PGDP Site Boundary
- DOE Boundary

Plant North
True North

Approximate Scale (ft)
0 2000 4000

Figure ES-5
EXTENT OF URANIUM CONTAMINATION IN SURFACE DRAINAGES

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



PCB Contamination

Legend

- ● Sample Location Where PCBs > 50,000 µg/kg
- • Sample Location Where PCBs > 1,000 µg/kg
- - - - - - PGDP Site Boundary
- ——— DOE Boundary

Plant North

True North

Approximate Scale (ft)

0 2000 4000

Figure ES-6
EXTENT OF PCB CONTAMINATION IN SURFACE DRAINAGES

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION

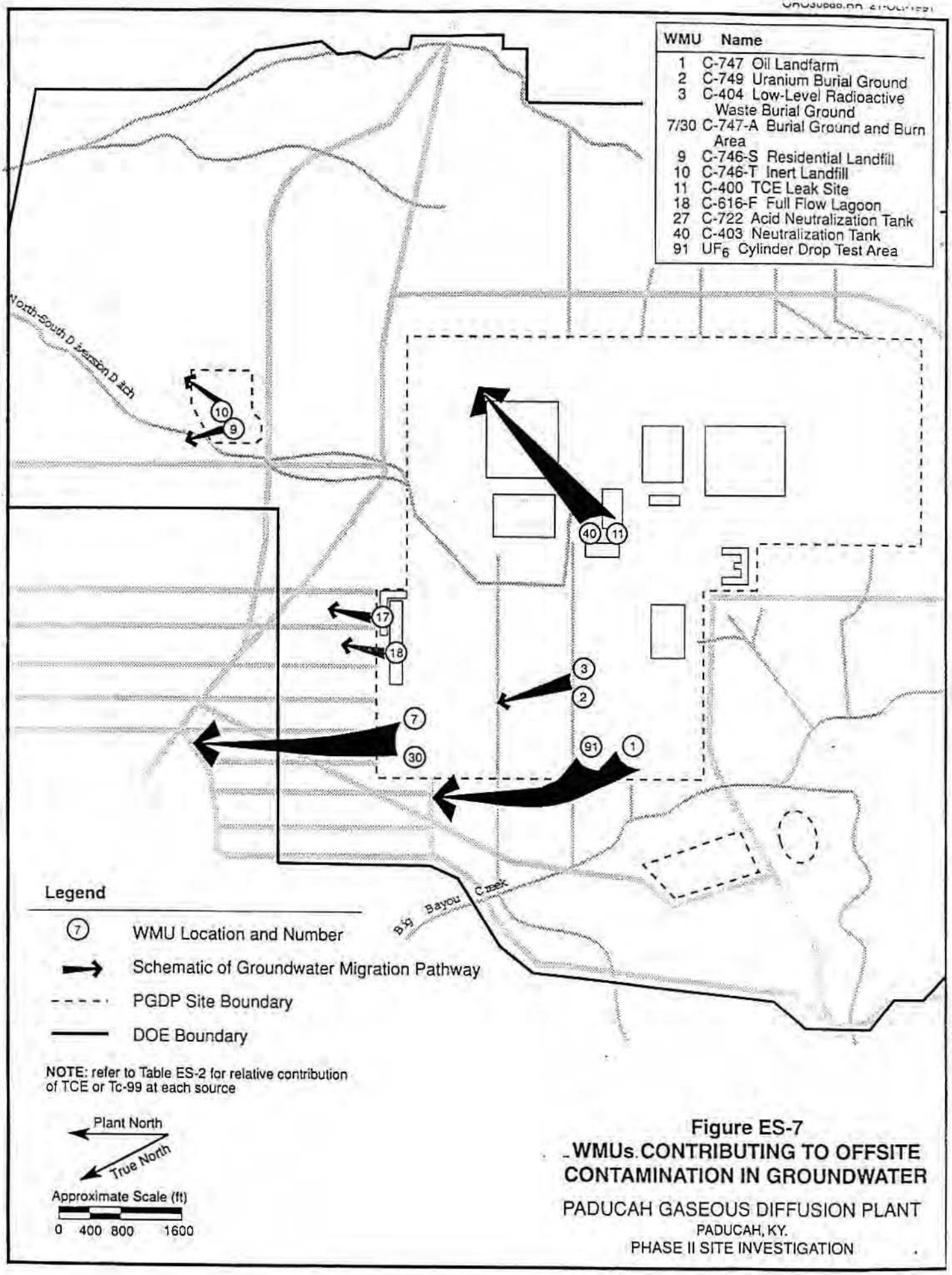
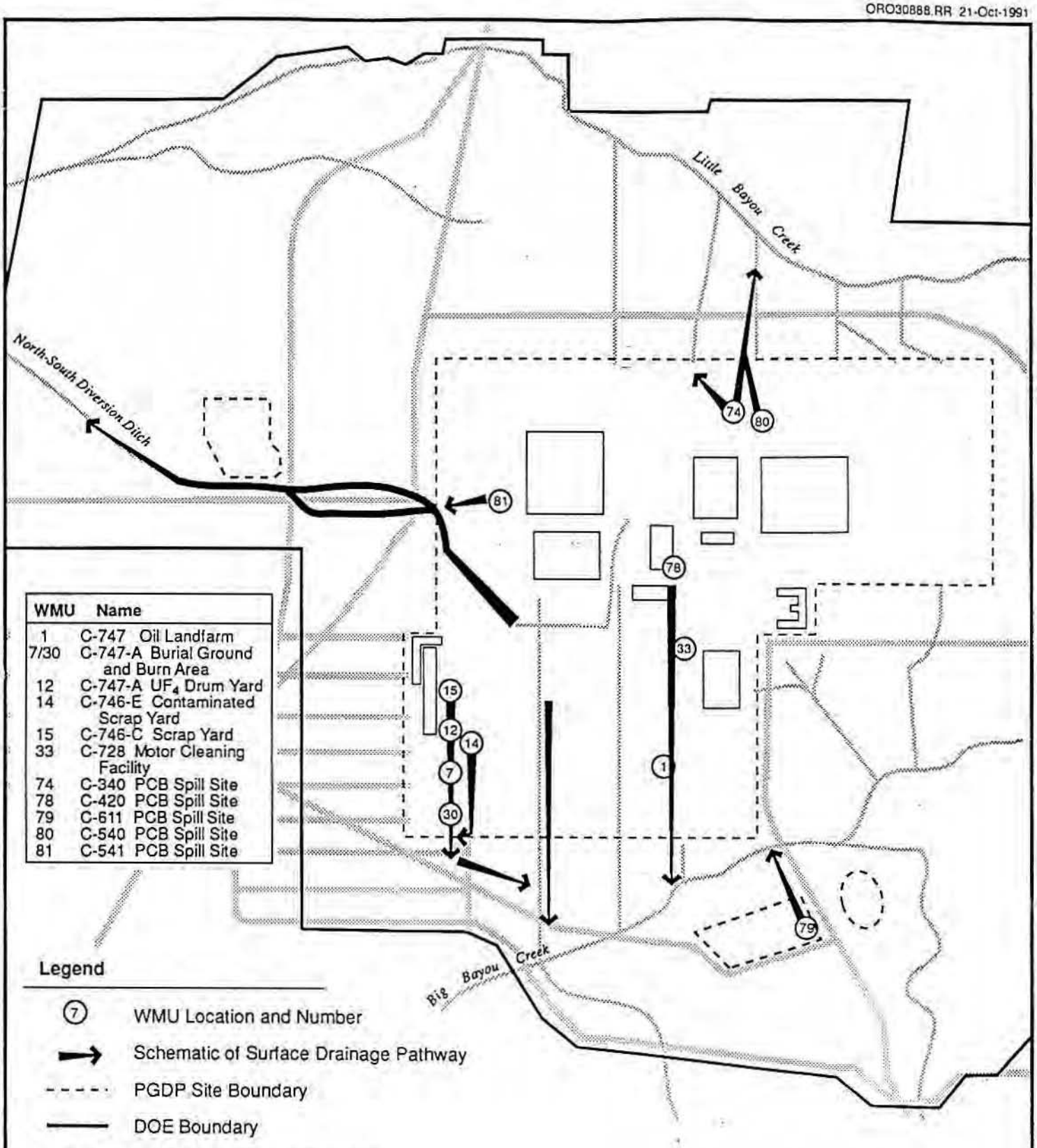


Figure ES-7
WMUs CONTRIBUTING TO OFFSITE CONTAMINATION IN GROUNDWATER

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION



WMU	Name
1	C-747 Oil Landfarm
7/30	C-747-A Burial Ground and Burn Area
12	C-747-A UF_4 Drum Yard
14	C-746-E Contaminated Scrap Yard
15	C-746-C Scrap Yard
33	C-728 Motor Cleaning Facility
74	C-340 PCB Spill Site
78	C-420 PCB Spill Site
79	C-611 PCB Spill Site
80	C-540 PCB Spill Site
81	C-541 PCB Spill Site

Legend

- (7) WMU Location and Number
- Schematic of Surface Drainage Pathway
- PGDP Site Boundary
- DOE Boundary

NOTE: refer to Table ES-3 for relative contribution of PCBs or uranium at each source

Plant North

North

Approximate Scale (ft)

0 400 800 1600

Figure ES-8
WMUs CONTRIBUTING TO OFFSITE CONTAMINATION IN SURFACE WATERS

PADUCAH GASEOUS DIFFUSION PLANT
PADUCAH, KY.
PHASE II SITE INVESTIGATION

1. EXECUTIVE SUMMARY

The United States Department of Energy (DOE) is conducting environmental remediation activities at the Paducah Gaseous Diffusion Plant (PGDP) under the DOE Environmental Restoration and Waste Management (ERWM) Program. The PGDP was placed on the National Priorities List (NPL) in 1994. Remedial efforts are required to address contamination which has resulted from historical waste-handling and disposal practices. The DOE is conducting these remedial activities in compliance with the requirements of the Commonwealth of Kentucky and the United States Environmental Protection Agency (EPA).

Source units at the PGDP have been combined into Waste Area Groups (WAGs). Waste Area Group 22, commonly referred to as the "Burial Grounds," has been identified in the PGDP ~~draft~~ Site Management Plan (SMP) (MMES, 1992a), as the fourth overall operable unit priority and the primary source unit priority. Waste Area Group 22 is composed of four solid waste management units (SWMUs), or source units. Solid Waste Management Units 2 and 3 are contiguous, as are SWMUs 7 and 30. However, SWMUs 2 and 3 are separated from SWMUs 7 and 30. State and federal regulators have determined that, due to an excessive amount of data gaps associated with the remedial investigation, it would not be prudent for the DOE to conduct a feasibility study (FS) on SWMUs 7 and 30 at this time. Additional sampling will be conducted at SWMUs 7 and 30 in 1995. Solid Waste Management Units 7 and 30 will be addressed in a separate FS at a later date. Therefore, the scope of this FS includes SWMUs 2 and 3 only.

Solid Waste Management Unit 3, also known as the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground, was previously addressed in 1987 by emplacement of a multilayered cap in accordance with Resource Conservation and Recovery Act (RCRA) closure requirements. In addition, data gaps exist which prevent the development and evaluation of alternatives for final remedial action at SWMU 2. Therefore, the purpose of this FS report is to develop and evaluate alternatives for an interim remedial action at SWMU 2, also known as the C-749 Uranium Burial Ground. The interim remedial action is not expected to be inconsistent with a final remedial action, and the DOE is preparing plans to collect additional data necessary to evaluate a final action.

The DOE's approach to environmental restoration activities integrates the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and RCRA. Although commonly referred to as a FS, this integrated study fulfills the requirements for a CERCLA FS and a RCRA Corrective Measures Study (CMS). Environmental concerns identified in the National Environmental Policy Act (NEPA) are also addressed.

This FS report presents available historical information for SWMU 2 and a relatively brief description of SWMU 3. The development and screening of alternatives is presented, and the following five alternatives for an interim remedial action at SWMU 2 are evaluated in detail utilizing, primarily, the nine criteria prescribed by CERCLA:

(1) No action;

(2) Limited action consisting of institutional controls;

(3) Excavation and treatment of the buried waste (with two storage/disposal options);

PREFACE

This *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant* (DOE/OR/06-1351&D1) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation and Liability Act, Resource Conservation and Recovery Act, and K.R.S. 224.46-530 for documenting the selection of a preferred interim remedial action, or corrective measure, for a solid waste management unit. This Record of Decision has been prepared in accordance with the "Record of Decision" outline prescribed in Appendix D of the draft Federal Facility Agreement for the Paducah Gaseous Diffusion Plant dated December 22, 1993. This work was performed under Work Breakdown Structure 1.4.12.7.1.02.11.02 (Activity Data Sheet 5302, "Offsite Groundwater Contamination"). Publication of this document meets a milestone pursuant to the United States Department of Energy's fiscal year 1995 commitments to federal and state regulatory agencies. This primary milestone document provides a record of information to be considered and the rationale which the United States Environmental Protection Agency and the United States Department of Energy will utilize in the selection of a preferred remedial action, or corrective measure, at Solid Waste Management Unit 2, the C-749 Uranium Burial Ground, and will formally record the decision to implement this interim action. This document also contains a schedule for conducting remedial design phase activities for this project. Information provided in this document forms the basis for the development of the Remedial Design Report for this project.

PREFACE

This Proposed Remedial Action Plan for Interim Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22, Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/06-1315&D1) was prepared in accordance with the requirements under both the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). This work was performed under Work Breakdown Structure 1.4.12.7.1.02.11.02 (Activity Data Sheet 5302). Publication of this document meets a Primary Document Deliverable milestone for the Paducah Gaseous Diffusion Plant. This document provides the public with the opportunity to evaluate and comment on the preliminary remedial alternative. Following public review and comment, the remedial alternative will be selected and documented in the *Record of Decision for Interim Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/06-1351&D0).

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP), located within the Jackson Purchase region of western Kentucky, is an active uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). Effective July 1, 1993, DOE leased the PGDP production operations facilities to the United States Enrichment Corporation, which, in turn, contracted with Martin Marietta Utility Services, Inc. to provide operations and maintenance services. Lockheed Martin Energy Systems, Inc. manages the Environmental Management and Enrichment Facility activities at PGDP for DOE.

The U.S. Environmental Protection Agency (EPA), DOE, and Kentucky Department of Environmental Protection are negotiating a Federal Facilities Agreement (FFA) in conjunction with the final listing of PGDP on the National Priorities List of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, which occurred on May 31, 1994. The primary purpose of an FFA is to establish a procedural framework and schedule to investigate and remediate contaminant releases at sites that pose a threat to human health and welfare and the environment. The FFA for PGDP will incorporate the site investigation process as initiated in accordance with the CERCLA Administrative Order by Consent, and the requirements as stated in the EPA Hazardous and Solid Waste Amendments and Kentucky Hazardous Waste Management Permit. An important aspect of the FFA is effective integration of the PGDP Resource Conservation and Recovery Act (RCRA) Corrective Action Program and the CERCLA Remedial Action Program. The draft Site Management Plan developed for PGDP has been designed to integrate the RCRA and CERCLA activities at the site to reflect on a consolidated program.

This document represents a Remedial Investigation (RI) Sampling and Analysis Plan (SAP) for the two Solid Waste Management Units (SWMUs) located within the C-747-A Area of PGDP at the northwest corner of the plant site. The SWMUs addressed in the RI-SAP are the C-747-A Burial Ground (SWMU 7) and the C-747-A Burn Area (SWMU 30), which are all located within Waste Area Grouping 22. To facilitate the environmental restoration process at PGDP, and to focus investigations toward the most effective and efficient remedial actions, Operable Units (OUs) have been defined. Two types of OUs have been defined: source control units (units that may contribute contamination to other units) and integrator units (units that "collect" contamination from source control units). At present, two integrator units have been defined at PGDP: the Groundwater Integrator Unit (the regional gravel aquifer) and the Surface Water Integrator Unit. In the C-747-A Area, each of the SWMUs to be investigated is defined as a source control OU.

The scope of the RI-SAP is to conduct a field sampling investigation at the two SWMUs located within the C-747-A Area of the PGDP facility. The goal of the RI-SAP is to fulfill existing information and/or data gaps not addressed by previous investigations that are required to complete the RI, Feasibility Study (FS), and risk assessment, for the C-747-A Area. The approach to be utilized for the C-747-A Area RI-SAP consists of three general steps: (1) field investigation, (2) site characterization, and (3) RI Report, which will include the Baseline Risk Assessment. Groundwater sampling results from the regional gravel aquifer (RGA) will be used to interpret the current flux of contaminants from the C-747-A Area waste burial pits to the Northwest Groundwater Plume. These sampling results also will be submitted to the PGDP Groundwater Protection Program for evaluation and inclusion in the Groundwater Integrator Unit RI Report.

EXECUTIVE SUMMARY

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The U.S. Environmental Protection Agency (EPA), DOE, and Kentucky Department for Environmental Protection (KDEP) are negotiating a Federal Facilities Agreement (FFA) pursuant to the final listing of PGDP on the National Priorities List (NPL) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, which occurred on May 31, 1994 (the effective date of placement on the NPL was June 30, 1994). The primary purpose of an FFA is to establish a procedural framework and schedule to investigate and remediate contaminant releases at sites that pose a threat to human health and welfare and the environment. The FFA for PGDP will incorporate the site investigation process, as initiated in accordance with the CERCLA Administrative Order by Consent (ACO) and the requirements of the EPA Hazardous and Solid Waste Amendments (HSWA) and Kentucky Hazardous Waste Management Permit (HWMP). An important aspect of the FFA is effective integration of the PGDP Resource Conservation and Recovery Act (RCRA) Corrective Action Program and the CERCLA Remedial Action Program. The draft Site Management Plan (SMP) developed for PGDP has been designed to integrate the RCRA and CERCLA activities at the site to reflect a consolidated program.

This document represents a Sampling and Analysis Plan (SAP) for the Interim Remedial Design (referred to as SAP in this document) for Solid Waste Management Unit (SWMU) 2 (the C-749 Uranium Burial Ground) located in Waste Area Grouping (WAG) 22. The scope of this SAP is to conduct a field sampling investigation at SWMU 2 and report the results. The goal of the SAP is to fill data gaps not addressed by previous investigations to support a final action as well as collect the necessary data to support the interim remedial design. Filling these data gaps is required to conduct the RI, risk assessment (RA), and Feasibility Study (FS) needed to complete the final Record of Decision (ROD) for SWMU 2. The approach for the SAP consists of two general steps: (1) site characterization, which includes a field investigation and (2) RI report, which includes a baseline risk assessment (BRA).

To facilitate the environmental restoration process at PGDP and focus investigations toward the most effective and efficient remedial actions, PGDP has defined two operable units (OUs): source control units (units that are sources of contamination) and integrator units (units that "collect" contamination from source control units). SWMU 2 is defined as a source control unit.

All existing data, potential final remedial action alternatives, and final FS data requirements were identified and were evaluated to focus the sampling strategy on specific media, contamination, and migration pathways. Based on the results of this evaluation, specific Data Quality Objectives (DQOs) were identified and subsequently were used to focus sampling and data collection requirements for an optimized sample design for SWMU 2.

The sampling strategy focuses on surface soils, subsurface soils, and groundwater within the upper continental recharge system (UCRS) and Regional Gravel Aquifer (RGA). This strategy also addresses ditch sediments west and south of SWMU 2.

The field investigation will focus primarily on the following elements:

- collection of waste characterization samples (soils and water) if the sampling can be accomplished without endangering the health and safety of the workers (see Sect. 5.2),
- collection of surface soils and ditch sediment samples for analysis of contaminants,
- collection of subsurface soil samples for analysis of chemical (i.e., sorption capacity) and physical (i.e., permeability and grain size distribution) characteristics,
- collection of groundwater samples from the upper continental recharge system (UCRS) along site boundaries and at existing monitoring wells for analysis of contaminants,
- collection of groundwater samples from the Regional Gravel Aquifer (RGA) at existing monitoring wells or at temporary well points for the analysis of contaminants,
- collection of McNairy Formation samples for analysis of contaminants if the RGA is determined to be contaminated with trichloroethene concentrations greater than 10 ppm, and
- collection of geophysical data.

In addition, groundwater sampling results from the RGA will be submitted to the PGDP Groundwater Protection Program for evaluation and inclusion in the Groundwater Integrator Unit RI report in accordance with the requirements defined in the *Groundwater Strategy Document for the Paducah Gaseous Diffusion Plant* report (DOE 1994a).

A combination of the current monitoring wells onsite and the monitoring wells presented in this SAP will constitute the monitoring system specified in the final ROD for an interim action for SWMU 2. The monitoring system for the site (the number of wells and their placement) will be based on the results of the additional sampling presented in Chapter 5. The final monitoring system and analytical sampling will be provided in an Operations and Maintenance report following the investigation.

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Volume II
Solvents

Handbook of Environmental FATE and EXPOSURE DATA

For Organic Chemicals

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500/2-82-001a page I.12.9-1 to I.12.9-4
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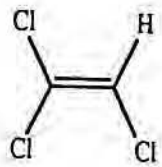
rks Assoc 76: 52-9 (1984)
34-42 (1983)
501-6 (1981)
231-49 (1980)
47: 37-55 (1976)

Trichloroethylene

SUBSTANCE IDENTIFICATION

Synonyms:

Structure:



CAS Registry Number: 79-01-6

Molecular Formula: C_2HCl_3

Wiswesser Line Notation: GYGU1G

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point: 87 °C

Melting Point: -73 °C

Molecular Weight: 131.40

Dissociation Constants:

Log Octanol/Water Partition Coefficient: 2.42 [27]

Water Solubility: 1100 mg/L at 25 °C [31]

Vapor Pressure: 69.0 mm Hg at 25 °C [4]

Henry's Law Constant: 1.03 x 10^{-2} atm-m³/mole [44]

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Over 155 million pounds of trichloroethylene are used for vapor degreasing of metals which should result in releases to the environment through evaporation, spills, and leaks in storage tanks.

Trichloroethylene

Trichloroethylene released to the atmosphere will exist primarily in the vapor phase based on its relatively high vapor pressure. It will react fairly rapidly, especially under smog conditions. Atmospheric residence time of 5 days has been reported with formation of phosgene, dichloroacetyl chloride, and formyl chloride. It is not subject to direct photolysis. If trichloroethylene is released to water, the primary removal process will be evaporation with a half-life of minutes to hours, depending upon turbulence. Biodegradation, hydrolysis, and photooxidation are extremely slow by comparison. Adsorption to sediment and bioconcentration in aquatic organisms are not important processes. Releases to soil will be partially evaporated and partially leached into ground water, where it may remain for a long time. However, there is some monitoring data that suggests degradation to other chlorinated alkenes. High levels of exposure are expected for workers in degreasing plants due to inhalation of vapors or adsorption through the skin. Lower exposure by inhalation is expected in persons living near degreasing plants or at spill sites. Broad population exposure to low levels is expected from inhalation of contaminated ambient air and ingestion of contaminated drinking water.

Natural Sources:

Artificial Sources: Air emissions from metal degreasing plants [11] are likely. Wastewater from metal finishing, paint and ink formulation, electrical/electronic components, and rubber processing industries contain trichloroethylene [56].

Terrestrial Fate: Spills or releases of trichloroethylene to soil will evaporate rapidly due to its reasonably high vapor pressure. It will also leach into ground water rapidly. Trichloroethylene appears to be fairly stable in soil although one field study of ground water contamination from a leaking trichloroethylene tank has detected cis- and trans-1,2-dichloroethylene [39] which suggests that degradation in ground water can occur. Hydrolysis is not an important process.

Aquatic Fate: The primary removal process will be evaporation [18,57] with a half-life of minutes to hours, depending upon turbulence. Biodegradation, hydrolysis, and photooxidation are extremely slow by comparison. Adsorption to sediment and bioconcentration in aquatic organisms are not important processes [18].

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Biodegradation: Trichloroethylene biodegrades very slowly in water under most conditions. Only a few studies have noted significant aerobic biodegradation [46,55], but acclimation was slow [55]. Other studies found no biodegradation under aerobic conditions in screening studies [5] or in seawater [33,57]. Biodegradation under anaerobic conditions has been noted and ranged from very little after 12 weeks [5] to 40% after 8 weeks [6]. In laboratory studies, trichloroethylene does not appear to biodegrade in ground water [59,58]. However, in microcosms of authentic aquifer material known to support methanogenesis, the percent removal after 40 weeks ranged from 70% to >99% (avg 89%) compared to an avg 48% removal using autoclaved aquifer material; a long lag period was indicated by the 4% removal after 7 weeks [60]. Also, in field studies, cis- and trans-1,2-dichloroethylene have been detected near trichloroethylene contamination sites which suggests biodegradation [39].

Abiotic Degradation: Trichloroethylene is not hydrolyzed by water under normal conditions [9]. It does not adsorb light of less than 290 nm and therefore should not directly photodegrade [9]. However, slow (half-life - 10.7 months) photooxidation in water has been noted [19]. Trichloroethylene is relatively reactive under smog conditions [62] with 60% degradation in 140 min [24] and 50% degradation in 1 to 3.5 hr [18] reported. Atmospheric residence times based upon reaction with hydroxyl radicals is 5 days [10,16,50] with production of phosgene, dichloroacetyl chloride, and formyl chloride [16,24].

Bioconcentration: Marine monitoring data only suggest moderate bioconcentration (2-25 times the concentration in water) [17,40]. Bioconcentration factors of 17 to 39 have been reported in bluegill sunfish and rainbow trout [3,36].

Soil Adsorption/Mobility: Low adsorption coefficient (log Koc = 2.0) [59] to a number of soil types [19] indicates ready transport through soil and low potential adsorption to sediments. The mobility in soil is confirmed in soil column studies [59] and river bank infiltration studies

[48,52,63]. 4-6% of environmental concentrations of trichloroethylene adsorbed to two silty clay loams (Koc = 87 and 150) [45]. No adsorption to Ca-saturated montmorillonite and 17% adsorption to Al-saturated montmorillonite was observed [45].

Volatilization from Water/Soil: The high Henry's Law constant indicates rapid evaporation from water [36]. Half-lives of evaporation have been reported to be on the order of several minutes to hours, depending upon the turbulence [19,36]. Field studies also support rapid evaporation from water [57]. Relatively high vapor pressure indicates rapid evaporation from near-surface soil and other surfaces.

Water Concentrations: SURFACE WATER: 1-24 ppb industrial rivers in US, with Lake Erie - 188 ppb, 88 of 204 samples pos [22]; third most frequently detected compound in Ohio River - 2427 of 4972 samples pos, 86% 0.1-1.0 ppb [38]; Zurich, Switzerland lake surface - 38 ppb, 30 m depth - 65 ppb [26]; USEPA STORET data base, 9,295 data points, 28.0% pos, 0.10 ppb median [53]. DRINKING WATER: 28 of 113 US public water supplies pos, mean 2.1 ppb [8]; finished ground water mean 6.76 ppb, range 0.11-53.0 ppb in 36% of 25 US cities [12]. Love Canal, Niagara Falls, NY 7 of 9 samples pos, 10-250 ppt [2]; finished ground water, 466 random samples, 6.4% pos, 1 ppb median concn, 78 ppb max concn [13]. State data, 2894 samples, 28.0% pos, trace to 35,000 ppb; US National Screening Program, 142 samples, 25.4% pos, trace to 53 ppb; Community Water Supply Survey, 452 samples, 3.3% pos, 0.5-210 ppb [14]. GROUND WATER: Most frequently detected and in highest concentration, 28% of wells in 8 states sample pos max concn reported 35,000 ppb [20]; 38.5% of 13 US cities pos mean 29.72 ppb range 0.2-125 ppb [12]. New Jersey, 670 wells, 1.8% and 4.0% of wells had concn >100 ppb and > 10 ppb, respectively [61]. Ground water in the Netherlands 1976-78, 232 pumping stations, 67% pos (>0.01 ppb) [64]. MARINE: average 0.3 ppb, max 3.6 ppb [20]. RAIN WATER: La Jolla, CA 5 ppt, industrial area in England 150 ppt [54]. Portland, OR, Feb-Apr 1984, concn (ppt), 7 rain events, 100% pos, 0.78-16, 5.6 avg [34]. SNOW: Southern California 30 ppt, Central California <1.5 ppt, Alaska 39 ppt [54].

Effluent Concentrations: Detected, not quantified, in wastewater in vicinity of a specialty chemicals plant [30]. Industries with mean concentrations greater than 75 ppb, paint and ink formulation, electrical/electronic components, rubber processing, mean range, 7-530 ppb, max range 3-1600 ppb [56]. USEPA STORET data base, 1,480

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ater [36]. Half-lives of evaporation
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; Zurich, Switzerland lake surface
26]; USEPA STORET data base,
0 ppb median [53]. DRINKING
er supplies pos, mean 2.1 ppb [8];
b, range 0.11-53.0 ppb in 36% of
ara Falls, NY 7 of 9 samples pos
er, 466 random samples, 6.4% pos
ncn [13]. State data, 2894 samples
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<1.5 ppt, Alaska 39 ppt [64]

not quantified, in waste
plant [30]. Industries with
pb, paint and ink form
per processing, mean ran
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data points, 19.6% pos, 5.0 ppb median [53]. Ground water at 178 CERCLA hazardous waste disposal sites, 51.3% pos [43]. Minnesota municipal solid waste landfills, leachates, 6 sites, 83.3% pos, 0.7-125 ppb, contaminated ground water (by inorganic indices), 13 sites, 69.2% pos, 0.2-144 ppb, other ground water (apparently not contaminated as indicated by inorganic indices), 7 sites, 28.6% pos, 0.2-6.8 ppb [47].

Sediment/Soil Concentrations: Not detected in sediment in vicinity of specialty chemicals plant [30]. Detected in marine sediments at a max of 9.9 ppb Liverpool Bay, England [40]. USEPA STORET data base, 338 data points, 6.0% pos, <5.0 ppb median concn [53]. Lake Pontchartrain at Passes, sediment from 3 sites, 66.7% pos, 0.1-0.2 ppb, wet weight [23].

Atmospheric Concentrations: Global avg 8 ppt, northern hemisphere 15-16 ppt, southern hemisphere <3 ppt [15,51]; major US cities mean 96-483 ppt, max 236-3097 ppt, min 5-36 ppt [49,50]. Portland, OR, Feb-Apr 1984, concn in air (ng/m^3) during 7 rain events, 100% pos, 240-3900, 1537 avg [34]. Industrial - 1.2 ppb mean; urban/suburban-0.25 ppb mean, rural - trace-0.10 ppb [7,25,35]. England: industrial 40-60 ppb, suburban 1-20 ppb, rural 5 ppb [40]. Love Canal (Niagara Falls, NY): 2 of 3 samples pos (1.6 and 3.4 ppb), home basement level estimated at 0.83 ppb [2]. Waste disposal site (Edison, NJ) trace-61 ppb [42].

Food Survey Values: Intermediate grain-based foods (1984): 9 varieties, 44.4% pos, 0.77-2.7 ppb, 1.9 ppb max concn in yellow corn meal; wheat, corn, oats (1984), 10, 2, and 1 samples, respectively: not detected [28]. Table-ready foods: 19 varieties, 47% pos, 1.7-8.0 ppb, 1.5 ppb avg, max concn in plain granola; butter, 7 samples, 100% pos; 1.6-20 ppb, 9.7 ppb avg; margarine, 7 samples, 100% pos, 3.7-980 ppb, 135 ppb avg; cheese, 4 types, 8 samples, 87.5% pos, 1.2-9.5 ppb, 4.3 ppb avg of pos, max concn in mozzarella cheese [29]. Trace detected in extracted edible oils [32]. Also detected in meat, beverages, dairy products, fruits and vegetables, oil and fats, range 0.02-60 ug/kg [32].

Plant Concentrations:

Fish/Seafood Concentrations: marine fish, flesh - 0.04-1.1 ppm, liver 0.66-20.0 ppb, mussels - 50 day exposure 1.37 ppm [40]. Lake Pontchartrain at Passes, oysters, 5 samples, 2.2 ppb avg; clams, composite samples from 2 sites, 5.7 and 0.8 ppb [23].

Animal Concentrations:

Milk Concentrations: Detected in dairy products [32].

Other Environmental Concentrations:

Probable Routes of Human Exposure: High levels of exposure are expected for workers in degreasing plants due to inhalation of vapors or adsorption through the skin. Lower inhalation exposure is expected in persons living near degreasing plants or at spill sites. Broad population exposure to low levels from inhalation of contaminated ambient air and ingestion of contaminated drinking water.

Average Daily Intake: AIR INTAKE: (assume typical concn of 100-500 ppt [49,50]) - 11-33 ug; WATER INTAKE: (assume 2-7 ppb [8,12]) 2-20 ug; FOOD INTAKE: insufficient data.

Occupational Exposures: The number of US workers exposed to trichloroethylene is estimated to be 283,000 [32]. Operating room levels range from 0.3-103 ppm, with an estimated 5000 medical, dental, and hospital personnel being routinely exposed [32]. Levels at a dial assembly workshop in Japan measured 25-100 ppm; degreasing room levels, 150-250 ppm [32]. NIOSH (NOES Survey 1981-83) has statistically estimated that 392,805 workers are exposed to trichloroethylene in the US [37].

Body Burdens: Human milk, 4 US urban areas, 8 of 8 samples pos [41]. Post-mortem wet tissue samples 1-32 ppb [32]. Love Canal, Niagara Falls, NY - breath - trace 4 of 9 samples pos, blood - 09-2.50 ppb, 6 of 9 samples pos, urine - 40-550 ppt, 9 of 9 samples pos [2]. Whole blood specimens from 250 subjects, not detected to 1.5 ppb, 0.4 ppb avg [1].

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DRAFT

TOXICOLOGICAL PROFILE FOR TRICHLOROETHYLENE

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5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

The relatively short predicted half-life of trichloroethylene in the atmosphere indicates that long-range global transport is unlikely (Class and Ballschmiter 1986). However, its constant release, as well as its role as an intermediate in tetrachloroethylene degradation, may account for its persistence and the fact that trichloroethylene is often present in remote areas.

Trichloroethylene has been detected in a number of rainwater samples collected in the United States and elsewhere (see Section 5.4.2). It is moderately soluble in water, and experimental data have shown that scavenging by rainwater occurs rapidly (Jung et al. 1992). Trichloroethylene can, however, be expected to revolatilize back to the atmosphere after being deposited by wet deposition. Evaporation from dry surfaces can also be predicted from the high vapor pressure.

The Henry's law constant value of 2.0×10^{-2} atm-m^3/mol at 20°C suggests that trichloroethylene partitions rapidly to the atmosphere from surface water. The major route of removal of trichloroethylene from water is volatilization (EPA 1985c). Laboratory studies have demonstrated that trichloroethylene volatilizes rapidly from water (Chodola et al. 1989; Dilling 1977; Okouchi 1986; Roberts and Dandliker 1983). Dilling et al. (1975) reported the experimental half-life with respect to volatilization of 1 mg/L trichloroethylene from water to be an average of 21 minutes at approximately 25°C in an open container. Although volatilization is rapid, actual volatilization rates are dependent upon temperature, water movement and depth, associated air movement, and other factors. A mathematical model based on Fick's diffusion law has been developed to describe trichloroethylene volatilization from quiescent water, and the rate constant was found to be inversely proportional to the square of the water depth (Peng et al. 1994).

Mathematical modeling of trichloroethylene volatilization from a rapidly moving, shallow river (1 meter deep, flowing 1 meter per second, with a wind velocity of 3 meters per second) has estimated its half-life at 3.4 hours (Thomas 1982). Measured volatilization half-lives in a mesocosm, which simulated the Narragansett Bay in Rhode Island during winter, spring, and summer, ranged from 13 days in summer conditions to 28 days in spring conditions (Wakeham et al. 1983).

experimentally confirmed with real soil samples, in which it was found that the solid/vapor partition coefficient decreased dramatically with increased moisture content (Peterson et al. 1994).

A number of groundwater monitoring studies have detected trichloroethylene in groundwater (see Section 5.4.2), which is further evidence of its leachability. The mobility of trichloroethylene in soil was demonstrated in a field study of river water infiltration to groundwater in which trichloroethylene was observed to leach rapidly into groundwater near sewage treatment plants in Switzerland (Schwarzenbach et al. 1983). No evidence of biological transformation of trichloroethylene in groundwater was found. Accurate prediction of trichloroethylene transport in groundwater is complicated by the sorption effect of organic and inorganic solids (Doust and Huang 1992).

Experimentally measured bioconcentration factors (BCFs), which provide an indication of the tendency of a chemical to partition to the fatty tissue of organisms, have been found to range between 10 and 100 for trichloroethylene in fish (Kawasaki 1980; Kenaga 1980; Neely et al. 1974; Veith et al. 1980). Barrows et al. (1980) estimated a value of 17 for bluegill sunfish. Somewhat lower BCFs were determined by Saisho et al. (1994) for blue mussel (4.52) and killifish (2.71). These numbers are suggestive of a low tendency to bioaccumulate.

Monitoring data on trichloroethylene concentrations in seawater and associated aquatic organisms are in agreement with the experimental BCF data. Concentrations of trichloroethylene (dry weight basis) detected in fish (eel, cod, coalfish, dogfish) from the relatively unpolluted Irish Sea ranged from below detection limits to 479 ppb (Dickson and Riley 1976). Levels of 2–56 ppb (wet weight) in liver tissue, and up to 11 ppb (wet weight) in other tissue, were found in various species of fish collected off the coast of Great Britain near several organochlorine plants (Pearson and McConnell 1975). Fish taken from the western coast of the United States near the discharge zone of the Los Angeles County wastewater treatment plant contained trichloroethylene levels of up to 6 ppb (wet weight) in liver tissue (Gossett et al. 1983). Clams and oysters from Lake Pontchartrain near New Orleans had trichloroethylene levels averaging between 0.8–5.7 ppb (wet weight) (Ferrario et al. 1985).

To assess bioaccumulation in the environment, the level of trichloroethylene in the tissues of a wide range of organisms was determined (Pearson and McConnell 1975). Species were chosen to represent several trophic levels in the marine environment. The maximum overall increase in concentration between sea water and the tissues of animals at the top of food chains, such as fish liver, sea bird

5.3.2.2 Water

Oxidation of trichloroethylene in the aquatic environment does not appear to be a significant fate process, probably because of its having already been oxidized by the chlorine atoms. The rate of hydrolysis is also too slow to be an important transformation process. (EPA 1979b). A study by Jensen and Rosenberg (1975) indicated that the rate of volatilization of trichloroethylene proceeds more rapidly than photooxidation or hydrolysis. Studies of photolysis and hydrolysis conducted by Chodola et al. (1989) demonstrated that photolysis did not contribute substantially to the transformation of trichloroethylene. Chemical hydrolysis appeared to occur only at elevated temperature in a high pH environment and, even then, at a very slow rate.

Results from experiments conducted at high pH and temperature were extrapolated to pH 7 and 25°C (Jeffers et al. 1989), and the estimated half-life was 1.3×10^6 years, which suggests that hydrolysis does not occur under normal environmental conditions. In contrast, estimates of the hydrolysis half-life of trichloroethylene under corresponding conditions were cited in other studies as about 10.7 months (Dilling et al. 1975) and 30 months (Pearson and McConnell 1975). It is not clear why there is such a large difference between these values; however, errors inherent in the extrapolation method used in the first approach (Jeffers et al. 1989) and the presence of transformation factors other than chemical hydrolysis, such as microbial degradation, in the second approach (Dilling et al. 1975; Pearson and McConnell 1975) may account for the discrepancy in the numbers.

An aerobic degradation study of trichloroethylene in seawater showed that 80% of trichloroethylene was degraded in 8 days (Jensen and Rosenberg 1975). Degradation products were not reported. Another study using domestic waste water as a microbial inoculum found that after the first week of incubation, 64% and 38% degradation was achieved for initial trichloroethylene concentrations of 5 and 10 ppm, respectively (Tabak et al. 1981). After the fourth week of incubation, these percentages were 87% and 84%, respectively. Microbial degradation products of trichloroethylene in groundwater were reported to be dichloroethylene and vinyl chloride (Smith and Dragun 1984).

Biotransformation was also strongly indicated as a factor in the degradation of trichloroethylene in a case of soil and groundwater pollution (Milde et al. 1988). The only ethylenes at the point source of pollution were tetrachloroethylene and trichloroethylene; however, substantial amounts of known metabolites of these two compounds (dichloroethylene, vinyl chloride, and ethylene) were found at

Anaerobic incubations of trichloroethylene with soils collected from lotus, rice, and vegetable fields in Japan resulted in biodegradation rates which varied with soil type, temperature, and initial concentration of trichloroethylene (Yagi et al. 1992). The lotus field soils degraded more than 80% of the trichloroethylene after 42 days, while the degradation in vegetable field soils was minimal. A study by Watson and Anderson (1990) compared soil samples collected from a former chlorinated solvent disposal site and microbial degradation of trichloroethylene in vegetated and nonvegetated soils. Biomass determinations, disappearance of trichlorethylene from the headspace of spiked soil slurries, and mineralization of ^{14}C-trichloroethylene to radiolabelled carbon dioxide ($^{14}CO_2$) all showed that microbial activity is greater in vegetated soils and that trichloroethylene degradation occurs faster in the vegetated than in the nonvegetated soils.

Aerobic biodegradation of trichloroethylene occurs by cometabolism with aromatic compounds (Ensley 1991), and thus requires a cosubstrate such as phenol (Nelson et al. 1987, 1988) or toluene (Fan and Scow 1993). Trichloroethylene degradation by toluene-degrading bacteria has been demonstrated in the presence, but not absence, of toluene (Mu and Scow 1994). Isoprene, a structural analog of trichloroethylene, has also been used as a cosubstrate for trichloroethylene oxidation by some bacteria (Ewers et al. 1990). One source of inhibition of degradation in the absence of cosubstrate may be the toxicity of trichloroethylene itself to indigenous bacteria.

Bacteria have been found which use methane as an energy source and simultaneously degrade trichloroethylene using methane monooxygenase (Alvarez-Cohen and McCarty 1991a, 1991b; Bowman et al. 1993; Eng et al. 1991; Fox et al. 1990; Henry and Grbic-Galic 1991a, 1991b; Oldenhuis et al. 1991). Methane-utilizing bacteria were shown to aerobically degrade trichloroethylene to carbon dioxide in soil columns perfused with natural gas within 2 weeks (Wilson and Wilson 1985). Methanotrophs isolated from sediment likewise degraded 650 ng/mL of trichloroethylene in liquid culture to 200 ng/mL in 4 days (at 20°C), producing carbon dioxide and no dichloroethylene or vinyl chloride (Fogel et al. 1986). A possible reason for the persistence of trichloroethylene in the environment despite these natural decomposition processes lies in the sensitive balance which must be maintained between enough cosubstrate to induce the degrading enzymes and too much cosubstrate, which could outcompete the trichloroethylene and inhibit its decomposition (Ensley 1991). Such balance is probably rarely achieved in nature.

Chronology of Statutory Authorities

1980 The *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* of 1980 established ATSDR as an agency of the Public Health Service with mandates to 1) establish a National Exposure and Disease Registry, 2) create an inventory of health information on hazardous substances, 3) create a listing of closed and restricted-access sites, 4) provide assistance in hazardous substances emergencies, and 5) determine the relationship between hazardous substances exposure and illness.

1984 The *Resource Conservation and Recovery Act (RCRA)*, as amended in 1984, mandated that ATSDR work with the Environmental Protection Agency (EPA) to 1) identify new hazardous wastes to be regulated, 2) conduct health assessments at RCRA sites at EPA's request, and 3) consider petitions for health assessments from the public or states.

1986 The *Superfund Amendments and Reauthorization Act (SARA)* of 1986 broadened ATSDR's responsibilities in the areas of health assessments, establishment and maintenance of toxicologic databases, information dissemination, and medical education.

1988 The *Medical Waste Tracking Act* of 1988 required ATSDR to prepare a report on the health effects of medical waste and mandated that the report be submitted to Congress by November 1, 1990.

1990 The *Great Lakes Critical Programs Act* of 1990 required EPA, in cooperation with ATSDR, to report to Congress on the adverse health effects of water pollutants on people, fish, shellfish, and wildlife.

1990 The *Clean Air Act* of 1990 designated ATSDR as one of eight members of a task force to coordinate research on methods to identify and assess the risks to human health from exposure to air pollutants.

1992 The *Housing and Community Development (Lead Abatement) Act* of 1992 mandated that EPA, in conjunction with ATSDR and the Secretary of Housing and Urban Development, sponsor public education and outreach activities to increase public awareness of the scope and severity of lead poisoning from household sources.

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ATSDR

Fact Sheet

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency, located in Atlanta, Georgia, that is part of the Public Health Service within the U.S. Department of Health and Human Services. ATSDR's mission is to prevent exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment.

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To carry out its mission and to serve the needs of the public, ATSDR conducts activities in several areas.

Public Health Assessments

- ☑ The Agency evaluates data and information on the release of hazardous substances into the environment to assess any current or future impact on public health, to develop health advisories or other health recommendations, and to identify studies or actions needed to evaluate and mitigate or prevent human health effects. ATSDR conducts public health assessments of all waste sites on the National Priorities List and in response to petitions from concerned individuals and organizations.

Health Consultations

- ☑ To address specific requests for information about health risks related to a specific site, chemical release, or hazardous material, ATSDR provides written or oral responses. These health consultations, which are intended to prevent or mitigate exposures, may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing contaminated material.

Health Investigations

- ☑ Through epidemiologic, surveillance, and other studies of toxic substances and their effects, ATSDR increases understanding of the relationship between exposure to hazardous substances and adverse human health effects.

Exposure Registry

- ☑ The Agency has established and maintains a national registry of persons exposed to hazardous substances in the environment.

Toxicological Profiles

- ☑ The Agency summarizes and makes available to the public data on the health effects of hazardous substances, identifies significant gaps in knowledge, and initiates research in toxicology and health effects where needed.

Applied Research

- ☑ ATSDR conducts or sponsors research to increase scientific knowledge about the effects on human health of hazardous substances released from waste sites or of other releases into the environment.

Health Education

- ☑ ATSDR develops and disseminates to physicians and other health care providers materials on the health effects of toxic substances, establishes and maintains a publicly accessible inventory of hazardous substances, and maintains a list of sites that are closed to the public or have restricted access because of hazardous substance contamination.

Emergency Response

- ☑ To improve response to public health emergencies involving exposure to hazardous substances, ATSDR provides health-related support—including health consultations upon request and training for first responders—to states, local agencies, and health care providers.

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