

Federal Publications on Alternative and Innovative Treatment Technologies For Corrective Action and Site Remediation

Fourth Edition

Prepared by the Member Agencies of the
Federal Remediation Technologies Roundtable:

	U.S. Environmental Protection Agency
	Department of Defense
	U.S. Air Force
	U.S. Army
	U.S. Navy
	Department of Energy
	Department of Interior
	National Aeronautics and Space Administration
	Tennessee Valley Authority
	Coast Guard

NOTICE

This document has been funded by the United States Environmental Protection Agency under Contract 68-W2-004. It has been subject to administrative review by all agencies participating in the Federal Remediation Technologies Roundtable, and has been approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

This bibliography provides a list of titles and ordering information for publications on innovative technology development and demonstration issued by member agencies of the Federal Remediation Technologies Roundtable. This bibliography is meant to improve access to information on innovative technologies and assist in the coordination of ongoing research initiatives to develop and implement innovative technologies for corrective action and site remediation. The bibliography focuses on innovative technologies that provide for the treatment of hazardous wastes, and contains neither information on non-treatment alternatives such as landfilling and capping, nor information on more conventional treatment technologies, such as incineration and solidification. Inclusion of a resource in this publication is based on the ability to identify, locate, and order the document.

The Roundtable was established in 1990 as an interagency committee to exchange information and provide a forum for joint action regarding the development and demonstration of innovative technologies for hazardous waste remediation. Roundtable member agencies expect to complete many site remediation projects in the near future. They recognize the importance of documenting the results of these projects and making the information available to anyone interested in innovative technology development.

The bibliography is organized by media or technology type, and it is further categorized by the issuing Agency. Information on ordering listed publications can be found at the end of the bibliography.



Walter W. Kovalick, Jr., Ph.D.

Chairman

Federal Remediation Technologies Roundtable

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PREFACE

The Federal Remediation Technologies Roundtable (Roundtable) has prepared this bibliography to publicize the availability of Federal documents pertaining to innovative and alternative technologies to treat hazardous wastes. The last edition of the bibliography was published in 1993.

This updated edition contains references for documents and reports from the U.S. Environmental Protection Agency (EPA), the U.S. Army, the U.S. Navy, the U.S. Air Force, the U.S. Department of Energy (DOE), and the U.S. Department of Interior (DOI). Publications appearing for the first time in this edition are denoted with an asterisk. The Roundtable obtained reference information from a variety of sources:

- Federal Agency reports, project and publication lists from EPA, the Naval Civil Engineering Laboratory, the U.S. Army Environmental Center, the U.S. Army Engineer Waterways Experiment Station, the Air Force Engineering and Sciences Center, DOE, and DOI; and
- the National Technical Information Service (NTIS) and other data bases.

This bibliography includes technologies that provide for the treatment of hazardous wastes; therefore, it does not contain information or references for containment or other non-treatment strategies, such as landfilling and capping. This bibliography emphasizes innovative technologies for which detailed cost and performance data are not readily available. Information on more conventional treatment technologies, such as incineration and solidification, is not included.

In addition to improving access to information on innovative technologies, the Roundtable hopes this bibliography will assist in the coordination of ongoing research initiatives and increase the development and implementation of these innovative technologies for corrective action and site remediation. This bibliography is intended as a starting point in your pursuit of information on innovative alternative hazardous waste treatment technologies and should not be considered all-inclusive. In the last chapter of this document (page 48), you will find instructions for ordering the publications cited.

This bibliography is a joint effort of the Roundtable member agencies, and is revised periodically. Therefore, if your agency has produced any publications on innovative remediation technologies that should be included in future versions of this bibliography, or if you have any suggestions for improving this document, please complete the suggestion form on page 50 and return it to: **Naomie Smith, Technology Innovation Office, U.S. Environmental Protection Agency (5102W), 401 M Street, SW, Washington, DC 20460.**

A. CONFERENCES AND INTERNATIONAL SURVEYS

EPA

- * • *Approaches for Remediation of Federal Facility Sites Contaminated With Explosives or Radioactive Waste.*
EPA/625/R-93/013
- *Assessment of International Technologies for Superfund Applications: Technology Review and Trip Report Results.*
EPA/540/2-88/003
- *Assessment of International Technologies for Superfund Applications: Technology Identification and Selection.*
EPA/600/2-89/017
- * • *Biological Remediation of Contaminated Sediments, with Special Emphasis on the Great Lakes: Report of a Workshop.*
EPA/600/9-91/001
- *Forum on Innovative Hazardous Waste Treatment Technologies, Domestic and International, (Abstract Proceedings).*
(First Forum, Atlanta, GA), EPA/540/2-89/055; NTIS: PB90-268509
(Second Forum, Philadelphia, PA), EPA/540/2-90/009; NTIS: PB91-145649
(Third Forum, Dallas, TX), EPA/540/2-91/016; NTIS: PB92-233881
(Fourth Forum, San Francisco, CA), EPA/540/R-92/081
- * • *International Workshop in Pesticide Treatment/Disposal/Waste Minimization.*
EPA/600/9-91/047; NTIS: PB92-119940
- *NATO/CCMS Project — International Evaluation of In Situ Bioremediation of Contaminated Soil and Groundwater.*
EPA/540/2-90/012
- *NATO/CCMS Project — Demonstration of Remedial Action Technologies for Contaminated Land and Groundwater.*
Proceedings are maintained in the Hazardous Waste Collection, EPA Headquarters Library, Washington, DC
- * • *NATO/CCMS Pilot Study — Evaluation of Demonstrated and Emerging Technologies for the Treatment and Clean Up of Contaminated Land and Groundwater (Phase II). Interim Status Report. Number 203. May 1995.*
EPA/542/R-95/006
- *Proceedings of the Symposium on Soil Venting.*
EPA/600/R-92/174; NTIS: PB93-122323

- * • *Remedial Action, Treatment, and Disposal of Hazardous Waste: Proceedings of the 20th Annual RREL Hazardous Waste Research Symposium.*
EPA/600/R-94/011; NTIS: PB94-159092
- *Residual Radioactivity and Recycling Criteria: Workshop Proceedings.*
EPA 520/1-90/013; NTIS: PB91-179119
- *Second International Conference on New Frontiers for Hazardous Waste Management: Proceedings of a Conference Held in Pittsburgh, PA, Sept. 27-30, 1987.*
EPA/600/9-87/018F
- * • *Summary Proceedings-Northeast Remediation Marketplace: Business Opportunities for Innovative Technologies.*
EPA/542/R-94/001; NTIS: PB94-154770
- * • *Summary Proceedings-Rocky Mountain Remediation Marketplace: Business Opportunities for Innovative Technologies.*
EPA/542/R-94/006
- * • *Summary Proceedings-West Coast Remediation Marketplace: Business Opportunities for Innovative Technologies.*
EPA/542/R-94/008
- *Third International Conference on New Frontiers for Hazardous Waste Management: Proceedings of a Conference Held in Pittsburgh, PA, Sept. 10-13, 1989.*
EPA/600/9-89/072
- * • *Workshop on Removal, Recovery, Treatment, and Disposal of Arsenic and Mercury.*
EPA/600/R-92/105; NTIS: PB92-216944

DOE

- *Bioremediation of Mercury-Contaminated Sites: Foreign Trip Report, Sept. 9-17, 1989. Turner, R.R. Oak Ridge National Laboratory, DOE, TN. Sept. 1989.*
ORNL/FTR-3393; NTIS or OSTI: DE90001248

B. TECHNOLOGY SURVEY REPORTS

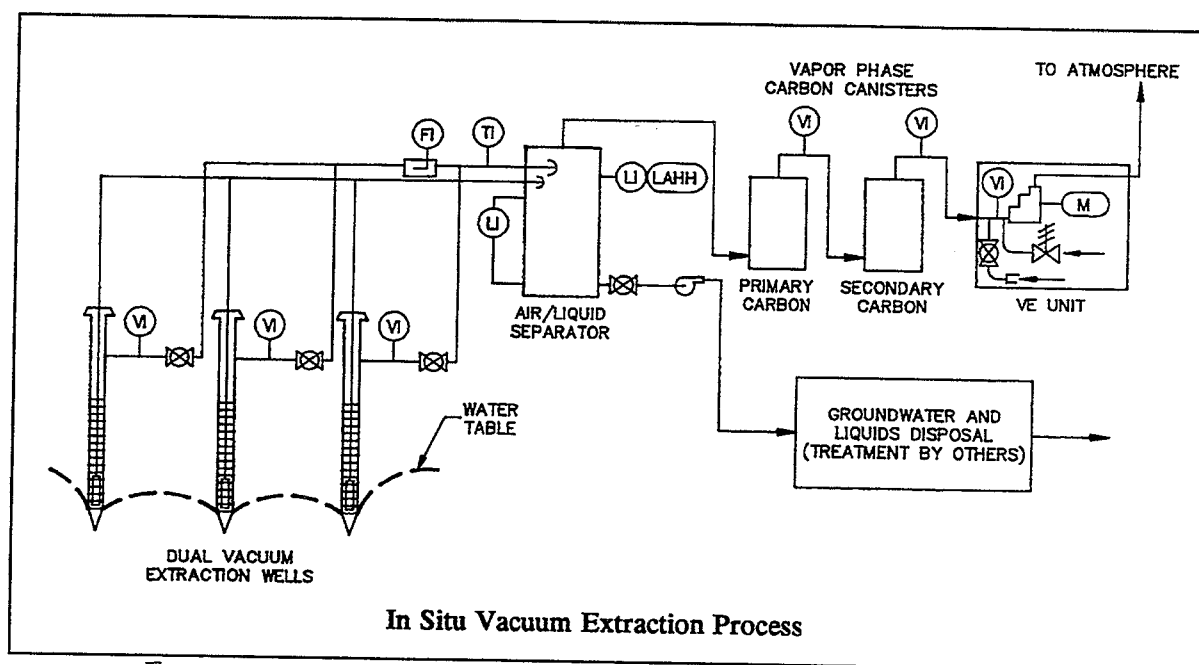
EPA

- * • *Abstracts of Remediation Case Studies*
EPA/542/R-95/001
- *A Compendium of Technologies Used in the Treatment of Hazardous Waste.*
EPA/625/8-87/014
- * • *An Overview of UST Remediation Options*
EPA/510/F-93/029

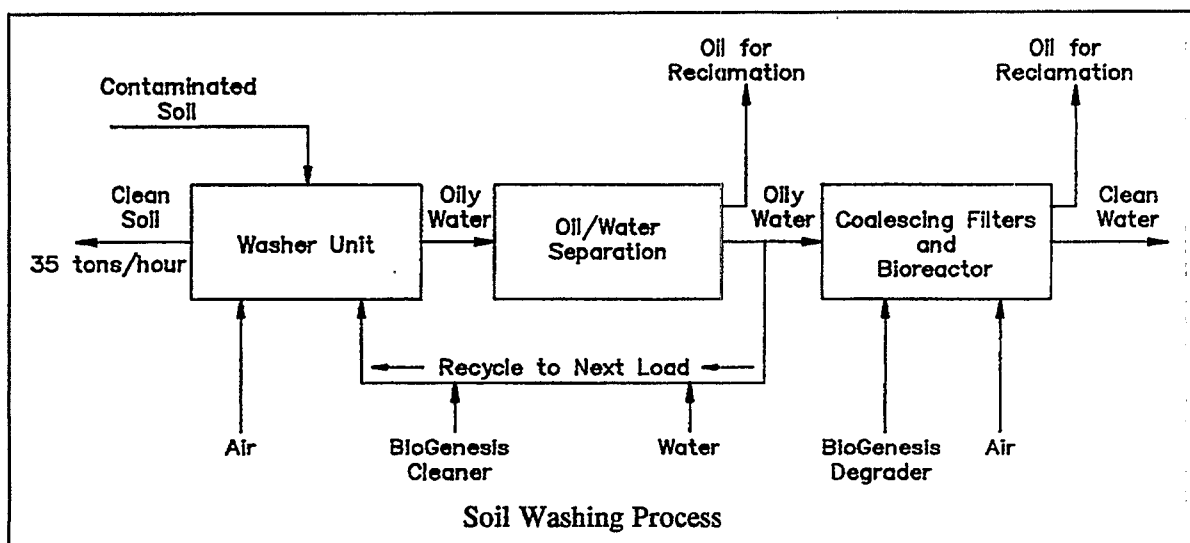
- *Approaches for Remediation of Uncontrolled Wood Preserving Sites.*
EPA/625/7-90/011
- *Assessing Detoxification and Degradation of Wood Preserving and Petroleum Wastes in Contaminated Soil.* April, W., et al. *Waste Management & Research.* 8(1): 45-65. Feb. 90.
EPA/600/J-90/009; NTIS: PB90-243275
- *Assessment of International Technologies for Superfund Applications — Technology Identification and Selection.*
EPA/600/S2-89/017
- *Assessment of Technologies for the Remediation of Radioactively Contaminated Superfund Sites.*
EPA/540/2-90/001; NTIS: PB90-204140
- *Behavior of Metals in Soils.*
EPA/540/S-92/018; NTIS: PB93-131480
- *Cleaning Up the Nation's Waste Sites: Markets and Technology Trends.*
EPA/542-R-92/012; NTIS: PB93-140762
- *Compendium of Costs of Remedial Technologies at Hazardous Waste Sites.*
EPA/600/S2-87/087
- *Contaminants and Remedial Options at Wood Preserving Sites.*
EPA/600/R-92/182; NTIS: PB92-232222
- *Engineering Bulletin: Control of Air Emissions from Materials Handling During Remediation.*
EPA/540/2-91/023
- *EPA Workshop on Radioactively Contaminated Sites.*
EPA/520/1-90/009; NTIS: PB90-227950/AS
- *General Methods for Remedial Operation Performance Evaluation.*
EPA/600/R-92/002
- * • *Groundwater Treatment Technologies Resource Guide*
EPA/542/B94/009; NTIS: PB95-138657
- *Guidance on Remedial Action for Superfund Sites with PCB Contamination.*
EPA/540/G-90/007; NTIS: PB91-921206
- * • *Guide to Documenting Cost and Performance for Remediation Projects*
EPA/542/B-95/003
- *Guide to Treatment Technologies for Hazardous Wastes at Superfund Sites.* Office of Environmental Engineering and Technology Demonstration, U.S. EPA. Mar. 1989.
EPA/540/2-89/052; NTIS: PB 89-190821/XAB

- *Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils.*
EPA/540/2-90/002; NTIS: PB90-155607
- *Handbook: Stabilization Technologies for RCRA Corrective Action.*
EPA/625/6-91/-2C; NTIS: PB92-114495
- * • *How to Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites: A Guide For Corrective Action Plan Reviewers*
EPA/510/B-94/003
- *Innovative Operational Treatment Technologies for Applications to Superfund Sites.*
EPA/540/2-90/006; NTIS: PB90-202656
EPA/540/2-90/004 (Nine Case Studies)
- *Innovative Processes for Reclamation of Contaminated Subsurface Environments.* Canter, L.W., et al.
EPA/600/2-90/017; NTIS: PB 90-199514
- * • *Innovative Treatment Technologies: Annual Status Report, Sixth Edition*
EPA/542/R-94/005; NTIS: PB95-138152
- *Innovative Treatment Technologies: Overview and Guide to Information Sources, October 1991.*
EPA/540/9-91/002; NTIS: PB92-179001
- *In Situ Restoration Techniques for Aquifers Contaminated with Hazardous Wastes.* Lee, M.D., et al. *Journal of Hazardous Materials.* Elsevier Science Publishers B.V. Amsterdam, The Netherlands. 14:71-82. 1987.
EPA/600/J-87/032; NTIS: PB87-198396
- *Literature Survey of Innovative Technologies for Hazardous Waste Site Remediation: 1987-1991.* July 1992.
EPA/542/B-92/004
- *Mobile Treatment Technologies for Superfund Wastes.*
EPA/540/2-86/003f
- *On-Site Treatment of Creosote and Pentachlorophenol Sludges in Contaminated Soil.*
EPA/600/2-91/019; NTIS: PB91-223370
- *PCB (Polychlorinated Biphenyl) Sediment Decontamination, Technical/Economic Assessment of Selected Alternative Treatments: Final Report, Jun. 1985-Feb. 1986.* Carpenter, B.H. Hazardous Waste Engineering Research Laboratory, U.S. EPA, Cincinnati, OH. Dec. 1986.
EPA/600/2-86/112
- * • *Physical/Chemical Treatment Technology Resource Guide*
EPA/542/B-94/008
- *Procuring Innovative Technologies at Remedial Sites: Q's and A's and Case Studies.*
EPA/542/F-92/012

- * • *Remediation Case Studies: Bioremediation*
EPA/542/R-95/002; NTIS: PB95-182911
- * • *Remediation Case Studies: Groundwater Treatment*
EPA/542/R-95/003; NTIS: PB95-182929
- * • *Remediation Case Studies: Soil Vapor Extraction*
EPA/542/R-95/004; NTIS: PB95-182937
- * • *Remediation Case Studies: Thermal Desorption, Soil Washing, and In Situ Vitrification*
EPA/542/R-95/005; NTIS: PB95-182945
- *Remediation of Contaminated Sediments.*
EPA/625/6-91/028
- *Remediation of Sites Contaminated with TCE.*
EPA/600/J-91/030; NTIS: PB91-182311
- * • *Remediation Technologies Screening Matrix and Reference Guide: Second Edition*
EPA/542/B-94/013; NTIS: PB95-104782
- *Report on Decontamination of PCB-Bearing Sediments.* Wilson, D.L. Hazardous Waste Engineering Research Laboratory, U.S. EPA, Cincinnati, OH. Oct. 1987.
EPA/600/2-87/093
- *Review of In-Place Treatment Techniques for Contaminated Surface Soils. Volume I. Technical Evaluation.*
EPA/540/2-84/003a



- *Selection of Control Technologies for Remediation of Lead Battery Recycling Sites.*
EPA/540/2-91/014; NTIS: PB92-114537
- *Seminar Publication — Corrective Actions: Technologies and Applications.*
EPA/625/4-89/020
- * • *Soil Vapor Extraction Treatment Technology Resource Guide*
EPA/542/B-94/007
- *Subsurface Contamination Reference Guide.*
EPA/540/2-90/011; NTIS: PB91-921292
- *Summary of Treatment Technology Effectiveness for Contaminated Soil: Final Report.*
EPA/540/2-90/002
- *Superfund Engineering Issue—Treatment of Lead Contaminated Soils.*
EPA/540/2-91/009; NTIS: PB91-921291
- *Superfund Innovative Technology Evaluation (SITE) Program — Brochure.*
EPA/540/8-89/010
- *Superfund Innovative Technology Evaluation Program — SITE Program Fact Sheet.*
OSWER Directive 9330.1-03FS
- * • *The Superfund Innovative Technology Evaluation Program: Technology Profiles, Seventh Edition*
EPA/540/R-94/526
- *Superfund Treatability Clearinghouse Abstracts.*
EPA/540/2-89/001; NTIS: PB90-119751
- *Survey of Materials-Handling Technologies Used at Hazardous Waste Sites.*
EPA/540/2-91/010; NTIS: PB91-921283



- *Technical Resource Document: Treatment Technologies for Halogenated Organic Containing Wastes. Volume I.*
EPA/600/2-87/098
- *Technological Approaches to the Cleanup of Radiologically Contaminated Superfund Sites.*
EPA/540/2-88/002; NTIS: PB89-122121
- *TCE Removal from Contaminated Soil and Ground Water.*
EPA/540/S-92/002; NTIS: PB92-224104
- *Technologies and Options for UST Corrective Actions: Overview of Current Practice.*
EPA/542/R-92/010
- *Technologies for In Situ Treatment of Hazardous Wastes.* Sanning and Lewis. Hazardous Waste Engineering Research Laboratory, U.S. EPA, Cincinnati, OH. Jan. 1987.
EPA/600/D-87/014; NTIS: PB87-146007/XAB
- *Technologies of Delivery or Recovery for the Remediation of Hazardous Waste Sites.*
EPA/600/S2-89/066; NTIS: PB90-156225
- *Technology Screening Guide for Treatment of Soils and Sludges.*
NTIS: PB 89-132674
- *Treatment of Lead-Contaminated Soils.*
EPA/540/2-91/009
- *Treatment Potential for 56 EPA Listed Hazardous Chemicals in Soil.* Sims, R.C., et al. 1988.
EPA/600/6-88/001; NTIS: PB89-174446
- *Treatment Technology Background Document.* Berlow and Vorbach. Office of Solid Waste, U.S. EPA, Washington, DC. Jun. 1989.
EPA/530/SW-89/048A; NTIS: PB89-221410/XAB
- *Workshop on Innovative Technologies for Treatment of Contaminated Sediments, June 13-14, 1990, Summary Report.*
EPA/600/S2-90/054

DOE

- * • *Applied Research and Development Private Sector Accomplishments: Final Summary Report.* Beskid, N.J., et al. 1993.
NTIS: DOE/CH-9303
- *Demonstrations of Technology for Remediation and Closure of Oak Ridge National Laboratory Waste Disposal Sites.* Spalding, B.P., et al. Oak Ridge National Laboratory. Sept. 1989.
NTIS: ORNL/TM-11286; or OSTI: DE90001854

- * • *Electrokinetic Treatment of Contaminated Soils, Sludges, and Lagoons*. Office of Technology Development. 1992.
NTIS: DOE/CH-9206
- * • *Innovation Investment Area: Technology Summary*. Office of Environmental Management; Office of Technology Development. Mar. 1994.
NTIS: DOE/EM-0146P
- * • *In Situ Remediation Integrated Program: Technology Summary*. Office of Environmental Management; Office of Technology Development. Feb. 1994.
NTIS: DOE/EM-0134P
- * • *Mixed Waste Integrated Program: Technology Summary*. Office of Environmental Management; Office of Technology Development. Feb. 1994.
NTIS: DOE/EM-0125P
- *Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics*. Walton, B.T., et al. Oak Ridge National Laboratory. Jul. 1989.
NTIS: ORNL-6451; or OSTI: DE89016892 (Also available from EPA, Ada, OK)
- * • *VOCs in Non-Arid Soils Integrated Demonstration: Technology Summary*. Office of Environmental Management; Office of Technology Development. Feb. 1994.
NTIS: DOE/EM-0135P

U.S. Air Force

- *Remedial Technology Design, Performance, and Cost Study*. U.S. Air Force Center for Environmental Excellence, Brooks AFB, Texas. July 1992.

U.S. Army

- * • *An Assessment of Selected Enhancement Techniques in Electrokinetic Remediation of Inorganic Species*. Acar, Y., et al. I&EC Special Journal, American Chemical Society, Vol. I, Sept. 1993.
- *Guidelines for Selecting Control and Treatment Options for Contaminated Dredged Material Requiring Restrictions: Final Report*. Cullinane, M.J., et al. U.S. Army Corps of Engineers Waterways Experiment Station. Sept. 1986.
No published document number.
- * • *Heavy Metal Soil Contamination at U.S. Army Installations: Proposed Research and Strategy for Technology Development*. Bricka, R.M., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. March 1994.
TR-IRR-94-1
- *Installation Restoration and Hazardous Waste Control Technologies*. 1990 Edition. U.S. Army Environmental Center. Aug. 1990.
CETHA-TS-CR-90067

- *Proceedings from the 15th Annual Army Environmental R&D Symposium*. U.S. Army Environmental Center. Jun. 1991.
CETHA-TS-CR-91076
 - *Review of Removal, Containment and Treatment Technologies for Remediation of Contaminated Sediment in the Great Lakes*. Averett, D.E., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1990.
WES: MP-90-25
 - * • *Technical Approach for In Situ Biotreatment Research: Bench-Scale Experiments*. Zappi, M.E., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1993.
TR-IRRP-93-3
 - * • *Technology Assessment of Currently Available and Developmental Techniques for Heavy Metals-Contaminated Soils Treatment*. Bricka, R.M., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1993.
WES: IRRP-93-4
- U.S. Navy**
- * • *Environmental Cleanup Technology Transfer Initiatives*. Muehlhausen, L.A. Naval Facilities Engineering Service Center, Port Hueneme, CA. August 1994.
NFESC: TR-2023-ENV

C. TREATABILITY STUDIES

EPA

- *Conducting Treatability Studies Under RCRA*.
OSWER Directive 9380.3-09 (Fact Sheet); NTIS: PB92-963501
- *Groundwater and Leachate Treatability Studies at Four Superfund Sites*.
EPA/600/2-86/029
- *Guide for Conducting Treatability Studies Under CERCLA: Aerobic Biodegradation Remedy Screening*.
EPA/540/2-91/013 A&B; NTIS: PB92-109065 and PB92-109073
- *Guide for Conducting Treatability Studies Under CERCLA: Chemical Dehalogenation*.
EPA/540/R-92/013 A&B; NTIS: PB92-169044 and PB92-169275
- *Guide for Conducting Treatability Studies Under CERCLA: Soil Vapor Extraction*.
EPA/540/2-91/019 A&B
- *Guide for Conducting Treatability Studies Under CERCLA: Soil Washing*.
EPA/540/2-91/1020 A&B; NTIS: PB92-170570 and PB92-170588

- *Guide for Conducting Treatability Studies Under CERCLA: Solvent Extraction.*
EPA/540/R-92/016 A; NTIS: PB92-239581
- *Guide for Conducting Treatability Studies Under CERCLA, Update.*
EPA/540/R-92/017A
- *Inventory of Treatability Study Vendors, Volume I.*
EPA/540/2-90/003a; NTIS: PB91-228395
- *Results of Treatment Evaluations of Contaminated Soils.* Esposito, P., et al. Hazardous Waste Engineering Research Laboratory, U.S. EPA, Cincinnati, OH. Aug. 1988.
EPA/600/D-88/181
- *Treatability of Hazardous Chemicals in Soils: Volatile and Semi-Volatile Organics.*
NTIS: DE89-016892
- *Treatability Potential For EPA Listed Hazardous Wastes in Soil.* Loehr, R.C.
EPA/600/2-89/011 (Available from EPA, Ada, OK); NTIS: PB 89-166581
- *Treatability Potential for 56 EPA Listed Hazardous Chemicals in Soil.*
EPA/600/6-88/001 (Available from EPA, Ada, OK); NTIS: PB 89-174446
- *Treatability Studies Under CERCLA: An Overview, 12/89.*
OSWER Directive 9380.3-02FS (Fact Sheet); NTIS: PB90-273970

U.S. Army

- * • *Chemical Extraction of Heavy Metals from Contaminated Soils.* Bastain, C., et al. I&EC Special Journal, American Chemical Society, Vol. II. September 1993.
- * • *Electrokinetic Remediation: Basics and Technology Status.* Acar, Y., et al. Journal of Hazardous Materials, Vol. 39, No. 3. 1994.
- * • *Enhancement Techniques in Electrokinetic Remediation.* Acar, Y., et al. Journal of Geotechnical and Geoenvironmental Engineering. (In Review). 1993.
- *Treatability of Ninth Avenue Superfund Site Groundwater.* Zappi, M.E., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1991.
WES: EL-91-8
- * • *Use of Activated Carbon for the Treatment of Explosive-Contaminated Groundwater at Picatinny Arsenal.* Bricka and Fleming. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1995.
No published document number (in publication).
- * • *UV/Chemical Oxidation Treatment of RDX Contaminated Waters at Picatinny Arsenal.* Fleming, E., et al. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1995.
WES: EL-95-7

D. GROUNDWATER

Three-quarters of the hazardous waste sites across the U.S. include groundwater contamination. The conventional *ex situ* approach to groundwater remediation at most sites is to determine the source and extent of aquifer contamination, drill a number of extraction and injection wells, pump out contaminated groundwater for treatment (air stripping, activated carbon filter, *etc.*), and reinject clean water until the aquifer meets applicable standards. Groundwater remediation is often complicated by hydrogeologic features such as fractured media and the attributes of certain contaminants like dense non-aqueous phase liquids (DNAPLs) that are difficult to recover and treat. Most pump-and-treat remedies, even under ideal conditions, can take decades of operation and maintenance, depending on the extent of contamination and contaminant characteristics. For this reason, most innovative groundwater technologies provide a time-saving alternative that either enhances the performance and efficiency of conventional pump-and-treat systems (*e.g.*, surfactants, co-solvents) or replaces it with an *in situ* remedy (*e.g.*, bioremediation, biorecovery).

EPA

- *Bioremediation of Aquifers Contaminated with Organic Compounds.*
EPA/600/J-88/78; NTIS: PB89-103527
- *Chemical Enhancements to Pump-and-Treat Remediation.*
EPA/540/S-92/001 (Available from EPA, Ada, OK); NTIS: PB92-180074
- *Contaminant Transport in Fractured Media: Models for Decision Makers (Issue Paper).*
EPA/540/4-89/004 (Available from EPA, Ada, OK); NTIS: PB92-268517
- *Considerations in Groundwater Remediation at Superfund Sites and RCRA Facilities—Update.*
OSWER Directive 9283.1-06; NTIS: PB92-963358
- *Critical Evaluation of Treatment Technologies with Particular Reference to Pump-and-Treat Systems.*
EPA/600/A-92/224; NTIS: PB93-119857
- *Dense Nonaqueous Phase Liquids — A Workshop Summary.*
EPA/600/R-92/030 (Available from EPA, Ada, OK); NTIS: PB92-178938
- *Emerging Technology Report — Biorecovery Systems Removal and Recovery of Metal Ions from Ground Water.*
EPA/540/5-90/005a (Evaluation Report); NTIS: PB90-252594
EPA/540/5-90/005b (Data and Supporting Information); NTIS: PB90-252602
- *Estimating Potential for Occurrence of DNAPL at Superfund Sites.*
EPA Publication 9355.4-07FS (Available from EPA, Ada, OK); NTIS: PB92-963338
- *Evaluation of Ground Water Extraction Remedies.*
NTIS: PB90-18358 (Vol. 1, Summary Report)
PB90-274440 (Vol. 2, Case Studies [Interim Final])
PB90-274457 (Vol. 3, General Site Data, Data Base Reports [Interim Final])

- * • *Evaluation of Technologies For Cleanup of DNAPL Contaminated Sites*
EPA/600/R-94/120; NTIS: PB94-195039
- *Facilitated Transport (Issue Paper).*
EPA/540/4-89/003 (Available from EPA, Ada, OK); NTIS: PB91-133256
- *Fundamentals of Ground Water Modeling.*
EPA/540/S-92/005; NTIS: PB92-232354
- *Ground Water Issue: Dense Nonaqueous Phase Liquids.*
EPA/540/4-91/020A (Available from EPA, Ada, OK); NTIS: PB91-195974
- *Ground Water Issue: Evaluation of Soil Venting Application.*
EPA/540/S-92/004; NTIS: PB92-235605
- *Ground Water Issue: Reductive Dehalogenation of Organic Contaminants in Soils and Ground Water.*
EPA/540/4-90/054 (Available from EPA, Ada, OK); NTIS: PB91-191056
- * • *Ground Water Treatment Technology Resource Guide*
EPA/542/B-94/009
- *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites.*
EPA/540/G-88/003; NTIS: PB89-184618
- *In Situ Aquifer Restoration of Chlorinated Aliphatics by Methanotrophic Bacteria.*
EPA/600/2-89/033; NTIS: PB219992
- *In Situ Bioremediation of Contaminated Ground Water.*
EPA/540/S-92/003; NTIS: PB92-224336
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EPA/500/K-93/001
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Hydrofracturing/Pneumatic Fracturing
Cosolvents
Electrokinetics
Altering Chemical Conditions

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WES: EL-90-9

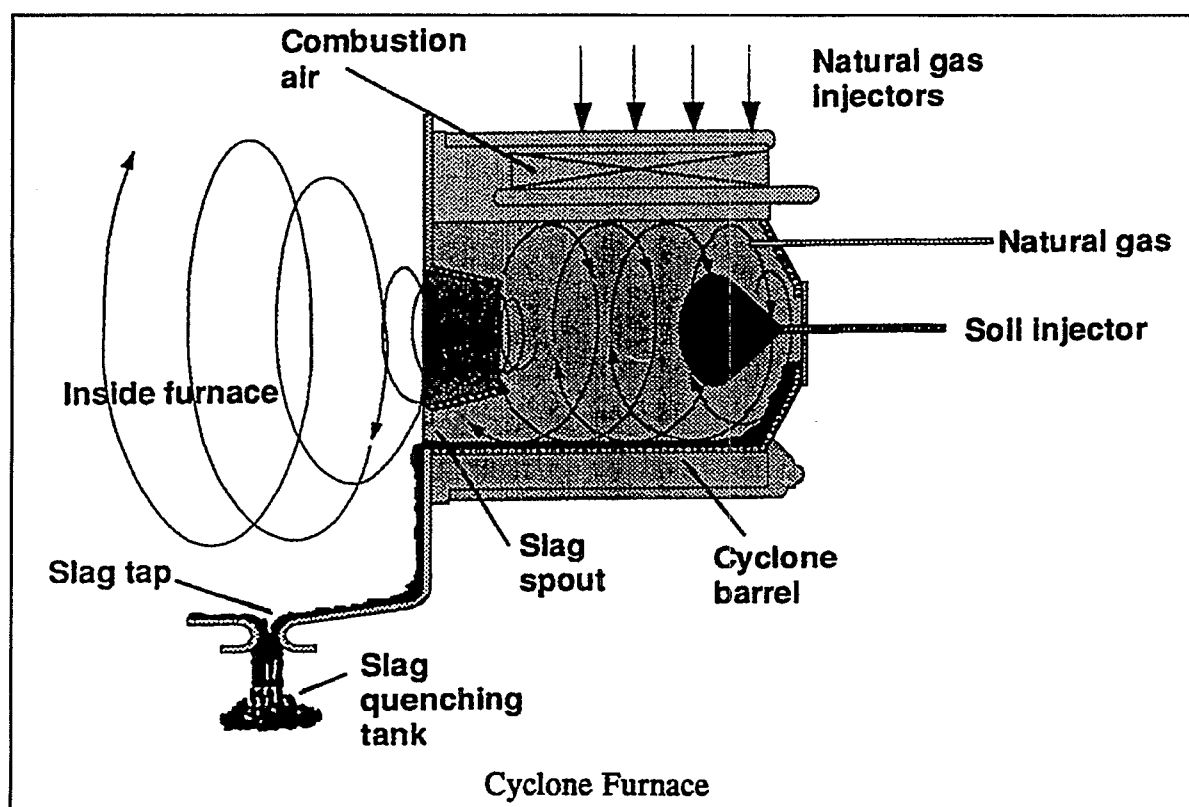
E. THERMAL PROCESSES

Innovative thermal treatment technologies include processes that go beyond simple "burn units." *In situ* thermal processes include thermally enhanced soil vacuum extraction (SVE) and vitrification. SVE is a physical treatment technology described below. **Vitrification** uses an electric current to melt soil or sludge at extremely high temperatures (1,600°C to 2,000°C), destroying organic pollutants by pyrolysis. *Ex situ* techniques add thermal desorption and other enhanced incineration techniques to the list. **Thermal desorption** includes physical separation processes that do not destroy contaminants directly but rather heat waste to volatilize and contaminants for treatment.

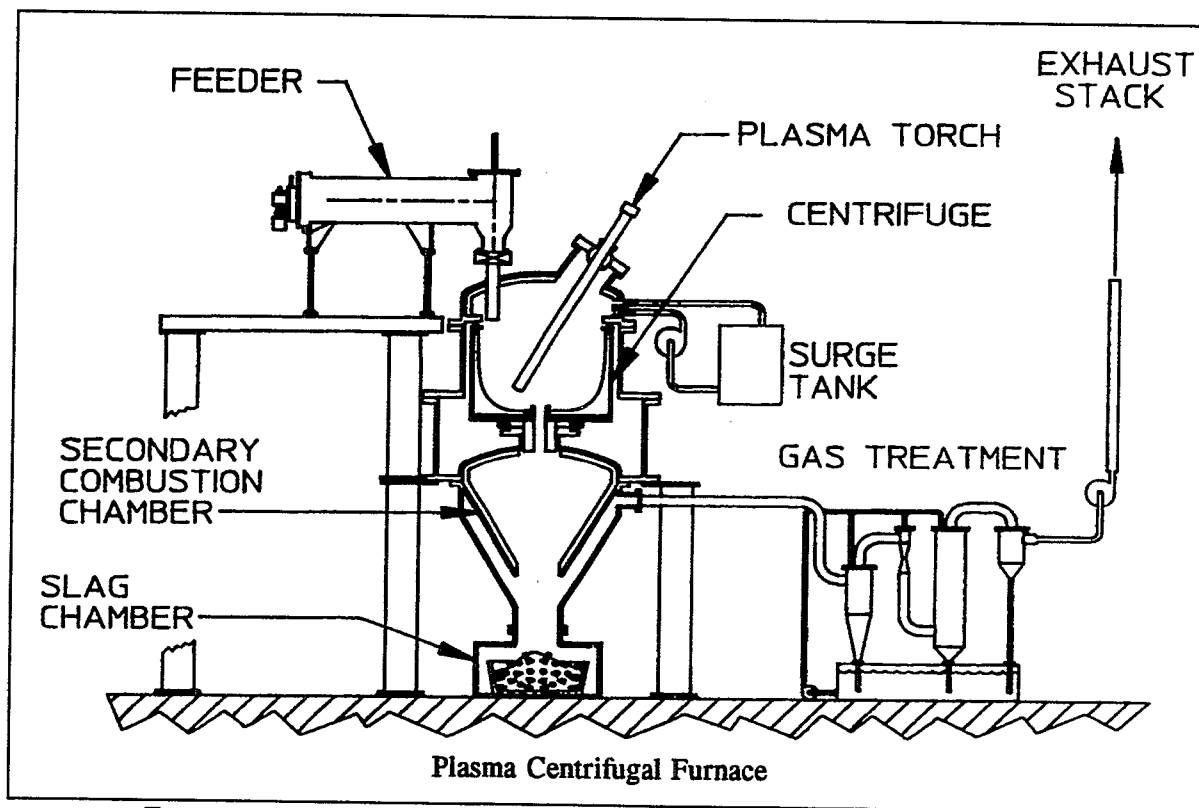
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EPA/540/A5-91/005
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- * • *Applications Analysis Report: Thermal Desorption Unit, Eco Logic International, Inc.*
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EPA/540/MR-94/507
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EPA/540/MR-93/502
- *Engineering Bulletin: Mobile/Transportable Incineration Treatment.*
EPA/540/2-90/014
- *Engineering Bulletin: Pyrolysis Treatment.*
EPA/540/S-92/010
- *Engineering Bulletin: Thermal Desorption Treatment.*
EPA/540/2-91/008
- *Handbook: Vitrification Technology for the Treatment of Hazardous and Radioactive Waste.*
EPA/540/R-92/012
- *Innovative Technology: In Situ Vitrification.*
OSWER Directive 9200.5-251-FS (Fact Sheet)



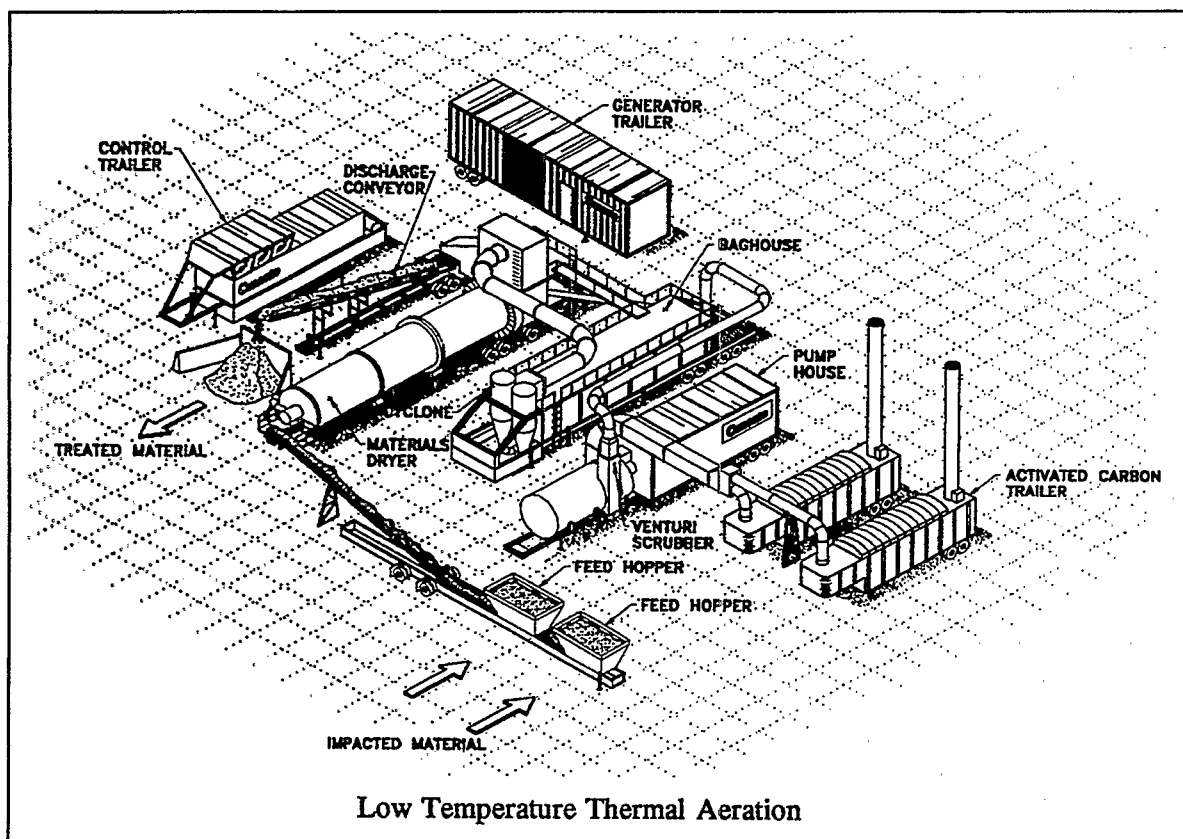
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DOE

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F. BIOLOGICAL

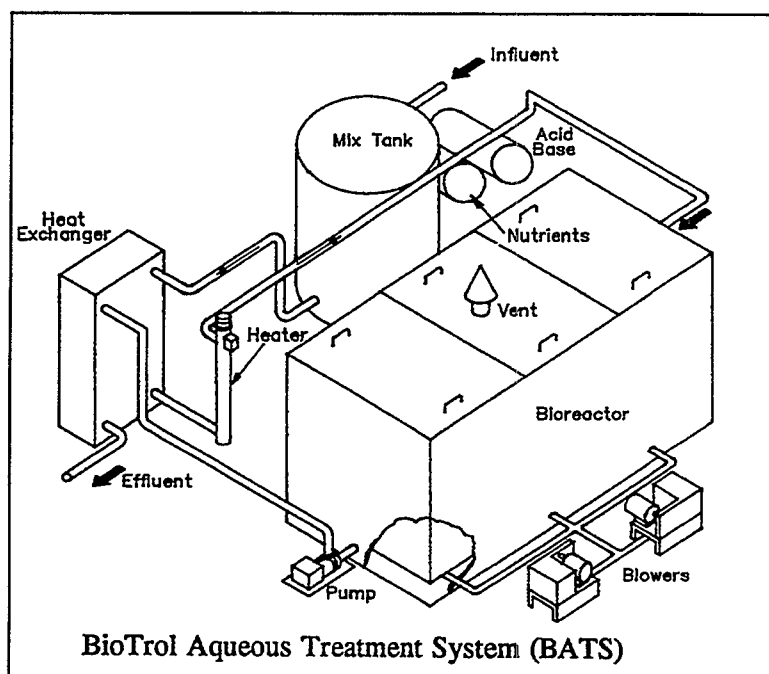
Biological treatment technologies are any treatment system that includes a biological component. Most fall under the heading bioremediation since they involve the active introduction of a biological agent (e.g., microbe) in the cleanup. **Bioremediation** techniques are destruction techniques that seek to stimulate microorganisms to degrade organic contaminants by using them as a food and energy source. Most techniques seek to create an environment that will support agent growth. **Bioventing** injects air into contaminated soil to provide a continuous oxygen source, enhancing the growth of microorganisms naturally present in the soil (additives also may be required to stimulate microbial growth). **Composting** is a process by which organic materials are biodegraded by microorganisms, generating organic and inorganic by-products and energy in the form of heat, which is trapped within the compost matrix.

Although not all organic compounds are amenable to biodegradation, bioremediation techniques have been used to remediate soils, sludges, and groundwater contaminated by petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals. Bioremediation is not applicable for the remediation of inorganic contaminants.

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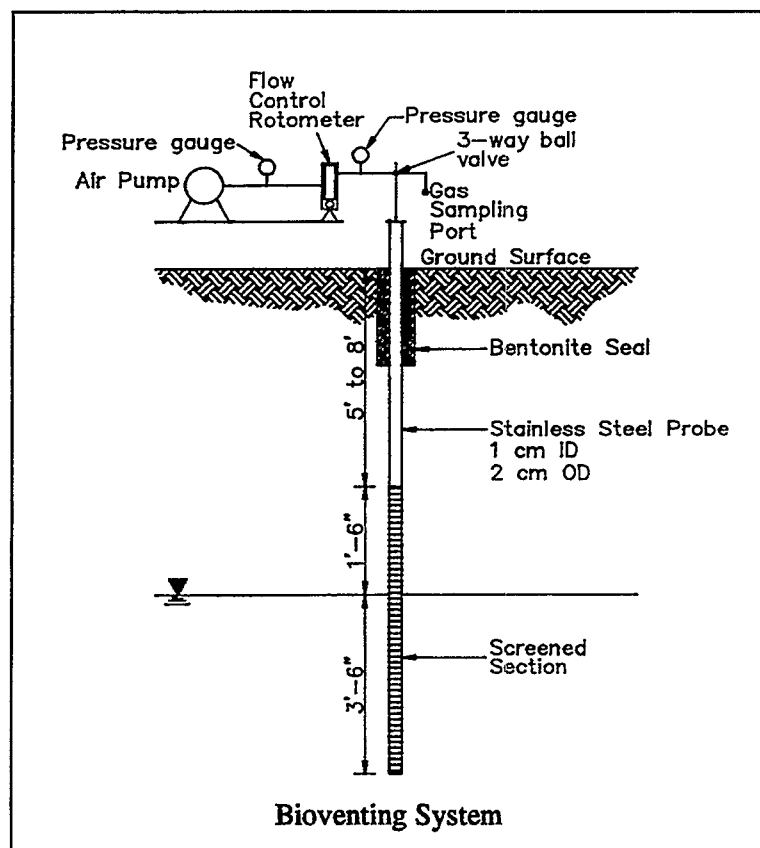
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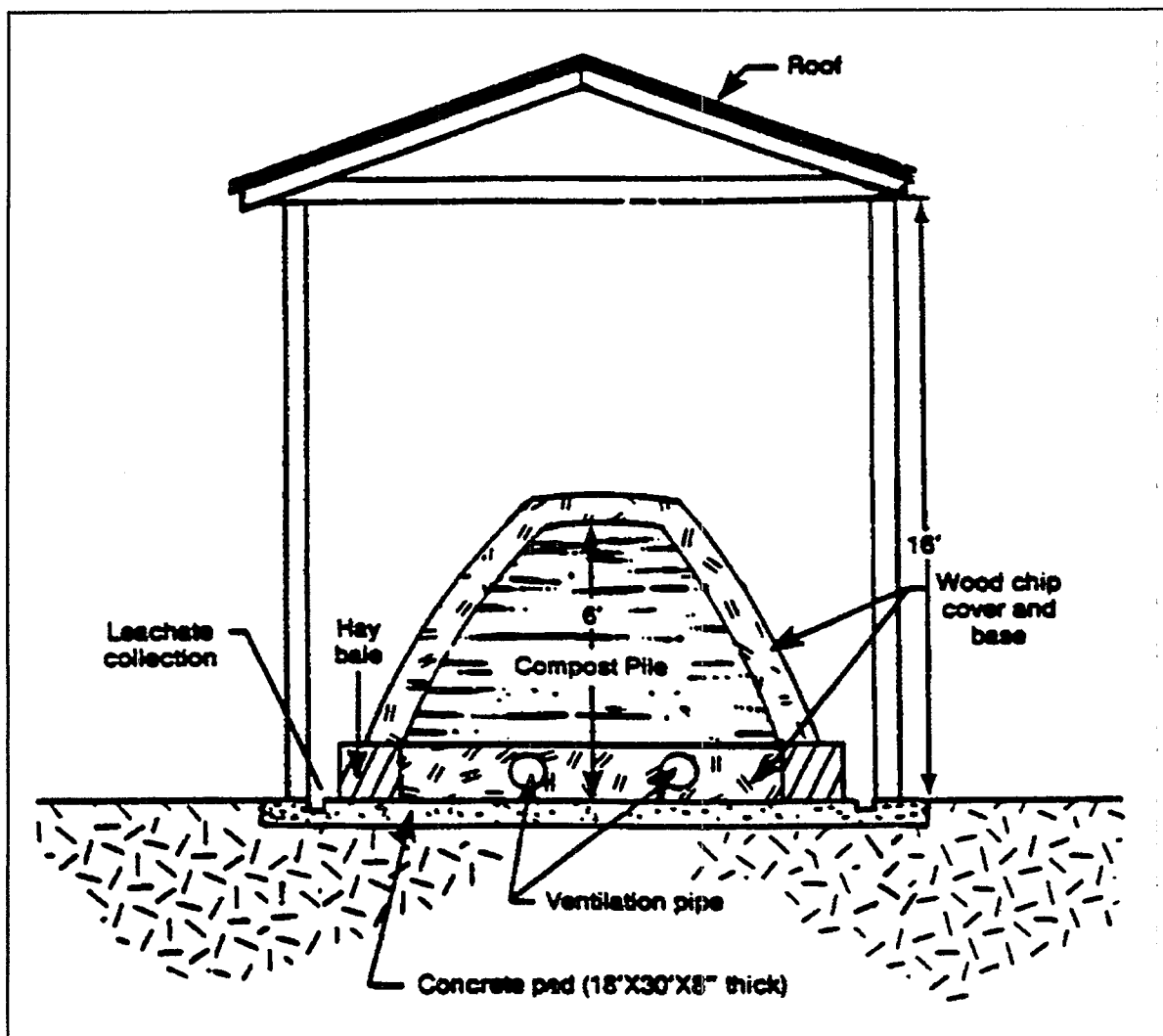
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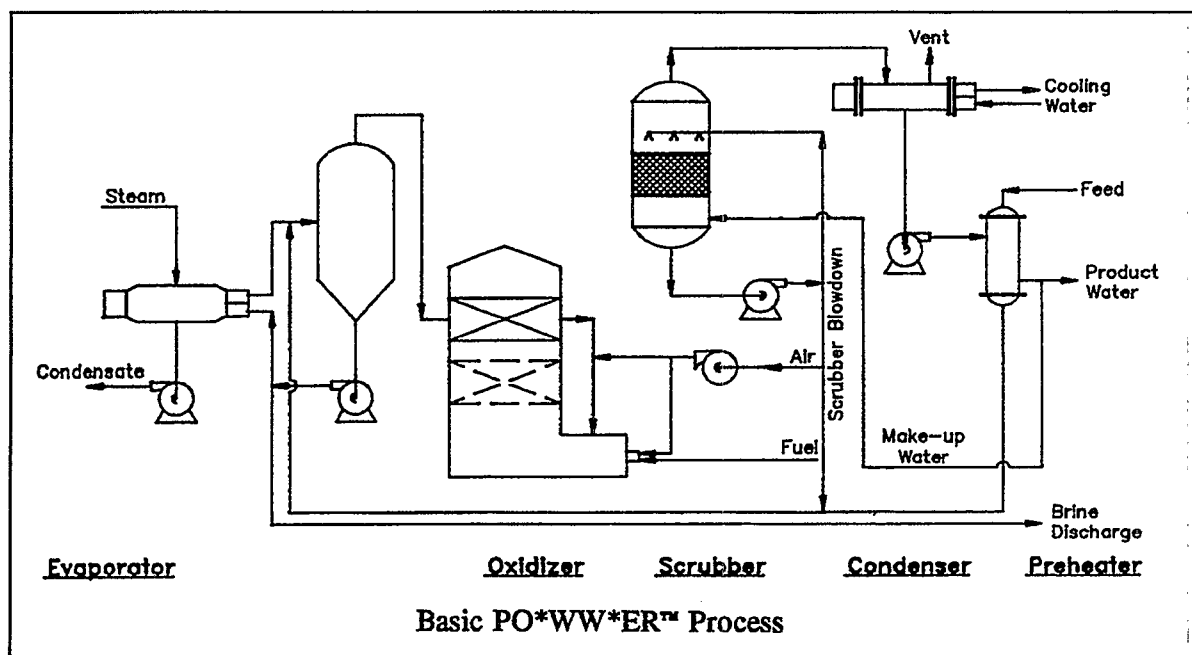
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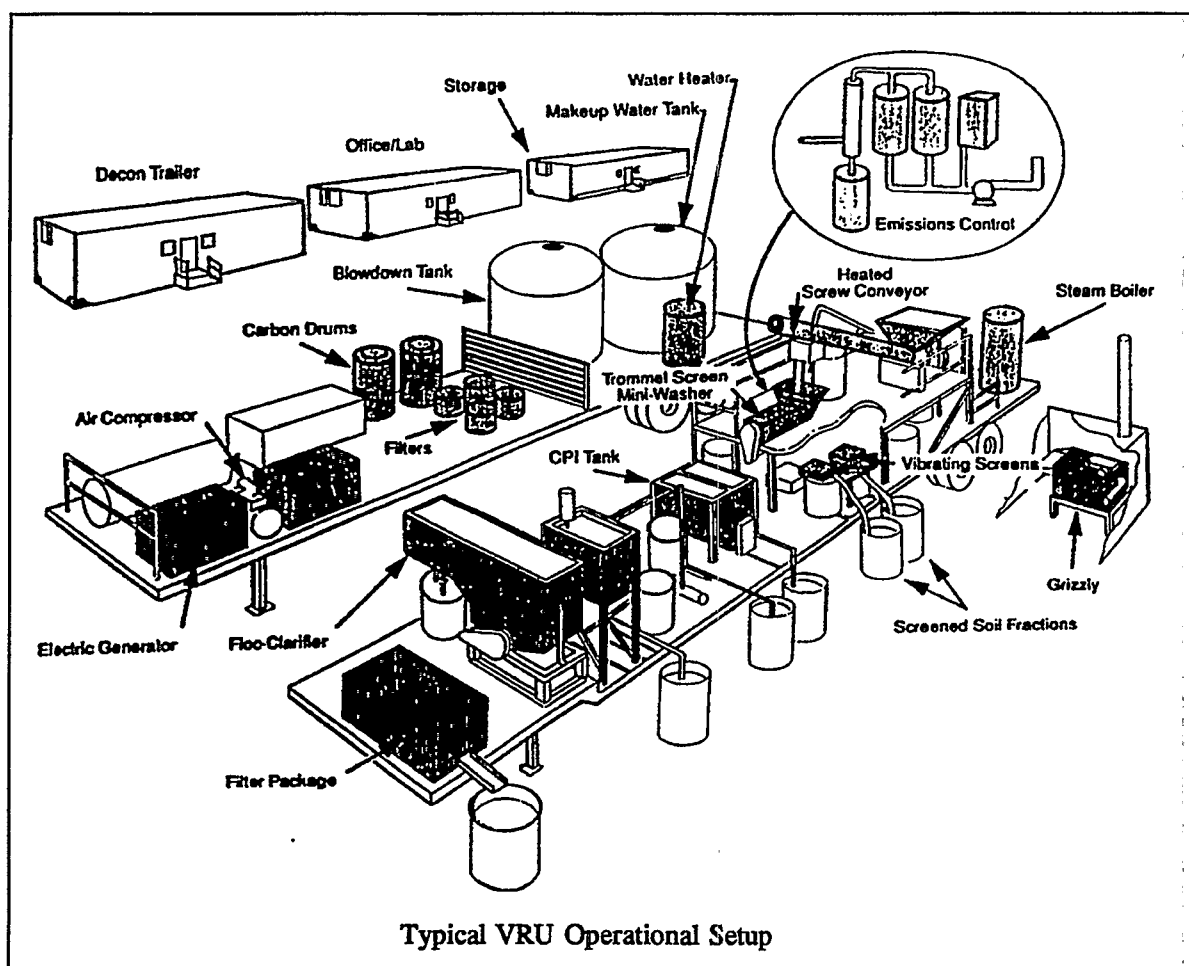
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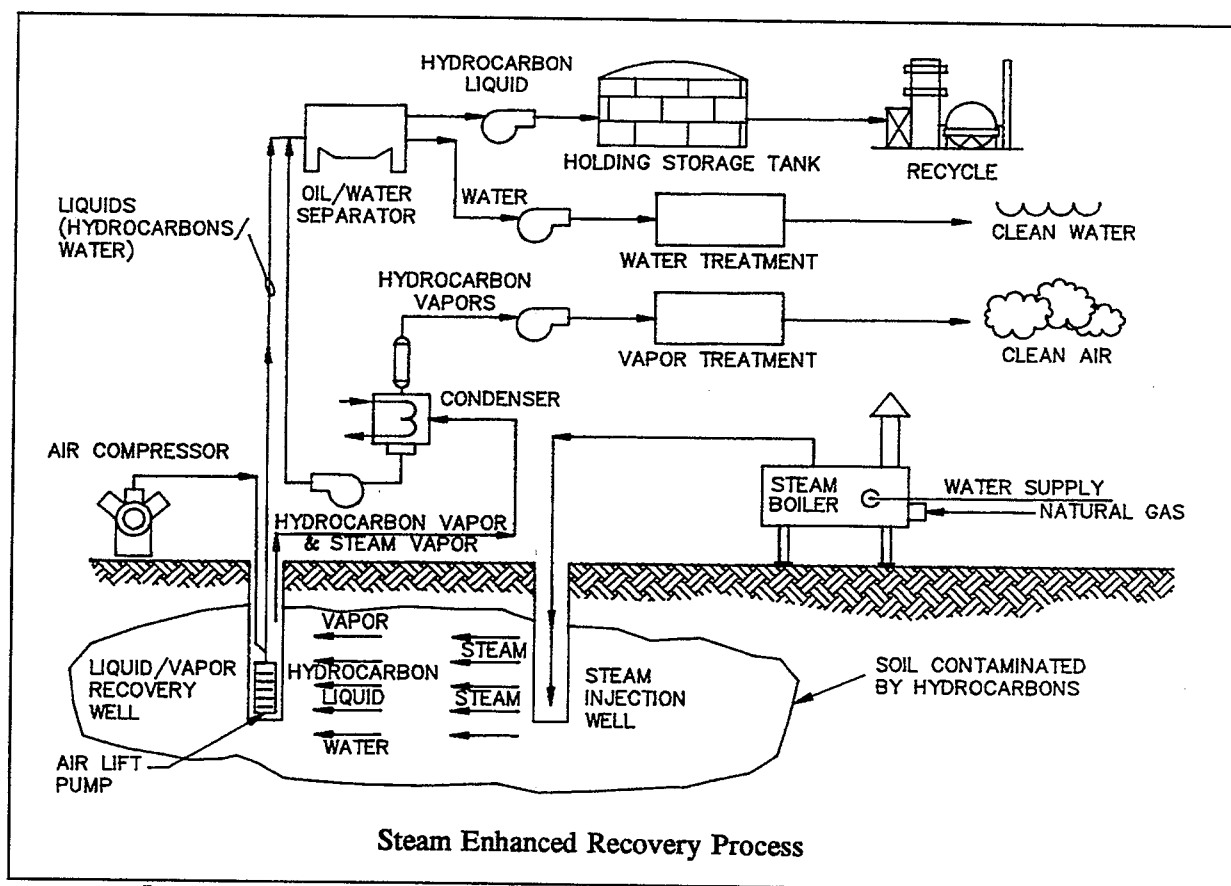


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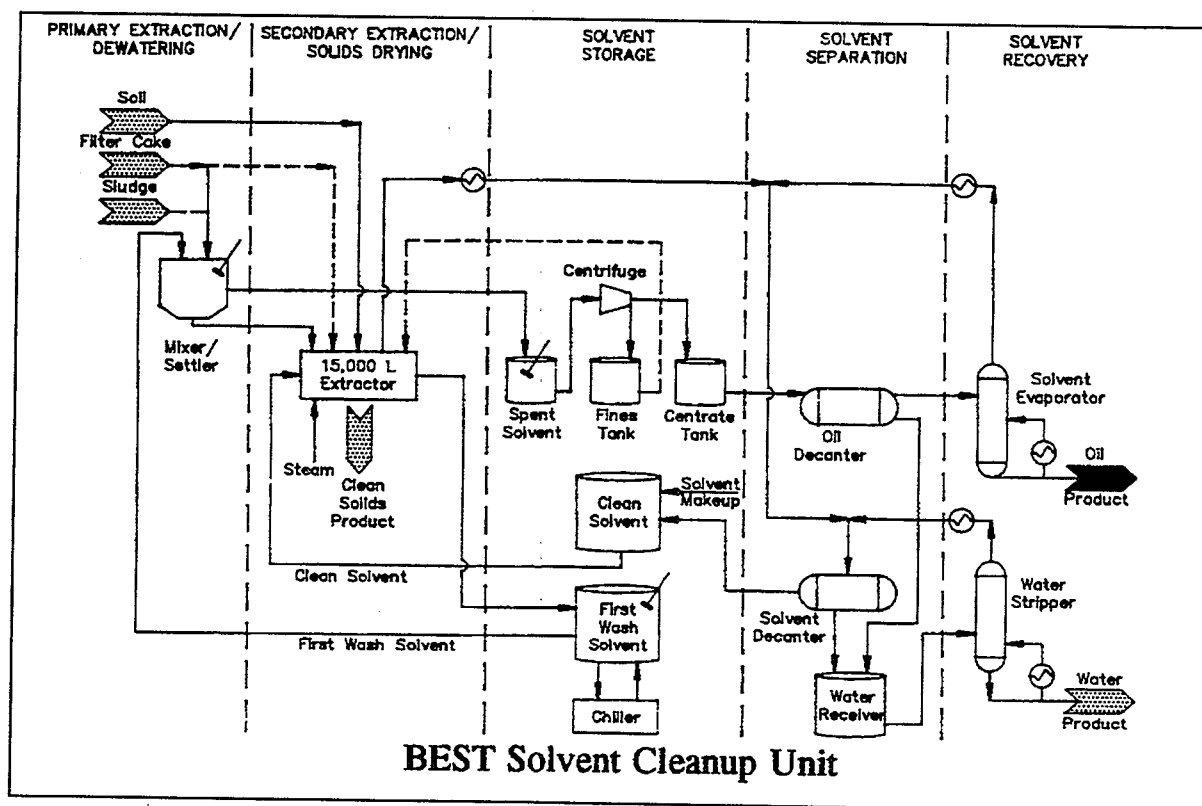


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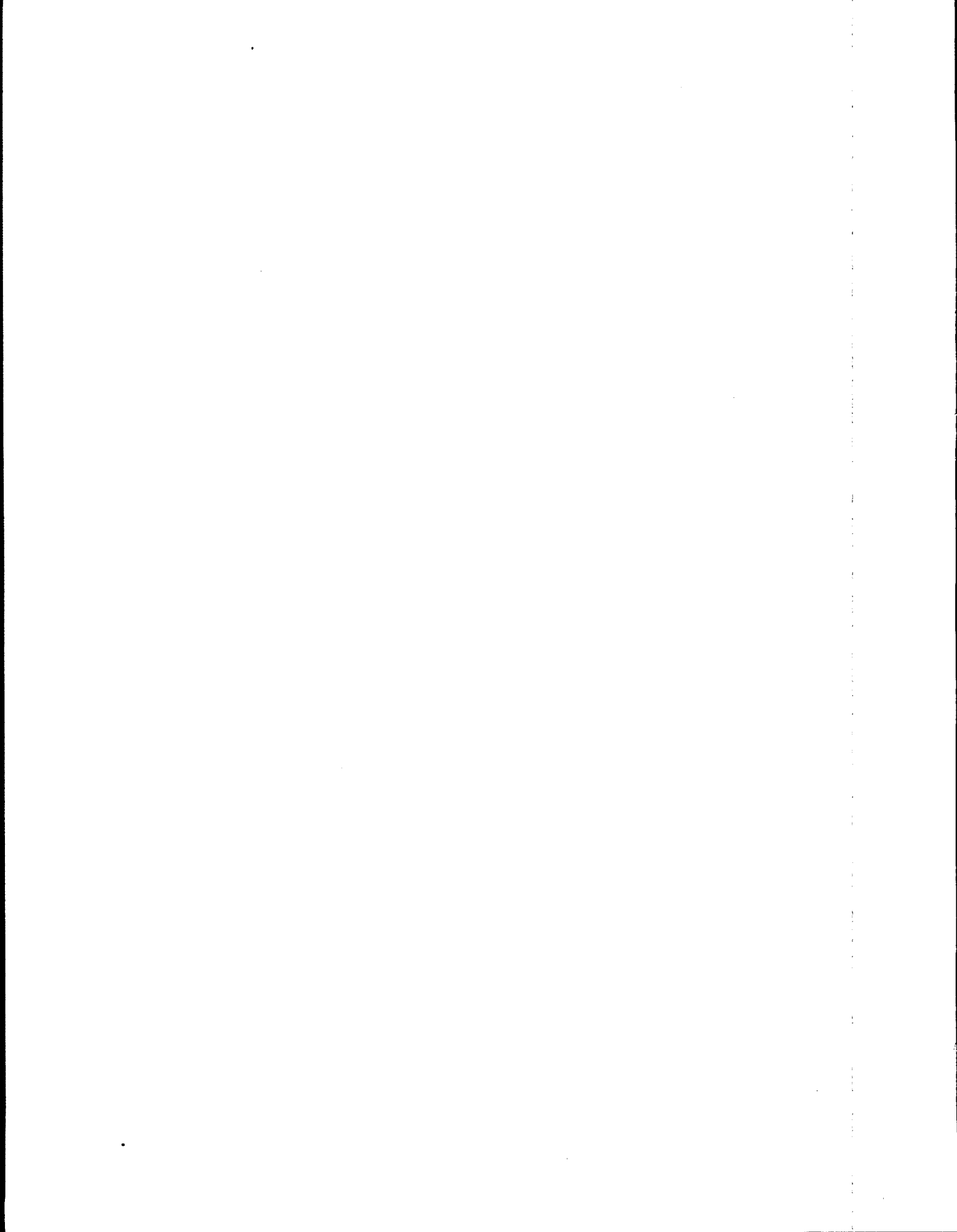
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