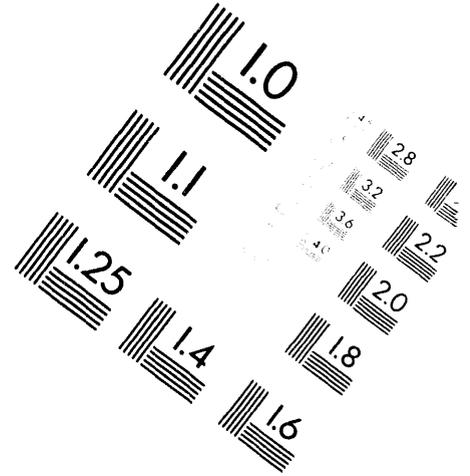
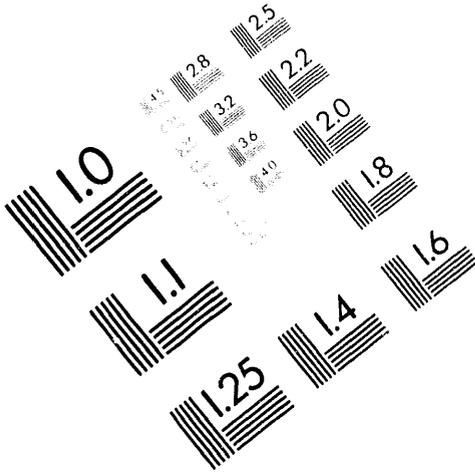




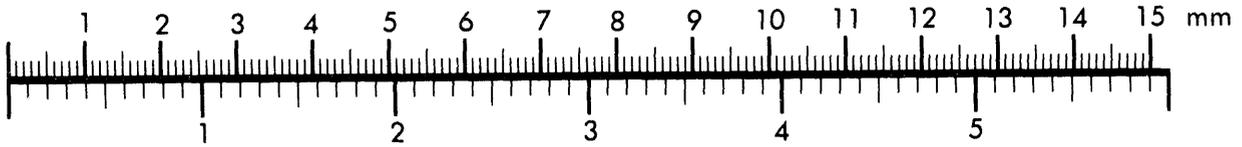
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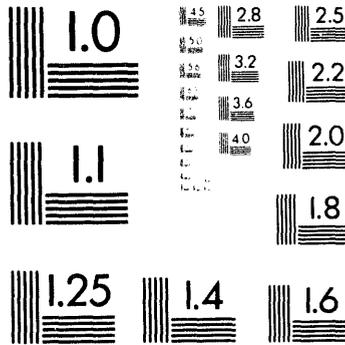
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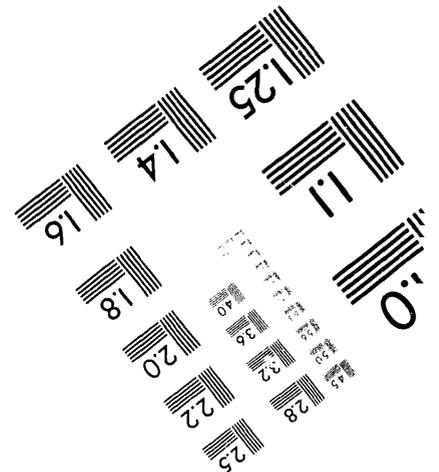
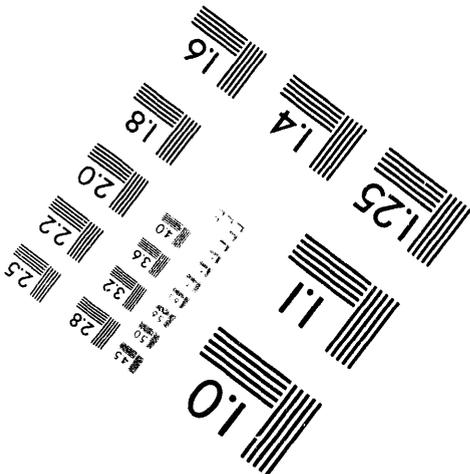
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Test Plan for the sOILS Facility Demonstration—Petroleum Contaminated Soil Bioremediation Facility^(U)

Prepared by:

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Environmental Sciences Section
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Project S-4946

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Prepared for the U.S. Department of Energy under contract no. DE-AC09-89SR18035

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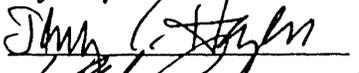
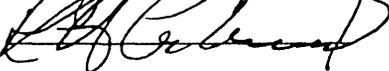
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Derivative Classifier

Test Plan for the Soils Facility Demonstration—A Petroleum Contaminated Soil Bioremediation Facility^(U)

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Prepared for the U.S. Department of Energy under contract no. DE-AC09-89SR18035

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1.0 Test Plan Summary

The amount of petroleum contaminated soil (PCS) at the Savannah River Site (SRS) that has been identified, excavated, and is currently in storage has increased several fold during the last few years. Several factors have contributed to this problem:

- South Carolina Department of Health and Environmental Control (SCDHEC) lowered the sanitary landfill maximum concentration for total petroleum hydrocarbons (TPH) in the soil from 500 to 100 ppm.
- SCDHEC mandated removal and replacement of underground storage tanks at several sites.
- SCDHEC disallowed aeration to treat contaminated soil.
- Several large contaminated areas of soil associated with leaking underground storage tanks, leaking pipes, disposal areas, and spills were discovered.

Because of the factors listed above, SRS urgently needs to remediate large quantities of petroleum contaminated soil that is currently stockpiled. Accidental spills are likely to be a long-term source of new PCS. As long as petroleum-based products are used at the Site, we will generate contaminated soil that will require remediation.

The sOILS Facility is the location where PCS will be remediated. This facility is a concrete structure 400 feet long and 40 feet wide and divided into four cells 200 feet long and 20 feet wide. The bases slope to a leachate control system and any water collected is reapplied via sprinklers. The leachate collection system is designed to hold a catastrophic 25-year rainfall event. A base of clean soil

will be applied to a depth of 6-9 inches to provide good soil drainage. Contaminated soil will be applied on the drainage bed 6-12 inches deep. The soil will be kept moist but not damp and aerated via roto-tilling once a week. The design uses existing site equipment, such as trucks and graders, to transport, apply, and distribute the soil. Monthly analyses will consist of inorganic nutrients, pH, and microbes. Weekly measurements for volatile organic compounds (VOCs) in the air and moisture will be taken from random parts of the system to ensure that volatilization and particulate emissions are below annual air emission limits. Once demonstrated to be below 100 ppm TPH and 10 ppm benzene, ethyl benzene, toluene, and xylenes (BTEX) treated soil will be removed to a sanitary landfill. The facility should be able to treat 900 yd³ of contaminated soils every 6-12 weeks, depending on the concentration level of PCS and weather. Thus, 3000-8000 yd³ of soil can be processed every year. The facility is permitted by SCDHEC via the Soil Correction Action Plan (sCAP) and an air permit waiver, based on the air emissions calculations found in the sCAP.

The facility has no precedence in South Carolina or Georgia and as such represents new technology for the area. However, since several other states have demonstrated similar facilities, the sOILS Facility represents low risk and should receive high public acceptance. The facility will also provide South Carolina with the opportunity to demonstrate and evaluate an innovative, environmentally sound, remediation technique onsite that can be used to handle fuel spill cleanup and the growing leaking underground storage tank (LUST) problem. The system demonstration and optimization is expected to last approximately two years, at which time, Central Services Works Engineering (CSWE) will continue to operate the facility as the PCS treatment center onsite.

2.0 Test Plan Objective

The objectives of this test plan are to show the value added by using bioremediation as an effective and environmentally sound method to remediate PCS by:

- demonstrating bioremediation as a permanent method for remediating soils contaminated with petroleum products
- establishing the best operating conditions for maximizing bioremediation and minimizing volatilization for SRS PCS during different seasons
- determining the minimum set of analyses and sampling frequency to allow efficient and cost-effective operation
- determining best use of existing site equipment and personnel to optimize facility operations and conserve SRS resources
- as an ancillary objective, demonstrating and optimizing new and innovative analytical techniques that will lower cost, decrease time, and decrease secondary waste streams for required PCS assays.

3.0 Site Background and Chronology

In 1982, Watts and Corey demonstrated at SRS that waste oils could be spread over the surface and tilled with fertilizer as a waste treatment technique. This study demonstrated that surface soils at SRS have the indigenous microbes necessary for petroleum hydrocarbon degradation and that their activity could be enhanced by simple inorganic fertilizers. More recent work by Hazen and Bledsoe (WSRC 1990) has further demonstrated that soil contaminated with diesel fuel from a leaking underground storage tank has hydrocarbonclastic microbes that can be enhanced by aeration and inorganic nutrient supplementation. Thus, the biological feasibility of the technology for SRS has been demonstrated.

The concept of using bioremediation to cleanup PCS was presented to the Westinghouse Savannah River Company (WSRC) Board of Directors in June 1990. SRS formed a committee of members with PCS problems, the site's regulatory personnel, and technical experts from Waste Management, Savannah River Technology Center (formerly the Savannah River Laboratory), the Environmental Protection Department (EPD) and Bechtel Savannah River, Inc. (BSRI) Construction Management Environmental Group. With WSRC Board approval, EPD, assisted by the committee, briefed SCDHEC on developing the technology for a bioremediation facility to treat PCS. On October 15, 1990, SCDHEC responded to SRS approving the technology for development in the State of South Carolina. After evaluating cost, effectiveness, and permitability of several remediation options, a prepared bed bioremediation facility was chosen as the most attractive. On December 6, 1990, the committee made a formal proposal to SCDHEC to construct a soils bioremediation facility at SRS. Between December 1990 and December 1991, SCDHEC and WSRC resolved fugitive air emissions and treatment level issues. The final guidance document submitted on August 13, 1992, to SCDHEC was the sCAP, which received SCDHEC approval on September 9, 1992.

Concurrent with preparing the sCAP, the Site permitting process began. In January 1992, National Environmental Policy Act (NEPA) documentation was submitted to DOE/SR and Categorical Exclusion SR-CX-9202001 was issued by DOE/SR on January 26, 1992. Site Use and Site Clearance documents were submitted for approval, but because of the proposed location was already a construction laydown and mobilization area, a Site Use permit

would not be required. The Site Clearance permit was approved on March 5, 1992, for the D-Area location shown in Figure 3.6.2. In May 1992, based on the conceptual BSRI/CSWE proposed design (see Appendix A), the SRTC Laboratory Site Services Engineering Group began the facility design and preliminary process hazards review (PPHR). The final design was completed by BSRI-Design Engineering in August and funding was approved as Capital Project S-4946 by DOE/SR in November 1992. Based on the sCAP emissions calculations, SCDHEC issued an air permit exemption on January 15, 1993, completing the regulatory permitting process. A Notice of Authorization was issued to BSRI-Construction Management on February 10, 1993, and pre-construction activities began on February 18, 1993. Excavation and other major construction activities began in late March, with concrete placement starting in mid May and continuing through mid September. Final electrical and mechanical work was complete in early October and the system was accepted by SRTC on January 10, 1994.

The petroleum contaminated soil stored at SRS is estimated to be 7000 yd³ with 1000 yd³ of new material expected per year. The existing contaminated soil came from oil spill cleanups (4000 yd³) and underground tank excavations (3000 yd³) and is stockpiled and/or stored in containers. Contaminated soil that is stockpiled is covered with an impervious material (e.g., plastic sheeting) and bermed to prevent or minimize erosion. Samples taken from stockpiled and containerized materials show a total petroleum hydrocarbon (TPH) median range of 189 to 6340 ppm and benzene at 0.6 to 15 ppm. Analytical data for the different types of contaminated soil are summarized in Table 4.3.1. Several samples were subjected to the toxicity characteristic leaching procedure (TCLP) test and were determined to be below the TCLP limits and therefore not hazardous. SRS plans to test contaminated soils from waste oil spills using TCLP procedure to ascertain they are not hazardous. Process knowledge or Material Safety Data Sheets are also acceptable methods for determining the hazard class of the contaminant. The SOILS Facility will not generate, treat, or process hazardous waste.

While the technology has not been used at SRS or in South Carolina, the facility uses technology that has been proven in other states. This technology should represent a substantial cost savings over conventional remediation methods (e.g., incineration). Site-specific data for this approach came from a bioremediation feasibility study done at the N-Area (Central Shops) Bulk Fuels Storage Facility.

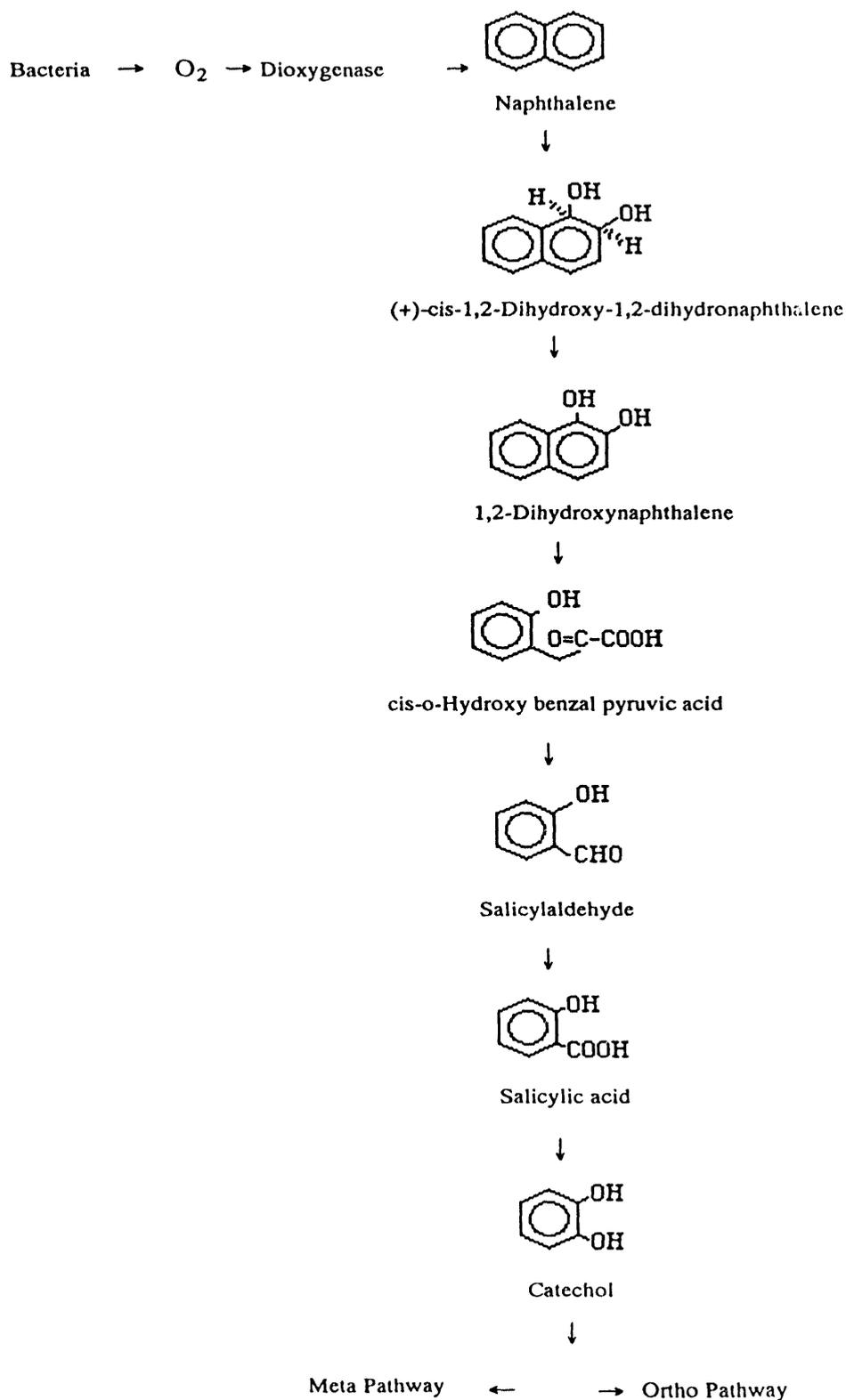


Figure 3.2 Bacterial Oxidation Pathway of Naphthalene to Catechol

large volume of contaminants at many of these sites, a considerable amount of time and money will be required to complete the mandated cleanup. Thus, another priority stemming from this cleanup program is to develop and demonstrate new and innovative technologies that may decrease costs, time, and environmental impact and/or result in a cleaner end point.

The site for the sOILS Facility is near Building 402-D in D Area, approximately two miles from the Savannah River. The site and general vicinity are not located on a flood plain and every effort will be made to contain and control a catastrophic 25-year rainfall event. A site map, Figure 3.6.1, is attached for orientation.

A map of D Area and vicinity, Figure 3.6.2, shows the location of wells DWW1 and DWW2, which are now completed and developed. These wells are more than 1000 feet from the site and are not expected to be affected. Both DWW1 and DWW2 are screened from 620 to 680 feet below ground level and are therefore in the Cretaceous. Because this aquifer is confined and is below Ellenton, which has a reverse head (upward flow when penetrated), it would be physically impossible for a released material from the proposed facility to affect the quality of water in these wells. Figure 3.6.2 also shows the site location, local facilities, infrastructure, and transportation routes.

3.6.1 D-Area Hydrogeology

The sOILS Facility is located within 3000 feet of the D-Area Coal Pile Runoff Basin (CPRB). The D-Area CPRB is underlain by stream terrace deposits of the Savannah River (O'Brien and Gere 1987). These deposits consist predominantly of unconsolidated silt, sand, and clay with

minor gravel. A clay zone lies just below the average water table depth; however, the confining characteristics, if any, are unknown. The average depth to the water table is approximately 10 feet with a range between 5 and 20 feet. Since monitoring began in 1982, water table levels have remained relatively constant compared to the other CPRBs. The water table at this time had a gradient of approximately 50 feet/mile to the southwest. Based on the water table contours, D Area lies on a groundwater divide. Flow in the vicinity of D Area is to the west and southeast, perpendicular to the trend of the divide.

In the immediate vicinity of the D-Area CPRB, the groundwater table mounding with historical groundwater flow to the west-southwest. No significant flow variations over time have occurred. Well responses to recharging and discharging aquifer conditions, shown in the DCB-series hydrographs, have been consistent among the wells with little variance over time. The subdued well responses and lack of significant impacts of the D-Area CPRB on these wells may reflect that the Savannah River exerts a principal controlling influence on the water table in D Area. The Savannah River is a major groundwater sink with the SRS region.

Any potential contaminants from the D-Area CPRB that intercept the water table are likely to initially migrate in a general southwest direction. Since D Area is on a groundwater divide, contaminant migration, after the initial southwest trend, would be expected to follow flow patterns noted for the D-Area vicinity. Contaminants, therefore, would likely be discharged along with groundwater to swamps west of the basin and southeast along Four Mile Branch and ultimately to the Savannah River.

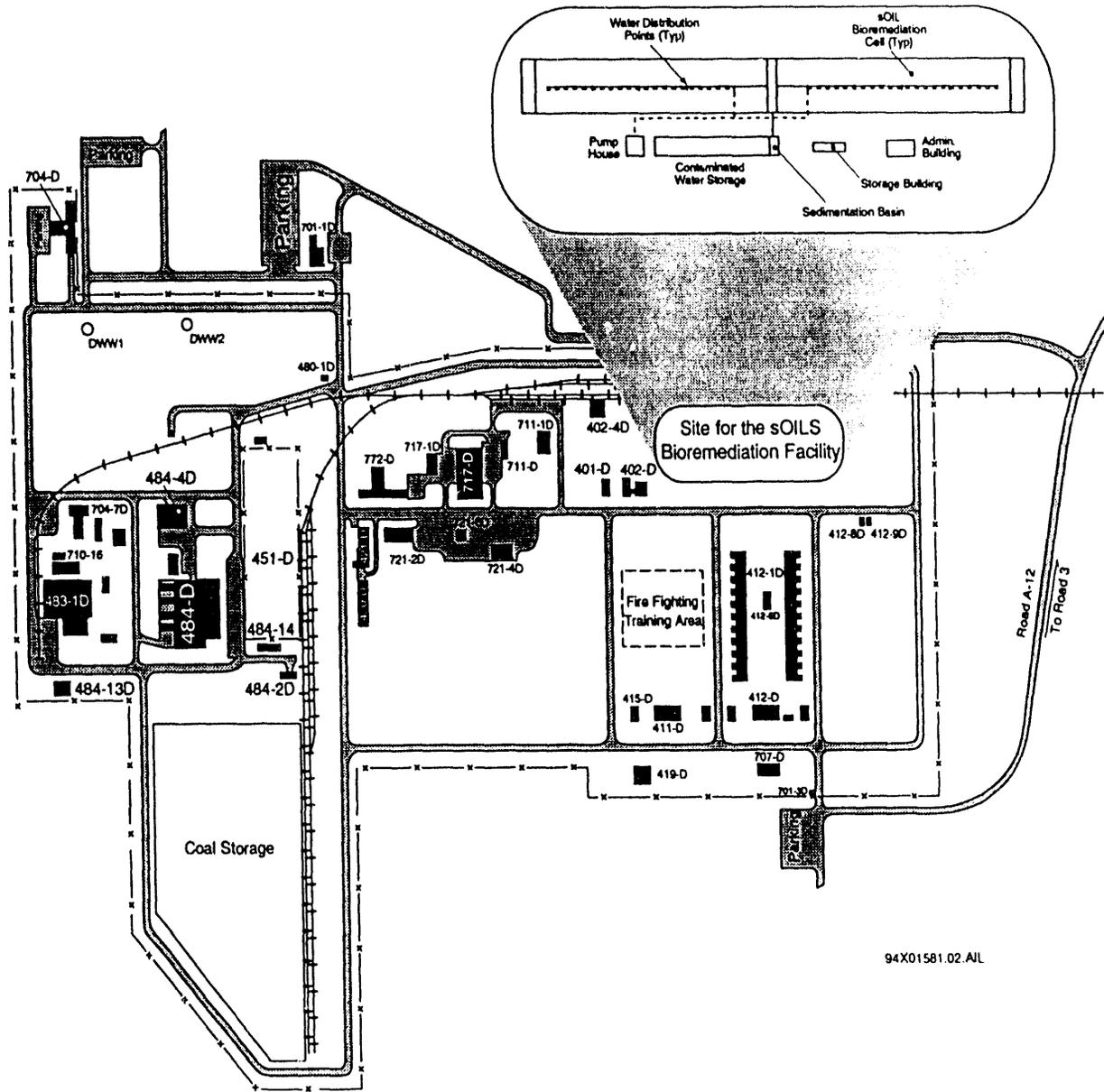


Figure 3.6.2. D Area and Vicinity

4.0 Test Plan

4.1 Criteria for Success

There are three primary criteria by which the overall success of this demonstration will be evaluated:

1. Evidence of biological destruction (biodegradation) of petroleum (TPH and BTEX) from the contaminated soils. Since a major advantage of bioremediation is destruction, it is important and significant to demonstrate that biodegradation is occurring. The evidence is to come from comparing soils analysis taken before and after the PCS is treated (nutrient addition, aeration, pH adjustment, and moisture control) to stimulate biodegradation.
2. Relatively simple and trouble-free operation. A critical assumption for successfully demonstrating the facility is that the system, as designed, will function with little or no down time and provide operating conditions that minimize fugitive air emissions and maximize biodegradation rates. Low risk can and has been demonstrated. The proposed facility has no precedence in South Carolina or Georgia and as such represents new technology for the area. However, since several other states have demonstrated similar facilities, it represents low risk and should receive high public acceptance. The simplistic design contributes direct benefits associated with the ease of management and operation. A minimal staff would be required to operate the facility again adding to the low-risk factor by limiting exposure to operations personnel.

3. Demonstration of ELISA or enzyme-linked immunosorbent assay (immunoassay) as an effective method for screening TPH and BTEX. Using these assays for interim screening required during the treatment process will significantly reduce cost and a secondary waste stream normally generated from other analytical methods (freon extraction) used for PCS assays. Minimizing the number of sets of analyses will also reduce field and analytical time, adding to the cost-effective and efficient operation of the facility.

4.2 Groundwater Protection Program

The SOILS Facility has concrete floors and a storm water drainage containment system. Contaminated rainwater will be collected into a leachate collection tank to be reapplied to cells for moisture adjustment. Because of the unlikely possibility of contamination of groundwater from the bioremediation facility, there are no plans to install monitoring wells around the facility.

4.3 Air Emissions

Stockpiled or containerized contaminated soil will be transported into the bioremediation site to be placed directly into cells, 9-12 inches deep, 20 feet wide, and 400 feet long. Fugitive dust will be emitted from unloading (placing into cells) and loading (removal of treated soil to the landfill) operations. Another emission source is from volatilization of organic constituents (i.e., TPH and BTEX) from contaminated soil during soil turnover or tilling operation. Fugitive dust and volatile organic emissions have been calculated using the U.S. Environmental Protection Agency (USEPA), recommended AP-42 formula (USEPA 1985), and have been determined to be 397.1 lb/mo TPM and 288.1 lb/mo VOC using the highest median value (i.e., 6.34 K ppm TPH) presented in Table 4.3.1. In order to remain in

Table 4.3.1. Petroleum Contaminated Soil (PCS) Analysis

Source	yd ³	TPH	Benzene	Toluene	Ethyl Benzene	Xylene
Spill	3,000	144-719,000 (6.34000)	0.5-15 (11)	0.5-160 (11)	0.5-18 (11)	1-118 (22)
Spill	2,000	16,000- 654,500 (189)	0.01-250 (15)	0.01-410 (0.8)	0.01-1400 (0.8)	0.02-41000 (1)
UST	2,000	210-880 (551)	0.02-40 (0.6)	0.02-77 (10)	0.02-19 (9)	0.02-111 (34)

Note: Values in parenthesis represent median (PPM).

4.4 Air Dispersion Modeling

The operations of the sOILS Facility will result in airborne emissions of particulates, VOC/TPH, and the air toxics benzene, toluene, ethyl benzene and xylenes. The toxics are regulated emissions under SCDHEC, Air Pollution Regulation 62.5, Standard 8, Toxic Air Pollutants (1991). Both median and worst-case data for emissions of particulates and toxics were modeled using initial values from the Bureau of Air Quality Control Modeling Toxics Questionnaire (Appendix B).

Using the median estimates, the maximum 24-hour average concentrations of air toxics at the site boundary were found to be near zero (Stewart 1992). The characteristics of the source and the emission rates, in lb/hr, of each pollutant are shown in Tables 4.4.1 and 4.4.2, respectively.

Table 4.4.1. Source Characteristics Input to Industrial Source Complex Screening Technique Model

Release Height	1.0 ft
Exit Temperature	64°F (ambient)
Surface Area	16,000 ft ²

Source: SRT-ETS-920 419; Stewart

The format used for the air dispersion modeling of the sOILS Facility was developed by the USEPA (1987). The Industrial Source Complex Screening Technique is approved by SCDHEC for use in supporting air permit applications. The maximum concentration value for VOC/TPH were calculated using emission estimates of 45.4 lb/hr. The maximum site boundary concentrations of particulates and the worst-case emissions of VOC/TPH shown in Table 4.4.2 are considerably below applicable ambient standards set by the state of South Carolina.

Table 4.4.2. "Worst Case" Maximum Concentration in µg/m³ at Site Boundary

Pollutant	Lb/hour	1-hour Average	24-hour Average	Standard
Particulates	0.550	7.29	2.92	260.00
VOC/TPH	45.400	601.83	240.73	none
Benzene	0.016	0.22	0.09	150.00
Toluene	0.026	0.34	0.14	2000.00
Ethyl Benzene	0.090	1.17	0.47	4350.00
Xylene(s)	2.600	34.47	13.79	4350.00

Source: SRT-ETS-920 419; Stewart

4.5 Facility Design and Construction

The facility design consists of a reinforced concrete floor 400 feet long and 40 feet wide. This base is divided into four cells 200 feet long and 20 feet wide. The bases slope to the center where a leachate control system collects any water in a reinforced concrete holding tank that can reapply any leachate or rainwater via a pumping system powered by a Burks model SWT5, 1/2-horsepower self-priming centrifugal-type pump connected to a sprinkler system with distribution heads mounted on the center wall. The sprinkler heads are designed to provide water to each cell or to the entire unit as needed. The leachate collection system is designed to hold water from a catastrophic 25-year rainfall event. Each cell is equipped with a full-size, dark-brown, ultraviolet light-resistant tarp to act as a watershed and heat sink during cold weather operation. The tarps made of light weight, high-strength, tear resistant material and can be easily removed for roto-tilling or quickly installed by one person in the case of heavy rain. A base of clean soil will be applied to a depth of 6-9 inches to provide good soil drainage. The contaminated soil will be applied to the top surface of the drainage bed to a depth of 6-12 inches. The design loading requirements consider using existing site equipment (e.g., special trucks and graders) to transport, apply, and distribute the soil in the facility. Each cell is open on the end easy access by large vehicles. The facility will be able to treat approximately 900 yd³ of contaminated soils every 6-12 weeks, depending on the concentration level of the PCS, ambient temperature, and weather conditions. Thus, 3000 - 8000 yd³ of soil could be processed every year. Although relatively simplistic, the design provides good environmental control and operating conditions that minimize fugitive air emissions and maximize biodegradation rates. The as-built design drawings listed in Table 4.5.1 are available in the SRS document control center at Central Shops.

Table 4.5.1. Controlled Design Drawings of the sOILS Facility

Drawing Number	Description
C-CT-D-0001	Site Plan
C-CC-D-0089	Concrete Details
C-CC-D-0090	Concrete Details
P-PA-D-0031	Piping Plan and Details
E-E9-D-0112	Electrical

CSWE personnel will remove the remediated soil. The final concentration of the soil will dictate the final disposition of the material or its disposal location. Soils with TPH and/or BTEX below detectable levels (< 1 ppm) may be used as erosion control material or road base material. Other soil (i.e., above detection but below clean-up criteria) will be removed to a sanitary landfill per SCDHEC mandate.

4.7 Sampling and Analysis

Initial sampling and analysis of the soil put into the facility will consist of three random samples per cell for inorganic nutrients (nitrogen/nitrates, sulfates, phosphorus/phosphate), pH, contaminants, TPH, BTEX, heavy metals, polycyclic aromatic hydrocarbons (PAH), moisture, and microbes (direct counts and viable counts and enrichments). Fertilizer may be applied if necessary depending on the results of the inorganic nutrient analysis. Monthly (weekly if necessary) random samples will be taken from each of the four cells to determine if cleanup criteria has been met and/or if additional nutrients are necessary.

4.7.1 Sampling Protocol

The primary goal of the sampling activity will be to obtain an unbiased statistical estimate of the mean TPH and/or BTEX concentration within the treatment cell(s). As discussed above, simple random samples will be taken for analysis for the parameters shown in Table 4.7.1.1 after the contaminated soil is applied to a cell. Random samples will be taken monthly to monitor the soil biodegradation rate. Sampling and analysis will be performed using EPA protocols (i.e., SW 846, Third Edition, 1986). Required holding times for soil samples can be seen in Table 4.7.1.2.

Table 4.7.1.1 Frequency Parameters for Soil Samples

	Initial	Monthly	Weekly	Final
Organics				
TPH	Y	Y	as needed	Y
BTEX	Y	Y	as needed	Y
PAH	Y	as needed	as needed	as needed
Inorganics				
N	Y	Y	-	-
P	Y	Y	-	-
Moisture	Y	Y	Y	-
pH	Y	Y	Y	-
Metals	Y	-	-	-
Microbes	Y	Y	-	-

Tables of uniformly distributed random x, y, and depth coordinates will be used to establish sampling locations and depths. These tables will be generated using a computer software random number generator. The coordinates represent the distance in feet from the origin of each axis. Depth values represent the distance below the surface in inches. The range of values are based on the size of the cell and the extent of the distribution of contaminated material within the cell. Using the SRS coordinate grid system, the orientation of the x and y axis will be north/south and east/west respectively, with the northerly and easterly directions from the origins being positive. Each cell has been assigned an alpha-numeric designator, the northeast cell being "A", southeast "B", southwest "C", and northwest "D". The center wall that forms the cells is numbered 1 through 40 in an easterly and westerly direction from the point of origin. The end of each cell will be numbered 1 through 4 forming sample plots that are five square feet in size in each cell.

4.7.2 Analytical Procedures

The EPA 8000 series analytical procedures found in Table 4.7.1.2 will be used to analyze PCS samples. The use of these methods is now nearly universal in public and private sector laboratories. Each of these methods has an associated list of target compounds for which it was specifically developed and evaluated. These methods use gas chromatography (GC) and mass spectrometers (MS) or a combination of both GC/MS techniques to detect organic compounds. These instruments are well known for their excellent sensitivity and selectivity for specific target compounds.

Table 4.7.1.2 Soil Sample Holding Times

Contaminant	Holding Time
Benzene, toluene, ethylbenzene, xylenes	Analyze as soon as possible (maximum 14 days)
Total petroleum hydrocarbon (low to medium bp fuels)	Analyze as soon as possible (maximum 14 days)
Total petroleum hydrocarbon (high bp fuels)	Extract within 14 days
Polycyclic aromatic hydrocarbons (PAH) (including naphthalene)	Analyze within 40 days
Mercury	28 days ¹
Metals (except mercury)	6 months ¹

¹ Soil samples must be at least 200 g and usually required no preservation other than storing at 4°C until analyzed.

Table 4.7.2.2 Sensitivity and Specificity of Immunoassay Test Kits

Test Kit/Specificity	Sensitivity ppm	Comments
DTech™/BTEX	Low <2.5	Not quantifiable without their detector; uses color card comparisons
Millipore™/TPH	Gasoline Low = <7/Hi = >485 Diesel Low = <4/Hi = >592	Quantifiable, but only by converting from home heating oil equivalents
Quantix™/BTEX	Low* = 3.5 Hi = 940 Low* = 0.7 Hi = 140	Quantifiable, but only with their quantimeter, which has two ranges for readings. Technician must assume whether to use Low or Hi range calcurve. The procedure is not user friendly.
Ensys™/TPH	Gasoline Low* = 10 Diesel Low* = 15	

*Vendor supplied specification may vary pending test results

found in SRTC laboratory notebooks number WSRC-NB-90-357, p. 126, and WSRC-NB-93-321, pp. 29-34 and 39-44.

4.7.3 Microbiological Procedures

Three microbiological analyses will be done on a monthly basis. The soil samples from the facility will be collected and processed on the same day the sampling was done. The first test will give total direct cell counts in the soil, using an acridine orange stain for bacterial nucleic acids. This test will provide a total bacterial cell count, expressed in cells per gram dry weight. The second analysis to be performed is viable counts that will give the total number of organisms that can be cultured on an oligotrophic media. This number is expressed in colony-forming units per gram dry weight. The third analysis is an enrichment for TPH. Bacteria will be grown on minimal salts media with trace metals and no available carbon source.

Acridine Orange Direct Counts

The acridine orange direct counts (AODC) will provide a direct estimate of the total number of bacteria in the environment, regardless of ability to grow on any media that might be used. Samples are preserved in phosphate buffered formalin. Samples (1 to 3 grams) are extracted three times with a non-ionic homogenizing detergent to remove bacteria from the sediment particles. Homogenates are

cleared by low-speed centrifugation and the supernatants are pooled. Ten microliters of supernatant is spotted onto each well of a toxoplasmosis microscope slide, stained with 0.01% acridine orange, then rinsed with distilled water. The number of cells stained with acridine orange are counted by epifluorescence microscopy. The number of cells per sample is normalized by dividing by the dry weight of the sediment (ASTM 1987). Counts are reported as cells per gram (Sinclair and Ghiorse 1989).

Aerobic Heterotrophic Plate Count

This method will provide an estimate of the total number of viable aerobic and facultatively anaerobic bacteria in the groundwater. Low and high nutrient concentrations of a medium will be used to indicate differences in bacteria adapted to oligotrophic and eutrophic conditions. Samples (1 to 3 grams) are weighed directly into 15 ml conical centrifuge tubes containing 9 ml of pyrophosphate buffer. Subsequent serial dilutions are made in phosphate buffered saline. Exactly 0.1 ml of each appropriate dilution was inoculated onto a corresponding plate of appropriate medium. For this study, 1% peptone-trypticase-yeast extract-glucose (PTYG) is used (Balkwill 1989). Plates are incubated at room temperature for at least two weeks before to counting. Bacterial colonies are counted using low-power magnification. Counts are normalized to sediment dry weights and reported as colony-forming units (CFU) per gram.

5.0 Safety, Quality Assurance, and Security

5.1 Safety

The chemical hazards and health risks associated with PCS are very low, based on the concentration levels of TPH and BTEX seen in the soil analyses taken from site samples. To reduce the possibility of exposure, work gloves (rubber gloves during sampling) and boots with shoe covers should be worn while working in the SOILS Facility. The majority of the work performed in the facility is done with enclosed cab heavy equipment, therefore workers will be protected from potential air emissions. A weekly air emissions inventory will be taken for the first six months of operations to establish a baseline and assure compliance with South Carolina emissions standards.

5.1.1 Savannah River Site

General safety rules for the Savannah River Site are documented in the Savannah River Site (SRS) Safety Manual (8Q) and in DOE Order 5483.1A.

5.1.2 Savannah River Technology Center

Savannah River Technology Center Safety Practices and Procedures Manual (8Q8) documents safety procedures for all activities for SRTC employees, SRTC visitors, and vendors/subcontractors.

5.1.3 Screening Process Hazards Review

As defined in Savannah River Site (SRS) Safety Manual (8Q) in Procedure 10-1, a screening process hazards review was performed onsite with cognizant functional personnel and completed August 20, 1992. The Screening Process Hazards Review Report and a review of the design output document did not identify any potential hazards. Thus, in accordance with Section 5.1.1.1 of procedure DE-DP-300, a Design Process Hazard Review is not required.

5.1.4 Other Safety Information

Other sources of safety information include: NIOSH Pocket Guide to Chemical Hazards, publication No. 90-117, Federal Motor Carrier Safety Regulations Pocket-book, and WSRC Safety Guidelines for Subcontractors.

5.2 Quality Assurance and Quality Control

All activities at SRS are governed by WSRC Quality Assurance Program as outlined in WSRC Management Policies, WSRC-1-01, MP 4.2. Specific quality assurance procedures are documented by organization as required. A task technical plan (QA record) has been produced to document the record keeping and procedural documentation required for each task in this test plan.

5.2.1 Westinghouse Savannah River Company

WSRC quality assurance is documented in WSRC Quality Assurance Manual (1Q).

5.2.2 Waste Management and Environmental Technology Department

Quality assurance implementation procedures for the WM&ET Department are documented in WM&ET Quality Assurance Implementation Procedures (1Q31).

5.2.3 Environmental Sciences Section

Quality assurance procedures for the section are found in ESS Quality Assurance Implementation Procedures (1Q31-1). Operating procedures for the section are documented in ESS Operating Procedures Manual (WSRC-L-14-1).

5.3 Security

WSRC security requirements and procedures are documented in the WSRC Security Manual (7Q). These procedures are as required by federal laws and applicable DOE orders (e.g., DOE Order 5631.1A).

6.0 Permits, Patents, and Authorizations

6.1 National Environmental Policy Act

In January of 1992, NEPA documentation was submitted to DOE/SR and Categorical Exclusion SR-CX-9202001 was issued by DOE/SR on January 26, 1992.

6.2 Air Permit from South Carolina Department of Health and Environmental Control

Based on the sCAP emissions calculations, SCDHEC issued an air permit exemption on January 15, 1992.

6.3 DOE/SRS Site Use and Site Clearance Permits

Site Use and Site Clearance documents were submitted for approval, because the proposed location was already a construction laydown and mobilization area, a Site Use permit would not be required. The Site Clearance Permit SC-3221 was approved on March 5, 1992.

6.4 Soils Corrective Action Plan

The final guidance document submitted on August 13, 1992, to SCDHEC was the Soils Corrective Action Plan (sCAP), which gained final SCDHEC approval on September 9, 1992.

6.5 Patents

The DOE Office of Patent Counsel prepared a preliminary patentability search report, File No. 93-1427/SRS-92-410/DOE Case No.: S-77,153, for the prepared bed bioreactor. Design patent references listed in Table 4.7.2.1 have been issued.

Table 6.5.1 Related Patent References

Parent	Date	Inventor	Search Class
5,134,078	07/92	Sieksmeyer, et al.	432/262
5,128,262	07/92	Lindoefer, et al.	435/262 XR
4,962,034	10/90	Kahan	435/262
4,871,673	10/89	Rehm, et al.	435.262
4,678,582	07/87	Lavigne	435/262 XR
4,584,102	04/89	Bogart, et al.	405/128 XR
4,447,541	05/84	Peterson	435/262

6.6 Notice of Authorization (Construction)

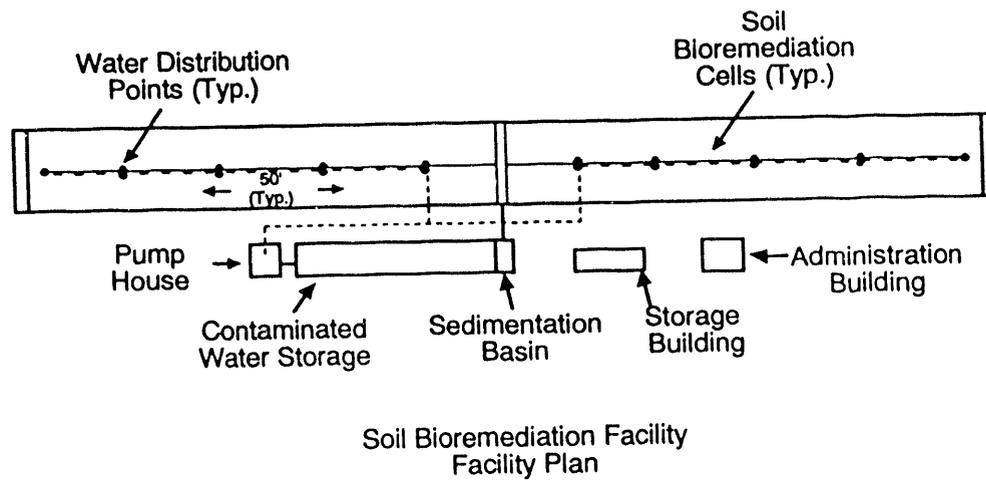
A Notice of Authorization to (FMS-FPC-93-0226) construct the facility was issued to BSRI Construction Management by SRTC on February 10, 1993.

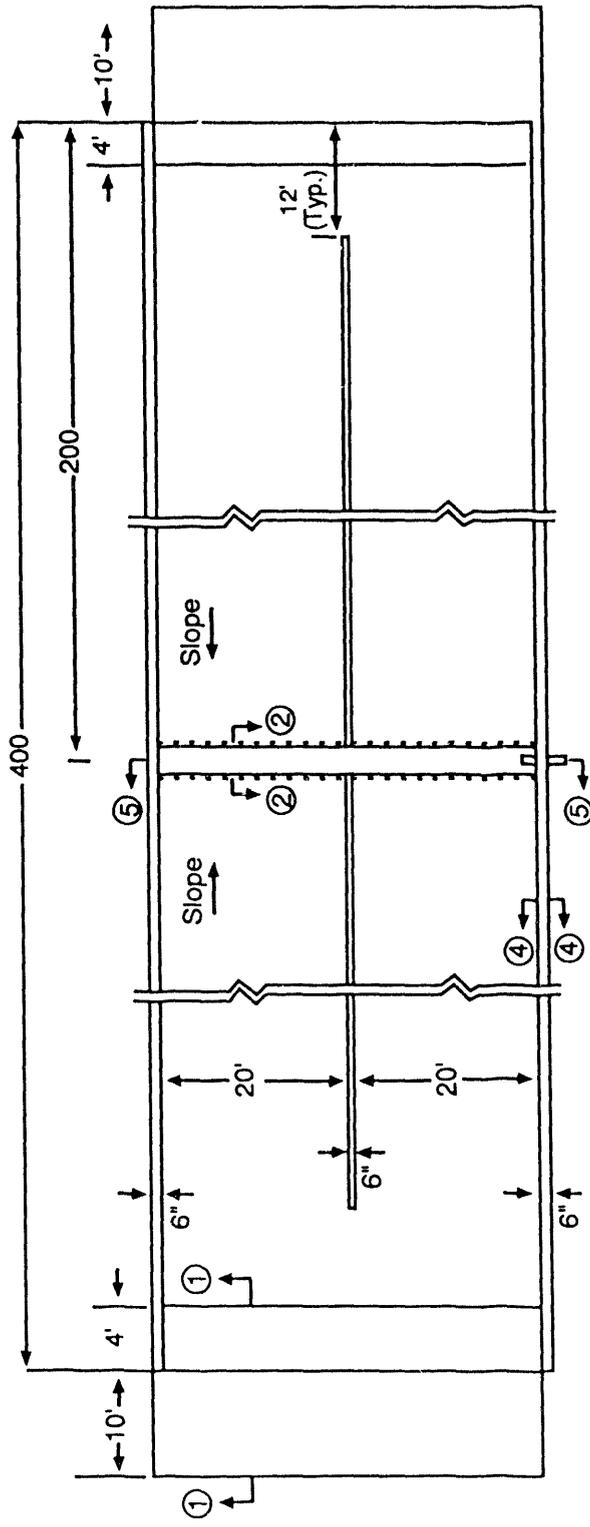
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Appendix A

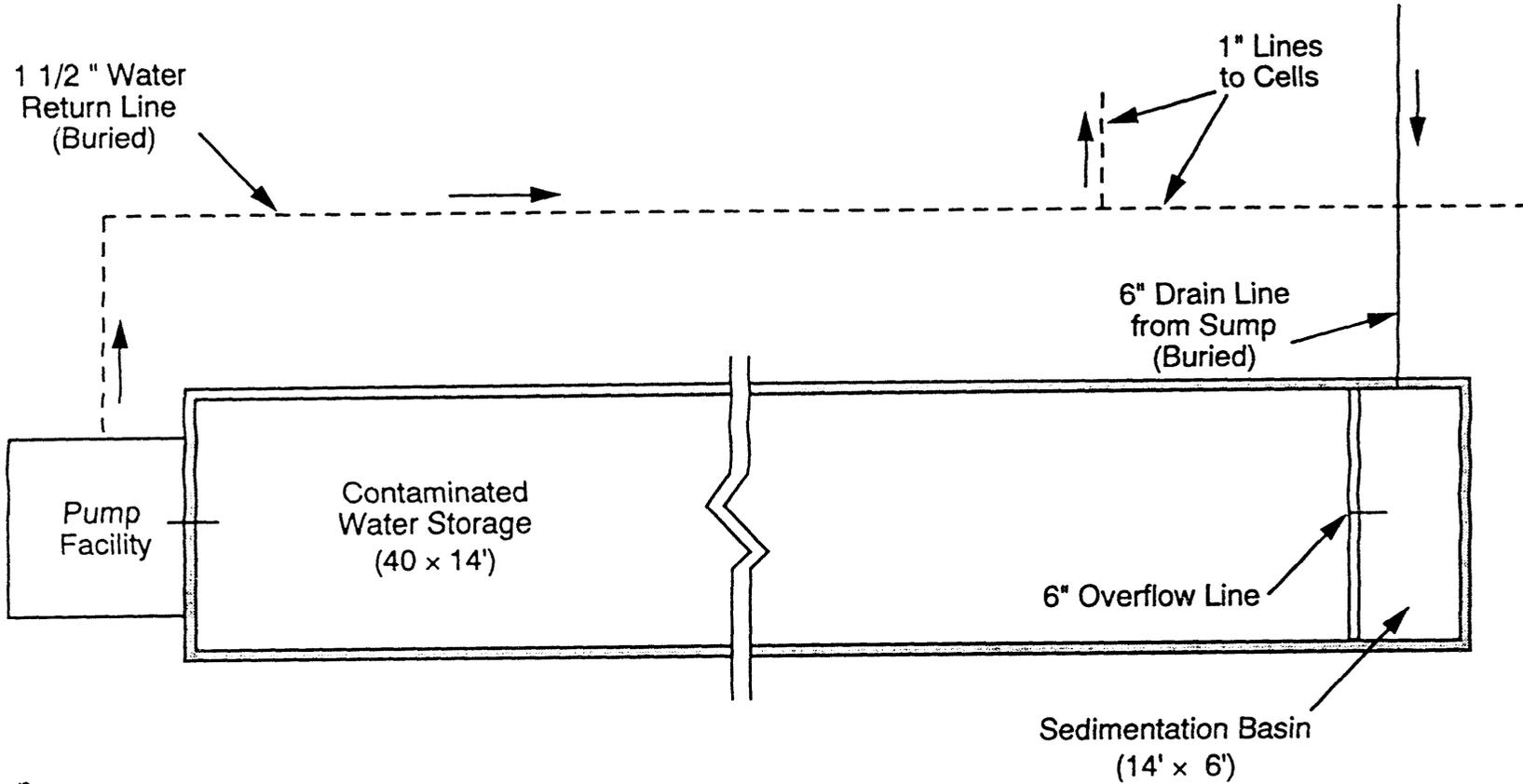
Conceptual Facility Design





Soil Bioremediation Facility
Double Unit - Plan View

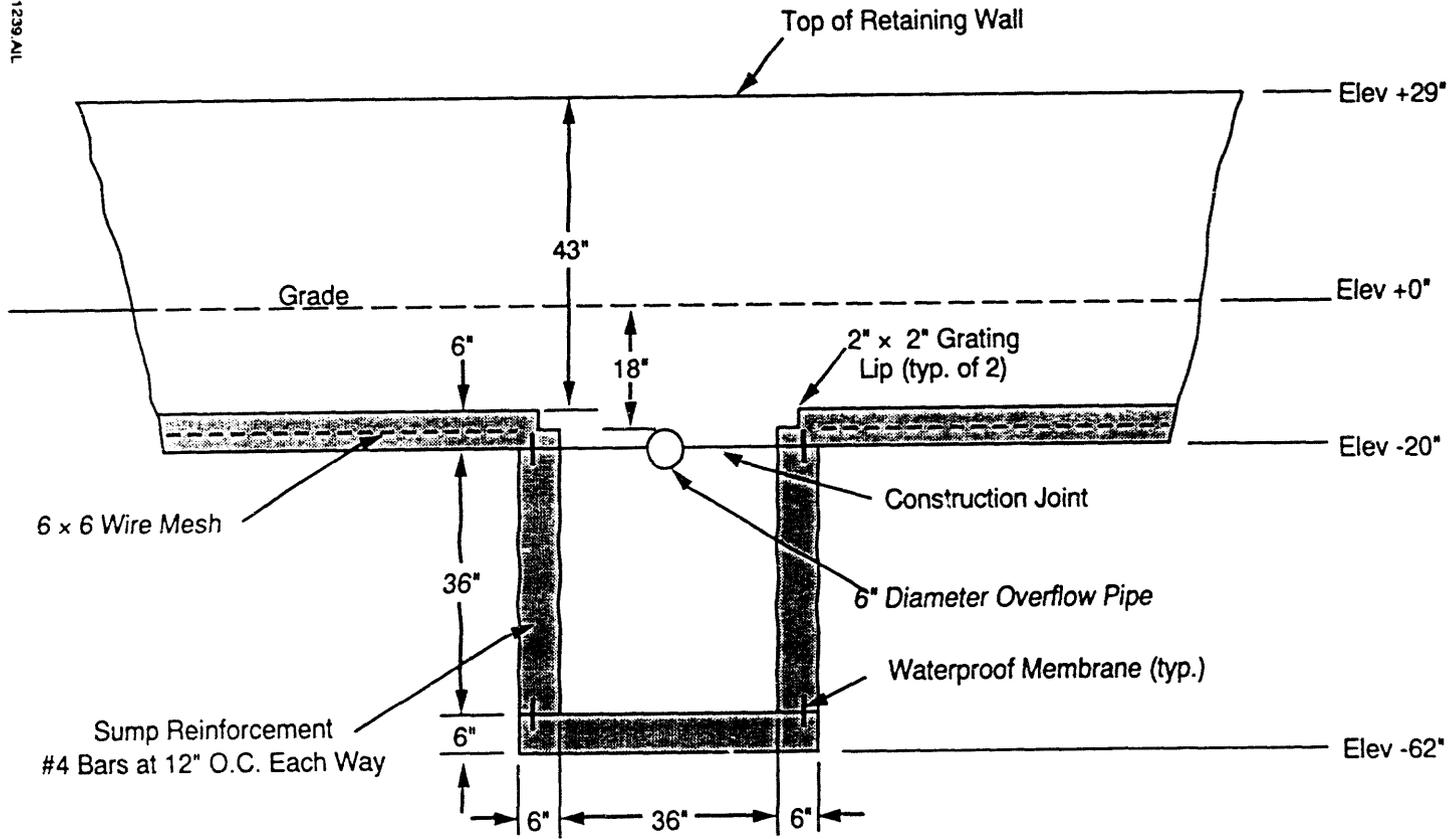
94X01239.AIL



94X01239 AIL

Soil Bioremediation Facility
Basins and Pump House

94X01239.A1L



Soil Bioremediation Facility
Section #2-Sump Details

**SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
BUREAU OF AIR QUALITY CONTROL
PART I PERMIT APPLICATION FORM**

PLEASE REFER TO INSTRUCTIONS ON BACK BEFORE COMPLETING THIS FORM

1. Air Permit Number for Existing Plant: 0 0 8 0 - 0 0 4 4
2. Company Name for Permit: U. S. Department of Energy, Savannah River Site
3. Mailing Address: Westinghouse Savannah River Company, Box 616
City: Aiken State: SC ZIP: 29808
4. Plant Location (Street or Highway): _____
City: Aiken County: Aiken
5. Person to Contact: M. D. Duke Phone #: (803) 225-2696
6. Standard Industrial Classification (SIC) Code for Plant: 2819
7. Attach the following applicable part(s) for each emission source:

Number Attached

- | | |
|--|----------|
| A. Fuel Burning Application (Part IIA): | <u>0</u> |
| B. Process Application (Part IIB): | <u>1</u> |
| C. Incinerator Application (Part IIC): | <u>0</u> |
| D. Asphalt Plant Application (Part IID): | <u>0</u> |

8. Proposed Construction Start Date: 30 days after Finish Date: 2 years
DHRC approval

9. Signatures:
I certify, to the best of my knowledge and belief, that no undesirable levels of air pollutants will be created and no applicable standards and/or regulations will be contravened or violated. I understand that any statements and/or descriptions which are found to be incorrect may result in the immediate revocation of any permit issued for this application.

Company Official Signature or Authorized Representative of Owner Title/Position Date

I have placed my signature and seal on the engineering documents submitted, signifying that I accept responsibility for the accuracy of this application as it pertains to DHRC Air Pollution Regulation 61-62.

John Arthur Duke 9504 10 NOV. 1992
Professional Engineer Signature S.C. Registration No. Date

If consultant or professional engineer that prepared this application, wants a copy of issued permit(s) please complete.

Name/Consulting Firm: _____
Address: _____ City: _____
State: _____ ZIP: _____ Phone #: _____

*****INCOMPLETE APPLICATIONS WILL BE RETURNED FOR ADDITIONAL INFORMATION*****

DHRC 1924 (Rev 8/91)

John Arthur Duke

BUREAU OF AIR QUALITY CONTROL MODELING / TOXICS QUESTIONNAIRE

Fill out a questionnaire for each stack which has air emissions other than steam, air, nitrogen, oxygen, carbon dioxide, or any physical combination of these.

COMPANY NAME U. S. Department of Energy, Savannah River Site
ADDRESS P. O. Box 616, Aiken, SC 29802
CONTACT PERSON M. D. Duke
PHONE NO. (803) 725-2696
STACK DESIGNATION (NAME) Petroleum Contaminated Soil Bioremediation Fac.
POLLUTANT / AIR TOXIC EMITTED Particulate Matter
CAS NO. (FOR AIR TOXICS ONLY) N/A
EMISSION RATE (lb/hr) 0.55
PROCESS NAME (IF APPLICABLE) Bioremediation of Contaminated Soil
BOILER HEAT INPUT (10⁶ BTU / hr) (IF APPLICABLE) N/A
FUELS(S) USED (IF APPLICABLE) N/A
STACK HEIGHT (ft) 1
UTM'S OR LATITUDE/LONGITUDE OF STACK 33.19945/81.75696
STACK DIAMETER (ft) N/A
STACK TEMPERATURE (deg. F) Ambient
STACK VELOCITY (ft/sec) 0.0325
DISTANCE FROM STACK TO NEAREST PLANT BOUNDARY (ft) 6600
BUILDING LENGTH¹ (ft) N/A
BUILDING WIDTH¹ (ft) N/A
BUILDING HEIGHT¹ (ft) N/A

1 - If there are several buildings near the stack, include a plot plan showing stack location as well as length, width and height of nearby buildings.

John Littlefield
6/10/92
9509

BUREAU OF AIR QUALITY CONTROL MODELING / TOXICS QUESTIONNAIRE

Fill out a questionnaire for each stack which has air emissions other than steam, air, nitrogen, oxygen, carbon dioxide, or any physical combination of these.

COMPANY NAME U. S. Department of Energy, Savannah River Site
ADDRESS P. O. Box 616, Aiken, SC 29802
CONTACT PERSON M. D. Dukes
PHONE NO. (803) 725-2696
STACK DESIGNATION (NAME) Petroleum Contaminated Soil Bioremediation Pac.
POLLUTANT / AIR TOXIC EMITTED Benzene
CAS NO. (FOR AIR TOXICS ONLY) 71432
EMISSION RATE (lb/hr) 0.016
PROCESS NAME (if applicable) Bioremediation of Contaminated Soil
BOILER HEAT INPUT (10⁶ BTU / hr) (if applicable) N/A
FUELS(S) USED (if applicable) N/A
STACK HEIGHT (ft) 1
UTM'S OR LATITUDE/LONGITUDE OF STACK 33.19945/81.75696
STACK DIAMETER (ft) N/A
STACK TEMPERATURE (deg. F) Ambient
STACK VELOCITY (ft/sec) 0.0325
DISTANCE FROM STACK TO NEAREST PLANT BOUNDARY (ft) 6600
BUILDING LENGTH¹ (ft) N/A
BUILDING WIDTH¹ (ft) N/A
BUILDING HEIGHT¹ (ft) N/A

1 - If there are several buildings near the stack, include a plot plan showing stack location as well as length, width and height of nearby buildings.

[Signature]
10/10/92
9509

BUREAU OF AIR QUALITY CONTROL MODELING / TOXICS QUESTIONNAIRE

Fill out a questionnaire for each stack which has air emissions other than steam, air, nitrogen, oxygen, carbon dioxide, or any physical combination of these.

COMPANY NAME U. S. Department of Energy, Savannah River Site
ADDRESS P. O. Box 616, Aiken, SC 29802
CONTACT PERSON M. D. Duke
PHONE NO. (803) 725-2696
STACK DESIGNATION (NAME) Petroleum Contaminated Soil Bioremediation Pac.
POLLUTANT / AIR TOXIC EMITTED Ethyl benzene
CAS NO. (FOR AIR TOXICS ONLY) 100414
EMISSION RATE (lb/hr) 0.088
PROCESS NAME (if applicable) Bioremediation of Contaminated Soil
BOILER HEAT INPUT (10⁶ BTU / hr) (if applicable) N/A
FUELS(S) USED (if applicable) N/A
STACK HEIGHT (ft) 1
UTM'S OR LATITUDE/LONGITUDE OF STACK 33.19945/81.75696
STACK DIAMETER (ft) N/A
STACK TEMPERATURE (deg. F) Ambient
STACK VELOCITY (ft/sec) 0.0325
DISTANCE FROM STACK TO NEAREST PLANT BOUNDARY (ft) 6600
BUILDING LENGTH¹ (ft) N/A
BUILDING WIDTH¹ (ft) N/A
BUILDING HEIGHT¹ (ft) N/A

1 - If there are several buildings near the stack, include a site plan showing stack location as well as length, width and height of nearby buildings.

John R. Duke

10/27/72
9501

Appendix C

Example of the Tracking and Inventory Database

An example of the tracking and inventory database.

Inventory of Petroleum Contaminated Soil				
Date Soil Received	Customer Department	Customer Name	Work Req. No.	Activity Code
Received by	Quantity Received (pounds)	Quantity Removed (pounds)	Quantity Remaining (pounds)	Additional Information
Date Shipped to Soils Facility	Date Removed from Soils Facility	Disposition	Location	

DATE

FILMED

9 / 7 / 94

END

