N60200.AR.000547
NAS CECIL FIELD, FL
5090.3a

TECHNICAL MEMORANDUM SUPPLEMENT FOR FREE PRODUCT REMOVAL AT NORTH FUEL FARM AREA NAS CECIL FIELD FL

1/23/1995

ABB ENVIRONMENTAL SERVICES INC

M E M O R A N D U M

TO: Bryan Kizer

FROM: John Kaiser, Task Order Manager
Mike Dunaway P.E., P.G.
Celora Jackson

DATE: January 23, 1995

SUBJECT: North Fuel Farm, Cecil Field

BACKGROUND

On December 8, 1994, a joint meeting including ABB Environmental Services, Inc. (ABB-ES), Bechtel Environmental Inc. (BEI), and the Base Closure Team (BCT) was conducted at Cecil Field. On that morning, ABB-ES, BEI, Groundwater Technology, Inc. (GTI) subcontractor to BEI, and Cecil Field personnel met to discuss the Technical Memorandum being presented and discussed later that day in the joint meeting. The Technical Memorandum addressed the first part of the Phase I approach to implementing remedial actions for cleanup of contamination at the North Fuel Farm (NFF), Naval Air Station (NAS), Cecil Field, Jacksonville, Florida. The final Phase will be the complete remediation of the North Fuel Farm area.

The Technical Memorandum submitted on December 8, 1994, fulfilled partial requirements of the Phase I, Remedial Action Initiatives. It is the task of ABB-ES to develop a Technical Memorandum that will address the complete concerns of the Phase I, Remedial Action Initiatives. This Technical Memorandum will address free product removal from the NFF and associated areas. The remedial action objective of this memorandum is to remove the free product from the aquifer to the extent practicable in accordance with Chapter 62-770.300(3), Florida Administrative Code (FAC).

During the 1991 and 1992 contamination assessment, free product was measured in seven of the twenty-six shallow monitoring wells installed at the site. Apparent thickness of free product in the monitoring wells measured during 1991 and 1992, was from 0.02-foot to 6.00-feet.

The apparent thickness of free product contained in each monitoring well was calculated by subtracting the depth to free product from the depth to groundwater. Apparent free product thickness in the monitoring wells measured in March 1994, was from 0.22-foot to 5.03-feet. A generalized contour map of apparent free product thickness based on measurements collected March 1994, is presented in Figure 1.

The apparent thickness of free product measured in the monitoring wells is affected by the seasonal rains that cause the groundwater table to fluctuate in

a range from 1 to 4 feet. The average groundwater elevation below the tank mound is from 77 to 78 feet mean sea level. A mounding effect in the groundwater below the tank farm induces migration of free product down the tank mound, radially in the west and south directions.

However, the empirical relationship that exists to convert the apparent thickness of free product measured in the monitoring wells to the true thickness of free product present in the subsurface formation, is typically one fourth of the apparent thickness of free product measured. A baildown test conducted by ABB-ES has determined that for this site the factor for converting apparent thickness of free product to true thickness of free product is one third.

Volume estimates of free product in the subsurface based on apparent thickness must also account for the porosity (or pore space) of the subsurface and the fraction of pore space that is occupied by free product (or percent saturation). Further, the volume of total recoverable free product is a fraction of the calculated volume. Free product adsorbed to soil may not be recovered by collection of free product floating on groundwater.

Based on the approximate extent of the free product plume, the estimated maximum volume of free product present is 87,000-gallons. This quantity is based on the apparent thickness of free product at the site. Since these calculations are all estimates, the actual conditions will be determined in the field. The free product volume calculations are included in Attachment A.

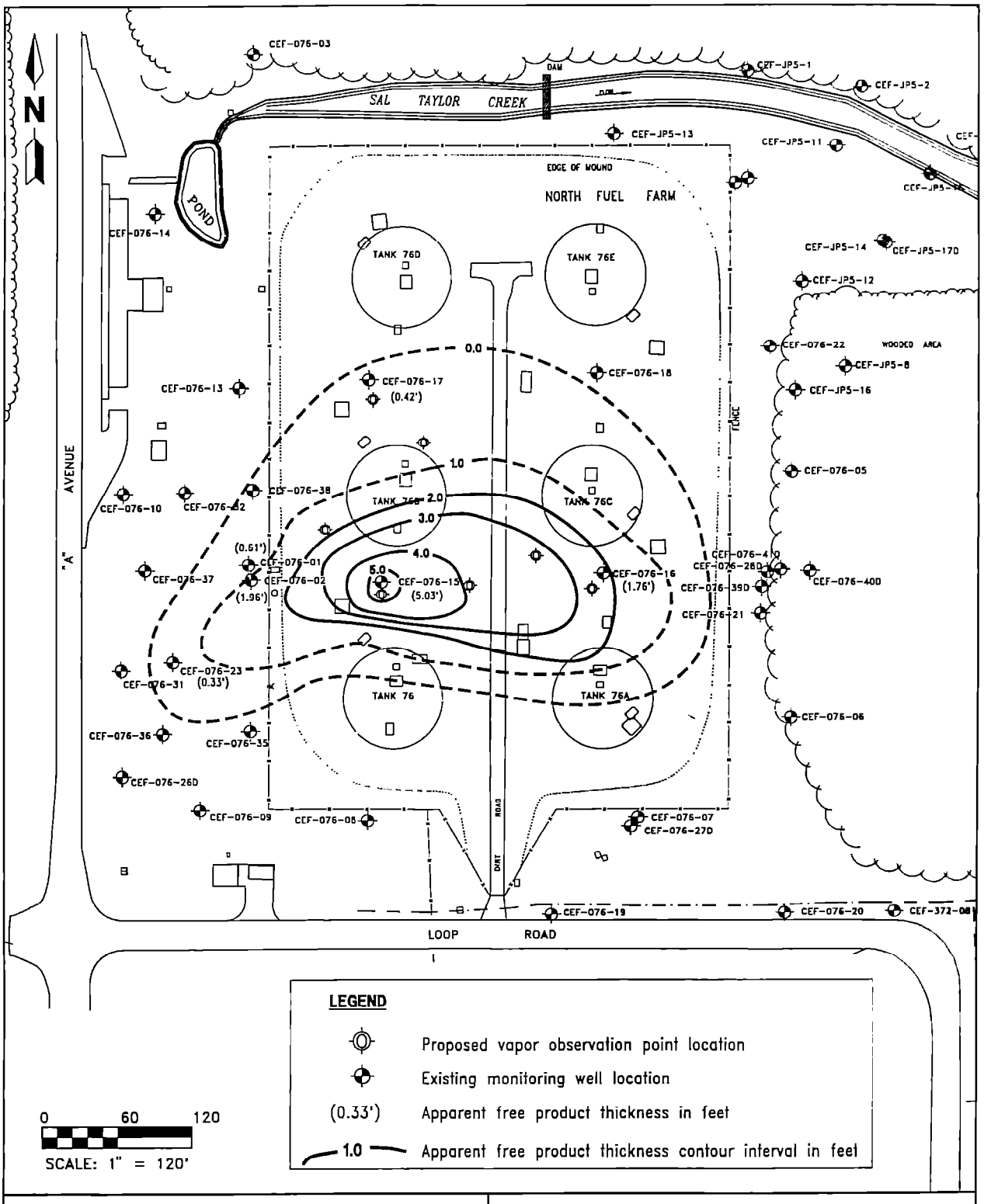


FIGURE 1
GENERALIZED APPARENT THICKNESS OF FREE PRODUCT, MARCH 1994

TECHNICAL MEMORANDUM
NORTH FUEL FARM SITE

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

H:\CECIL\NFFPROD\WDW\01-19-95

Product Recovery

The overall performance objective of the product recovery system is to remove the largest volume of free product at the North Fuel Farm in the shortest period of time. To achieve this objective, a minimum system design is recommended that can be augmented at a later date to improve system performance, if desired by the Navy.

Recovery Rationale - Technology Selection

The horizontal extent of the free product plume shown in Figure 1, indicates migration of free product down the tank mound, radially in the west and south directions. The tank mound free product extent will be addressed separately from the free product that has migrated down the mound and on the other side of the fence.

The following alternatives were considered for free product recovery in the tank area. They are described briefly with pros and cons in Table 1.

- Bioslurping
- Wells and skimmer pumps
- Perimeter collection system
- Horizontal recovery wells

Table 1
Screening Alternatives

Technology	Description	Pros	Cons
Bioslurping	Vacuum enhanced free product recovery -- a suction tube is dipped into a well, where it skims off free product floating on the water table Because the primary mode of recovery is based on an air suction, bioventing is expected and modifications for soil vapor extraction can be made if necessary	• Subsurface obstruction would be limited to extraction wells only • Combines two remediation technologies: Bioventing and Free product recovery • Only one system is necessary for product removal • Existing wells could be utilized for product recovery	• Recovery wells would be needed to cover the aerial extent • Low water table could create problems for vacuum lift
Skimmer Pumps	Product-only pumps are installed within wells to recover free product only	• Subsurface obstruction would be limited to extraction wells only • Pumps will only be in operation while product is present	• Separate pump will be necessary in each well which could require more O&M • Recovery wells would be needed to cover the aerial extent • Small diameter of existing wells limits choice of pumps
Perimeter Collection System	Subsurface drainage network utilizing gravity flow to collect product saturated water at the perimeter	• Gravity flow will centralize recovery at perimeter location	• Extensive piping network will be required at depths up to 20' bls • Water and product would be recovered simultaneously • Obstructions could be met in the subsurface • Tanks will limit accessibility for areas beneath the tanks
Horizontal Recovery Wells	Horizontal recovery wells would be installed at the groundwater free product interface Free product and groundwater would be extracted either by pumping or vacuuming	• Area of influence would be maximized per well if the interface were met	• Subsurface obstructions make drilling horizontally risky • Interface may vary causing the recovery system to be inoperable at times • Uncertainty for recoveries are inherent due to the use of vertical rather than horizontal conductivities - low recovery rates may be encountered • Entry angle for drilling would require an entry close to 200' from the tank area

The recommended product recovery system consists of utilizing the bioslurping technology in three existing monitoring wells and installation of seven push-probe observation wells. These observation well locations have been presented in Figure 1. The actual location of these wells will be determined in the field. Only free product floating on groundwater within the monitoring wells should be collected with this system. To the extent possible, groundwater should not be extracted or collected during product recovery.

The bioslurping technology combines bioventing and free product recovery. The utilization of a vacuum system to enhanced free product recovery, also increases the hydraulic gradient and aquifer transmissivity which enhances fluid recovery in the wells. With bioslurping, unlike conventional product recovery using skimmer pumps, there is no cone of depression and associated oil smear zone. Once installed, the flexibility exists to modify the bioslurping system to treat deeper soil and groundwater. Once the free product has been removed from the monitoring wells, it will then flow by gravity into an air-liquid separation system then flow into an oil-water separation system. The recovered free product will be stored onsite until it is either sent offsite for disposal or recycled at the direction of facility personnel. Groundwater is not anticipated in the collection process however, any groundwater collected in the separation process will be direct discharged to the sanitary sewer for treatment at the POTW. A schematic of the bioslurping system is shown on Figure 2.

The observation wells are recommended in the vicinity of the monitoring wells used for bioslurping. These wells are to be used to monitor the effectiveness of the recovery system, i.e., to measure the radius of influence created by the bioslurping system.

The free product as defined west of the tank mound, will be recovered during the Phase I, excessively contaminated soil removal. As described in the Technical Memorandum, dated December 7, 1994, several sumps will run north and below the excavation area. The sumps will act to intercept and collect free product that may migrate from the free product plume under the fuel farm towards the excavation area. The interceptor drain for groundwater only and sumps will actually act as a containment system for further migration of free product in the west-south direction. It is not anticipated that large volumes of free product will drain into the sumps, however, the free product that is collected in the sumps will be removed on a regular basis. The free product will be pumped into the storage tanks set up onsite for disposal or recycling.

Groundwater depression is often implemented in conjunction with product recovery to induce a cone of depression into which free product may drain. However, based on the guidance listed below, groundwater depression is not being considered.

- As stated in Chapter 62-770.300(2), FAC, free product recovery which requires dewatering or groundwater extraction which causes groundwater table depression is prohibited unless approval by the Florida Department of Environmental Protection (FDEP) as an alternate procedure.

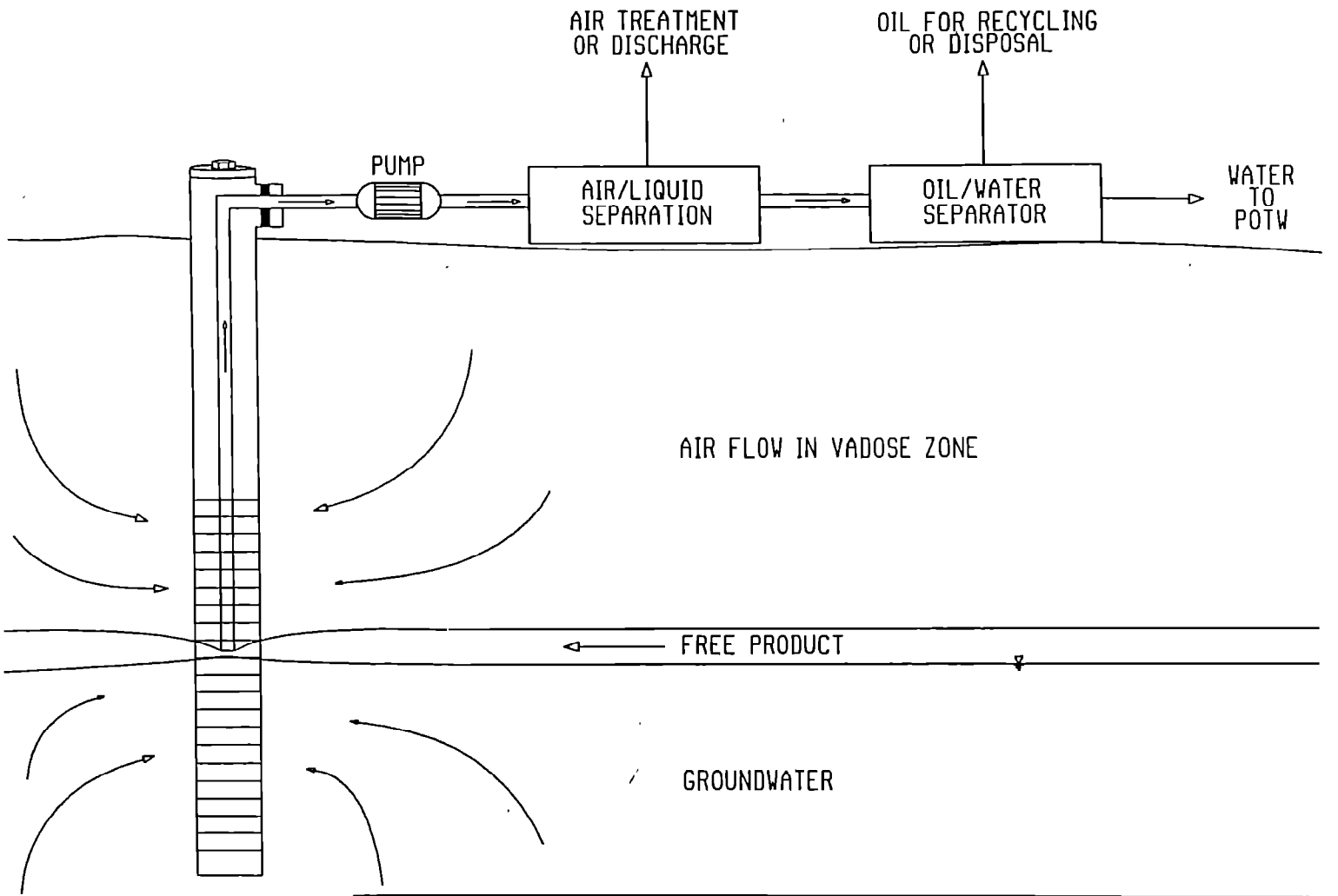


FIGURE 2
SCHEMATIC BIOSLURPING SYSTEM

TECHNICAL MEMORANDUM
NORTH FUEL FARM SITE

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

System Monitoring and Modifications

A monitoring program is designed to evaluate the performance, progress, and effectiveness of the system installed and to identify possible methods of improving the performance.

It is anticipated that the recovery system shall be effective in removing the majority of the floating free product at the North Fuel Farm. After the implementation and evaluation of the product recovery system, the Navy may desire a more aggressive approach to remove any remaining free product, such as thin layers or sheens.

Additionally, the product thickness, amounts of product recovered, and radius of influence measured in the observation wells will be recorded during each visit.

Additional Work

The RAC Contractor will also be responsible for the inspection and cleaning of five (5) of the aboveground fuel storage tanks. The tanks will be clean and inspected in accordance with the workplan submitted by Enterprise.

ATTACHMENT A

FREE PRODUCT VOLUME CALCULATION
North Fuel Farm, NAS Cecil Field

The estimated thickness and extent of product at the North Fuel Farm is illustrated on Figure 1. Free product was detected in wells MW-15, 16, and 17 at apparent thicknesses varying from 0.42 foot to 5.03 feet. The volume of free product saturated soil has been estimated in the table below using the average end area method.

Depth BGS (ft)	Incremental Thickness (ft)	Area (ft^2)	Average Area (ft^2)	Average Area X Incremental Thickness (ft^3)
0.0		96,624		
	1.0		71,496	71,496
1.0		46,368		
	1.0		35,568	35,568
2.0		24,768		
	1.0		20,016	20,016
3.0		15,264		
	1.0		9,719	9,719
4.0		4,176		
	1.0		2,376	2,376
5.0		576		
Volume of Soil Saturated With Product				139,175 ft^3

The porosity of the soil is estimated to be 0.25. Therefore, the volume of free product is estimated to be:

$$139{,}175 ft^3 \times 0.25\ porosity = 34{,}795 ft^3 = 260{,}260\ gallons\ of\ product.$$

Based upon baildown test results, converting apparent thickness of free product to true thickness of free product:

$$260{,}260\ gallons of product \div 3 = 87{,}000\ gallons.$$

M E M O R A N D U M

TO: Bryan Kizer

FROM: John Kaiser, Task Order Manager
Mike Dunaway P.E., P.G.
Celora Jackson

DATE: December 7, 1994

SUBJECT: North Fuel Farm, Cecil Field

BACKGROUND

On November 9, 1994, a joint meeting including ABB Environmental Services Inc. (ABB-ES), Bechtel, Southern Division, and Cecil Field personnel was conducted at Cecil Field. During this meeting we were informed that a new unloading truck stand is being planned at the North Fuel Farm. The truck stand construction area is proposed in the vicinity of the excessively contaminated soil. It was further determined in this meeting that ABB-ES would put together a memorandum that would outline the facts, criteria and recommendations to be implemented for the excavation of contaminated soil, prior to the construction of the truck unloading stand.

In 1991, ABB-ES conducted a Contamination Assessment (CA) to characterize and assess the vertical and horizontal extent of contamination at the NFF. Thirty-seven soil borings, 26 shallow monitoring wells, and 4 deep monitoring wells were installed at the site.

During this assessment, free product was discovered in seven of the monitoring wells. Free product migration is down the tank mound, radially in the west and south directions. Therefore, precautions must be taken to ensure that free product does not migrate into the excavated areas.

Excessively contaminated soil was detected in the area between the tank farm and "A" Avenue at depths ranging from 0 to 4.5 feet below land surface (bls). Excessively contaminated soil in the area of the new truck unloading stand will be removed before construction begins. During the CA groundwater beneath the site was encountered at a depth of between 2 to 4 feet bls in the upper part of the aquifer. Seasonal rains have raised the groundwater, in the areas of concern, to be encountered at depths of 1 foot to 1.5 feet bls.

TECHNOLOGIES

Abandonment

The extent of excessively contaminated soil, in the vicinity of the proposed truck unloading facility, will need to be excavated prior to construction of the truck stand. A sewer system, a six inch fuel line, an eight inch fuel line and several monitoring wells are known to exist in the vicinity of the proposed excavation area. Each of these features as well as any unknown utilities encountered, will be located and abandoned prior to commencement of excavation activities. The monitoring wells located in the proposed excavation area shall be properly abandoned in accordance with applicable state and local government requirements.

The six- and eight-inch fuel distribution lines in the vicinity of the proposed excavation area shall be properly abandoned in accordance with applicable state and local government requirements. The principal regulatory requirement for Underground Storage Tank Systems in Florida is Chapter 62-761, Florida Administrative Code (FAC).

The sewer system located in the vicinity of the proposed excavation area shall be properly abandoned in accordance with applicable state and local government requirements and with the County Health Department requirements.

SOIL REMEDIAL ACTIONS. The physical values measured or estimated for soil characteristics used as the basis of the phase I soil remedial actions are summarized in Table 1. Ranges of values are provided when appropriate. Table 2 summarizes the phase I soil remedial actions performance criteria.

Regulatory Standards. The principal regulatory requirements for thermal treatment of petroleum hydrocarbon contaminated soils in Florida are specified in Chapter 62-775, FAC. A copy of Chapter 62-775, FAC, has been provided in Attachment A.

Soil Excavation Excessively contaminated soil in the area of the new truck stand and in the areas identified during the CA will be excavated. The areas of excavation presented in Figure 1 are approximately 53,000 square feet. Personnel will excavate contaminated soil horizontally to the circumference where contaminant concentrations are below the cleanup criteria as shown on the figure. The vertical extent of excavation will be a seasonal low water depth of five feet bls. Approximately 11,028 cubic yards (15,439 tons) of soil require excavation and treatment. A 12% swell factor has been applied to the estimated volume of soil to be excavated.

Stormwater runon and runoff controls should be implemented to prevent off-site migration of sediment or contaminated stormwater during site activities. Disturbed areas around the excavation will be maintained to direct runoff into the excavation. Silt fences and other erosion control methods will be used as necessary to prevent discharges of sediment from the site. Other methods may include sandbagging, baled hay or straw dams, or berms. Dust control should also

Table 1
Basis of Remedial Action for Soil

Technical Memorandum
North Fuel Farm
NAS Cecil Field
Jacksonville, Florida

Parameter	Estimated Value
Soil type	Fine sand
Soil debris (> 2 inches), percent by volume[1]	≤ 1
Soil moisture content, percent	20 to 25
Soil porosity[2]	0.25
Soil specific gravity	1.52 to 2.63
Soil (field screening), ppm	<1 to >1,000[3]
Soil TRPH (certified laboratory[4]), mg/kg	9 to 5,000
Soil PAH (certified laboratory), ppm	0.2 to 33
Soil VOC, (certified laboratory), ppm	0.0053 to 5.3
Depth of excavation, feet	to 5 feet bls
Soil contaminated volume, yd^3	11,028

[1] Small volume of debris (e.g., roots, rock, concrete, metal, and wood; less than 1 percent by volume).
[2] Porosity is estimated from typical observed values at NAS Cecil Field.
[3] Field screening method (organic vapor analyzer) outside linear range above approximately 5,000 parts per million (ppm).
[4] U.S. Environmental Protection Agency Method 418.1.

Notes: TRPH = total recoverable petroleum hydrocarbon.
mg/kg = milligrams per kilogram.
PAH = total polynuclear aromatic hydrocarbons.
ppm = parts per million.
VOC = volatile organic compounds.
bls = below land surface.
yd^3 = cubic yards.

Table 2
Remedial Action Performance Criteria Summary

Technical Memorandum
North Fuel Farm
NAS Cecil Field
Jacksonville, Florida

Parameter[1]	Test Method	Criterion
Soil TRPH, mg/kg	418.1/3540/9073	≤ 50
Soil PAH, mg/kg	8100, 8250, 8270, or 8310	≤ 5
Soil VOH, μg/kg	5030/8010 or 5030/8021	≤ 50
Air particulate emissions, gr/dscf		≤ 0.08
Destruction removal efficiency, percent		> 99.99
Soil compaction and grading	ASTM D1557	≥ 85 percent Proctor[2] and local grades

[1] Observed average inorganic concentrations are within acceptable regulatory criteria; however, performance monitoring should verify this in accordance with Chapter 17-775, Florida Administrative Code.
[2] American Society for Testing and Materials D1557 or approved equivalent.

Notes: TRPH = total recoverable petroleum hydrocarbon.
mg/kg = milligram per kilogram.
PAH = total polynuclear aromatic hydrocarbons.
VOH = volatile organic halocarbons.
μg/kg = microgram per kilogram.
gr/dscf = grains per dry standard cubic meter.
ASTM = American Society for Testing and Materials.

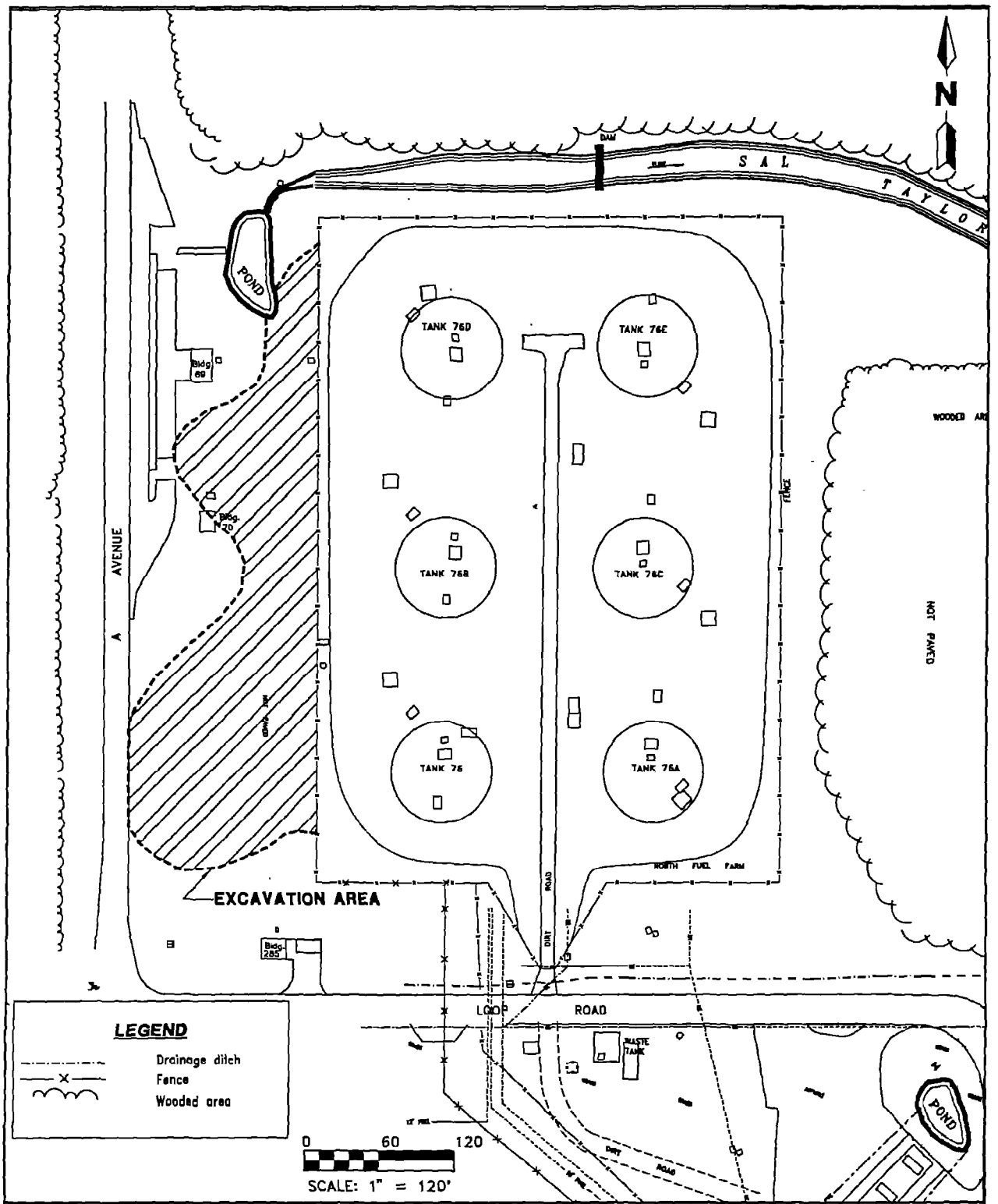


FIGURE 1
APPROXIMATE EXTENT OF REMEDIAL EXCAVATION

NORTH FUEL FARM

NAVAL AIR STATION
CECIL FIELD
JACKSONVILLE, FLORIDA

be implemented to prevent fugitive emissions during excavation and soil handling. Description of pollution control measures will be required in the contractor submittals.

The soil is classified as poorly graded sands (SP) to silty sands (SM) based on the Unified Soil Classification System (USCS). The contractor will slope the sides or shore the excavation in accordance with applicable standards to prevent unstable conditions during excavation that could pose hazards to personnel or surrounding structures and pavements.

Benchmarks, existing structures, fences, sidewalks, roadways, and other cultural features identified by the NTR to remain shall be protected from excavation equipment. If excavated soil is stockpiled prior to treatment, it will be placed on an impermeable barrier installed to allow drainage of stormwater runoff to the excavation area or otherwise contained for proper disposal. The contaminated soil stockpile will be covered as necessary to prevent infiltration of rain water. Stockpiling for an extended period of time is discouraged. Due to the abbreviated time period for remedial action, soils will be treated directly following excavation without stockpiling when possible. If treatment is provided offsite, stockpiling for more than 30 days will be allowed provided the stockpile containment and cover are properly maintained.

A decontamination area will be constructed for equipment and vehicles. Trucks loaded with contaminated soil will be decontaminated before they leave the site to prevent the spread of contaminated soil to other parts of the base. The decontamination area will include containment of all rinse water. Rinse water will be collected and treated in the water treatment process provided for the dewatering system.

Quality Assurance/Quality Control (QA/QC) procedures should be followed in all types of sampling and analysis (i.e., process monitoring as well as verification sampling). An appropriate number of QA/QC samples such as field duplicates, field blanks, and rinsate blanks should be collected to verify the precision and accuracy of sample analyses. Analyses will be conducted by a FDEP certified laboratory. Field sampling and analytical methods will be described in the approved Comprehensive Quality Assurance Project Plan submitted by the contractor.

Soil Treatment Thermal treatment of the soil will consist of a counter flow rotary furnace equipped with an afterburner (e.g., thermal oxidizer) for off-gas treatment, unless specified otherwise by the contractor and approved by the NTR. A process flow diagram for a typical thermal treatment unit is presented in Figure 2. The thermal treatment unit will be appropriately permitted by FDEP. If possible usage of a mobile treatment facility on site would be desirable.

Hazardous Materials. Fuels and other hazardous materials required to operate the treatment system will be managed in accordance with applicable standards to prevent spills, explosions, and fires. The contractor will be required to have adequate equipment and trained personnel onsite to respond to emergencies associated with their operations. Should an emergency occur that exceeds the contractor's capacity to respond, base emergency response services will intervene. Emergency prevention and response measures will be described in the

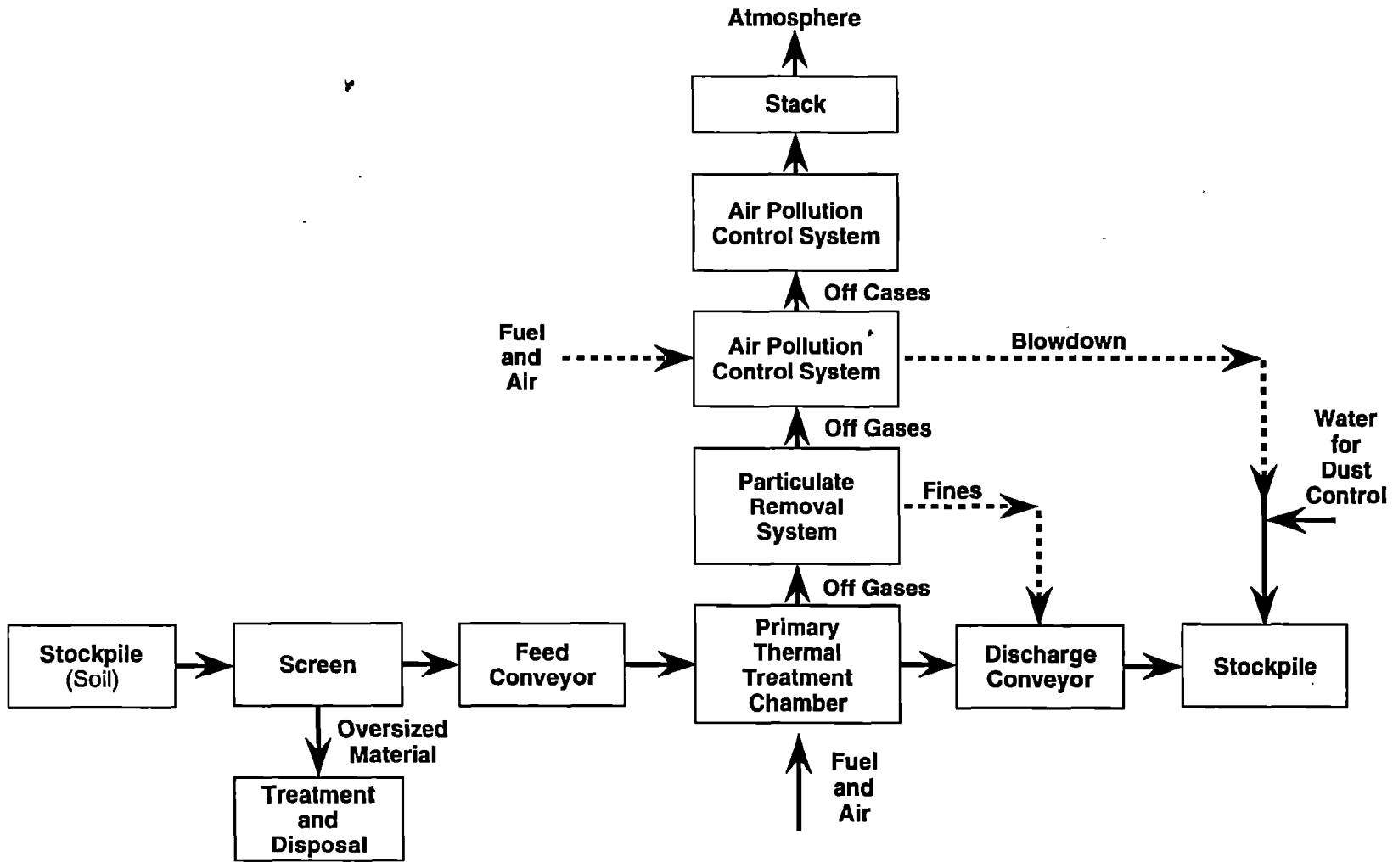


FIGURE 2

PROCESS FLOW DIAGRAM FOR A TYPICAL THERMAL TREATMENT UNIT

NORTH FUEL FARM

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

8520-53 941205WEM

contractor submittals.

Soil Conditioning. Condition soil. as required, to remove objects greater than permitted by the selected thermal treatment system. This is typically 2 inches in size. The heterogeneity of the soil characteristics (e.g., organic content, moisture, and particle size) appears moderate. Some blending of soil to a consistent quality is expected and will be dependent on the actual treatment technology applied.

Small amounts of debris may be encountered and preprocessing of soil will be necessary to assure proper soil size. Contaminated debris that can not be treated to applicable performance criteria will be containerized, sampled, analyzed, labeled, and disposed offsite as hazardous waste, if applicable. Hazardous waste water management will be described in the contractor submittals.

Pay Basis. The soil processing unit will be equipped with a weighbelt scale, or an approved equivalent soil weighing device, placed after debris screening but before the feed hopper to the rotary furnace. The principal unit price for treatment will be on a unit weight basis for raw, untreated soil. A lower, secondary unit price will be negotiated for retreating soil that was previously treated but did not attain the cleanup standards. Should blending of raw and previously treated soil be necessary, the unit price will be prorated based on the weight ratio of the mixture components. The contractor will describe procedures for accurate record-keeping of treated soil weights in their submittals.

Process Rate. Treatment rates are expected to be approximately 25 tons per hour for a typical mobile system and would require roughly a minimum of 620 operational hours to treat the estimated soil volume. Actual treatment rates and treatment times will be a function of the thermal treatment system specified by the contractor and the encountered soil contamination concentrations, moisture content, blending requirements, density, and volume. Applying a factor of 125 percent to address contingencies, 775 continuous operational hours is used as an estimate of the time required to thermally treat the soil. This does not take into account coordination between soil excavation and placement, planned or unplanned maintenance, re-treatment of non-attaining soil, weather days, or administrative delays. Backfilling and site restoration may proceed independent of the treatment rate of the excavated soil.

Operating Conditions. Actual operating conditions will be dependent on the type of thermal treatment system proposed by the contractor. The contractor will be required to describe in their submittals the process instrumentation and controls for the specific thermal treatment system they recommend and its normal range of operations. Monitored process conditions, system interlocks, and alarm conditions will be described. Alarm conditions may include high and low temperatures, high and low pressures, thermocouple failures, and motor failures.

Process parameters monitored during operations (depending on the selected system) may include:

- contaminated soil feed rate (weight basis),
- rotary furnace (dryer) vacuum,

- baghouse pressure differential,
- furnace (dryer) exit gas temperature,
- furnace (dryer) exit soil temperature,
- baghouse inlet temperature,
- afterburner (thermal oxidizer) exit gas temperature, and
- stack gas carbon dioxide, carbon monoxide, oxygen, and hydrocarbon concentrations.

Performance Monitoring. Monitoring will include Continuous Emissions Monitoring (CEM) of stack gases to assure compliance with air permit requirements. CEM will depend on the type of thermal treatment system and permit requirements. Grab samples of stack gases will be periodically collected and analyzed to assure that combustion by-products are not emitted at levels exceeding permitted amounts. The Site Monitoring Plan prepared by the contractor will describe CEM and stack gas sampling and analysis.

Processed soil sampling and analysis, as a minimum, will comply with Chapter 62-775.410, FAC. Florida Department of Environmental Protection (FDEP) guidance recommends a sample be collected for every 50 tons of treated soil and composite for analysis of every 400 tons. Analytical parameters and cleanup standards are described in Chapter 62-775, FAC, and summarized in Table 2.

Analytical results verifying cleanup standards are required prior to reuse or disposal of treated soil. Sampling and analysis will be described in the contractor's approved Site Monitoring Plan, Treated Soil Sampling and Analysis Plan, and Comprehensive Quality Assurance Project Plan.

Residual Management. Residuals are expected to fall into one of the following categories: treated soil attaining cleanup criteria, baghouse fines attaining cleanup criteria, debris classified as solid waste, treated soil not attaining cleanup criteria, baghouse fines not attaining cleanup criteria, and petroleum hydrocarbon contaminated debris.

Treated soil, baghouse fines, and some masonry debris, (e.g., concrete and bricks) may be placed in the abandoned borrow pit which is south of the pistol range. The pistol range is located on 6th Street, off Perimeter Road. Baghouse fines may require wetting to prevent dust emissions during placement and/or storage. Solid wastes that are not suitable for storage in the borrow pit will be disposed offsite in an appropriate manner.

Treated soil not attaining cleanup criteria may be returned to the head of the treatment train for additional treatment depending on why attainment was not achieved initially, with NTR approval. Baghouse fines not attaining cleanup criteria will be analyzed for hazardous waste characteristics (e.g., flammability and toxicity characteristics), containerized, labeled, and temporarily stored onsite prior to treatment and disposal. Petroleum contaminated debris that cannot be thermally treated may be decontaminated by high pressure wash or other method proposed by the contractor in the workplan submittal. All residuals that can not attain cleanup criteria and are determined to be hazardous by characteristic will be containerized and labeled with adequate waste profile information for offsite disposal.

Site Restoration and Demobilization Residuals attaining cleanup criteria will not be returned to the excavation, except that treated soil may be used as common backfill above the depth of 1-foot bls.

The contractor will remove all water from the excavation during soil placement. The excavated area will be backfilled with a clean sand from an off-site source to no shallower than 1-foot bls. The sand should have a low fraction of organic carbon (FOC) (e.g. approximately < 0.5%) (American Society for Testing and Materials [ASTM] D 2974-87 standards for moisture, ash, and other organic matter or approved equal). No soft or spongy or highly plastic materials shall be used as backfill. This will minimize contaminant adsorption and therefore reduce the potential for recontamination of the backfill by contaminated groundwater. Backfill materials will be placed in the excavation and field compacted in place to surrounding conditions with earthmoving equipment tracks to a minimum of 85 percent Proctor (ASTM) D1557 or approved equal) or greater depending upon construction needs. Backfill material will be compacted in lifts of at least 6-inches.

The contractor will raise the excavation grade to above surrounding elevations and slope the grade from the center outward to a minimum slope of 50 horizontal to 1 vertical (2% grade) so that runoff will flow away from the backfilled area. The contractor will blend the slope into level areas and make the grade changes gradual. Common fill compatible with surrounding soils can be used if additional backfill materials are needed to obtain slopes. Certification that the common fill is free of petroleum hydrocarbon contamination is required from the backfill source prior to delivery.

The contractor will dismantle and remove the thermal treatment equipment. The contractor will smooth grades to original conditions and re-vegetate the site in accordance with the NTR-approved workplan. The contractor will disconnect temporary utility services in coordination with base personnel. The contractor will repair benchmarks, existing structures, fences, sidewalks, roadways, utilities, and other cultural features identified by the NTR to remain that were damaged during remedial activities. The contractor will remove the perimeter fence. The contractor will verify line and grades after all equipment and materials have been removed from the site and work is complete. The contractor will review project documentation and will walk over the site with the NTR to obtain consensus with the NTR that work was adequate and to transfer the project site to the Navy.

DEWATERING SYSTEM

Trench and Drain Placement

If groundwater levels are higher than the excavation depth, 5 feet below land surface, it becomes necessary to lower the groundwater table and dewater saturated soils above the excavation depth. Portions of the excavation extending below groundwater will be removed in using typical dewatering technologies (trench recovery, Figures 3 and 4). Other acceptable methods may be used provided that the performance criteria are achieved.

Several interceptor drains will run north and south below the excavation area.

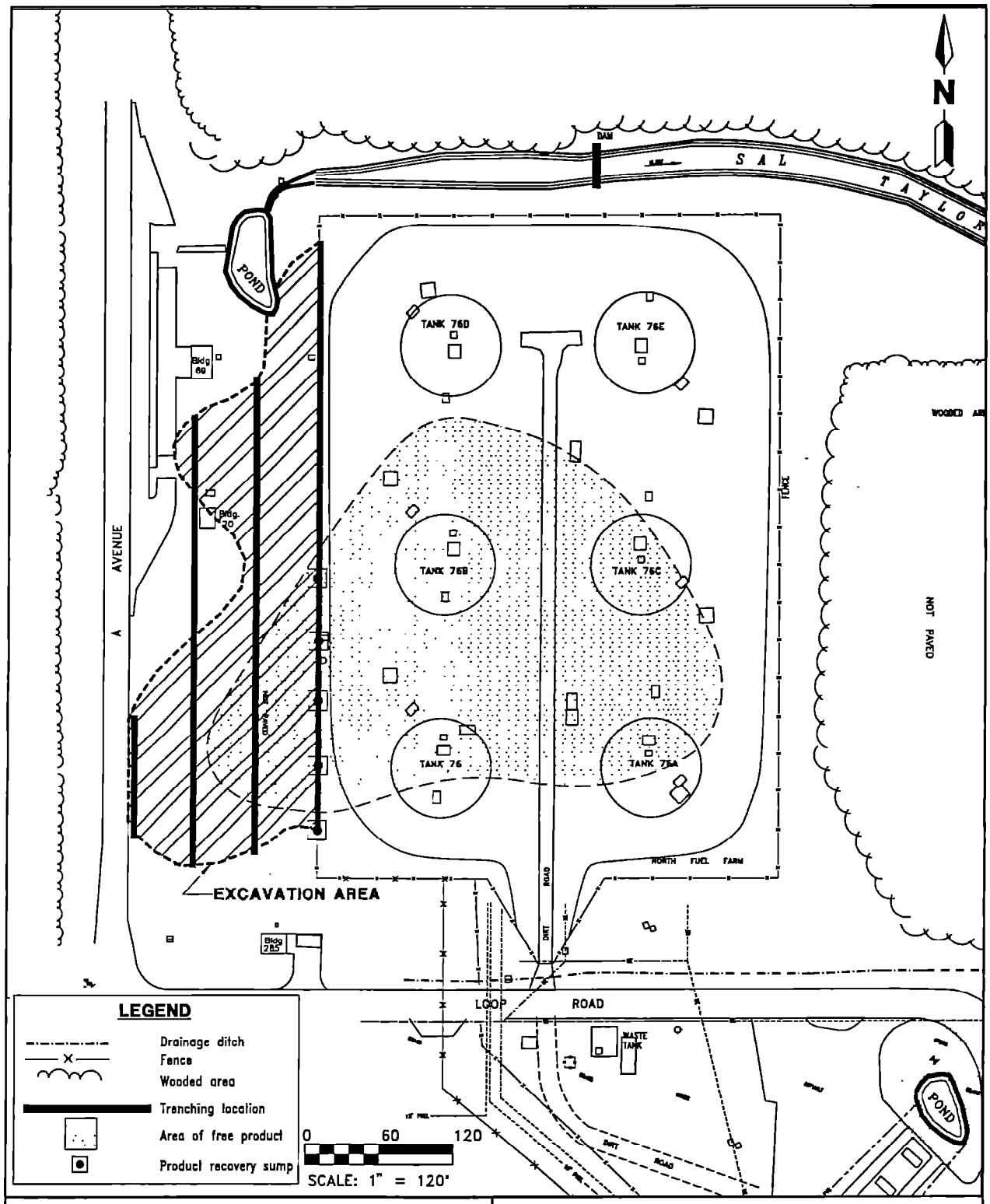


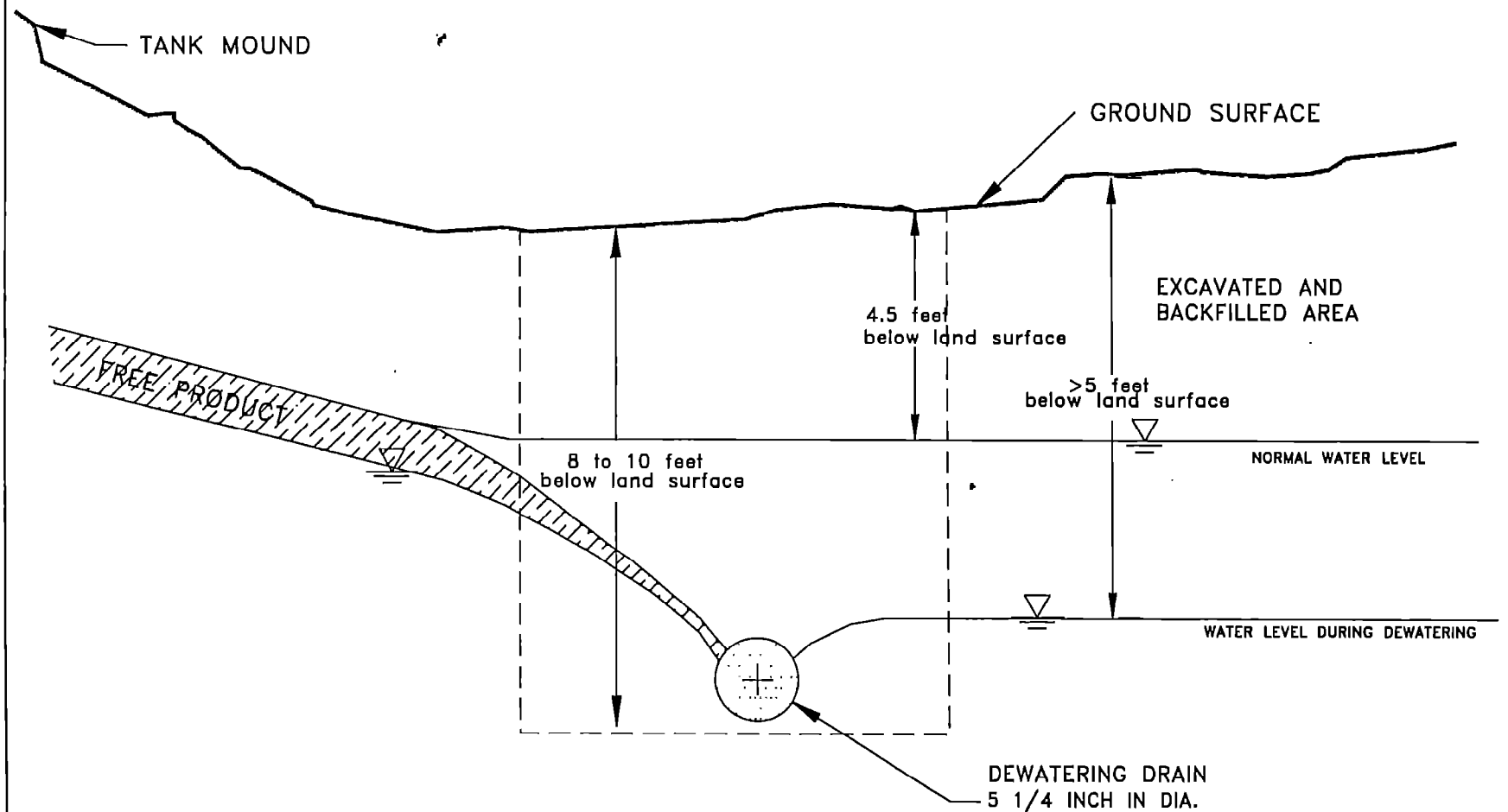
FIGURE 3
APPROXIMATE LOCATION OF DRAINAGE SYSTEM

NORTH FUEL FARM

NAVAL AIR STATION
CECIL FIELD
JACKSONVILLE, FLORIDA

H:\CECIL\NNFARM\WDW\12-7-94

TRENCH PROFILE VIEW



NOT TO SCALE

FIGURE 4
DEWATERING AND FREE PRODUCT RECOVERY DESIGN

NORTH FUEL FARM

NAVAL AIR STATION
CECIL FIELD
JACKSONVILLE, FLORIDA

H:\CECIL\TRENCH\WDW\12-6-94

Pumps will be connected to the end of each drain to recover groundwater and send it to the groundwater treatment system. The main interceptor drain at the base of the North Fuel Farm will act to intercept and collect free product that may migrate from the free product plume under the fuel farm towards the excavation area. All north/south drains will act to dewater the site below the excavation depth. If free product moves into the excavation area it will be collected by a vacuum truck.

Trenches will initially be dug to install the groundwater drains. It may be necessary to use a well point system or an open sump with a centrifugal pump during the installation process of the drain trenches. Water removed for dewatering when placing the drainage trenches will be contained for treatment in the onsite groundwater treatment system.

It is recommended that a synthetic filter material be placed around the drainage piping to prevent silts from clogging the drain pipes. The perforated flexible pipe should be located along the center line of each trench. The perforated pipe will be placed from eight to ten feet bls.

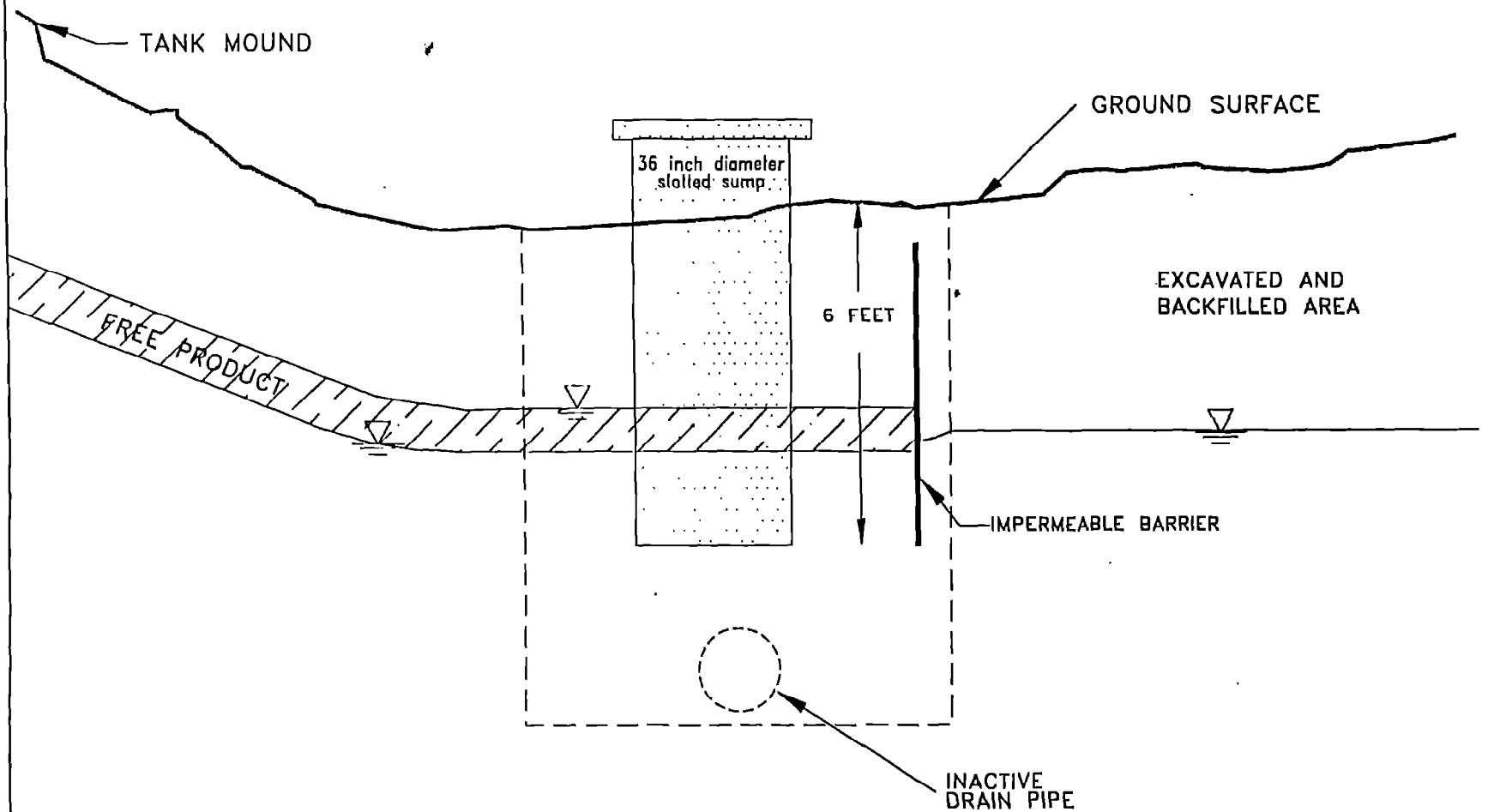
If the drain pipe installation method allows, excavated trenches should be backfilled with a clean sand from an off-site source. The sand backfill should have a low fraction of organic carbon (e.g. < 0.5%) to minimize potential for contaminant adsorption and recontamination by contaminated groundwater.

A 36-inch diameter product recovery slotted sump will be placed above the eastern most dewatering drain to a depth of 6 feet bls in the areas where free product was determined during the CA. An impermeable liner will be placed on the western side of the trench, from 1 to 6 feet bls. This liner will prevent free product from moving into the excavated and backfilled area upon completion of dewatering. An estimated five free product sumps are specified, however, the actual number of sumps is to be determined during excavation. A profile of the free product sump system is shown in Figure 5.

Dewatering

Following the completion of the trench drainage system vacuum pumps will be activated to remove groundwater from the drainage system until the piezometric surface across the entire excavation area is lowered a minimum 5 feet bls. It may be necessary to remove groundwater for several days before the piezometric surface has reached an acceptable level. Once the piezometric surface has reached 5 feet bls the vacuum pumps may be adjusted to maintain the piezometric surface at that level. Contaminated water extracted during dewatering will be sent to an onsite groundwater treatment system.

TRENCH PROFILE VIEW



NOT TO SCALE

FIGURE 5
FREE PRODUCT RECOVERY SUMP DETAIL

NORTH FUEL FARM

NAVAL AIR STATION
CECIL FIELD
JACKSONVILLE, FLORIDA

H:\CECIL\TRENCH\WDW\12-7-94

Average Groundwater Concentrations

The water below the excessively contaminated soil is also contaminated with JP-5 jet fuel, however, information on the contaminant concentrations in the groundwater below the excessively contaminated soil is limited to samples from five groundwater monitoring wells within the excavation area. Three of the monitoring wells in the excavation area contain free product and cannot be sampled. Due to free product on the groundwater table, high concentrations for total VOA in the remaining two monitoring wells and the limited pretreatment capabilities of the base POTW, a pretreatment facility will be required.

The average contaminant concentration in the groundwater was determined by making the following assumptions:

- Total VOA concentration in the free product area is 2,000 parts per billion (ppb). This assumed concentration is 900 ppb higher than a sample collected just below the free product layer.

- An average Total VOA concentration for the five wells within the excavation area will give a conservative concentration for extracted groundwater during dewatering.

The groundwater extracted for dewatering the excavation area may be treated by an oil water separator and an air stripper. To ensure the air stripping unit will be able to treat the influent concentrations effectively, the total VOA concentration number will be directly related to benzene on a one to one basis. Total VOA concentrations have been converted to benzene for the analysis and design modeling of and air stripping unit. Benzene is approximately equal to or less volatile than the combination of total VOAs in the groundwater.

Using this method, the average total VOA concentration for influent into the air stripping tower would be 1,403 ppb as benzene.

Effluent treatment standards for discharge to the sanitary sewer are displayed in the following table. These standards are under the direction of the POTW.

GROUNDWATER EFFLUENT DISPOSAL CRITERIA	
BENZENE	1 PPB
TOTAL VOAs	50 PPB
TOTAL NAPHTHALENES	100 PPB

Groundwater Treatment

Extracted contaminated groundwater will require treatment prior to disposal. The specified groundwater treatment system will utilize a oil/water separator which will gravity feed to a vented flow equalization tank. Groundwater accumulating in the equalization tank will be cycled through a skid mounted, packed tower, air stripper or equivalent.

The oil/water separator should be able to handle an influent flow rate range from 5 to 60 gallons per minute (gpm). Product removed from the contaminated water will be collected in a suitable size tank for disposal or recycling.

The groundwater effluent from the oil water separator will be gravity fed to a flow equalization tank. The vented flow equalization tank will contain a high level sensor at 90 percent capacity and a low level sensor at 10 percent capacity that will initiate and terminate flow through the air stripping tower.

Water flow from the flow equalization tank to the air stripper will have to be set manually. The initial setting for the air stripper should be set to run at a minimum of 10 gpm in excess of the initial groundwater extraction rate. The air stripping flow rate should be adjusted twice daily to ensure the air stripping flow rate is set to 10 gallons above the groundwater extraction flow rate. If groundwater extraction flow rates fall below 15 gpm, the air stripping influent rate will remain set at 25 gpm. The air stripping unit should not be set to run with an influent flow rate less than 25 gpm or greater than 60 gpm.

When the air stripping water influent rate is increased or decreased, the blower which provides air to the tower should also be adjusted. Adjustments to air flow rates should be made according to the curve in Attachment B.

A two-foot diameter air stripper has been modeled for a range of 25 to 60 gpm with an estimated 55 ppb benzene concentration and an estimated 1,403 ppb total VOA concentration as benzene. Model results can be found in Attachment B. The air stripper will contain 11 feet of two inch packing material as specified in the air stripping model results. The blower that supplies air to the air stripper should be able to provide an air flow capacity from 100 to 800 cubic feet per minute (cfm) and maintain an inch of water head pressure.

The effluent from the air stripping unit should discharge to the local sanitary sewer. Vapor emissions from the air stripping unit described above are below state discharge limits. Vapor emissions must meet the requirements of FDEP Rap

Guidance Document.

A monitoring program is designed to evaluate the performance, progress, and effectiveness of the system installed and to identify possible methods of improving the performance. The air stripper influent and effluent will be sampled weekly for the duration of system operation.

ATTACHMENT A

CHAPTER 17-775
SOIL THERMAL TREATMENT FACILITIES

PART I
INTENT, DEFINITIONS AND GENERAL PROVISIONS

17-775.100 Intent
17-775.200 Definitions
17-775.210 Reference Standards
17-775.300 General Permits
17-775.400 Criteria for Clean Soil
17-775.410 Soil Sampling and Analysis
17-775.500 Approval of Alternate Procedures

PART II
SPECIFIC CONDITIONS FOR STATIONARY FACILITIES

17-775.600 Security
17-775.610 Ground Water Monitoring
17-775.620 Receiving, Handling, and Stockpiling

PART III
SPECIFIC CONDITIONS FOR MOBILE FACILITIES

17-775.700 Notices and Security
17-775.710 Excavating, Handling, and Stockpiling

PART IV
SOIL THERMAL TREATMENT FACILITY FORMS

17-775.900 Forms

INDEX

PART I
INTENT, DEFINITIONS AND GENERAL PROVISIONS

17-775.100 Intent

(1) Chapter 17-770, F.A.C., establishes petroleum or petroleum product contamination cleanup criteria and a cleanup process which must be undertaken at all petroleum contamination sites. As a result of this cleanup effort, petroleum contaminated soils may be removed for thermal treatment.

(2) The State of Florida Department of Environmental Regulation promulgates this chapter in order to provide assurances that petroleum contaminated soils as defined in Rule 17-775.200, F.A.C., which are removed for thermal treatment, are properly handled and are treated to levels that will not endanger public health or cause future contamination of other soils, ground water, and surface water.

(3) The Department recognizes that thermal treatment of petroleum contaminated soils in asphalt plants, cement kilns, rotary kilns, or their equivalents, is a viable method of remediating petroleum contaminated soils.

(4) The Department intends for this rule to apply only to thermal treatment facilities and the petroleum contaminated soils which will be treated therein.

Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.3071, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.200 Definitions

All words and phrases defined in Section 376.301, F.S., shall have the same meaning when used in this Chapter unless the context clearly indicates otherwise. The following words and phrases when used in this Chapter shall, unless the context clearly indicates otherwise, have the following meanings:

(1) "Contamination" or "contaminated" means a discharge of petroleum or petroleum products into the surface waters, ground waters or upon the land, in quantities which may result in a violation of water quality standards set forth in Chapters 17-3 and 17-302, F.A.C.

(2) "Department" means the State of Florida Department of Environmental Regulation.

(3) "Environmental Protection Agency" or "EPA" means The United States Environmental Protection Agency.

(4) "Existing facility" shall mean a soil thermal treatment facility which is in operation prior to the effective date of this Chapter.

(5) "Hazardous substance" means any substance which is defined as a hazardous substance in the United States Comprehensive Environmental Response, Compensation and Liability Act of 1980, 94 Stat. 2767, as cited in Rule 17-150.200(2), F.A.C.

(6) "Hazardous waste" means a solid waste identified as a hazardous waste in 40 CFR 261.3.

(7) "Leachate" means liquid which percolates through or emerges from stockpiled soil and contains soluble, suspended or miscible materials.

(8) "Mobile facility" means a thermal treatment system which is transported to a soil contamination site and only treats soil from that specific site.

(9) "Petroleum contaminated soil" means soil which has become contaminated with one or more of the following liquid products made from petroleum: all forms of fuel known as gasoline, diesel fuel, jet fuel, kerosene, grades 2 through 6 fuel oils, crude oil, bunker C oil, residual oils; and non-hazardous petroleum based lubricating, hydraulic, and mineral oils. This definition applies only to the regulation of soil thermal treatment facilities.

(10) "Stationary facility" means a thermal treatment system which thermally treats contaminated soil transported to the facility.

(11) "Thermal treatment" means to apply heat to increase soil temperatures sufficiently to volatilize or burn contaminants within the soil.

(12) "Soil thermal treatment facility" means either a stationary or mobile facility designed, constructed or utilized, and permitted by the Department to handle, store, and thermally treat or process petroleum contaminated soils. "Soil thermal treatment facility" does not include electrical power plants in which thermal treatment of contaminated soils from their own property results in ash which is disposed of in accordance with Chapters 17-701 or 17-702, F.A.C., or facilities that treat hazardous waste or hazardous substances.

(13) "Total Volatile Organic Aromatics" or "total VOA" means the sum of concentrations of benzene, toluene, total xylenes, and ethylbenzene as determined by EPA Method 602, 5030/8020, or 5030/8021.

(14) "Used oil" means any lubricant which has been refined from crude oil and, as a result of use, storage or handling, has become unsuitable for its original purpose due to the presence of impurities or loss of properties, but which may be suitable for further use as a fuel or may be economically recycled for use as a fuel. "Used oil" shall not include any oil which has been mixed with any material which is a hazardous waste, unless the material is a

hazardous waste solely due to the characteristic of ignitability as defined in 40 CFR Part 261, Subpart C as of July 1, 1991. Used oil containing more than 1000 parts per million of total organic halides is presumed to be mixed with a halogenated hazardous waste listed in 40 CFR Part 261, Subpart D, unless a demonstration is made that the used oil does not contain a hazardous waste.

Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.3071, 403.031, 403.061, 403.062, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.210 Reference Standards

(1) Reference standards are available for inspection at the Department's district and central offices.

(2) Specific references to documents or parts thereof are adopted and incorporated as standards only to the extent that the documents are specifically referenced in this Chapter.

(a) DER Manual for Preparing Quality Assurance Plans (DER-QA-001/90), Florida Department of Environmental Regulation, Quality Assurance Section.

(b) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW 846, Third Edition, Document No. 955-001-00000-1, as amended by Final Update Package I (November, 1990).

(c) EPA Draft Method 9073 for Total Recoverable Petroleum Hydrocarbons.

(d) Federal Register; Volume 55, No. 61, pages 11798 to 11877; dated Thursday, March 29, 1990; on Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule.

(e) Quality Assurance Standard Operating Procedures Manual for Soil Thermal Treatment Facilities as of November, 1991.

(f) EPA Method 3665 for sulfuric acid/permanganate cleanup as written in Proposed Update II (November 1990) of (b) above.

Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.3071, 403.061, 403.062, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.300 General Permits

(1) Soil thermal treatment facilities shall operate pursuant to a general permit, and shall meet the applicable general permit requirements in Rules 17-4.510 through 17-4.540, F.A.C., and the requirements of this Chapter.

(2) Prior to operating under a general permit, the owners of a soil thermal treatment facility shall notify the Department on Form 17-775.900(1). For a new soil thermal treatment facility, renewal of a general permit, or modification of a general permit, the notification must be submitted 30 days before the operation begins or the existing permit expires. Any existing facility not in compliance with the requirements of this amended rule shall, by December 1, 1992, submit a new Notice of Intent, which demonstrates how the facility will comply.

(3) The notice of intent to use the general permit to treat petroleum contaminated soils at a soil thermal treatment facility shall bear the signature, date and seal of a professional engineer licensed in the State of Florida and the signature of the facility owner or operator.

(4) Soil thermal treatment facilities also must be permitted under Rule 17-2, F.A.C., prior to thermally treating contaminated soil.

(5) Soil thermal treatment facilities shall treat soils to the extent necessary to comply with the criteria for clean soil in accordance with Rule 17-775.400, F.A.C. Soil sampling and analysis shall be in accordance with Rule 17-775.410, F.A.C.

(6) For stationary soil thermal treatment facilities, the specific conditions in Rules 17-775.600 through 17-775.620, F.A.C., shall apply. For mobile soil thermal treatment facilities, the specific conditions in Rule 17-775.700 and 17-775.710, F.A.C., shall apply.

(7) All soil thermal treatment facilities operating under a general permit shall maintain accurate records of operations. Operating report logs shall be maintained on a normal work day basis on Forms 17-775.900(2) and (3), F.A.C., and shall be maintained for a period of three years at the facility for a stationary facility, or, at an approved location for mobile facility. The Department shall have complete access to all records, field and laboratory chain-of-custody records, quality control records, raw data records, calibration records, and laboratory analyses.

(8) When treating petroleum contaminated soil, soil thermal treatment facilities shall have a minimum soil retention time and a minimum operating soil temperature which provides treatment to comply with the criteria in Rule 17-775.400, F.A.C.

(9) Soil must be screened, or otherwise processed in order to prevent particles greater than two inch mesh (diameter) from entering the thermal treatment unit. Soil thermal treatment facilities are allowed to treat debris, other than soil, such as concrete, rocks, and wood.

17-775.300(2) - 17-775.300(9)

(10) All sampling and analysis shall be conducted pursuant to Rule 17-160.300(7), F.A.C. Soil sampling procedures shall be in accordance with the Quality Assurance Standard Operating Procedures Manual for Soil Thermal Treatment Facilities. Analysis of soil samples shall be conducted by a laboratory with an approved Quality Assurance plan under Chapter 17-160, F.A.C.

Specific Authority: 376.303, 376.3071, 403.0877, F.S.
Law Implemented: 376.3071, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.400 Criteria for Clean Soil

Treated soil must comply with the following cleanup levels to be classified as clean soil. Mixing of treated soils to achieve these standards is prohibited.

(1) Total Volatile Organic Aromatics shall not exceed 100 ug/kg (100 ppb) using the analysis identified in Rule 17-775.410(1)(a), F.A.C.,

(2) Total Recoverable Petroleum Hydrocarbons (TRPH) shall:

(a) not exceed 10 mg/kg (10 ppm) using the analysis identified in Rule 17-775.410(1)(b), F.A.C., or

(b) not exceed 50 mg/kg (50 ppm) using the analysis identified in Rule 17-775.410(1)(b), F.A.C., provided the total of the Polynuclear Aromatic Hydrocarbons (PAH) does not exceed 1 mg/kg (1 ppm) using the analysis identified in Rule 17-775.410(1)(c), F.A.C., and the total of the Volatile Organic Halocarbons (VOH) does not exceed 50 ug/kg (50 ppb) using the analysis identified in Rule 17-775.410(1)(d), F.A.C.,

(3) Metals shall not exceed the following concentrations in Table I using the analyses identified in Rule 17-775.410(1)(e), F.A.C. The appropriate preparation methods identified in Rule 17-775.410(2), F.A.C., shall be used prior to metal analysis.

TABLE I

	Maximum Concentration	
Metals	TCLP* (mg/l)	Total (mg/kg)
Arsenic	5.0	10
Barium	100.0	4940
Cadmium	1.0	37
Chromium	5.0	50
Lead	5.0	108
Mercury	0.2	23
Selenium	1.0	389
Silver	5.0	353

*TCLP = Toxicity Characteristic Leaching Procedure

17-775.300(10) - 17-775.400(3)

(4) Under no circumstances may soils which exhibit the characteristic of toxicity for metals (EPA HW No. D004-D011) as established in 40 CFR 261.24 be blended. However, blending of soils prior to treatment to achieve the total metals criteria in Rule 17-775.400(3), F.A.C., is allowed if the pre-blended soil does not exhibit the characteristic of toxicity for those metals. Records shall be maintained of blending procedures used to comply with the total metals standards. Either records of blending ratios with calculations to estimate total metals concentrations of blended soil or resampling and analysis of blended pretreatment soil are acceptable. Uncontaminated soil shall not be used for blending.

(5) Soil which exhibits the hazardous characteristic of toxicity must be treated or disposed of at an approved hazardous waste treatment/disposal facility.

Specific Authority: 376.303, 376.3071, 403.087, F.S.
Law Implemented: 376.3071, 403.087, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.410 Soil Sampling and Analysis

(1) Soil samples shall be analyzed for the following parameters using the test methods indicated:

(a)	Total Volatile Organic Aromatics (VOA)	EPA Method 5030/8021 or 5030/8020
(b)	Total Recoverable Petroleum Hydrocarbons	EPA Draft Method 3540/9073
(c)	Polynuclear Aromatic Hydrocarbons (PAH)	EPA Method 8100, 8250, 8270, or 8310
(d)	Volatile Organic Halocarbons (VOH)	EPA Method 5030/8021 or 5030/8010
(e)	Total Organic Halides	EPA Method 5050/9056, 5050/9252, 5050/9253
(f)	Metals	
	Arsenic	EPA Method 7060, 7061 or 6010
	Barium	EPA Method 7080, 7081 or 6010
	Cadmium	EPA Method 7130, 7131 or 6010
	Chromium	EPA Method 7190, 7191 or 6010
	Lead	EPA Method 7420, 7421 or 6010

Mercury	EPA Method 7471
Selenium	EPA Method 7740, 7741 or 6010
Silver	EPA Method 7760, 7761 or 6010

(2) The acid digestion procedure by EPA Method 3050 shall be used to prepare soil samples for total metal analyses except mercury, and the extraction procedure by EPA Method 1311 TCLP shall be used to determine leachability characteristic of metals.

(3) Pretreatment soil shall be analyzed for Volatile Organic Aromatics, Total Recoverable Petroleum Hydrocarbons, Volatile Organic Halocarbons and total metals. The number of composite soil samples for each contamination site shall be in accordance with Table II. Each composite soil sample shall consist of soil samples taken from at least four locations. Each sample shall be collected from locations equally distributed throughout the soil surface area and from a depth of at least six inches below the surface. Sampling procedures are described in the Standard Operating Procedures Manual for Soil Thermal Treatment Facilities.

TABLE II

Amount of Soil		Quantity of Composite
by Volume (cubic yards)	by Weight (tons)	Samples
Less than 100	Less than 140	1
100 to 500	140 to 700	3
500 to 1000	700 to 1400	5
For each additional 500	For each additional 700	1

(4) The soil must not be thermally treated pursuant to this Chapter if it is classified as a hazardous waste. If any soil is suspected of containing a hazardous waste, then screening analyses for other contaminants may include, but are not limited to the following: volatile organic halogens; corrosivity; reactivity; toxicity characteristic constituents by the TCLP, which includes metals, pesticides and additional organics. TCLP analysis for metals shall not be required if total metals analysis do not indicate the potential for toxic leachate concentrations. Soil contaminated with used oil, hydraulic oil, or mineral oil may be a hazardous waste and should be tested using toxicity characteristic, for total organic halides. Excavated soil which is classified as a hazardous waste must be managed as a hazardous waste and treated or disposed of at an approved hazardous waste treatment/disposal facility.

(5) Following thermal treatment, a soil sample shall be collected at least hourly and composited over an eight operational hour maximum time interval or at least once every 400 tons, whichever is less. Each composite sample shall be analyzed for the parameters identified in Rule 17-775.400(1),(2)(a), and (3), F.A.C. If the clean soil criterion in Rule 17-775.400(2)(a), F.A.C., is exceeded, the soil may be analyzed for PAH and VOH parameters identified in Rule 17-775.400(2)(b), F.A.C.

(6) Soil contaminated with used oil, hydraulic oil, or mineral oil may contain polychlorinated biphenyls (PCB). Such soil containing PCBs shall not be thermally treated at a mobile soil thermal treatment facility. Further, such soil containing PCBs shall not be thermally treated pursuant to this chapter at a stationary soil thermal treatment facility unless each of the following conditions are met:

(a) Soil contaminated with used oil, hydraulic oil, or mineral oil shall be analyzed by EPA Method 3550/3665/8080 for PCB concentrations. Soil PCB concentrations must be equal to or less than 10 ppm in accordance with cleanup requirements described in 40 CFR, Part 761, Subpart G (Spills Cleanup Policy). Such soil shall not be blended, mixed or diluted to meet this specification.

(b) If the analytical results obtained pursuant to paragraph (a) above are equal to or greater than 20 ppb, a sample of the used oil, hydraulic oil, or mineral oil must be obtained by the generator of such material and analyzed using the same EPA methodology referenced above. The used oil, hydraulic oil, or mineral oil must be shown to have a PCB concentration of less than 50 ppm in accordance with the criteria for non-PCB oil and excluded products defined in 40 CFR, Section 761.3. If a sample of the used oil, hydraulic oil, or mineral oil is not available, a previous record of laboratory data and analytical results may be utilized to show the PCB concentration in the used oil, hydraulic oil, or mineral oil.

(c) The generator of soil contaminated with used oil, hydraulic oil, or mineral oil containing PCBs shall maintain a copy of laboratory data and analytical results obtained pursuant to paragraphs (a) and (b) above confirming that the concentrations specified in such paragraphs are met. The generator shall maintain such records for a period of three years which shall be available for inspection upon request of the Department.

(d) The owner or operator of the soil thermal treatment facility shall ensure that any contaminated soil containing PCBs no greater than the concentrations specified in

paragraph (a) above, is recycled or reused after treatment, into a finished product line, or disposed of at a permitted, lined landfill. Finished product lines which shall meet this requirement are cement, concrete, and asphalt cement.

(e) The owner or operator of the soil thermal treatment facility shall maintain records demonstrating that any contaminated soil containing PCBs which has been treated by such facility has been recycled or reused after treatment into a finished product line or disposed of at a permitted, lined landfill as specified in paragraph (d) above. Such records should be prepared at the time such treated soil is recycled or reused or disposed of in an approved landfill after treatment. The owner or operator shall maintain such records for a period of three years which shall be available for inspection upon request of the Department.

(f) Soils containing PCBs meeting the specifications of Chapter 17-775, F.A.C., may be treated in a soil thermal treatment facility if the air permit for the facility, issued pursuant to Chapter 17-296, F.A.C., allows the facility to treat soil containing PCBs.

Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.3071, 403.061, 403.062, F.S.
History: New 12-10-90, Amended 11-30-92.

17-775.500 Approval of Alternate Procedures

(1) The owner or operator of a facility subject to the provisions of this Chapter may request in writing a determination from the Department that any requirement of this Chapter should not apply to such facility, and shall request approval of alternate procedures.

(2) The request shall set forth at a minimum the following information:

(a) The facility for which an exception is sought;

(b) The specific provision of Chapter 17-775, F.A.C., from which an exception is sought;

(c) The basis for the exception;

(d) The alternate procedure or requirement for which approval is sought and a demonstration that the alternate procedure or requirement provides a substantially equivalent degree of protection for the lands, surface waters, or ground waters of the state as the established requirement; and

(e) A demonstration that the alternate procedure or requirement is at least as effective as the established procedure or requirement.

(3) The Secretary or the Secretary's designee shall approve or deny each alternate procedure using the criteria in subsection (2) and shall provide written notice of such action.

Specific Authority: 376.303, 376.3071, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: 12-10-90, Amended 11-30-92.

PART II
SPECIFIC CONDITIONS FOR STATIONARY FACILITIES

17-775.600 Security

(1) All stationary thermal treatment facilities shall take appropriate measures to assure protection of the general public.

Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: 12-10-90.

17-775.610 Ground Water Monitoring

(1) A ground water monitoring program, to provide assurances that ground water quality is maintained, shall be developed for each stationary facility.

(2) A ground water monitoring plan shall be provided to the Department as an attachment to the general permit application. The ground water monitoring plan shall be signed, sealed, and dated by a professional geologist. The monitoring plan shall contain the following information:

(a) Location(s) of the proposed unaffected natural background and downgradient monitoring well(s) and construction details of the monitoring well(s).

(b) Hydrogeological, physical, and chemical data for the site, including:

1. Direction and rate of ground water flow;
2. Background ground water quality;
3. Porosity, horizontal and vertical permeability for the aquifer(s), and the depth to, and lithology of the first confining bed(s);
4. Vertical permeability, thickness, and extent of any confining beds;
5. Topography, soil information, and surface water drainage systems surrounding the site; and
6. Inventory depth, construction details (well drilling logs), and cones of depression of water supply wells located within a one mile radius of the site.

(3) Monitoring wells shall be constructed in accordance with the provisions of Chapter 17-532, F.A.C., except as follows:

(a) The minimum inside diameter shall be two inches.

(b) Flush threaded couplings shall be used to join polyvinyl chloride (PVC) pipe.

(4) The ground water monitoring wells shall be sampled and analyzed on a quarterly basis for the following parameters using the designated test methods:

(a) Volatile Organic Aromatics

1. Benzene	EPA Method 602, 5030/8020, 5030/8021
2. Toluene	EPA Method 602, 5030/8020, or 5030/8021
3. Ethylbenzene	EPA Method 602, 5030/8020, or 5030/8021
4. Total Xylenes	EPA Method 602, 5030/8020, or 5030/8021
(b) Methyl Tert-Butyl Ether (MTBE)	EPA Method 602, 5030/8020, or 5030/8021
(c) Polynuclear Aromatic Hydrocarbons	EPA Method 610, 625, 8100, 8310, 8250 or 8270
(d) Metals*	
1. Arsenic	EPA Method 206.2, 206.3, 7060 or 7061
2. Barium	EPA Method 200.7, 208.1, 208.2, 3010/6010, 3010/7080 or 3020/7081
3. Cadmium	EPA Method 200.7, 213.1, 213.2, 3010/6010, 3010/7130 or 3020/7131
4. Chromium	EPA Method 200.7, 218.2, 3010/6010, or 3020/7191
5. Lead	EPA Method 239.2 or 3020/7421
6. Mercury	EPA Method 245.1, or 7470
7. Selenium	EPA Method 270.2, 270.3, 7740 or 7741
8. Silver	EPA Method 200.7, 271.1, 271.2, 6010, 7760 or 7761

*The most sensitive analytical method of those methods listed above shall be used if the metal(s) of interest is not detected in natural background levels. An annual summary of ground water monitoring data shall be submitted to the Department's district office on the date the general permit notice of intent was submitted to the Department.

(5) If sampling analyses indicate any of the above parameters exceed the unaffected natural background levels, the permittee shall notify the Department in writing within seven days of receiving analytical results.
Specific Authority: 376.303, 376.3071, 403.061, 403.0877, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: New 12-10-90, 11-30-92.

17-775.620 Receiving, Handling, and Stockpiling
(1) Each batch of contaminated soil shall be clearly identified by source and stockpiled separately until all sampling and analyses in accordance with Rule 17-775.410, F.A.C, are complete. Unless pretreatment soil samples are taken at the contamination site, a stockpile identification system shall be used which is consistent with the sample numbering system described in the Quality Assurance Standard Operating Procedures Manual for Soil Thermal Treatment Facilities. Once the contaminated soil is determined to be acceptable for treatment, soil batches may be mixed with other soil batches found acceptable for thermal treatment. All contaminated soils shall be stored separately and apart from all treated soils.
(2) Contaminated soil shall be stored pursuant to this Chapter in such a manner to prevent contact with rainfall or release of leachate to ground water or surface water. The following pre-treatment storage measures shall be provided at each facility:
(a) All soil shall be stored under a permanent cover structure designed and constructed to prevent rainfall to either directly or indirectly come into contact with the stockpiled soil.
(b) The soil shall be stored on a permanent floor designed and constructed to prevent seepage, which will maintain a maximum hydraulic conductivity of no more than 10^{-7}cm/sec through a minimum of four inches.
1. Plastic or synthetic liners as flooring shall not be considered as suitable alternates.
2. The floor structure shall be designed and constructed for leachate collection and control. A record keeping system shall be provided to record quantity of leachate collected and means of treatment or disposal.
(3) A covered structure and surface seal shall be provided as described in Rule 17-775.620(2)(b), F.A.C., to prevent soil or ground water contamination during crushing, screening, off loading, or other handling. If these areas are cleared of contaminated soil daily, surface sealing as described in Rule 17-775.620(2)(b), F.A.C., shall be provided.

(4) No leachate shall be discharged to soils, ground water, or surface water prior to treatment. Prior to discharge, treated leachate shall meet the standards established in Rule 17-3, F.A.C. Applicable permits for discharges to either surface water or ground water must be obtained prior to any discharge.
(5) Leachate may be treated in the thermal treatment facility.
(6) Until soil analyses have verified that the soil meets the clean soil criteria identified in Rule 17-775.400, F.A.C., treated soil shall be stockpiled on a permanent floor structure, which meets the criteria in Rule 17-775.620(2)(b).
(7) The maximum quantity of untreated soil stored at a thermal treatment facility shall be limited to 90 days treatment capacity based on the facility rated capacity stated in the Notice of Intent, Form 17-775.900(1).
Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: New 12-10-90, Amended 11-30-92.

PART III
SPECIFIC CONDITIONS FOR MOBILE FACILITIES

17-775.700 Notices and Security
(1) Any mobile thermal treatment facility which intends to treat contaminated soil, shall notify the following entities by registered mail at least three days prior to initiating operation at a contaminant site:
(a) The local City and County governments and local environmental agency, and
(b) The appropriate District Office of the Department.
(2) Any permitted mobile thermal treatment facility shall take appropriate measures to assure protection of the general public including the following:
(a) A security fence shall surround all areas where contaminated soil is being processed, including stockpiling, handling and burning areas. The fence shall extend at least six feet above ground surface. In lieu of a security fence, surveillance personnel on site at all times is an acceptable alternative.
(b) Gate accesses shall be locked when no attendant is present.
(c) Appropriate warning notices shall be clearly posted.
Specific Authority: 376.303, 376.3071, 403.061, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: New 12-10-90.

17-775.710 Excavating, Handling, and Stockpiling

(1) Mobile facilities shall operate only at sites with confirmed contaminated soils and may treat only soil native to the site.

(2) Soil which is excavated shall remain on-site and within the area of suspected ground water contamination until soil has been treated, and cleanup levels identified in Rule 17-775.400, F.A.C., have been confirmed.

(3) Excavated soil shall be stockpiled on an impermeable surface or a liner with a minimum thickness of five mils. The stockpile shall be covered by a secured plastic cover with a minimum thickness of five mils until treatment in the thermal treatment unit commences.

(4) To the greatest extent possible, soil treated by mobile facilities shall be returned to the original excavation pit.

(5) The stockpile area for untreated soil shall be graded to direct leachate flow to return to the original excavation pit.

Specific Authority: 376.303, 376.3071, 403.061, 403.087, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: New 12-10-90, Amended 11-30-92.

PART IV
SOIL THERMAL TREATMENT FACILITY FORMS

17-775.900 Forms

The forms and instructions used by the Department in the general permitting of soil thermal treatment facilities are adopted and incorporated by reference in this section. The forms are listed by rule number, which is also the form number, and with the subject title and effective date. Copies of forms may be obtained by writing to the Director, Division of Waste Management, Department of Environmental Regulation, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

(1) Notice of Intent to Use the General Permit to Construct/Operate a Soil Thermal Treatment Facility, 1990.

(2) Untreated Soil Reporting Form, 1992.

(3) Treated Soil Reporting Form, 1990.

Specific Authority: 376.303, 376.3071, 403.061, 403.087, F.S.
Law Implemented: 376.303, 376.3071, F.S.
History: New 12-10-90, Amended 11-30-92.

ATTACHMENT B

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	68.0 degrees F.
Density of water	:	62.3 lb/ft^3
Density of air	:	0.0752 lb/ft^3
Viscosity of water	:	6.75E-04 lb/ft.s
Viscosity of air	:	1.19E-05 lb/ft.s
Surface tension of water	:	73 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Benzene
Molecular weight	:	78.1 g/mol
Boiling point	:	176 degrees F.
Molal volume at boiling point	:	0.0960 L/mol
Henry's Constant	:	0.23000
Temperature Constant	:	1849 deg K
Molecular diffusivity in air	:	1.01E-04 ft^2/s
Molecular diffusivity in water	:	9.59E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size	:	2.00 inch
Specific Area	:	47.9 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	11.0 ft
Air friction factor	:	15

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 2/2

LOADING RATES

Water mass loading rate	:	1.11E+00 lb/ft^2.s	*
Air mass loading rate	:	4.00E-02 lb/ft^2.s	*
Water volumetric loading rate	:	7.96E+00 gpm/ft^2	*
Air volumetric loading rate	:	2.39E+02 gpm/ft^2	*
Air pressure gradient	:	<.06 " H2O/ft	#
Volumetric air/water ratio	:	30.0	
Stripping factor	:	6.9	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	39.8 %	
Wetted packing area	:	19.0 ft^2/ft^3	*
Transfer rate constant in water	:	4.78E-04 ft/s	
Transfer rate constant in air	:	1.29E-02 ft/s	
Overall transfer rate constant	:	4.12E-04 ft/s	
Overall mass transfer coefficient	:	7.84E-03 1/s	
NTU	:	4.5866	
HTU	:	2.3983 ft	

CONTAMINANT REMOVAL

Influent concentration	:	5.50E+01 ug/L	
Effluent concentration	:	9.34E-01 ug/L	
Fraction removed	:	98.3 %	
Mass of contaminant removed	:	5.17E-03 lb/ft^2.day	*
Concentration in airstream	:	5.10E-02 mg/ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	68.0 degrees F.
Density of water	:	62.3 lb/ft^3
Density of air	:	0.0752 lb/ft^3
Viscosity of water	:	6.75E-04 lb/ft.s
Viscosity of air	:	1.19E-05 lb/ft.s
Surface tension of water	:	73 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Benzene
Molecular weight	:	78.1 g/mol
Boiling point	:	176 degrees F.
Molal volume at boiling point	:	0.0960 L/mol
Henry's Constant	:	0.23000
Temperature Constant	:	1849 deg K
Molecular diffusivity in air	:	1.01E-04 ft^2/s
Molecular diffusivity in water	:	9.59E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size	:	2.00 inch
Specific Area	:	47.9 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	11.0 ft
Air friction factor	:	15

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 2/2

LOADING RATES

Water mass loading rate	:	1.11E+00 lb/ft^2.s	*
Air mass loading rate	:	4.00E-02 lb/ft^2.s	*
Water volumetric loading rate	:	7.96E+00 gpm/ft^2	*
Air volumetric loading rate	:	2.39E+02 gpm/ft^2	*
Air pressure gradient	:	<.06 " H2O/ft	#
Volumetric air/water ratio	:	30.0	
Stripping factor	:	6.9	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	39.8 %	
Wetted packing area	:	19.0 ft^2/ft^3	*
Transfer rate constant in water	:	4.78E-04 ft/s	
Transfer rate constant in air	:	1.29E-02 ft/s	
Overall transfer rate constant	:	4.12E-04 ft/s	
Overall mass transfer coefficient	:	7.84E-03 1/s	
NTU	:	4.5866	
HTU	:	2.3983 ft	

CONTAMINANT REMOVAL

Influent concentration	:	1.40 mg/L	
Effluent concentration	:	2.38E+01 ug/L	
Fraction removed	:	98.3 %	
Mass of contaminant removed	:	1.32E-01 lb/ft^2.day	*
Concentration in airstream	:	1.30E+00 mg/ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	68.0 degrees F.
Density of water	:	62.3 lb/ft^3
Density of air	:	0.0752 lb/ft^3
Viscosity of water	:	6.75E-04 lb/ft.s
Viscosity of air	:	1.19E-05 lb/ft.s
Surface tension of water	:	73 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Benzene
Molecular weight	:	78.1 g/mol
Boiling point	:	176 degrees F.
Molal volume at boiling point	:	0.0960 L/mol
Henry's Constant	:	0.23000
Temperature Constant	:	1849 deg K
Molecular diffusivity in air	:	1.01E-04 ft^2/s
Molecular diffusivity in water	:	9.59E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size	:	2.00 inch
Specific Area	:	47.9 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	11.0 ft
Air friction factor	:	15

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 2/2

LOADING RATES

Water mass loading rate 50 GPM	:	2.21E+00 lb/ft^2.s	*
Air mass loading rate	:	1.87E-01 lb/ft^2.s	*
Water volumetric loading rate	:	1.59E+01 gpm/ft^2	*
Air volumetric loading rate	:	1.11E+03 gpm/ft^2	*
Air pressure gradient	:	<.06 " H2O/ft	#
Volumetric air/water ratio	:	70.0	
Stripping factor	:	16.1	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	48.8 %	
Wetted packing area	:	23.3 ft^2/ft^3	*
Transfer rate constant in water	:	6.62E-04 ft/s	
Transfer rate constant in air	:	3.41E-02 ft/s	
Overall transfer rate constant	:	6.10E-04 ft/s	
Overall mass transfer coefficient	:	1.42E-02 1/s	
NTU	:	4.3236	
HTU	:	2.5442 ft	

CONTAMINANT REMOVAL

Influent concentration	:	5.50E+01 ug/L	
Effluent concentration	:	8.95E-01 ug/L	
Fraction removed	:	98.4 %	
Mass of contaminant removed	:	1.03E-02 lb/ft^2.day	*
Concentration in airstream	:	2.19E-02 mg/ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	68.0 degrees F.
Density of water	:	62.3 lb/ft^3
Density of air	:	0.0752 lb/ft^3
Viscosity of water	:	6.75E-04 lb/ft.s
Viscosity of air	:	1.19E-05 lb/ft.s
Surface tension of water	:	73 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Benzene
Molecular weight	:	78.1 g/mol
Boiling point	:	176 degrees F.
Molal volume at boiling point	:	0.0960 L/mol
Henry's Constant	:	0.23000
Temperature Constant	:	1849 deg K
Molecular diffusivity in air	:	1.01E-04 ft^2/s
Molecular diffusivity in water	:	9.59E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size.	:	2.00 inch
Specific Area	:	47.9 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	11.0 ft
Air friction factor	:	15

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : NFF Cecil Field DATE : 12/1/1994

ENGINEER : BGS PAGE : 2/2

LOADING RATES

Water mass loading rate (75 gpm)	:	3.32E+00 lb/ft^2.s	*
Air mass loading rate	:	7.61E-01 lb/ft^2.s	*
Water volumetric loading rate	:	2.39E+01 gpm/ft^2	*
Air volumetric loading rate	:	4.54E+03 gpm/ft^2	*
Air pressure gradient	:	0.935 " H2O/ft	#
Volumetric air/water ratio	:	190.0	
Stripping factor	:	43.7	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	54.5 %	
Wetted packing area	:	26.1 ft^2/ft^3	*
Transfer rate constant in water	:	8.06E-04 ft/s	
Transfer rate constant in air	:	7.37E-02 ft/s	
Overall transfer rate constant	:	7.69E-04 ft/s	
Overall mass transfer coefficient	:	2.01E-02 1/s	
NTU	:	4.1385	
HTU	:	2.6580 ft	

CONTAMINANT REMOVAL

Influent concentration	:	5.50E+01 ug/L	
Effluent concentration	:	9.43E-01 ug/L	
Fraction removed	:	98.3 %	
Mass of contaminant removed	:	1.55E-02 lb/ft^2.day	*
Concentration in airstream	:	8.06E-03 mg/ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

ShallowTray™
low profile air strippers

System Performance Estimate

Client and Proposal Information:

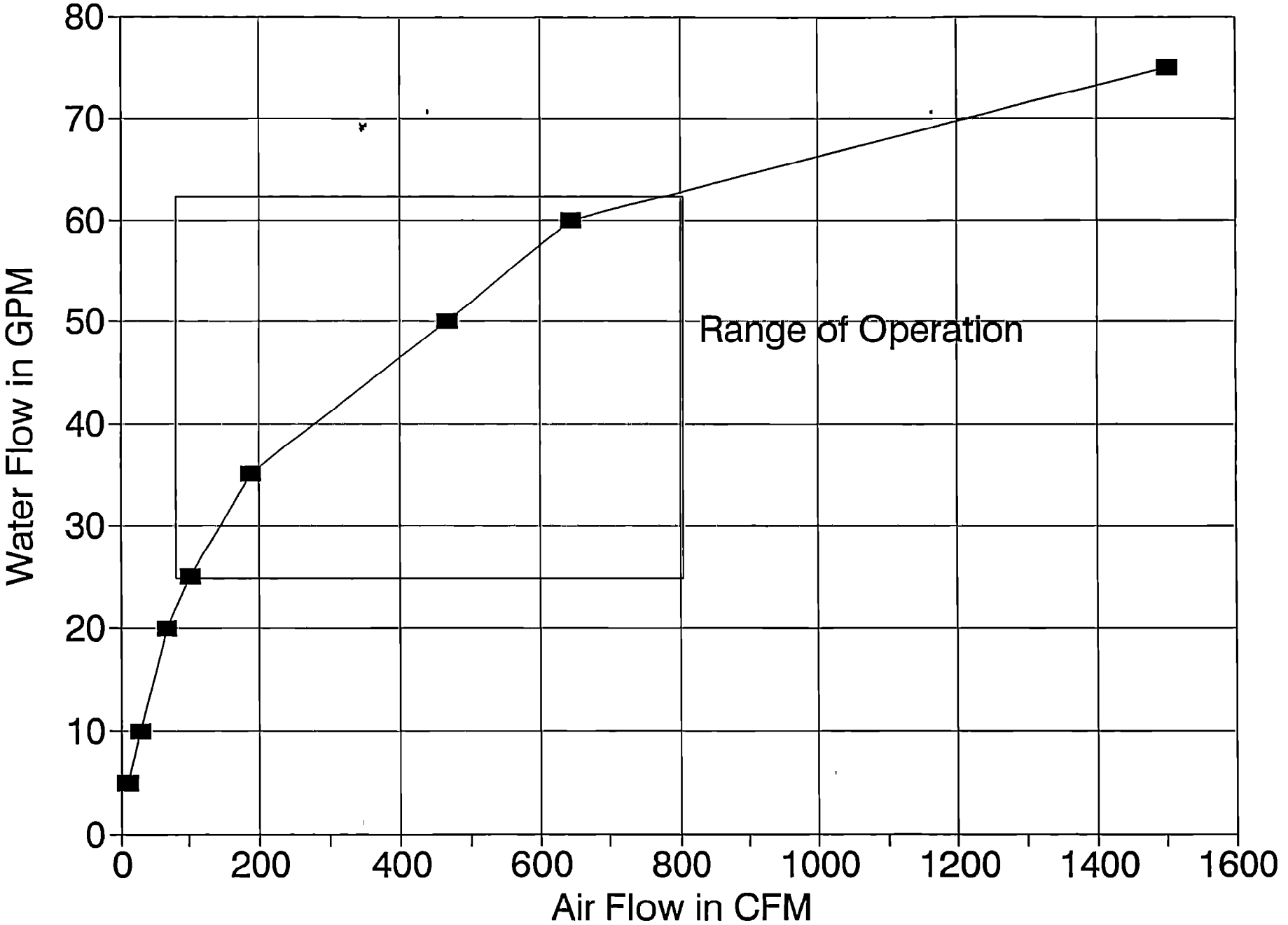
NFF Cecil Field
Water treatment for dewatering system

Model Chosen:	2300
Water Flow Rate:	25.0 gpm
Air Flow Rate:	300 cfm
Water Temp:	68.0 F
Air Temp:	70.0 F
A/W Ratio:	89.8 cu. ft/ cu. ft
Safety Factor:	None

Contaminant	Untreated Influent	Model 2311 Effluent	Model 2321 Effluent	Model 2331 Effluent	Model 2341 Effluent
		Water Air(lbs/hr) % removal	Water Air(lbs/hr) % removal	Water Air(lbs/hr) % removal	Water Air(lbs/hr) % removal
Benzene	**55 ppb**	**6 ppb** 0.000613 90.8289%	**1 ppb** 0.000675 99.1589%	**<1 ppb** 0.000687 99.9229%	**<1 ppb** 0.000688 99.9929%
BTEX (as Benzene)	**1400 ppb**	**129 ppb** 0.015894 90.8289%	**12 ppb** 0.017358 99.1589%	**2 ppb** 0.017483 99.9229%	**<1 ppb** 0.017506 99.9929%

This report has been generated by ShallowTray Modeler software version 1.4.1. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. The software will accurately predict the system performance when both the equipment and the software are operated according to the written documentation and standard operation.
N East Environmental Products, Inc. cannot be responsible for incidental or consequential damages resulting from the improper o, ion of either the software or the air stripping equipment. Report generated: 12/1/1994

Copyright 1992 North East Environmental Products, Inc. * 17 Technology Drive, West Lebanon, NH 03784
Voice: 603-298-7061 FAX: 603-298-7063 * All Rights Reserved.


Water Flow in GPM
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
Air Flow in CFM
Range of Operation

12-02-94
14:46:23

*** SCREEN-1.2 MODEL RUN ***
*** VERSION DATED 90XXX ***

NrF - Air Stripper Emissions

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.8670E-04
STACK HEIGHT (M)	=	4.88
STK INSIDE DIAM (M)	=	.61
STK EXIT VELOCITY (M/S)	=	.1621
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IOPT (1=URB,2=RUR)	=	2
BUILDING HEIGHT (M)	=	.00
MIN HORIZ BLDG DIM (M)	=	.00
MAX HORIZ BLDG DIM (M)	=	.00

****
*** SUMMARY OF SCREEN MODÉL RESULTS ***
****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	.9144	100.	0.

****
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = .00 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES **

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	
100.	.9144	6	1.0	1.0	5000.0	3.5	4.1	2.3	NO
200.	.5999	6	1.0	1.0	5000.0	3.5	7.7	4.1	NO
300.	.3582	6	1.0	1.0	5000.0	3.5	11.2	5.6	NO
400.	.2358	6	1.0	1.0	5000.0	3.5	14.6	7.0	NO
500.	.1674	6	1.0	1.0	5000.0	3.5	18.0	8.4	NO
600.	.1255	6	1.0	1.0	5000.0	3.5	21.2	9.7	NO
700.	.9796E-01	6	1.0	1.0	5000.0	3.5	24.5	10.9	NO
800.	.7982E-01	6	1.0	1.0	5000.0	3.5	27.6	12.0	NO
900.	.6655E-01	6	1.0	1.0	5000.0	3.5	30.8	13.0	NO

1000.	.5652E-01	6	1.0	1.0	5000.0	3.5	33.9	14.0	NO
1100.	.4896E-01	6	1.0	1.0	5000.0	3.5	37.0	14.8	NO
1200.	.4293E-01	6	1.0	1.0	5000.0	3.5	40.0	15.7	NO
1300.	.3804E-01	6	1.0	1.0	5000.0	3.5	43.0	16.5	NO
1400.	.3400E-01	6	1.0	1.0	5000.0	3.5	46.0	17.3	NO
1500.	.3062E-01	6	1.0	1.0	5000.0	3.5	49.0	18.0	NO
1600.	.2776E-01	6	1.0	1.0	5000.0	3.5	52.0	18.8	NO
1700.	.2532E-01	6	1.0	1.0	5000.0	3.5	54.9	19.5	NO
1800.	.2321E-01	6	1.0	1.0	5000.0	3.5	57.9	20.2	NO
1900.	.2138E-01	6	1.0	1.0	5000.0	3.5	60.8	20.9	NO
2000.	.1977E-01	6	1.0	1.0	5000.0	3.5	63.7	21.6	NO
2100.	.1843E-01	6	1.0	1.0	5000.0	3.5	66.6	22.2	NO
2200.	.1724E-01	6	1.0	1.0	5000.0	3.5	69.4	22.8	NO
2300.	.1617E-01	6	1.0	1.0	5000.0	3.5	72.3	23.3	NO
2400.	.1521E-01	6	1.0	1.0	5000.0	3.5	75.1	23.9	NO
2500.	.1434E-01	6	1.0	1.0	5000.0	3.5	77.9	24.4	NO
2600.	.1356E-01	6	1.0	1.0	5000.0	3.5	80.8	25.0	NO
2700.	.1284E-01	6	1.0	1.0	5000.0	3.5	83.6	25.5	NO
2800.	.1219E-01	6	1.0	1.0	5000.0	3.5	86.4	26.0	NO
2900.	.1159E-01	6	1.0	1.0	5000.0	3.5	89.1	26.5	NO
3000.	.1103E-01	6	1.0	1.0	5000.0	3.5	91.9	27.0	NO
3500.	.8946E-02	6	1.0	1.0	5000.0	3.5	105.7	29.0	NO
4000.	.7461E-02	6	1.0	1.0	5000.0	3.5	119.2	30.8	NO
4500.	.6357E-02	6	1.0	1.0	5000.0	3.5	132.5	32.6	NO
5000.	.5509E-02	6	1.0	1.0	5000.0	3.5	145.7	34.2	NO
5500.	.4840E-02	6	1.0	1.0	5000.0	3.5	158.7	35.8	NO
6000.	.4300E-02	6	1.0	1.0	5000.0	3.5	171.6	37.2	NO
6500.	.3858E-02	6	1.0	1.0	5000.0	3.5	184.3	38.6	NO
7000.	.3489E-02	6	1.0	1.0	5000.0	3.5	197.0	40.0	NO
7500.	.3188E-02	6	1.0	1.0	5000.0	3.5	209.5	41.2	NO
8000.	.2930E-02	6	1.0	1.0	5000.0	3.5	222.0	42.3	NO
8500.	.2707E-02	6	1.0	1.0	5000.0	3.5	234.3	43.4	NO
9000.	.2512E-02	6	1.0	1.0	5000.0	3.5	246.6	44.4	NO
9500.	.2341E-02	6	1.0	1.0	5000.0	3.5	258.8	45.4	NO
10000.	.2190E-02	6	1.0	1.0	5000.0	3.5	270.9	46.4	NO
15000.	.1292E-02	6	1.0	1.0	5000.0	3.5	388.4	54.9	NO
20000.	.9121E-03	6	1.0	1.0	5000.0	3.5	500.9	60.3	NO
25000.	.6968E-03	6	1.0	1.0	5000.0	3.5	609.8	64.9	NO
30000.	.5595E-03	6	1.0	1.0	5000.0	3.5	715.6	68.8	NO
40000.	.4022E-03	6	1.0	1.0	5000.0	3.5	920.2	74.5	NO
50000.	.3116E-03	6	1.0	1.0	5000.0	3.5	1117.4	79.2	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

100.	.9144	6	1.0	1.0	5000.0	3.5	4.1	2.3	NO

DIST = DISTANCE FROM THE SOURCE
CONC = MAXIMUM GROUND LEVEL CONCENTRATION
STAB = ATMOSPHERIC STABILITY CLASS (1=A, 2=B, 3=C, 4=D, 5=E, 6=F)
U10M = WIND SPEED AT THE 10-M LEVEL
USTK = WIND SPEED AT STACK HEIGHT
MIX HT = MIXING HEIGHT
PLUME HT= PLUME CENTERLINE HEIGHT
SIGMA Y = LATERAL DISPERSION PARAMETER
SIGMA Z = VERTICAL DISPERSION PARAMETER
DWASH = BUILDING DOWNWASH:
DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

```
************************************
*** USER SPECIFIED AVERAGING TIMES ***
*  ***********************************
```

ESTIMATED MAXIMUM CONCENTRATION FOR 8 HR AVERAGING TIME = .64008(þ .18288)

Post-it™ Fax Note 7671
To BRYAN KIZER, 18442
Co./Dept. SOUTHDIV
Phone # (803) 743-0816
Fax #
Date 2/17/95 # of pages ▶ 19
From CELORA JACKSON
Co. ABB-ES
Phone # (904) 656-1293
Fax # (904) 818-0742

MEMORANDUM

TO: Bryan Kizer

FROM: John Kaiser, Task Order Manager
Mike Dunaway
Celora Jackson
Joe Ullo

DATE: February 17, 1995

SUBJECT: North Fuel Farm, Cecil Field
Phase I, Task 2; Free Product Removal

BACKGROUND

On January 24, 1995, a joint meeting including ABB Environmental Services, Inc. (ABB-ES), Bechtel Environmental Inc. (BEI), SOUTHDIV, and Cecil Field personnel was conducted at Cecil Field. It was determined in this meeting that several actions were to be implemented to identify the source of contamination and remedy the free product and soil contamination that currently has been identified at the site. These actions include the cleaning, inspecting, and repairing of the fuel storage tanks, an initial action to remove free product, and an initial action to remove excessively contaminated soil. Each of theses actions will be addressed separately but implementation could occur concurrently.

The cleaning, inspecting, and repairing of the fuel storage tanks will be performed by BEI. The fuel storage tanks will be cleaned, inspected, and repaired in accordance with the workplan submitted by Enterprise. The initiatives for the fuel storage tanks will take place concurrently with the implementation of the initial actions for free product and soil removal.

ABB-ES was tasked with submitting a Technical Memorandum that addresses the removal of free product at the North Fuel Farm (NFF), Naval Air Station (NAS) Cecil Field, Jacksonville, Florida. The remedial action objective of this memorandum is to remove the free product from the aquifer to the extent practicable in accordance with Chapter 62-770.300(3), Florida Administrative Code (FAC).

In 1991, ABB-ES conducted a Contamination Assessment (CA) to characterize and assess the vertical and horizontal extent of contamination at the NFF. Thirty-seven soil borings, 26 shallow monitoring wells, and 4 deep monitoring wells were installed at the site.

During this assessment, free product was measured in seven of the twenty-six shallow monitoring wells installed at the site. Apparent thickness of free product in the monitoring wells measured during 1991 and 1992, was from 0.02-foot to 6.00-feet.

The apparent thickness of free product contained in each monitoring well was calculated by subtracting the depth to free product from the depth to groundwater. Apparent free product thickness in the monitoring wells measured in March 1994, was from 0.22-foot to 5.03-feet. A generalized contour map of apparent free product thickness based on measurements collected March 1994, is presented in Figure 1.

The apparent thickness of free product measured in the monitoring wells is affected by the seasonal rains that cause the groundwater table to fluctuate in a range from 1 to 4 feet. The average groundwater elevation below the tank mound is from 77 to 78 feet mean sea level. A mounding effect in the groundwater below the tank farm induces migration of free product down the tank mound, radially in the west and south directions.

However, the empirical relationship that exists to convert the apparent thickness of free product measured in the monitoring wells to the true thickness of free product present in the subsurface formation, is typically one fourth of the apparent thickness of free product measured. A baildown test conducted by ABB-ES has determined that for this site the factor for converting apparent thickness of free product to true thickness of free product is one third.

Volume estimates of free product in the subsurface based on apparent thickness must also account for the porosity (or pore space) of the subsurface and the fraction of pore space that is occupied by free product (or percent saturation). Further, the volume of total recoverable free product is a fraction of the calculated volume. Free product adsorbed to soil (fraction of 20% sorbed to 80% recoverable) may not be recovered by collection of free product floating on groundwater.

Based on the approximate extent of the free product plume, the estimated maximum volume of free product present is 87,000-gallons. This quantity is based on the apparent thickness of free product at the site. Included also in this quantity is the product plume beneath the tanks and outside the tank perimeter fence. The overall plume geometry may be more comparable to separate "product pools" surrounding each tank. Since these calculations are all estimates, the actual conditions will be determined in the field. The free product volume calculations are contained in Attachment A.

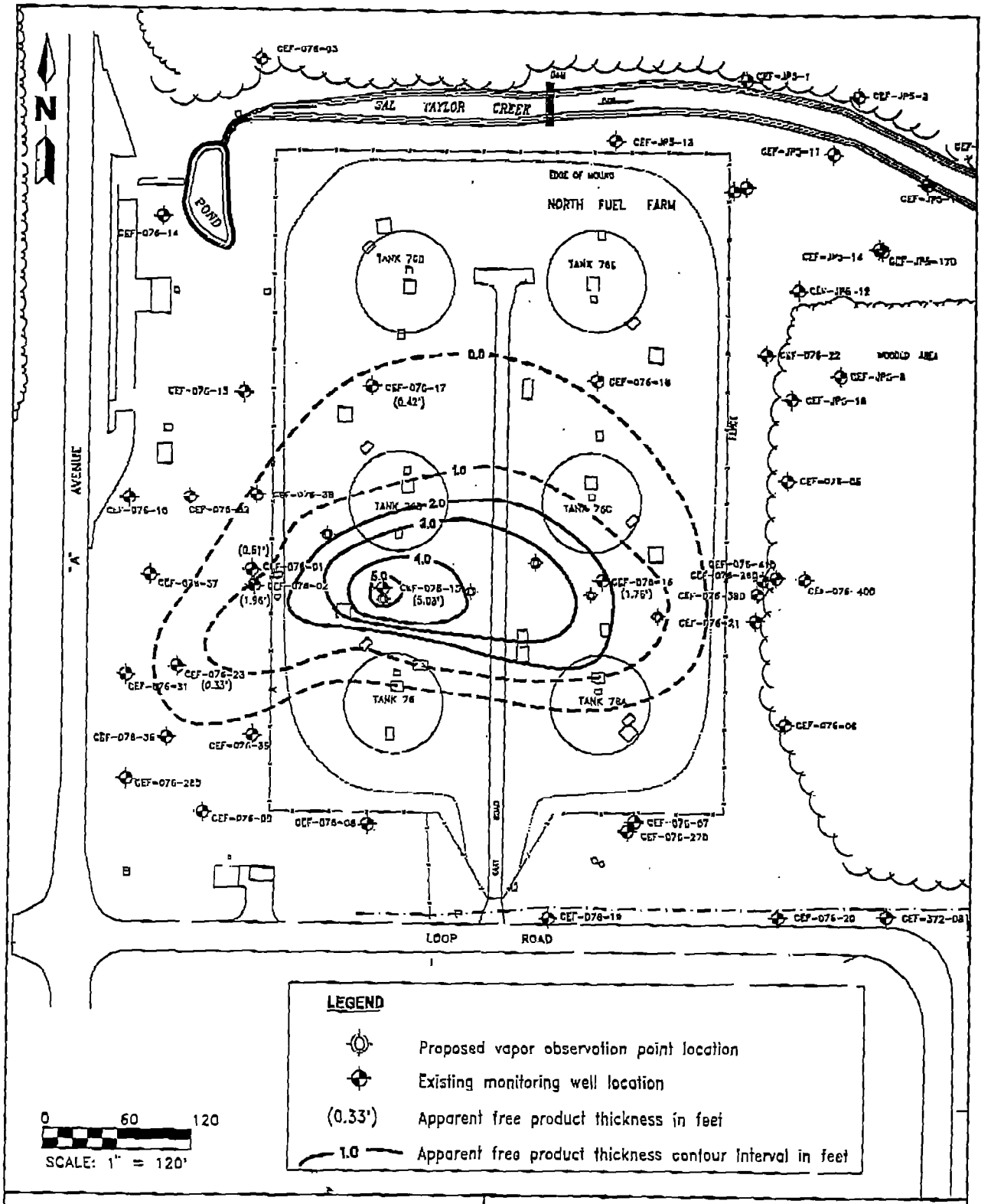


FIGURE 1
GENERALIZED APPARENT THICKNESS OF FREE PRODUCT, MARCH 1994

TECHNICAL MEMORANDUM
NORTH FUEL FARM SITE

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

H:\CECIL\NFFPROD\WDW\02-17-95

Product Recovery

The overall performance objective of the product recovery system is to remove the largest volume of free product at the North Fuel Farm in the shortest period of time. To achieve this objective, system design which takes maximum advantage of the existing infrastructure is recommended. The proposed system can be augmented at a later date to further improve system performance, if desired by the Navy. However, this design is an IRA, and a more comprehensive free product recovery system will be designed during the Remedial Action Plan (RAP) phase, if necessary.

Recovery Rationale - Technology Selection

The horizontal extent of the free product plume shown in Figure 1, indicates migration of free product down the tank mound, radially in the west and south directions. The tank mound free product extent will be addressed separately from the free product that has migrated down the mound and on the other side of the fence.

The following alternatives were considered for free product recovery in the tank area. They are described briefly with pros and cons in Table 1.

- Bioslurping
- Wells and skimmer pumps
- Perimeter collection system
- Horizontal recovery wells

Table 1
Screening Alternatives

Technology	Description	Pros	Cons
Bioslurping	Vacuum enhanced free product recovery – a suction tube is dipped into a well, where it skims off free product floating on the water table Because the primary mode of recovery is based on an air suction, bioventing is expected and modifications for soil vapor extraction can be made if necessary	• Subsurface obstruction would be limited to extraction wells only • Combines two remediation technologies: Bioventing and Free product recovery • Only one system is necessary for product removal • Existing wells could be utilized for product recovery	• Recovery wells would be needed to cover the aerial extent • Low water table could create problems for vacuum lift
Skimmer Pumps	Product-only pumps are installed within wells to recover free product only	• Subsurface obstruction would be limited to extraction wells only • Pumps will only be in operation while product is present	• Separate pump will be necessary in each well which could require more O&M • Recovery wells would be needed to cover the aerial extent • Small diameter of existing wells limits choice of pumps
Perimeter Collection System	Subsurface drainage network utilizing gravity flow to collect product saturated water at the perimeter	• Gravity flow will centralize recovery at perimeter location	• Extensive piping network will be required at depths up to 20' bls • Water and product would be recovered simultaneously • Obstructions could be met in the subsurface • Tanks will limit accessibility for areas beneath the tanks
Horizontal Recovery Wells	Horizontal recovery wells would be installed at the groundwater free product interface Free product and groundwater would be extracted either by pumping or vacuuming	• Area of influence would be maximized per well if the interface were met	• Subsurface obstructions make drilling horizontally risky • Interface may vary causing the recovery system to be inoperable at times • Uncertainty for recoveries are inherent due to the use of vertical rather than horizontal conductivities - low recovery rates may be encountered • Entry angle for drilling would require an entry close to 200' from the tank area

The recommended product recovery system consists of utilizing the bioslurping technology in two existing monitoring wells (CEF-076-15, and CEF-076-16) and the installation of six push-probe observation wells. The observation well locations have been presented in Figure 1. The actual location of these wells will be determined in the field.

Bioslurper systems are designed to recover free product via vacuum-enhanced pumping, while simultaneously initiating the remediation of the vadose zone soils via bioventing. The utilization of a vacuum system to enhance free product recovery also increases the hydraulic gradient and aquifer transmissivity which enhances fluid recovery in the wells. With bioslurping, unlike conventional product recovery using skimmer pumps, there is no cone of depression and associated oil smear zone. Once installed, the flexibility exists to modify the bioslurper system to treat deeper soil and groundwater. Once the free product has been removed from the monitoring wells, it will then flow by gravity into an air-liquid separation system then flow into an oil-water separation system. The recovered free product will be stored onsite until it is either sent offsite for disposal or recycled at the direction of facility personnel. Any groundwater collected in the separation process will be direct discharged to the sanitary sewer for treatment at the POTW. A schematic of the bioslurper system is shown on Figure 2.

The observation wells are recommended in the vicinity of the monitoring wells used for bioslurping. Three observation wells will be placed near the bioslurper wells, CEF-076-15 and CEF-076-16. These wells are to be used to monitor the effectiveness of the recovery system, i.e., to measure the radius of influence of the vacuum created by the bioslurper system.

The free product as defined west of the tank mound, will be recovered from a separate recovery system. The free product recovery system consists of two linear recovery trenches filled with high permeability, inert granular material. Collection sumps will be installed in the trenches at various lengths, and equipped with total fluids pumps. The total fluids pumped from each sump will flow into the same oil-water separator being recommended for the bioslurper system. The recovered free product will be stored onsite until it is either sent offsite for disposal or recycled at the direction of facility personnel. The recovered groundwater will be direct discharged to the sanitary sewer for treatment at the POTW.

Groundwater depression is often implemented in conjunction with product recovery to induce a cone of depression into which free product may drain. However, based on the guidance listed below, groundwater depression is not being considered.

- As stated in Chapter 62-770.300(2), FAC, free product recovery which requires dewatering or groundwater extraction which causes groundwater table depression is prohibited unless approval by the Florida Department of Environmental Protection (FDEP) as an alternate procedure.

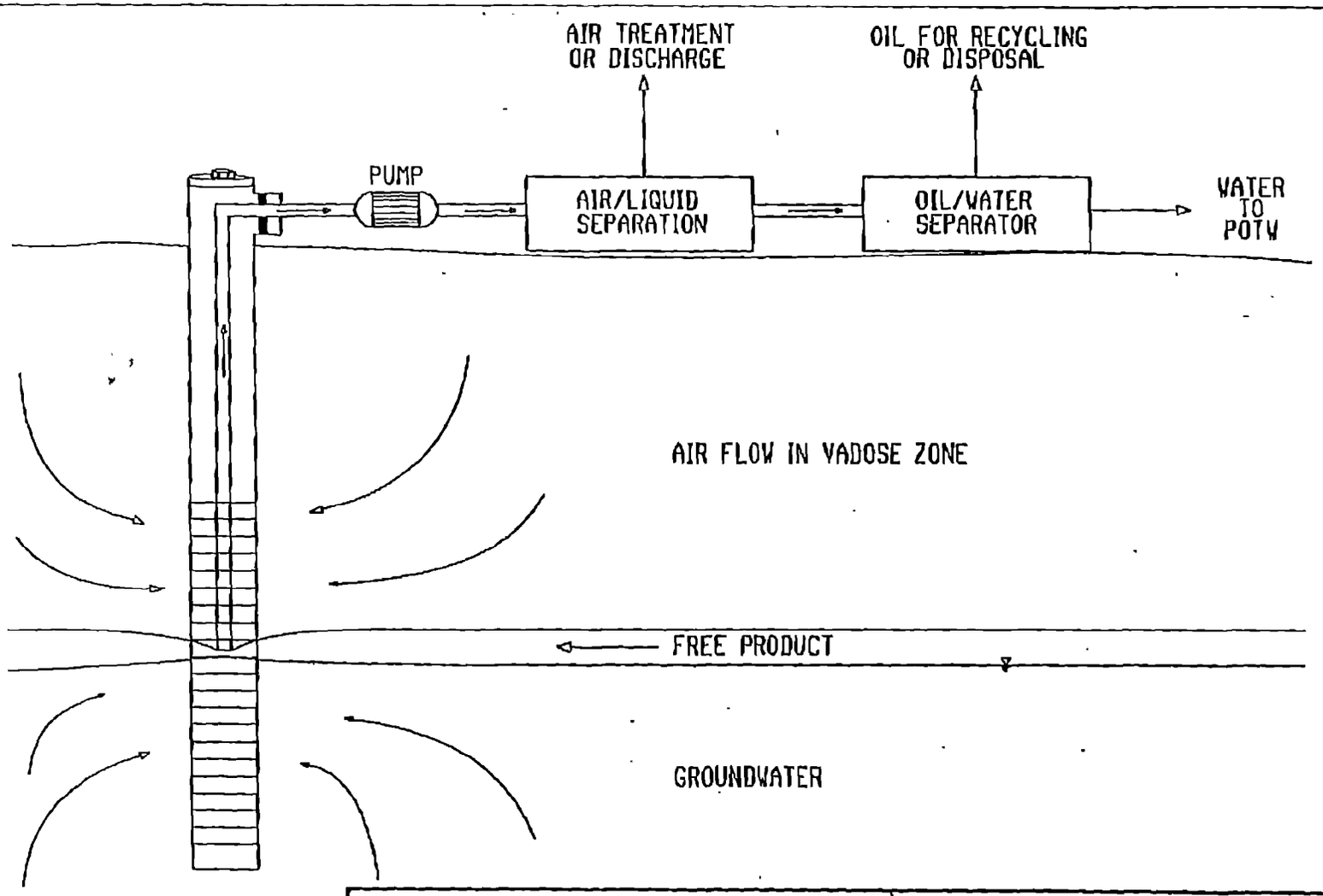


FIGURE 2
SCHEMATIC BIOSLURPING SYSTEM

TECHNICAL MEMORANDUM
NORTH FUEL FARM SITE

NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Bioslurper Well Design

The calculations for the bioslurping well design are contained in Attachment B. The calculations indicate the existing monitoring wells used for slurping has a design vacuum of 60 inches of water at the wellhead. The water vacuum at the wellhead would provide an equivalent hydraulic gradient increase of the groundwater depression in the well.

System Components

Figure 2 shows the aboveground components of the biosluper system. The bioslurper pump is a 10-hp pump capable of air extraction rates up to 200 cubic feet per minute (cfm). A 20,000-gallon air-liquid storage tank is connected to the vacuum pump. The tank should be equipped with a vent pipe to allow vapors an emission point and a tank-full shut-off sensor. A 25-gpm oil-water separator is connected to the tank-effluent line to receive any groundwater drawn from the bottom of the storage tank. The free product will gravity flow from the oil-water separator into a 500-gallon storage tank for disposal or recycling. Free product will be removed from the 20,00-gallon tank on an as-needed basis. The groundwater will gravity drain into the sanitary sewer for treatment at the POTW. A flow totalizer meter should be installed to quantify the volume of groundwater discharged to the sanitary sewer. The vacuum pump will be located on the tank mound near the bioslurper wells. The other pieces of equipment in the recovery system will be located at the toe of the mound. The location of all pieces of equipment will be determined in the field.

The bioslurper pump is connected to a 2-inch diameter schedule 80 PVC manifold that Tee's into each bioslurper well via 1-inch diameter suction lines. Each 1-inch suction line is connected to a 1-inch PVC drop tube, which enters the wellhead through a vacuum-tight seal and extends to the groundwater-product interface in each well. A ball valve should be placed at the wellhead of each extraction well to allow for release of the vacuum from the well.

The recovery trenches will be located on the west side of the tank mound and will be orientated in north and south directions. The trench designated as Trench 1, will be the trench located approximately 5 feet from the west side mound fence. The trench designated as Trench 2, will be located approximately 60 feet from Trench 1. The actual locations will be determined in the field. Trench dimensions are specified in Table 2. Trench orientations and lengths were chosen to maximize the likelihood of intercepting free product and contaminated groundwater based on the observed distribution of total volatile contamination at the site.

Trench depth will be approximately 6 feet bls depending on surface topography to intercept both free product and groundwater. Groundwater occurs at approximately 4 feet bls, subject to seasonal fluctuations. A collection sump will be placed vertically in the trenches to recover the free product and groundwater that collects in the trench, as applicable. Each sump will be placed approximately half the distance of the trench length which is 100 feet in Trench 1 and 75 feet in Trench 2. Sumps will be completed at the surface with vented utility boxes with removable water-tight covers. The utility boxes will be large enough for placement of valves, piping, and controls to service the pumps. Table 2 presents the dimensions and materials for the collection sumps.

Table 2
Recovery Trench and Collection Sump Specifications

Free Product Removal Technical Memorandum
North Fuel Farm, NAS Cecil Field
Jacksonville, Florida

Parameter	Trench 1	Trench 2
Length, feet	200	150
Width, feet	2	2
Depth, feet	6	6
Spacing, feet	5	60
Sump location	100	75
Sumps per trench	1	1
Sump diameter, feet	3	3
Sump depth, feet	6	6
Screen slot size, inch	0.25	0.25
Material	Corrugated plastic, or equivalent	Corrugated plastic, or equivalent

The total fluids recovered from the collection sump in each trench will flow by gravity into the 25-gpm oil-water separator. The piping coming from each of the sumps will be manifolded and sent to the same oil-water separator used by the bioslurper system. The free product will gravity flow from the oil-water separator into a 500-gallon storage tank for disposal or recycling. The groundwater will gravity drain into the sanitary sewer lift station for treatment at the POTW.

The total fluid pumps used in Trench 1 and 2 will have a designed flow rate of 10 gpm and 7 gpm, respectively. The pumps will need to pump against an estimated head of 20 feet. The pumps required will be determined in the field, since the designed head is based upon where we conceptualized the recovery equipment to be located this, however will be determined in the field also.

System Monitoring and Modifications

A monitoring program is designed to evaluate the performance, progress, and effectiveness of the system installed and to identify possible methods of improving the performance. The product recovery system will require at a minimum weekly operation and maintenance checks. The success of the bioslurper system will depend on the correct positioning of the drop tube in the free product interface.

It is anticipated that the recovery system shall be effective in removing the majority of the recoverable floating free product at the North Fuel Farm. After the implementation and evaluation of the product recovery system, the Navy may desire a more expanded approach to remove any remaining free product, through the installation of additional recovery wells.

Additionally, the product thickness, amounts of product recovered, and radius of influence measured in the observation wells will be recorded during each visit.

Schedule

The estimate for time to complete is based on data obtained from a bioslurping operation conducted at NAS Fallon which is located six miles southwest of Fallon, Nevada.

At NAS Fallon, the total of free product recovered in the first year of operation was 6,469 gallons. The total groundwater recovered during this same time frame was 180,385 gallons. The ratio of groundwater to product recovered is 30:1. Based on this ratio, preliminary estimates can be made for the rate of product recovery at the North Fuel Farm.

One gallon per minute is the design flow rate from the two bioslurper wells. Assuming the worst case of recovering one part hydrocarbon for thirty parts groundwater and using the former estimate of 87,000 gallons of product, five years would be necessary to remove product at the North Fuel Farm. This equates to a product recovery rate of approximately 50 gallons per day. This estimate is based on limited data from NAS Fallon. Due to differences in site conditions, the actual recovery rates will be verified during system operation.

References:

ABB Environmental Services, Inc., Contamination Assessment Report, North Fuel Farm, Facility 76, Naval Air Station, Cecil Field,
Jacksonville, Florida: prepared for Southern Division, Naval Facilities Engineering Command, July 1992.

Driscoll, Fletcher G. Groundwater and Wells Second Edition: Johnson Division, St. Paul, Minnesota, 1986.

Johnson, P.C., C.C. Stanley, et al., A Practical Approach to the Design, Operation, and Monitoring of InSitu Soil-Venting Systems.
Ground Water Monitoring Review, Spring 1990.

Kittel, Jeffrey A., Robert Hinchee, et al., Bioslurping -- Vacuum-Enhanced Free Product Recovery Coupled with Bioventing: A Case
Study. *Air Force Center for Environmental Excellence Issue 1*: March 1994.

Testa, S.M., and Winegardner, D.L. Restoration of Petroleum-Contaminated Aquifers: Lewis Publishers, Chelsea, Michigan, 1991.

Walton, William C. Principles of Groundwater Engineering: Lewis Publishers, Chelsea, Michigan, 1991.

ATTACHMENT A

FREE PRODUCT VOLUME CALCULATION
North Fuel Farm, NAS Cecil Field

The estimated thickness and extent of product at the North Fuel Farm is illustrated on Figure 1. Free product was detected in wells MW-15, 16, and 17 at apparent thicknesses varying from 0.42 foot to 5.03 feet. The volume of free product saturated soil has been estimated in the table below using the average end area method.

Depth BGS (ft)	Incremental Thickness (ft)	Area (ft^2)	Average Area (ft^2)	Average Area X Incremental Thickness (ft^3)
0.0		96,624		
	1.0		71,496	71,496
1.0		46,368		
	1.0		35,568	35,568
2.0		24,768		
	1.0		20,016	20,016
3.0		15,264		
	1.0		9,719	9,719
4.0		4,176		
	1.0		2,376	2,376
5.0		576		
Volume of Soil Saturated With Product				139,175 ft^3

The porosity of the soil is estimated to be 0.25. Therefore, the volume of free product is estimated to be:

$$139{,}175 ft^3 \times 0.25\ porosity = 34{,}795 ft^3 = 260{,}260\ gallons\ of\ product.$$

Based upon baildown test results, converting apparent thickness of free product to true thickness of free product:

$$260{,}260\ gallons\ of\ product \div 3 = 87{,}000\ gallons.$$

ATTACHMENT B

BIOSLURPING WELL DESIGN
NAS Cecil Field, North Fuel Farm

Following the principles outlined in Bioslurping – Vacuum-Enhanced Free Product Recovery Coupled with Bioventing: A Case Study, estimates were made for a bioslurping system to be incorporated in free product recovery at the North Fuel Farm Site.

The actual increase in hydraulic gradient at each well is equal to the vacuum that is translated to each wellhead. This is also affected by pressure drops in the system manifold and by the site soil permeability. Based on this fact the following procedure was used to estimate product recovery rates for the proposed bioslurping system.

First, the vacuum and associated flowrates necessary to affect the given radius of influence was determined using the following calculation which is also used for determining the same parameters for soil vapor extraction (SVE) treatment.

Soil vapor extraction (SVE) wells are designed based on a methodology presented in the article "A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems" (P. C. Johnson, et al). The predicted flow to a well is calculated using the following equation.

$$\frac{Q}{H} = \pi \times \frac{k}{\mu} \times P_w \times \frac{\left[1 - \left(\frac{P_{Atm}}{P_w}\right)^2\right]}{\ln\left(\frac{R_w}{R_I}\right)}$$

where:

	Q	= air flow rate in cubic centimeters per second
	H	= length of well screen in centimeters
	k	= soil permeability to air flow in cm^2 or darcy
	μ	= viscosity of air = 1.8×10^{-4} g/cm-s or 0.018 cp
	P_w	= absolute pressure at extraction well in g-cm/s² (PA)
	P_{Atm}	= absolute ambient pressure ≈ 1.01×10^5 g-cm/s² (PA)
	R_w	= radius of vapor extraction well in centimeters
	R_I	= radius of influence of vapor extraction well in centimeters.

The viscosity of air and the approximate ambient pressure are given as constants. The soil permeability to air flow is calculated from the hydraulic conductivity (K_w), the unit weight of water (γ_w), and the viscosity of water (μ_w) by the following equation.

$$k = K_w \times \frac{\mu_w}{\gamma_w}$$

The resulting value of k is considered to be within an order of magnitude of the actual soil permeability to air. Because of this uncertainty and to be conservative, the calculated value of k is increased by an order of magnitude. The variables H and R_w are from the well geometry. The absolute pressure at the extraction well is the ambient pressure minus the design vacuum, which is chosen based on experience. The desired radius of influence can be chosen to meet the design requirements since this method is not sensitive to large changes in its value (typical values are between 30 and 100 feet).

The selected radius of influence for the North Fuel Farm site was 90 feet based on the locations of the existing monitoring wells. Inducing a total vacuum of 60 inches of water at the well head resulted in a necessary air flowrate of 26 scfm per well.

The induced vacuum of 5 feet was then used as the hydraulic gradient increase or drawdown in our bioslurping wells as shown in the case study performed at Fallon Naval Air Station in Nevada. Based on this fact, total fluids recovery rates were obtained using the design approach for a groundwater recovery well.

This methodology is outlined below.

Given the following information:

Average Groundwater Gradient (I) in ft/ft;
Average Horizontal Hydraulic Conductivity (K_H) in ft/day;
Average Depth to Water in feet;
Saturated Aquifer Thickness (b) in feet;

The Transmissivity can be calculated using the following equation:

$$T = K_H \times b$$

Other design parameters are given as follows:

Aquifer Storage Coefficient (S);
Well Efficiency in percent;
Time Since Pumping Began (t) in days;
Total Well Depth in feet;
Well Screen Length in feet;
Well Sump Length in feet;
Saturated Screen Length in feet;
Well Casing Diameter (d) in feet;
Effective Well Diameter (d_w) in feet; and
Effective Well Radius (r_w) in feet;

The theoretical specific capacity of a well is equal to the discharge rate (Q) divided by the drawdown s) and can be calculated with the Cooper-Jacob equation (Walton, 1991).

$$\frac{Q}{s} = \frac{4 \pi T}{-0.5772 - \ln\left[\frac{r^2_w S}{4 T t}\right]}$$

A correction factor must be determined and applied for partially penetrating wells. A percent of the maximum specific capacity attainable can be obtained using the Kozeny equation (Driscoll, 1986).

$$\frac{Q / s_p}{Q / s} = L\left(1 + 7\sqrt{\frac{r}{2\,b\,L}\cos\frac{\pi L}{2}}\right)$$

where:

Q/s_p = specific capacity of a partially penetrating well (gpm/ft)
Q/s = maximum possible specific capacity of a fully penetrating well (gpm/ft)
r = well radius (ft)
b = aquifer thickness (ft)
L = well screen length as a fraction of the aquifer thickness

The corrected specific capacity can then be calculated as follows:

$$\frac{Q}{s}(actual) = \frac{Q}{s}(theoretical) \times Correction\ Factor$$

The vacuum applied at the wellhead is considered analogous to the drawdown produced from pumping. Assuming a well drawdown (s), a design flow rate (Q) is calculated as follows;

$$Q = s \times \frac{Q}{s}$$

To estimate the area which will be influenced by a well, a distance, in the down gradient direction, to the stagnation point can be calculated.

$$x_L = -\frac{Q}{2\,\pi\,K\,b\,I}$$

Finally, the design well drawdown must take the well efficiency into account. Therefore, the assumed well drawdown is corrected as follows and should be equal to the vacuum induced during bioslurping.

$$s_c = s_{assumed} \times 1 + well\ efficiency$$

BIOSLURPING WELL DESIGN
NAS Cecil Field, North Fuel Farm — Checked By:
Date: February 14, 1995 — Engineer: FJU

Existing Monitoring Wells

Average Gradient (I)	0.0008	ft/ft	
Hydraulic Conductivity (K)	2	ft/day	
Saturated Aquifer Thickness (b)	120	feet	
Transmissivity (T)	240	ft^3/day/ft	
Time Since Start of Pumping (t)	30	days	
Estimated Aquifer Storage Coefficient (S)	0.25		
Total Well Depth	28	feet	
Average Depth to Water	17	feet	
Well Casing Diameter	0.166667	feet	
Effective Well Diameter	0.333333	feet	
Effective Well Radius	0.166667	feet	
Well Screen Length	10	feet	
Well Sump Length	0	feet	
Saturated Screen Length	10	feet	
Theoretical Specific Capacity (Q/s)	1.07	gpm/ft	from p. 217, Walton(1991)
Partial Penetration Correction Factor	13.64	%	from Kozeny equation, p. 250, Driscoll(1986)
Corrected Q/s	0.15	gpm/ft	
Assumed Drawdown (s)	3.33	feet	
Design Flow Rate (s X Q/s)	0.5	gpm	
Distance to Stagnation Point	−77.4	feet	from p. 123, Todd
Estimated Well Efficiency	50	%	
Design Well Drawdown	5.00	feet	
Capture Boundary Distance (y)	243.2326		

BIOSLURPING WELL DESIGN
NAS Cecil Field, North Fuel Farm

Date: February 14, 1995 Engineer: FJU

Symbol	Value	Units	Description	Source
Kw	2	ft/day	hydraulic conductivity	measured
Kw	0.00070556	cm/sec		conversion
Rw	0.16666667	feet	radius of extraction well	selected
Rw	5.08	cm		conversion
Ri	90	feet	radius of influence	selected
Ri	2743.2	cm		conversion
H	7	feet	length of well screen	selected
H	213.36	cm		conversion
P design	60	in. H2O	design vacuum at the well	selected
P design	14.75	% of atm.		conversion
gamma-w	9800	N/m ^ 3	unit weight of water	constant
u_w	0.001	N-s/m ^ 2	viscosity of water	constant
u_a	0.00002	N-s/m ^ 2	viscosity of air	constant
Ka	7.200E-13	m ^ 2	pneumatic conductivity	calculated
Ka	7.200E-12	m ^ 2	X safety factor of 10	calculated
Ka	7.200E-08	cm ^ 2		conversion
Patm	101000	PA	absolute ambient pressure (1 atm.)	constant
Pw	86103	PA	pressure at extraction well	calculated
Q	0.00124146	m ^ 3/s	flow rate based on measured Kw	calculated
Q	2.63021063	cfm		conversion
Qd	0.01241459	m ^ 3/s	design flow rate w/ safety factor	calculated
Qd	26.3021063	cfm		conversion

note: unit conversions are included in calculations.