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NCBC GULFPORT
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LETTER REGARDING MOBILE BIOSLURPING SYSTEM INSTALLATION SITE 6 NCBC GULFPORT MS
12/13/2001
BATTELLE

NCBC Gulfport Administrative Record
Document Index Number

39501 - IRP
18.02.06.0009

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December 13, 2001

Naval Facilities Engineering Command
Southern Division
2155 Eagle Drive
P.O. Box 190010
North Charleston, SC 29419-9010

Attention: Mr. Art Conrad

Dear Mr. Conrad:

CONTRACT NO. N47408-01-D-8207, TASK ORDER 003
MOBILE BIOSLURPING SYSTEM INSTALLATION AT
NAVAL CONSTRUCTION BATTALION CENTER (NCBC) GULFPORT, MS

System Installation Report

1.0 INTRODUCTION

Battelle is pleased to submit two (2) copies of this System Installation Report for the Mobile Bioslurping System Installation at Naval Construction Battalion Center (NCBC) Gulfport, MS. This report describes the activities performed to complete the installation and startup of the mobile bioslurper system at Site 6, a former firefighting training area at NCBC Gulfport. The report includes information regarding well construction, system installation, startup activities, and system operation through December 4, 2001.

1.1 Site History

Site 6 at NCBC Gulfport was used as a firefighting training area from 1966 to 1975. Various flammable liquids were used in two burn pits at the site. Up to 500,000 gallons of waste oils, solvents, paint thinners, and cleaning compounds are suspected to have been burned in the pits. The pits were backfilled with sand and gravel when firefighting training activities were concluded in 1975 (Tetra Tech NUS, 2000). Previous reports by other contractors have estimated the area of the light, nonaqueous-phase liquid (LNAPL) plume at approximately 0.5 acres (Figure 1) (Tetra Tech NUS, 2000). Site 6 is bounded by Building 383 and Fifth Street to the north, Colby Avenue to the west, Simms Avenue to the east, and Building 391 to the south. Drainage ditches are located along the western and northern boundaries. The site is grass-covered with the exception of a small parking lot located south of Building 383.

A trench interceptor recovery system was installed at Site 6 in 1995 to recover LNAPL. The system includes a recovery trench located east of the drainage ditch on the east side of Colby Avenue, with three recovery wells and associated pumps. The aboveground treatment system includes an oil/water separator (OWS), an oil storage tank, an air stripper, and associated pumps, blowers, and controls (Morrison

Knudsen Corporation, 1995). Also included with the aboveground components is an air compressor to power the pneumatic recovery pumps. The aboveground components are enclosed within a concrete secondary containment area surrounded by a chain-link fence with vinyl privacy slats. The system was operated for approximately four years, until 1999. The average LNAPL thickness in the extraction wells decreased by 50% during the period of operation. However, it was believed that the system was no longer an efficient or cost-effective method of recovering the remaining LNAPL, and operation was discontinued. In 2001, Battelle was awarded the task of installing and operating a bioslurper system to extract the remaining recoverable LNAPL at the site.

1.2 Bioslurper Technology Description

Bioslurping combines vacuum-assisted LNAPL recovery with bioventing and soil vapor extraction (SVE) to simultaneously recover LNAPL and bioremediate the unsaturated zone. Bioslurper systems are designed to extract LNAPL from the water table, along with groundwater and soil vapor, in one process stream, utilizing the air lift created by a single aboveground liquid ring pump. Recovered groundwater is separated from the LNAPL and treated (if required) and discharged. Recovered soil vapor is treated (if required) and discharged to the atmosphere (Place et al., 2001).

Bioslurping results in an improved LNAPL recovery efficiency when compared to other technologies, including skimming and drawdown pumping. The bioslurper can pull a vacuum of up to 25 ft of water on a recovery well, inducing the pressure gradient necessary to force movement of LNAPL into the well. The system is operated to minimize drawdown of the water table, which reduces the problem of LNAPL entrapment in the soil.

Bioventing of the unsaturated zone is achieved by extracting soil vapor via the recovery well. The slurping action of the bioslurper results in alternating recovery of liquid (LNAPL or groundwater) and soil vapor. The rate of soil vapor extraction is dependent on the recovery rate of liquid into the well, as well as other factors including the length of the exposed screened interval and the permeability of the soil formation. When LNAPL recovery is complete, the bioslurper system can be converted into a conventional bioventing system in order to continue remediation of the vadose zone soils (Place et al., 2001).

2.0 SYSTEM CONSTRUCTION AND INSTALLATION

This section of the report describes the installation of the extraction wells and soil-gas monitoring points, the construction of the mobile bioslurper system at Battelle, and the installation of the bioslurper at Site 6.

2.1 Extraction Well Installation

Battelle and a drilling subcontractor mobilized to Site 6 on July 23, 2001, to install the extraction wells for the bioslurper system. In order to more effectively target the locations of the extraction wells, Battelle employed a strategy of direct-push soil sampling for field examination. This approach allowed the field geologist to observe the soil and screen for hydrocarbon contamination with a photoionization detector (PID) prior to deciding to install a well at each location. Prospective soil boring/extraction well locations were marked on a site map obtained by Battelle. A local surveyor was contracted to mark the prospective locations. Soil borings were advanced at 38 locations using a Super Duty (SD) Series VibraPush rig equipped with a 500-lb hammer. The borings were advanced to 12 ft below ground surface (bgs), with sample cores collected from 4 to 8 ft and 8 to 12 ft bgs. The soil cores were visually inspected for LNAPL by the field geologist, and a PID was used to detect total petroleum hydrocarbon (TPH) vapors.

Based on the degree of LNAPL saturation and soil staining, extraction wells were installed at 17 of the 38 boring locations. A map indicating the well locations is included as Figure 2. Thirteen of the extraction wells are screened from 5 to 15 ft bgs, and the four remaining wells are screened from 3.5 to 13.5 ft bgs. Sixteen of the wells were completed with polyvinyl chloride (PVC) stick-ups. One well, located in the asphalt parking area south of Building 383, was completed in a flush-mounted well vault.

At the time of the well installation, small amounts of LNAPL were observed in only three of the extraction wells. However, the water table was elevated to abnormally high levels due to heavy rains that occurred during the week of the field activities. The high water table likely would limit the ability of LNAPL to passively migrate into the wells.

2.2 Soil-Gas Monitoring Point Installation

Soil-gas monitoring points are used to measure concentrations of oxygen, carbon dioxide, and TPH in the soil gas, as well as to monitor the vacuum created in the subsurface by the bioslurper system. Soil-gas monitoring points were installed at six locations. Screens, approximately six inches in length, were placed at two depths at each location, with ¼-inch-diameter nylon tube connecting the screens to the surface. The shallow screen was centered at 2.5 ft bgs, and was attached to green tubing. The deep screen was centered at 5 ft bgs and was attached to red tubing. The nylon tubes were completed with quick-connect fittings to facilitate sampling and monitoring. The borehole was backfilled with clean sand, with a layer of bentonite granules to provide a seal between the two sampling screens. The surface completion at each location consists of a round flushmount, 8 inches in diameter by 12 inches deep.

2.3 Bioslurper System Construction

The mobile bioslurper system was constructed at Battelle's Columbus, OH, headquarters, tested, and partially disassembled for shipment to NCBC Gulfport via motor freight. Under the direction of NAVFAC Southern Division, Battelle shipped the components of two inactive, government-owned bioslurper systems from Naval Station Mayport, Florida, to Columbus. A single trailer-mounted bioslurper system was constructed from the best of these components. This new system also incorporates modifications to the system design based on advancements in the technology in the four years since the Mayport systems were designed. Materials returned from Naval Station Mayport also were refurbished prior to inclusion in the Gulfport system. After system construction was completed, the bioslurper was tested at Battelle to ensure all components were operating properly prior to shipment. With testing complete, the bioslurper system was partially disassembled, and the components were secured for shipment. The trailer-mounted bioslurper system was delivered to NCBC Gulfport on September 24, 2001. A crane was used to lift the bioslurper trailer from the freight truck and place the trailer in the secondary containment area.

2.4 Bioslurper System Installation

Installation of the bioslurper system began on September 24, 2001. Installation activities included construction of an extraction manifold to connect the well to the inlet of the bioslurper system; reassembly of the trailer-mounted bioslurper system; cleaning and refurbishing the aboveground treatment components from the previously operated system at Site 6; connecting the bioslurper system to the treatment system; and connecting the power supply and system safety interlocks.

2.4.1 Extraction Manifold. The extraction manifold connects the drop tube from the extraction well to the bioslurper system inlet. The manifold is constructed of Schedule 40 PVC pipe. The pipe size on each manifold branch varies depending on the number of wells connected to that branch, with the pipe diameter ranging from 1 inch up to 3 inches at the trunk line. The manifold pipe is mounted to concrete blocks with metal pipe straps. The manifold enters the secondary containment area and connects to an air/liquid separator (ALS) via a gate valve.

2.4.2 Cleaning of Existing Treatment System. The existing treatment system had not been operated or maintained since 1999, and was in unacceptable condition. The secondary containment area was filled with stagnant water, which had to be pumped out prior to performing any work within the containment area. The containment area and the treatment system components were cleaned using a power washer. The coalescing media also were removed from the OWS and power-washed.

2.4.3 Assembly of Trailer-Mounted System and Treatment System. The reassembly of the trailer-mounted system consisted of installing and connecting the taller components that were removed for shipping, including the ALS. Once the trailer-mounted system was reassembled, it was connected to the existing water treatment system. The liquid outlet from the ALS is connected to the inlet of a progressing cavity pump (PCP) located at the front of the trailer. The pump is controlled by liquid level switches in the ALS. When the liquid level reaches a certain height, the PCP turns on and discharges the recovered LNAPL and groundwater from the ALS to the OWS inlet. Free-phase LNAPL in the OWS drains by gravity into a 500-gallon double-walled oil storage tank located at the rear of the trailer. Water from the OWS flows to the air stripper, where it is treated prior to discharge to the Gulfport Publicly Owned Treatment Works (POTW).

A local licensed electrical contractor was hired to make the electrical connections required to operate the bioslurper system. These connections included providing power to the LRP, PCP, and heat exchanger; installing motor starters, an hour meter, an auto-dialer, and an annunciator panel; and wiring interlocks between the system components, the motor starters, and the annunciator panel.

The bulk of the installation activities were completed by October 5, 2001. At that time, Battelle staff demobilized from the site, awaiting the approval of a discharge permit required before beginning the system startup.

3.0 BIOSLURPER SYSTEM STARTUP

System startup activities were initiated on October 29, 2001, after the aqueous discharge permit was approved. Startup activities included completing the electrical interlocks, installing the oil storage tank on the trailer, and troubleshooting the bioslurper and treatment systems during initial operation. A photograph of the completed system is included as Figure 3. A set of oil/water level measurements was collected on October 30, prior to the November 1 system startup (Figure 4). An 8-ft-tall cypress wood fence also was installed at the site, enclosing the system and all of the wells, for safety, security, and appearance purposes. The three-week startup period concluded November 16, 2001. The data included in this section encompass the three-week startup period and the first 18 days of system operation, through December 4, 2001.

3.1 Discharge Permit

NCBC Gulfport received approval to discharge the treated bioslurper process water to the Gulfport POTW on October 22, 2001. Issued by the Mississippi Department of Environmental Quality (MDEQ), Permit No. MSP091208 grants permission to discharge wastewater meeting certain requirements. The limitations to the permit include:

- A discharge limit of 0.036 million gallons per day (mgd)
- A pH between 5.0 and 9.0 standard units
- Benzene concentration not exceeding 0.05 mg/L
- Total BTEX (benzene, toluene, ethylbenzene, and xylenes) concentration not exceeding 1.0 mg/L.

Grab samples collected twice monthly are required to document the pH, benzene, and total BTEX concentrations. The discharge limit is monitored using a totalizing flowmeter.

3.2 System Startup

The bioslurper system was started on Thursday, November 1. After the system was started, several modifications were made to facilitate and optimize system operation. On November 2, the distance between the float switches in the ALS was increased to allow the PCP to operate for longer intervals and cycle less frequently. After this adjustment was made, the bioslurper operated until November 5 without shutting down. During process-water sampling on November 5, it was observed that the water being discharged from the air stripper appeared more contaminated than the water entering the air stripper. The bioslurper system was shut down and the air stripper was opened. It was determined that the stripper required disassembly and cleaning. The air stripper was cleaned on November 6, and the bioslurper was restarted.

On November 7, the air stripper began to overflow. The system was turned off and the air stripper discharge pump was examined, but no problems were evident. The flowmeter on the discharge line was examined and found to be clogged. The flowmeter was cleaned and the system restarted. The air stripper discharge pump was observed to pump as high as 40 gpm. The system was shut down briefly on November 8, one week after system startup, for a round of oil/water level measurements (Figure 5).

The bioslurper continued to operate until November 20, when it was shut down to correct the orientation of a valve and to replace a faulty circuit breaker in the main electrical supply panel. The 100-amp breaker was tripping at 38 amps, causing the system to shut down. The breaker was replaced on November 23 and the system was restarted. The system operated until November 27, when it was turned off to allow the extraction wells to equilibrate for a complete round of oil/water level measurements. Depth to LNAPL/depth to water measurements were collected in the site extraction and monitoring wells on November 29, approximately one month after system startup. These data were used to create a contour plot of LNAPL thickness (Figure 6). The bioslurper was restarted on November 29 after the oil/water level measurements were concluded. Key operational parameters from the initial system startup through December 4, 2001, are provided in Table 1.

Table 1. Cumulative Process Parameters Through December 4, 2001

Operating Time (hours)	Total Groundwater Recovered (gal)	Avg. Groundwater Recovery Rate (gal/hr)	Total LNAPL Recovered (gal)[a]	LNAPL Recovery Rate (gal/hr)[a]
602.1	279,950	465	279	0.6

(a) The last reading from the oil storage tank was collected on November 27, after 480.4 hours of operation. The oil tank was emptied prior to the December 4 data collection.

As seen in Table 1, the rate of LNAPL recovery was approximately 0.6 gal/hr, or just under 14 gal/day. The oil storage tank was emptied on December 3 by Waste Oil Collectors of Gautier, MS. According to the manifest, approximately 300 gallons of LNAPL were removed from the tank.

An Operations and Maintenance Manual currently is being prepared for this bioslurper system. The manual will include detailed descriptions of the components of the system, as well as monitoring and troubleshooting information.

4.0 REFERENCES

Morrison Knudsen Corporation. 1995. *Construction Completion Report, Site 6 – Fire Fighting Training Area, Naval Construction Battalion Center Gulfport, Mississippi*. Prepared for Southern Division Naval Facilities Engineering Command Contract No. N62467-93-D-1106.

Place, M.C., C.T. Coonfare, A.S.C. Chen, R.E. Hoeppel, and S.H. Rosansky. 2001. *Principles and Practices of Bioslurping*. Battelle Press. Columbus, Ohio.

TetraTech NUS, Inc. 2000. Draft Letter Report of Findings, NCBC Gulfport – Site 6. Prepared for Southern Division Naval Facilities Engineering Command under CLEAN Contract No. N62467-94-D0888, Contract Task Order No. 0125.

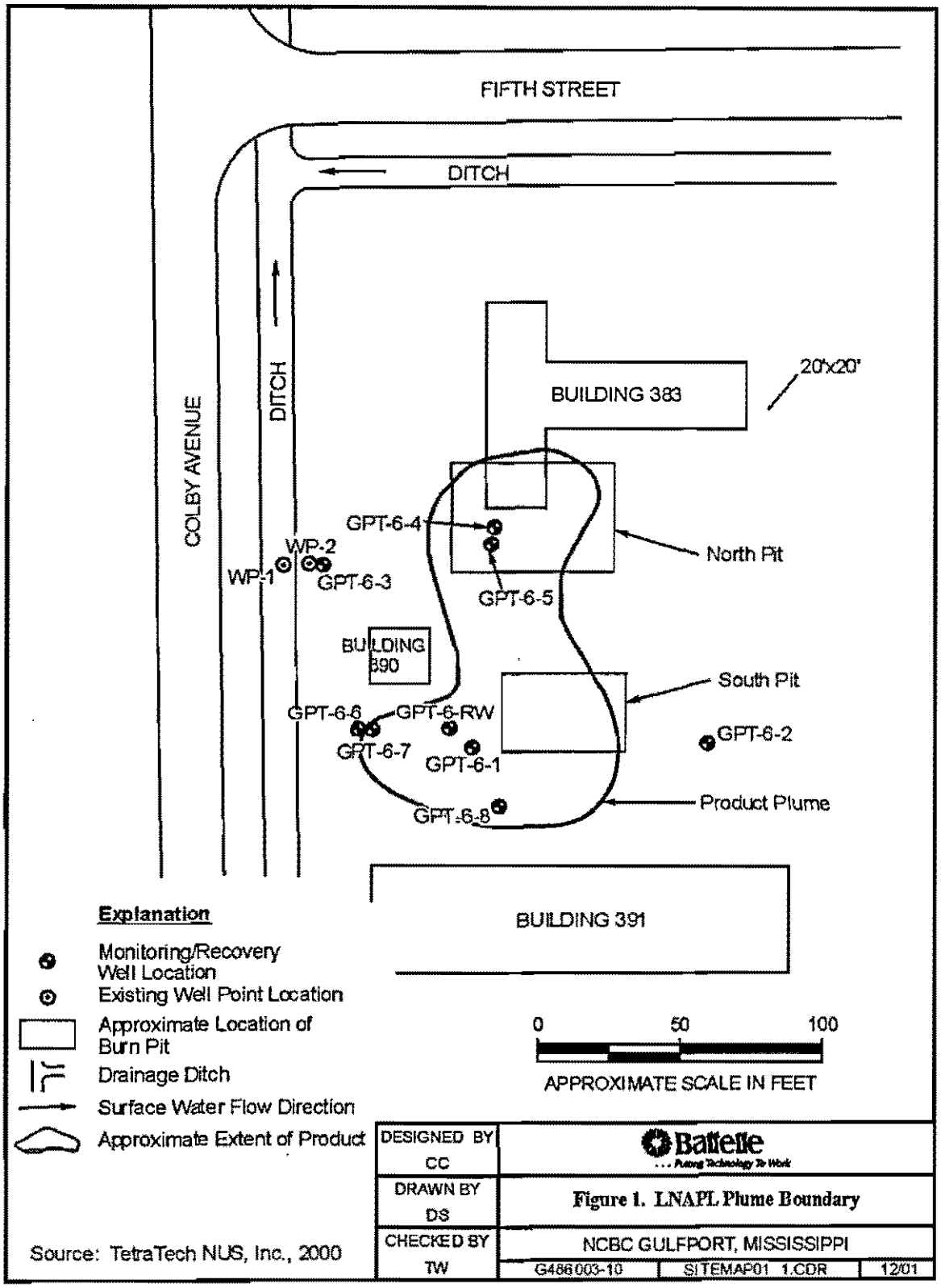
Please contact me at (614) 424-7289 or rosansky@battelle.org, or Chris Coonfare at (614) 424-3646 or coonfare@battelle.org, with any questions.

Sincerely,

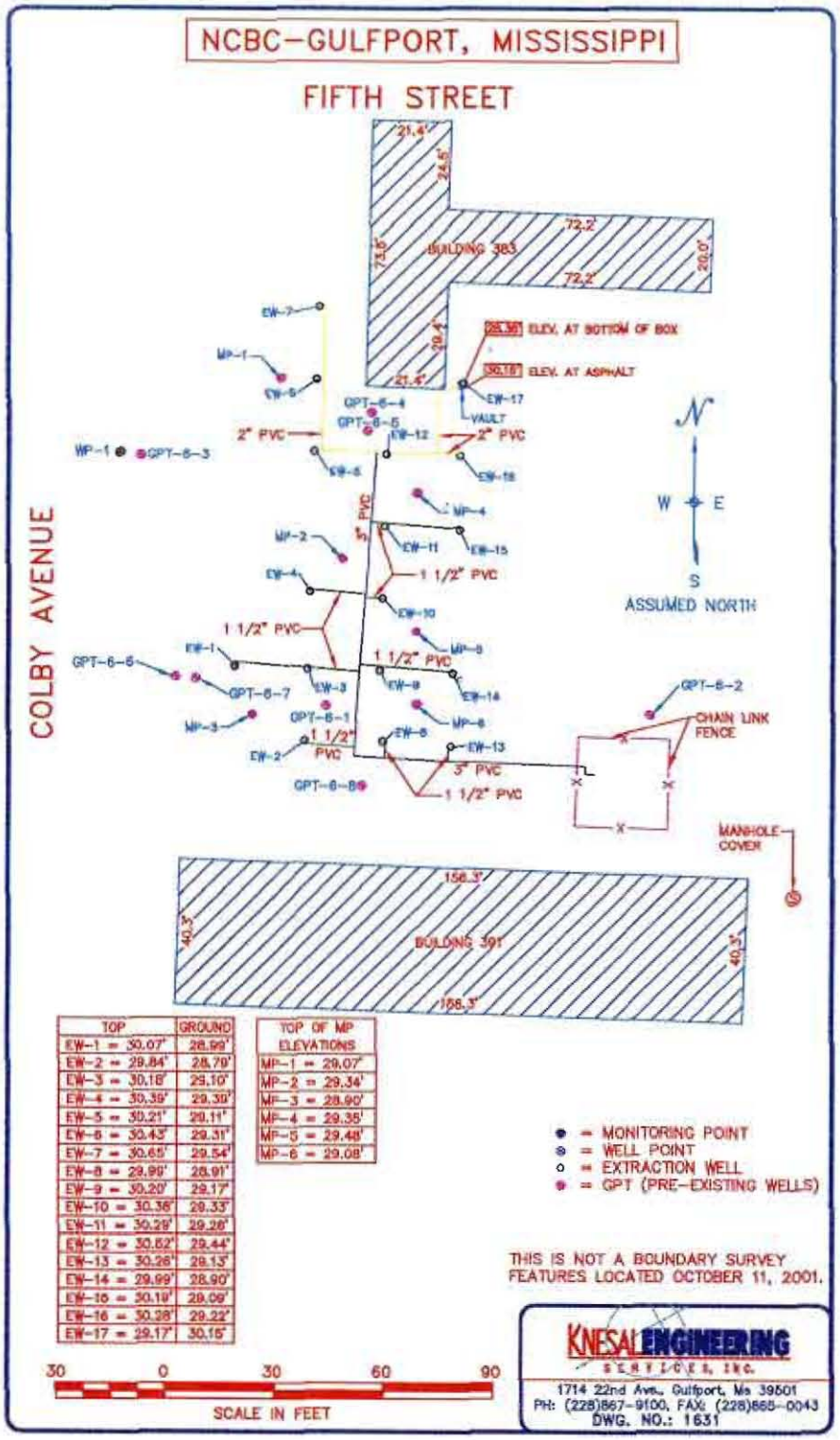
Stephen H. Rosansky
Environmental Engineer
Environmental Restoration Dept.

Christopher T. Coonfare
Geologist
Environmental Restoration Dept.

SHR/CTC:lb
cc: Mr. Gordon Crane, NCBC Gulfport (3 copies)



Source: TetraTech NUS, Inc., 2000

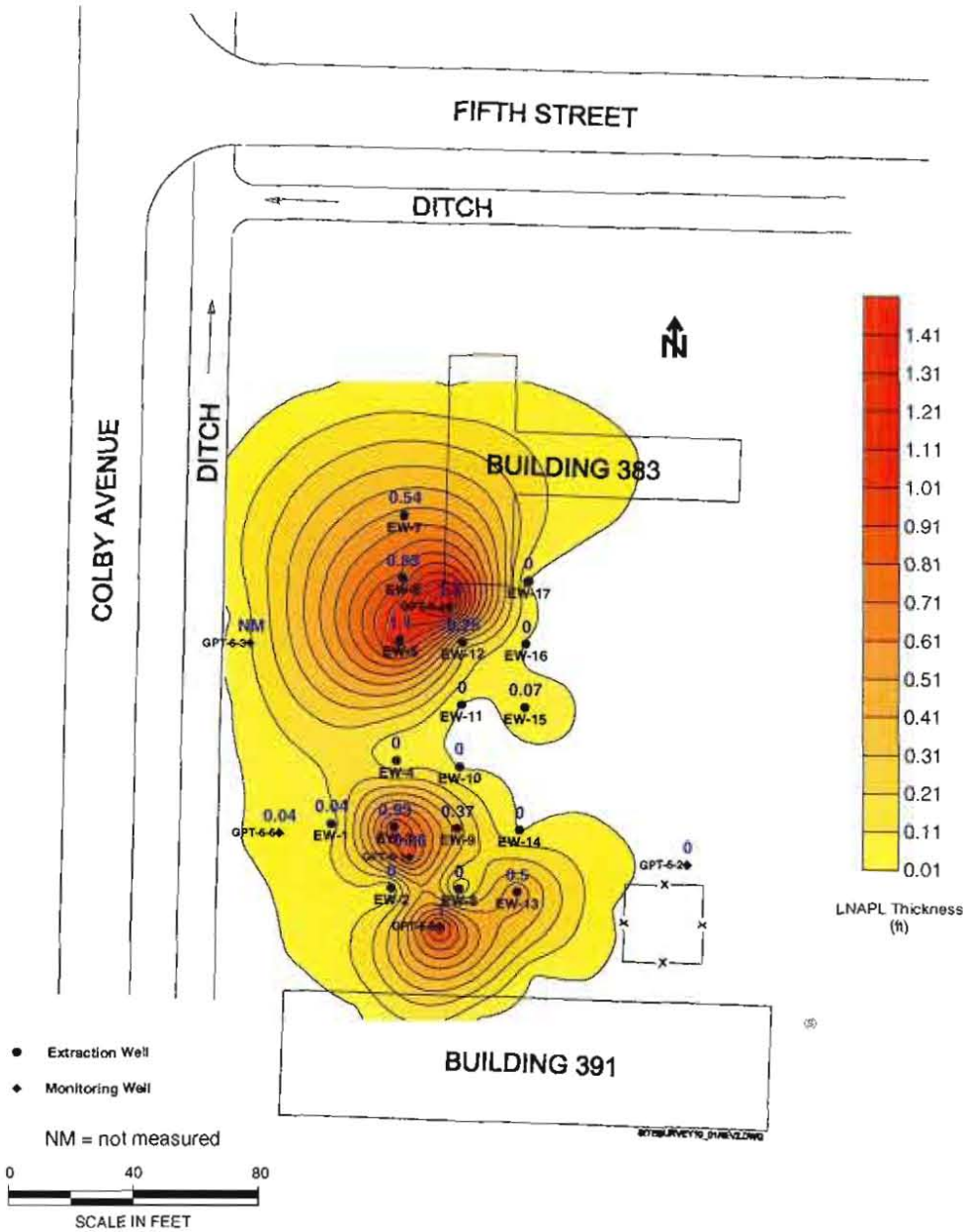


TOP	GROUND
EW-1 = 30.07'	28.99'
EW-2 = 29.84'	28.79'
EW-3 = 30.18'	29.10'
EW-4 = 30.39'	29.30'
EW-5 = 30.21'	29.11'
EW-6 = 30.43'	29.31'
EW-7 = 30.65'	29.54'
EW-8 = 29.99'	28.91'
EW-9 = 30.20'	29.17'
EW-10 = 30.36'	29.33'
EW-11 = 30.29'	29.26'
EW-12 = 30.52'	29.44'
EW-13 = 30.26'	29.15'
EW-14 = 29.99'	28.90'
EW-15 = 30.19'	29.09'
EW-16 = 30.28'	29.22'
EW-17 = 29.17'	30.15'

TOP OF MP ELEVATIONS
MP-1 = 29.07'
MP-2 = 29.34'
MP-3 = 28.90'
MP-4 = 29.35'
MP-5 = 29.48'
MP-6 = 29.08'

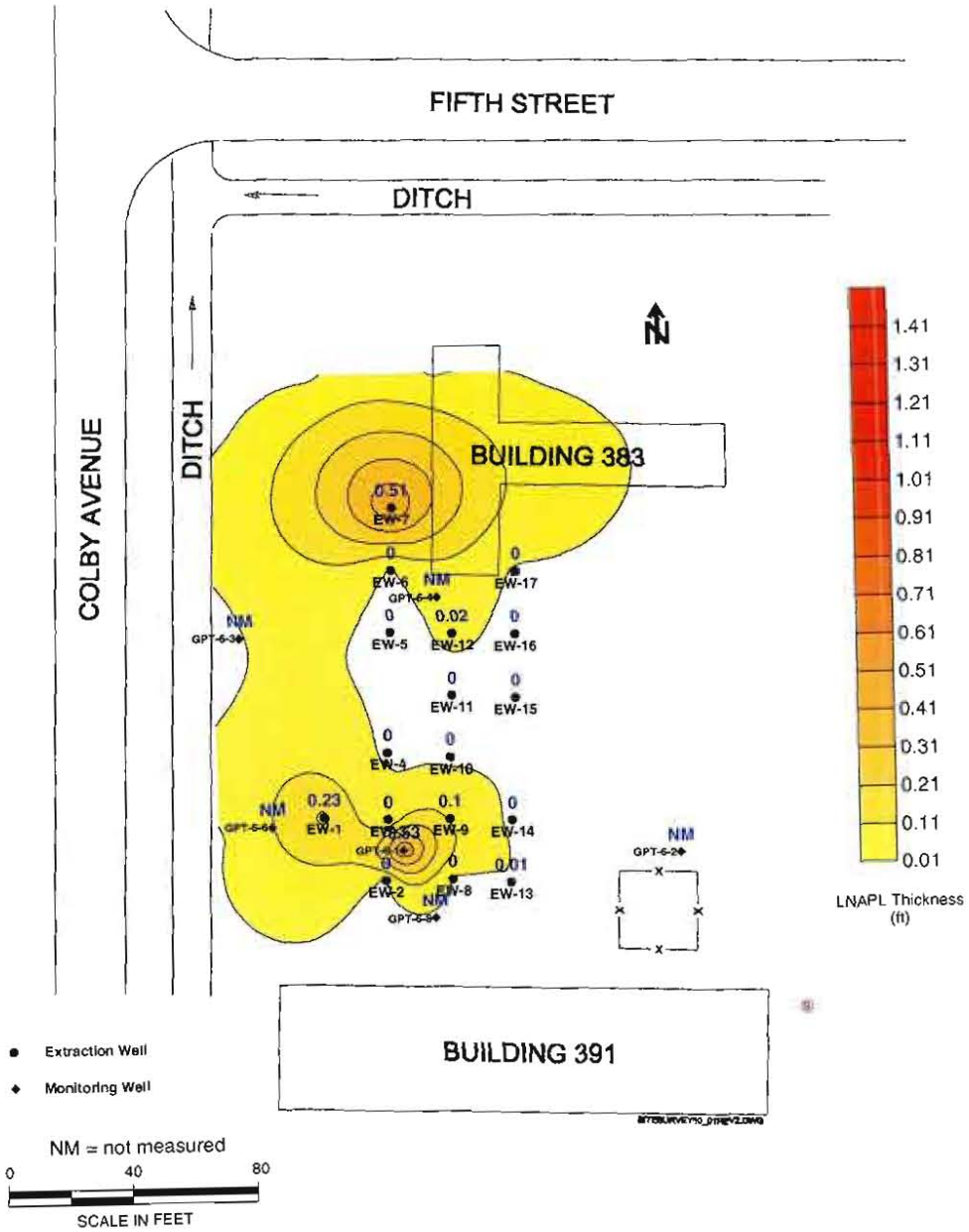
Figure 2. Site Survey Map

Figure 3. Photograph of Bioslurper System, Site 6, NCBC Gulfport



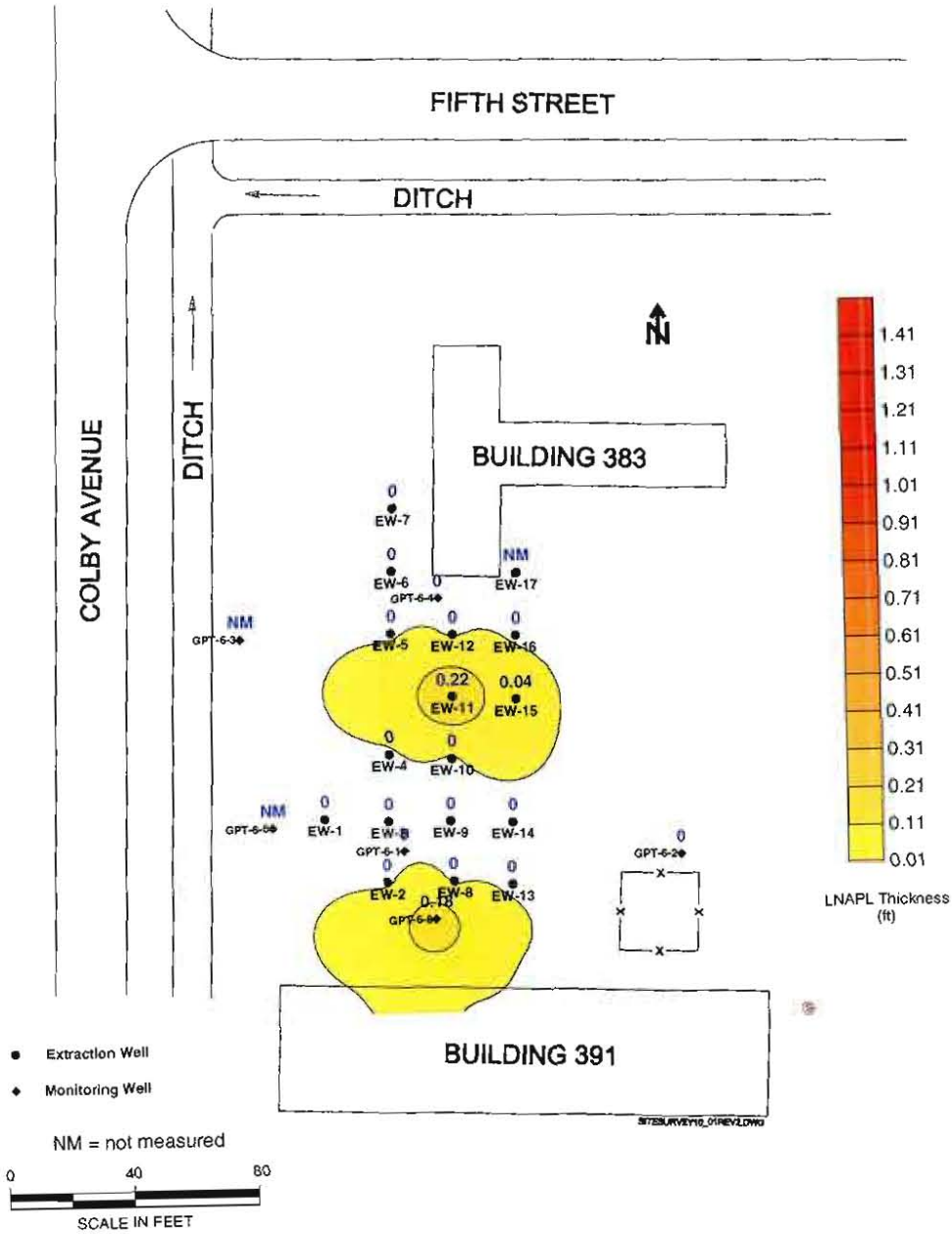
LNAPL Thickness (ft)
10/30/01
NCBC Gulfport, Site 6
Before Bioslurper Start-Up

Figure 4. LNAPL Thickness Measurement Prior to System Startup



LNAPL Thickness (ft)
11/08/01
NCBC Gulfport, Site 6
One Week After Bioslurper Start-Up

Figure 5. LNAPL Thickness Measurement One Week After System Startup



LNAPL Thickness (ft)
11/29/01
NCBC Gulfport, Site 6
Approx. One Month after Bioslurper Start-Up

Figure 6. LNAPL Thickness Measurement One Month After System Startup