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04.10-11/6/98-00399

FINAL

SAMPLE STRATEGY PLAN

CORRECTIVE ACTION PLAN/
NATURAL ATTENUATION EVALUATION STUDY
OPERABLE UNIT NO. 9, SITE 73
AMPHIBIOUS VEHICLE
MAINTENANCE FACILITY

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0312

NOVEMBER 6, 1998

Prepared for:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

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1.0 INTRODUCTION

This Final Sample Strategy Plan (SSP) has been prepared by Baker Environmental, Inc. (Baker) in support of the Natural Attenuation Evaluation Study (NAES) for Operable Unit (OU) No. 9 (Site 73 - Amphibious Vehicle Maintenance Facility) Marine Corp Base (MCB), Camp Lejeune, North Carolina. The objective of the SSP is to present the rationale, approach and methods that will be used to collect data during Phase I of the NAES field investigation. The approach and methods that will be employed in Phase II will be determined after a review of Phase I data.

Although the Final Feasibility Study (FS), OU No. 9, Site 73 has been submitted, a draft Record of Decision (ROD) for OU No. 9 has not been prepared. However, pending approval of the Final Proposed Remedial Action Plan (PRAP) and NAES Report/Corrective Action Plan (CAP) a draft ROD will be prepared. The selected remedy identified in the Site 73 PRAP and ROD will be largely determined by the results of the NAES. It is anticipated that the results of the NAES will demonstrate that natural attenuation is protective of human health and the environment, and a viable treatment alternative for remediating groundwater contamination at Site 73.

The NAES field investigation will be conducted in two phases. Data gathered under Phase I will be used for the following:

- To assess the contaminant, geochemical and microbial by-product distributions in the upper surficial aquifer.
- Determine the number and location of permanent monitoring wells that will be installed in the upper surficial aquifer during Phase II.
- Further define the extent of contamination in the Castle Hayne aquifer.
- Assess the need for further natural attenuation assessment in the Castle Hayne aquifer.

2.0 SITE BACKGROUND

This section and includes a brief site history, a summary of the Remedial Investigations (RI) conducted at Site 73, and brief descriptions of the nature and extent of groundwater contamination, geology and hydrogeology. Figures 1 and 2 depict site facilities and the extent of groundwater contamination in the surficial and Castle Hayne aquifers.

2.1 Site History

In general, Site 73 encompasses the Amphibious Maintenance Facility located in the Courthouse Bay Area of MCB Lejeune. Site 73 is roughly bounded by State Route 72 to the north, Courthouse Bay to the south, and unnamed tributaries to Courthouse Bay to the east and west. The Amphibious Maintenance Facility started operations in 1946 and is currently active. Available historical information indicates that approximately 400,000 gallons of waste oil, along with an undetermined amount of solvents, were discharged onto the ground surface at this facility, primarily near Building A-47. In addition to the waste oil, approximately 20,000 gallons of waste battery acid were disposed in the area northeast of Building A-47.

2.2 Summary of the Remedial Investigation

Although several investigations have been conducted at Site 73, the first site-wide RI, which occurred in two phases, was conducted by Baker Environmental, Inc. (Baker) in 1995 and 1996. The field programs conducted under the RI included soil and groundwater investigations, surface water and sediment investigations, and an ecological investigation. It should be noted that during the RI natural attenuation was not considered as a viable remedial alternative at this site and data supporting natural attenuation as a potential remedial alternative was not collected. This was in part due to the fact that natural attenuation was not widely accepted as a remedial alternative at the time of the investigation. The data obtained under the RI indicated the vertical and horizontal extent of contamination had been defined to within the vicinity of Site 73. The most significant contamination was encountered in groundwater in the vicinity of Building A-47 and the adjacent parking area. The extent of groundwater contamination detected is briefly discussed in Section 2.4.

Adverse human health risks were identified in the human health risk assessment. Under the current scenario, the risk values for the adult and child receptor exceeded the acceptable risk range for the ingestion of fish and crab tissue. This risk was driven by inorganic contaminants, not associated with previous site activities, that were identified in fish and crab samples. However, current site conditions do not present an adverse risk to military personnel engaged in daily activities. Under the future resident scenario adverse human health risks are associated with the exposure to groundwater. These risks are driven by both organic and inorganic contamination that was detected in groundwater. It should be noted that only organic contamination is associated with past site activities.

The following volatile organic compounds were identified as contaminants of concern at Site 73:

- 1,2-Dichloroethane
- 1,2-Dichlorethene (total)
- cis-1,2-Dichloroethene
- Vinyl Chloride
- Trichloroethene
- Benzene

2.3 Physical Characteristics of Site 73

This section briefly describes the geology and hydrogeology of Site 73.

2.3.1 Geology

The subsurface soils at the site consist of unconsolidated deposits of sand and silty sand separated by a clay layer that thickens and thins across the site, and becomes discontinuous on the eastern edge of the site. The sands are fine to medium grained and contain varied amount of silt and clay.

Underlying the sands described in the previous paragraph is a loose to very dense, greenish-gray, fine sand containing varying amounts of silt and shell fragments, trace clay and cemented sand

nodules. This unit constitutes the Belgrade Formation, that is typically referred to as the Castle Hayne semi-confining unit that separates the surficial and Castle Hayne aquifers. However, at site 73 this unit does not restrict hydraulic communication between the lower portion of the surficial and the Castle Hayne aquifers.

RI boring logs indicate that a much larger tributary (paleochannel) may have existed where the eastern unnamed tributary currently exists, that may have connected the New River, north of the site, with Courthouse Bay. In the vicinity of the paleochannel the surficial clay, Belgrade unit and the River Bend unit appear to have been eroded. Such features linking the Castle Hayne with the surficial aquifer may provide a conduit for vertical and horizontal contaminant migration.

2.3.2 Hydrogeology

Groundwater flow in the upper portion of the surficial aquifer is radial from a topographical high near Buildings A-8 through A-11. Groundwater in the upper portion of the surficial aquifer is believed to discharge into Courthouse Bay, and the eastern and western unnamed tributaries. Upper surficial flow patterns in the eastern portion of the site are influenced by the clay layer mention in the previous section. The absence of the clay in the eastern portion of the site allows the surficial groundwater to combine with the underlying groundwater zones causing a change in the direction of groundwater flow.

Groundwater in the lower surficial and upper Castle Hayne aquifers appears to flow in a southeasterly direction over most of the site. Groundwater in the mid-and lower-portion of the Castle Hayne aquifer is believed to flow in southerly direction.

According to the pathline analysis, performed as part of the overall modeling effort, a particle of groundwater that recharges the water table near the center of the parking area (located on the southeast side of Building A-47) would move in a northeasterly direction to an area northeast of Building A-47 before it reaches the bottom of the Castle Hayne aquifer. It should be noted that the clay layer that separates the surficial aquifer is absent in this vicinity. The particle would then

start to flow south, southwest towards Courthouses Bay. At some point the direction of the particle would shift from downward to upward as it enters the discharge area.

2.4 Nature and Extent of Contamination

Groundwater contamination was detected at Site 73 in the surficial aquifer and the upper portion of the Castle Hayne aquifer. Two contaminant plumes were identified in the upper portion of the surficial aquifer. Although a clay layer separates the surficial aquifer, contamination is believed to migrate downward from the upper surficial aquifer, as previously described, into the lower surficial and upper Castle Hayne aquifers. The results of the RI also indicate that contamination at Site 73 does not migrate vertically beyond a depth of 150 feet below ground surface (bgs).

2.4.1 Upper Surficial Aquifer

In general, the extent of contamination in the upper portion of the surficial aquifer was delineated during the RI. Groundwater contamination was detected in five areas in the upper portion of the surficial aquifer. However, three of these areas were identified by contaminant detections in single monitoring wells (73-MW01, 73-MW32 and 73-MW09) and do not appear to be part of a larger continuous groundwater contaminant plume. Contamination detected in wells 73-MW32 and 73-MW01 does not appear to impact the site's receptor, Courthouse Bay. However, contamination detected in well 73-MW09 appears to discharge into Courthouse Bay due to the close proximity of its location relative to the bay. The extent of contamination detected in these wells, as well as, any potential impact is believed to be minimal. It is assumed if natural attenuative processes are effectively remediating contamination in the adjacent larger plumes the same processes will be impacting these smaller plumes. As a result the three smaller plumes were not included in the NAES.

The extent of two larger contaminant plumes (see Figure 1) was delineated in the upper surficial aquifer during the RI. The northernmost plume is generally situated underneath Building A-47, and the adjacent parking area and extends in a northeasterly direction. Contamination in this plume consists primarily of trichloroethene (TCE) and 1,2 -dichloroethene (DCE). Combined levels of

TCE and DCE detected in this plume during Phase II do not exceed 60 parts per billion (ppb). The southernmost plume is situated southeast of Building A-47 and appears to extend in a southeasterly direction toward Courthouse Bay. Contamination in this plume consists of benzene, DCE and vinyl chloride. The maximum levels of benzene, DCE and vinyl chloride detected in this plume were 27 ppb, 44 ppb and 43 ppb, respectively. These two plumes are the focus of the NAES in the surficial aquifer.

2.4.2 Lower Surficial and Upper Castle Hayne Aquifer

Groundwater contamination was detected in four areas in the lower surficial and upper Castle Hayne aquifers. Three of these areas were identified by contaminant detections in single monitoring wells (73-MW01B, 73-MW02B and 73-MW11B) and do not appear to be part of a larger continuous groundwater contaminant plume. The extent of contamination detected in these wells, as well as, any potential impact is believed to be minimal. It is assumed if natural attenuative processes are effectively remediating contamination in the adjacent larger plume the same processes will be impacting these smaller plumes. As a result the three smaller plumes were not included not included in the NAES.

Based on Phase II RI data a plume of TCE, DCE and vinyl chloride appears to reside in the upper portion of the Castle Hayne aquifer. Although the estimated limits of this plume are shown in Figure 2, the vertical and horizontal extent of this plume has not been clearly established. It should be noted that these limits are estimated and based on the analytical results from only two wells, 73-DW03 and 73-DW04. During Phase II of the RI, TCE (320 ppb), DCE (120 ppb) and vinyl chloride (4 ppb) were detected only in well 73-DW03. No contamination was detected in 73-DW04 during Phase II of the RI. Baker believes that, depending on the interpretation of flow direction data, it is also possible that the centerline of this plume may be oriented in a southeasterly direction or a southerly direction as shown in Figure 2.

The vertical extent of this contamination is uncertain as well. Although contamination was detected in well 73-DW03, which is screened from 65 to 75 feet bgs, no contamination was detected in a temporary monitoring well that was installed to 150 feet bgs during the RI.

3.0 FIELD INVESTIGATION

The objective of the NAES is to evaluate the potential for natural attenuation to remediate the contaminants of concern detected in the groundwater to levels that are protective of human health and the environment. To evaluate the potential of natural attenuation the field investigation will consist of a hydrological investigation, groundwater investigation and a limited soil investigation. The data gathered during this investigation will be used to perform the following (Weidemeir, 1996):

- An assessment of site-wide hydrological parameters
- An assessment of contaminant concentrations along the flow path down gradient from source areas
- An assessment of trends in the levels of parent compounds, daughter compounds, electron acceptors and donors, metabolic byproducts
- Calculation of biodegradation rate constants

Field activities at Site 73 will be conducted in two phases. During Phase I groundwater data will be collected from the upper portion of the surficial aquifer and the Castle Hayne aquifer. Upon the completion of Phase I field activities the data will be reviewed and the specific approach to Phase II site activities will be determined. Additional activities may include the installation of permanent wells in the upper surficial aquifer, performance of slug tests and conducting additional assessment activities in the Castle Hayne aquifer.

3.1 General Approach

Phase I assessment activities will be conducted in both the upper surficial and Castle Hayne aquifers. However, due to site conditions the technical approach to evaluating both aquifers will differ.

Groundwater in the upper surficial aquifer resides in an interval approximately five feet bgs to 20 feet bgs. A Hydropunch™ probe can be used to collect a dense array of samples that will yield contaminant, geochemical and microbial by-product distributions with a high level of resolution. Sampling efforts in the upper surficial aquifer will focus on gaining a contaminant, geochemical, and microbial by-product distribution that will support an adequate assessment of natural attenuative processes and the optimal placement of permanent monitoring wells in Phase II.

The vertical extent of contamination in the Castle Hayne aquifer is estimated to be between 70 and 150 feet bgs, which is beyond the range of the of the Hydropunch™ probe in this particular environment. Baker experience from other sites at MCB Camp Lejeune has demonstrated that the Hydropunch has difficulty penetrating the dense layers of limestone nodules that are present at Site 73 in the deeper zones. The installation of monitoring wells through the clay layer will require the installation of casing to prevent the downward migration of contamination. As was previously noted the estimated limits of contamination are based on a limited number of samples. Considering these sampling efforts, Phase I activities in the Castle Hayne aquifer will focus on refining the available data base regarding the extent of contamination and the direction of the groundwater plume. Preliminary natural attenuation data will be used to assess the need for a more complete natural attenuation investigation in Phase II.

3.2 Groundwater Investigation

This section discusses the specific approach to the proposed investigations in the upper surficial, aquifer and the lower surficial/Castle Hayne aquifers. A summary of groundwater samples that will be collected during this investigation is included in Tables 1 and 2.

3.2.1 Groundwater Investigation in the Upper Surficial Aquifer

Previous investigations conducted at Site 73 were designed to determine the nature and extent of contamination. The emphasis was on the concentrations of the contaminants of concern and the size and shape of the contaminant plume. This approach was adequate for evaluating active remediation systems. However, the evaluation of natural attenuation requires a higher level of understanding of

mechanisms acting on the contaminant plume (EPA, 1998). The calculation of contaminant mass flow rates across boundaries and flux along a flowpath provides the best method for estimating the impact of natural attenuation on the site as a whole.

In order to perform flux calculations along the flow path, boundaries are required. To provide such boundaries the surficial contaminant plumes at Site 73 were overlaid with three planar transects, A through C, that are depicted in Figure 1. Along each of the transects groundwater samples will be collected at several predetermined discreet intervals via a Hydropunch™ probe. Transects were located based on known contaminant concentrations and are perpendicular to groundwater flow. In addition to groundwater samples gathered via Hydropunch™ four existing shallow monitoring wells will be sampled to provide additional information on the extent of contamination.

A total of 14 Hydropunch™ borings will be advanced at Site 73. A single background boring (73IR-IS01) will be advanced. Three borings (IR73-IS02, IR73-IS03 and IR73-IS04) will be advanced along transect A . Five borings (IR73-IS05, IR73-IS06, IR73-IS07, IR73-IS08 and IR73-IS09) will be advanced along transect B. Five borings (IR73-IS10, IR73-IS11, IR73-IS12, IR73-IS13 and IR73-IS14) will be advanced along transect C.

Groundwater samples will be collected continuously in four-foot discreet intervals between the water table and the top of the clay layer (approximately 20 feet bgs) from five borings located roughly along the centerlines of the two plumes (IR73-IS03, IR73-IS06, IR73-IS08, IR73-IS10 and IR73-IS12) as well as the background boring (IR73-IS01). Groundwater samples will be collected from two, four-foot discreet intervals between the water table and the top of the clay layer (approximately 20 feet bgs)from eight borings located lateral to the centerline borings (IR73-IS02, IR73-IS04, IR73-IS05, IR73-IS07, IR73-IS09, IR73-IS11, IR73-IS13 and IR73-IS14). The specific interval from where the two samples will be collected will be based on the results of samples collected from adjacent borings. The analytical parameters that will be performed on groundwater samples is discussed in following chapters.

3.2.2 Groundwater Investigation in the Lower Surficial and Castle Hayne Aquifers

As previously noted, the vertical and horizontal extent of groundwater contamination in the Castle Hayne aquifer is based on a limited number of data points. To further define the extent of groundwater contamination, five deep permanent wells will be installed and sampled, and two existing monitoring wells will be sampled. The locations of the proposed deep wells are shown in Figure 2.

The deep well array will consist of two, two-well clusters and a single well. Monitoring wells installed as a cluster will have well screens set at approximately 70 and 110 feet bgs. A depth of 70 feet was chosen because the highest levels of contamination were detected at this depth in the RI. A depth of 110 feet was chosen for the deeper well because it is halfway between the depth where the highest detection occurred (70 feet bgs) and the depth where no contamination was detected (150 feet bgs). One well cluster (IR73-MW38DW and IR73-MW39DW) will be installed immediately downgradient of IR73-DW03 to assess the extent of vertical contamination and contaminant concentrations along the plume centerline. To assess the orientation of the plume a second cluster (IR73-MW40DW and IR73-MW41DW) will be installed lateral to and slightly downgadient of the first cluster. The single deep well (IR73-MW42DW) will be installed adjacent to monitoring well IR73-DW04 to a depth of 110 feet bgs to assess the extent of vertical contamination.

3.3 Groundwater Analyses

A summary of all analytical methods to be performed by a fixed-base laboratory on groundwater samples is presented in Tables 1 and 2. Samples collected from Hydropunch™ borings IR73-IS03, IR73-IS08 and IR73-IS12 wells will be analyzed immediately and the results will be made available via facsimile within 24 hours. Raw data from permanent wells will be provided by the laboratory within 28 days. All samples to be analyzed will be shipped via overnight courier to EA Laboratories of Sparks, Maryland.

In addition to the fixed-base laboratory analysis that will be performed, all groundwater samples will be analyzed at the wellhead for the following parameters:

- Ferrous iron by method 8146.
- Sulfate by method 8051.
- Total alkalinity by method 8203.
- Chloride by method 8113.

A Hach DR2010 spectrophotometer will be used to analyze for ferrous iron, sulfate, and chloride in the field. Method 8203 (total alkalinity) is a manual titration method. In addition to chemical analysis, conductivity, pH, redox potential and dissolved oxygen will be monitored at each well.

3.4 Soil Investigation.

As previously stated, the surficial clay layer is discontinuous at the eastern edge of the site. The exact limits of this discontinuity is uncertain. Approximately six geoprobe borings will be advanced to assess the vertical and horizontal limits of the surficial clay layer. No samples will be collected from these borings for laboratory analysis. A total of four subsurface soil samples will be collected and analyzed for total organic carbon by the Walkley-Black method. Two of these will be collected from the surficial aquifer and two will be collected from the Castle Hayne aquifer. Surficial samples will be collected from background areas at depths where maximum groundwater contamination was observed. Castle Hayne samples will be collected from monitoring well borings IR73-MW40 and IR73-MW41 at depths of 70 and 110 feet bgs. A summary of soil samples is provided in Table 3.

3.5 Hydrological Investigation

The hydrological investigation will include the performance of slug tests on all proposed shallow permanent wells that will be installed during Phase II of this investigation.. These tests will provide hydraulic conductivity data that is needed to determine groundwater flow velocity. In addition to the slug tests, two rounds of static water levels will be collected from wells in the immediate vicinity of the contaminant plumes.

3.6 Field Investigation Methods

Groundwater samples will be collected from the Hydropunch probe and existing monitoring wells using low-flow purge and sampling techniques. All well installation and sample collection procedures will be conducted in accordance with the Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (Region IV,USEPA, 1996)

Permanent monitoring well installation methods, well development methods, soil and groundwater sampling methods and site health and safety practices that will be used during the NAES field investigation are described in the following documents:

- Remedial Investigation/Feasibility Study Work Plan Operable Unit No 9 (Sites 65 and 73) (Baker, 1993).

- Remedial Investigation/Feasibility Sampling and Analysis Plan Operable Unit No 9 (Sites 65 and 73) (Baker, 1993).

- Remedial Investigation/Feasibility Health and Safety Plan Operable Unit No 9 (Sites 65 and 73) (Baker, 1993).

4.0 INVESTIGATION DERIVED WASTE (IDW)

During this investigation drill cuttings will be generated from borehole advancement. These cuttings will be containerized in 55-gallon drums or a roll-off box. Development and purge water will be stored in a 5,000-gallon tanker or a 1,000-gallon polyethylene tank.

A composite of the drill cuttings will be collected from the roll-off box and analyzed for Target Compound Leaching Procedure (TCLP) Volatiles and RCRA Hazardous Waste Characteristics in order to assess disposal options. A single sample will be collected from the tanker or polyethylene tank used to store IDW during the investigation. This sample will be analyzed for Contract Laboratory Protocol (CLP) Volatile Organic Compounds (VOCs). Based on the analytical results and the prior approval of LANTDIV and MCB Camp Lejeune, liquid IDW will be transported to an on base facility for treatment and disposal.

5.0 REFERENCES

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TABLES

TABLE 1
GROUNDWATER SAMPLE SUMMARY
UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 73 - AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION
MARINE CORP BASE CAMP LEJEUNE, NORTH CAROLINA

Groundwater Sample Location	Sample Designation	VOAs, SW 5030A/ 8260B	Dissolved Gases, Method RSK 175	Nitrate by IC, EPA Method 300.0	Sulfate by IC, EPA Method 300.0	Nitrite by IC, EPA Method 300.0	Orthophosphate by IC, EPA Method 300.0	Total Organic Carbon SW 9060	Total Organic Nitrogen, EPA Method 351.2	Ammonia, EPA Method 350.1	1 Day Turn Around Time
HYDROPUNCH LOCATIONS											
Background											
IR73-IS01 [1]	**IR73-IS01-98DXX** [2,3]	x	x	x	x	x	x	x	x	x	
IR73-IS01	**IR73-IS01-98DXX**	x	x	x	x						
IR73-IS01	**IR73-IS01-98DXX**	x	x	x	x						
IR73-IS01	**IR73-IS01-98DXX**	x	x	x	x						
Transect A											
IR73-IS02	IR73-IS02-98DXX	x	x	x	x						
IR73-IS02	IR73-IS02-98DXX	x	x	x	x						
IR73-IS03	**IR73-IS03-98DXX**	x	x	x	x						x
IR73-IS03	**IR73-IS03-98DXX**	x	x	x	x						x
IR73-IS03	**IR73-IS03-98DXX**	x	x	x	x						x
IR73-IS03	**IR73-IS03-98DXX**	x	x	x	x						x
IR73-IS04	IR73-IS04-98DXX	x	x	x	x						
IR73-IS04	IR73-IS04-98DXX	x	x	x	x						
Transect B											
IR73-IS05	IR73-IS05-98DXX	x	x	x	x						
IR73-IS05	IR73-IS05-98DXX	x	x	x	x						
IR73-IS06	**IR73-IS06-98DXX**	x	x	x	x						
IR73-IS06	**IR73-IS06-98DXX**	x	x	x	x						
IR73-IS06	**IR73-IS06-98DXX**	x	x	x	x						
IR73-IS06	**IR73-IS06-98DXX**	x	x	x	x						
IR73-IS07	IR73-IS07-98DXX	x	x	x	x						
IR73-IS07	IR73-IS07-98DXX	x	x	x	x						
IR73-IS08	**IR73-IS08-98DXX**	x	x	x	x						x
IR73-IS08	**IR73-IS08-98DXX**	x	x	x	x						x
IR73-IS08	**IR73-IS08-98DXX**	x	x	x	x						x
IR73-IS08	**IR73-IS08-98DXX**	x	x	x	x						x
Holding Times		14D [4]	14D	48H [5]	28D	28D	48H	28D	48H	28D	

TABLE 1
GROUNDWATER SAMPLE SUMMARY
UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 73 - AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION
MARINE CORP BASE CAMP LEJEUNE, NORTH CAROLINA

Groundwater Sample Location	Sample Designation	VOAs, SW 5030A/ 8260B	Dissolved Gases, Method RSK 175	Nitrate by IC, EPA Method 300.0	Sulfate by IC, EPA Method 300.0	Nitrite by IC, EPA Method 300.0	Orthophosphate by IC, EPA Method 300.0	Total Organic Carbon SW 9060	Total Organic Nitrogen, EPA Method 351.2	Ammonia, EPA Method 350.1	1 Day Turn Around Time
Transect B (continued)											
IR73-IS09	IR73-IS09-98DXX	x	x	x	x						
IR73-IS09	IR73-IS09-98DXX	x	x	x	x						
Transect C											
IR73-IS10	**IR73-IS10-98DXX**	x	x	x	x						
IR73-IS10	**IR73-IS10-98DXX**	x	x	x	x						
IR73-IS10	**IR73-IS10-98DXX**	x	x	x	x						
IR73-IS10	**IR73-IS10-98DXX**	x	x	x	x						
IR73-IS11	IR73-IS11-98DXX	x	x	x	x						
IR73-IS11	IR73-IS11-98DXX	x	x	x	x						
IR73-IS12	**IR73-IS12-98DXX**	x	x	x	x						x
IR73-IS12	**IR73-IS12-98DXX**	x	x	x	x						x
IR73-IS12	**IR73-IS12-98DXX**	x	x	x	x						x
IR73-IS12	**IR73-IS12-98DXX**	x	x	x	x						x
IR73-IS13	IR73-IS13-98DXX	x	x	x	x						
IR73-IS13	IR73-IS13-98DXX	x	x	x	x						
IR73-IS14	IR73-IS14-98DXX	x	x	x	x						
IR73-IS14	IR73-IS14-98DXX	x	x	x	x						
Existing Monitoring Wells											
IR73-A47/3-15	IR73-A47/3-GW15-98D	x	x	x	x						
IR73-A47/3-11	IR73-A47/3-GW11-98D	x	x	x	x						
IR73-MW15	IR73-GW15-98D	x	x	x	x						
IR73-A47/3-19	IR73-A47/3-GW19-98D	x	x	x	x	x	x	x	x	x	
Holding Times		14D	14D	48H	28D	28D	48H	28D	48H	28D	

Notes

(1) H = Hours

(2) D = Days

(3) XX = Designates depth that will be determined out in the field.

(4) **Bold** = Indicates four sample intervals

(5) The sample interval of location IR73-IS01 to be analyzed for the full suite of natural attenuation parameters will be based on the results of location IR73-IS03.

TABLE 2
GROUNDWATER SAMPLE SUMMARY
CASTLE HAYNE AQUIFER
SITE 73 - AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION
MARINE CORP BASE CAMP LEJEUNE, NORTH CAROLINA

Groundwater Sample Location	Sample Designation	Approximate Depths	VOAs, SW 5030A/ 8260B	Dissolved Gases, Method RSK 175	Nitrate by IC, EPA Method 300.0	Sulfate by IC, EPA Method 300.0	Nitrite by IC, EPA Method 300.0	Orthophosphate by IC, EPA Method 300.0	Total Organic Carbon SW 9060	Total Organic Nitrogen, EPA Method 351.2	Ammonia, EPA Method 350.1
MONITORING WELL LOCATIONS											
IR73-MW38DW	IR73-GW38DW-98D	70	x	x	x	x					
IR73-MW39DW	IR73-GW39DW-98D	110	x	x	x	x					
IR73-MW40DW	IR73-GW40DW-98D	70	x	x	x	x	x	x	x	x	x
IR73-MW41DW	IR73-GW41DW-98D	110	x	x	x	x					
IR73-MW42DW	IR73-GW42-DW-98D	110	x	x	x	x					
IR73-DW03	IR73-GW03DW-98D	70	x	x	x	x					
IR73-DW04	IR73-GW04DW-98D	61	x	x	x	x					
IR73-DW05	IR73-GW05DW-98D	53	x	x	x	x	x	x	x	x	x
Holding Times			14D [1]	14D	48H [2]	28D	28D	48H	28D	48H	28D

Notes

[1] D = Days

[2] H = Hours

TABLE 3
SOIL SAMPLE SUMMARY
SITE 73 - AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION
MARINE CORP BASE CAMP LEJEUNE, NORTH CAROLINA

Soil Boring Sample Location	Sample Designation	VOAs, SW 5030A/ 8260B	Total Organic Carbon, Walkley Black
Miscellaneous Soil Borings			
IR73-SB01	IR73-SB01-XX [1,2]	x	x
IR73-IS01	IR73-IS01-XX [2]	x	x
IR73-MW40	IR73-MW39-XX	x	x
IR73-MW41	IR73-MW39-XX	x	x
Holding Times		14D [3]	28D

Notes

[1] XX = Designates depth that will be determined out in the field.

[2] Sample will be collected from the zone of maximum contamination.

[3] D = Days

FIGURES

312504NA

73-MW34
73-MW35
N.C. HWY 172
73-MW24
EASTERN UNNAMED TRIBUTARY
73-MW19
73-MW21
MW-08
73-MW01
73-MW20
MW-16
73-MW33
A'
C'
IR73-IS05
HAZ MAT STORAGE CENTER
A47/3-15
IR73-IS10
A47/3-19
73-MW37
73-MW17
IR73-IS06
IR73-IS02
A47/3-13
A47/3-16
IR73-IS11
IR73-IS07
PARKING LOT
MW-09
73-MW23
73-MW27
73-MW14
A47/3-5
A47/3-11
IR73-IS03
IR73-SB01
IR73-IS01
IR73-IS12
73-MW04
BUILDING A11
BUILDING A10
73-MW26
73-MW16
IR73-IS04
IR73-IS08
WASHDOWN RACKS
PARKING AREA
73-MW02
BUILDING A9
BUILDING A8
73-MW11
73-MW29
IR73-IS13
A
IR73-IS09
73-MW30
73-MW03
IR73-IS14
73-MW15
73-MW32
A-3
C
73-MW12
73-MW05
A-2
ASPHALT ROAD
A-1
COURTHOUSE BAY
73-MW28
73-MW10
73-MW08
73-MW29
73-MW09
73-MW07
73-MW06
EDGE OF BANK
73-MW31

LEGEND

73-MW01 EXISTING MONITORING WELLS INSTALLED BY BAKER DURING REMEDIAL INVESTIGATION, PHASE I (APRIL–MAY, 1995)

73-MW31 EXISTING MONITORING WELLS INSTALLED BY BAKER DURING REMEDIAL INVESTIGATION, PHASE II (FEBRUARY–MARCH, 1996)

A47/3-8 EXISTING MONITORING WELLS INSTALLED DURING UST INVESTIGATION BY GSI AND LAW–CATLIN AND ASSOCIATES (1993)

MW-15 EXISTING MONITORING WELLS INSTALLED BY BAKER DURING UST INVESTIGATION (1992 AND 1993)

MW-08 EXISTING MONITORING WELLS INSTALLED DURING A UST INVESTIGATION BY ATEC AND ASSOCIATES (1991)

IR73-IS14 HYDROPUNCH SAMPLE LOCATION

IR73-SB01 BACKGROUND SOIL BORING LOCATION

A47/3-19 EXISTING WELLS TO BE SAMPLED

DIRECTION OF GROUNDWATER FLOW

LIMITS OF CHLORINATED SOLVENTS CONTAMINATION

LIMITS OF BTEX CONTAMINATION

A A' TRANSECT

SOURCE: LANIER SURVEYING CO., APRIL 4, 1996.

250 0 125 250
1 inch = 250 ft.

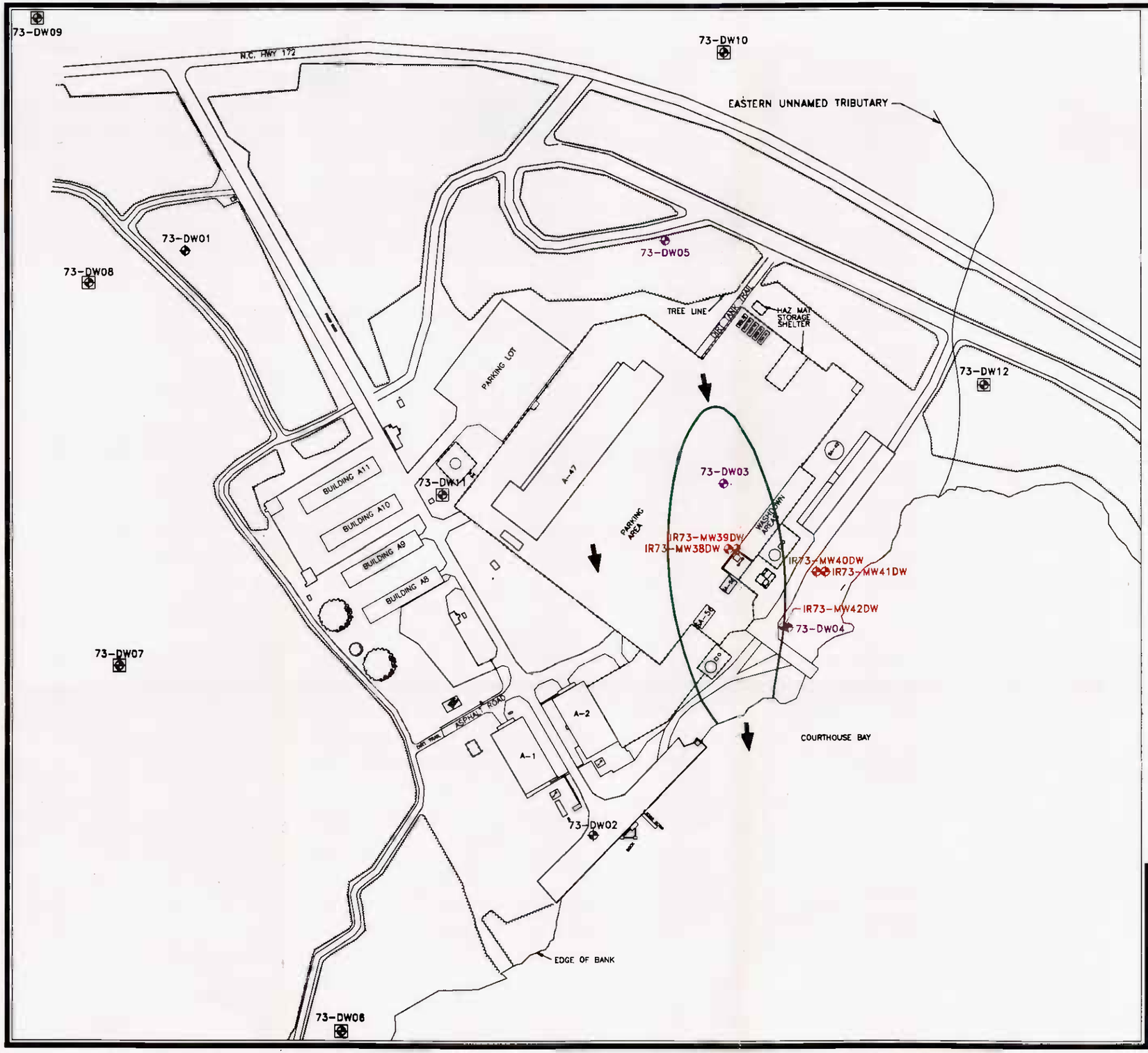
Baker
Baker Environmental, Inc.

FIGURE 1
PROPOSED SAMPLING LOCATIONS IN THE
UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 73 – AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION STUDY, CTO – 0312

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00399BBBIY

312505NA



LEGEND

- 73-MW01 — EXISTING MONITORING WELLS INSTALLED BY BAKER DURING REMEDIAL INVESTIGATION, PHASE I (APRIL-MAY, 1995)
- 73-MW31 — EXISTING MONITORING WELLS INSTALLED BY BAKER DURING REMEDIAL INVESTIGATION, PHASE II (FEBRUARY-MARCH, 1996)
- 73-MW41DW — PROPOSED MONITORING WELL LOCATION
- 73-DW04 — EXISTING WELLS TO BE SAMPLED
- DIRECTION OF GROUNDWATER FLOW
- LIMITS OF CHLORINATED SOLVENTS CONTAMINATION

SOURCE: LANIER SURVEYING CO., APRIL 4, 1996.

250 0 125 250
1 inch = 250 ft.

Baker
Baker Environmental, Inc.

FIGURE 2
PROPOSED MONITORING WELL LOCATIONS
IN THE CASTLE HAYNE AQUIFER
SITE 73 - AMPHIBIOUS VEHICLE MAINTENANCE FACILITY
NATURAL ATTENUATION EVALUATION STUDY, CTO - 0312

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA