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U.S Army Corps of Engineers

New England Division

Final Demonstration of Remedial Actions Operating Properly and Successfully

AOCs 32 AND 43A
DRMO AND POL

DEVENS, MASSACHUSETTS

Prepared Under:

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FINAL
DEMONSTRATION OF REMEDIAL ACTIONS OPERATING PROPERLY AND SUCCESSFULLY
DEFENSE REUTILIZATION AND MARKETING OFFICE YARD
(AREA OF CONTAMINATION 32)

AND

PETROLEUM, OIL, LUBRICANT STORAGE AREA
(AREA OF CONTAMINATION 43A)

DEVENS, MASSACHUSETTS

Prepared for:

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FINAL
DEMONSTRATION OF REMEDIAL ACTIONS
OPERATING PROPERLY AND SUCCESSFULLY REPORT
DEFENSE REUTILIZATION AND MARKETING OFFICE YARD (AOC 32)
PETROLEUM, OIL, LUBRICANT STORAGE AREA (AOC 43A)
DEVENS, MASSACHUSETTS

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EXECUTIVE SUMMARY

This Operating Properly and Successfully (OPS) Report has been prepared to demonstrate that the selected remedial action for the Defense Reutilization and Marketing Office Yard (DRMO), Area of Contamination (AOC) 32, and the former Petroleum, Oils, and Lubricants (POL) Storage Area, AOC 43A at the former Fort Devens is operating properly and successfully in accordance with the EPA Guidance Document (EPA, 1996). OPS as defined in this guidance document states:

> The phrase, "operating properly and successfully", involves two separate concepts. A remedial action is operating properly if it is operating as designed. The system is operating "successfully" if its operation will achieve the cleanup levels or performance goals delineated in the decision document. Additionally, in order to be successful that remedy must be protective of human health and the environment.

In 1991, the Army, through the U.S. Army Environmental Center (USAEC), initiated site investigations (SI) at AOC 32 and AOC 43A. The Interagency Agreement (IAG) under Section 120 of CERCLA requires that a Feasibility Study (FS) be undertaken at an AOC to develop and analyze potential remedial alternatives leading to a Record of Decision (ROD). In compliance with the IAG, the USACE completed a Remedial Investigation (RI) and a FS was issued in January 1997 to address groundwater and soil contamination at the AOCs. Following submission of the Army's Proposed Plan and receipt of public comments of the preferred remedial alternatives for each AOC, the Army issued a ROD, documenting the final choice of a remedy for cleanup of the two sites.

In the ROD, AOC 32 and AOC 43A were addressed as three operable units. The three operable units with the respective selected remedy and objectives include:

- *AOC 32 Soils Operable Unit.* The selected remedy was excavation and off-site disposal of contaminated soils. The objective of this remedy was to remove soils identified as contaminated and reduce the potential risk of future site worker exposure to contaminated soils;
- *AOC 32 (Underground Storage Tank #13) Groundwater Operable Unit; and*
- *DRMO/POL (AOC 32/43A) Groundwater Operable Unit.* The selected remedy for both AOCs was Monitored Natural Attenuation (MNA). The objective of this remedy was to mitigate existing groundwater contamination through the use of restrictions and natural attenuation, thereby reducing the potential risk of exposure to contaminated groundwater.

For the AOC 32 Soils Operable Unit, the remedial action was conducted between October 1998 and December 1998. The remedial action included the removal and disposal of approximately 50 cubic yards (cy^3) of metal debris; removal and disposal of approximately 1200 cy^3 of petroleum-contaminated soil; removal and disposal of approximately 800 cy^3 of non-hazardous soil with shredded tire scrap; removal and disposal of approximately 400 cy^3 of soil contaminated with lead and containing shredded tire scrap; removal and disposal of approximately 600 cy^3 of soil and asphalt contaminated with low levels of PCBs and pesticides.

Based on indications from analytical results of confirmatory soil samples collected from excavated areas, and the off-site disposal of excavated material and metal debris from AOC 32, site cleanup goals and remedial action objectives established in the ROD have been satisfied. This removal action is detailed in the *Final Soils Remedial Action Operable Unit Completion Report, AOC 32, Devens, Massachusetts* (Roy F. Weston, 2000).

For AOCs 32 (Underground Storage Tank #13) and AOCs 32/43A Groundwater Operable Units, the MNA Assessment (MNAA) was initiated in January 1999 as the primary component in the selected remedy specified in the ROD. The ultimate goal of the selected remedy is to degrade contaminants in the groundwater to a level below the cleanup criteria within 30 years.

The MNAA field activities performed at AOC 32 and AOC 43A have included:

- Four rounds of quarterly groundwater sampling,
- Groundwater level measurements collected during each sampling round,
- Installation of four microwells in AOC 43A between March 29 and March 31, 1999 to investigate the presence or absence of chlorinated Volatile Organic Compounds (VOCs),
- Installation of two piezometers between March 31 and April 1, 1999 to provide additional information regarding water table elevation and the direction of groundwater flow, and
- Installation of five monitoring wells between April 2 and April 8, 1999 to provide additional points of groundwater quality and confirm water table elevation and groundwater flow direction.

Groundwater sampling activities were conducted at AOCs 32 and 43A in January 1999, April 1999, July 1999, and October 1999. Groundwater samples collected from a number of monitoring wells were analyzed by an off-site laboratory for analytical parameters including; Extractable Petroleum Hydrocarbons (EPH)/Volatile Petroleum Hydrocarbons (VPH), VOCs (VOCs reported include Trichloroethene (TCE), trichloroethane (TCA), vinyl chloride, 1,2 dichloroethylene [DCE (cis and trans)], Polychlorinated Biphenyls (PCBs), lead, arsenic, manganese, and numerous natural attenuation parameters. In addition, natural attenuation field measurements for pH, temperature, specific conductivity, dissolved oxygen (DO), oxidation-reduction potential, and turbidity were also collected from each monitoring well sampled.

The following summarizes the analytical results for AOCs 32 and 43A for groundwater sampling rounds one through four:

> ***AOC 32***
> During the four groundwater sampling rounds there have only been two monitoring wells (32M-92-04X and 32M-92-06X) which have shown organic compounds in excess of cleanup goals.
>
> During the four groundwater sampling rounds, monitoring wells 32M-92-06X and SHL-15 have consistently had inorganics in excess of cleanup goals. In addition, monitoring wells 32M-92-04X and 32M-92-05X had inorganic exceedances during the first sampling rounds and monitoring wells 32M-92-01X and 32M-92-11X had inorganic exceedances during the fourth sampling round.
>
> ***AOC 43A***
> During the four groundwater sampling rounds there have only been two monitoring wells (43MA-93-10X and POL-3) which have shown organic compounds in excess of cleanup goals.
>
> During the four groundwater sampling rounds there have only been two monitoring wells (43MA-93-10X and POL-2) which have shown inorganic compounds in excess of cleanup goals.

Biodegradation of organic compounds is believed to be occurring at AOCs 32 and 43A. This is evidenced by observed concentration decreases of organic compounds in groundwater over time and by geochemical indicator parameters.

A limited number of chlorinated organic compounds have been detected over the years in a few wells at AOCs 32 and 43A. The data show that concentrations of such contaminants such as dichlorobenzene (DCB) and trichloroethene (TCE) have decreased over time. These concentration decreases suggest that biodegradation is occurring within these areas. This is supported by numerous geochemical parameters which are used as indicators of biodegradation. These geochemical parameters include; dissolved oxygen, redox potential (Eh), sulfate, ferrous iron, and methane concentrations.

Depleted DO concentrations and low Eh in groundwater are observed in three general areas. Two of these areas (one at AOC 32 and one at AOC 43A) were observed. The depletion of DO and low Eh conditions are associated with elevated aliphatic/aromatic hydrocarbons and chlorinated organic compounds present in groundwater. Low sulfate, elevated ferrous iron, and the presence of methane concentrations are also observed in the same general area where detectable concentrations of aliphatic/aromatic hydrocarbons and chlorinated organic compounds are present. This data is a strong indication that a combination of aerobic and anaerobic biodegradation is occurring within these source areas. At the on-set of anaerobic conditions, DO becomes depleted and by-products such as carbon dioxide (CO_2) and methane are produced. At this juncture, aliphatic/aromatic hydrocarbons do not appear to biodegrade as rapid, however, anaerobic bacteria utilize aerobic by-products as electron acceptors to assist in the degradation of chlorinated organic compounds such as trichloroethene. The presence of aliphatic/aromatic hydrocarbons appear to be reduced under aerobic conditions, and chlorinated organic compounds are biodegraded under primarily anaerobic conditions by utilizing aerobic generated by-products.

Arsenic in groundwater was detected in a number of monitoring wells. In all cases, the elevated concentrations coincide with areas where the groundwater has a relatively low Eh, indicating that redox conditions are controlling the solubility of arsenic. More important here, however, is the mobility and transport of arsenic. The data suggests that as groundwater moves from areas of low Eh to areas of high Eh, the concentration of arsenic in solution should decrease, probably due to precipitation and formation of solid phases. Thus, the mobility and transport of arsenic in groundwater should be limited at AOCs 32 and 43A.

The criteria set forth in the ROD states that a MNAA be completed (the MNAA will be finished at the end of 2000 and the results will be presented in a Final Report); site reviews be conducted on 5-year intervals for 30 years or until contamination is reduced to acceptable concentrations; and annual data reports be provided to the United States Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protections (MADEP). After the MNAA is completed, a long-term monitoring plan (LTMP) will be developed which specifies the monitoring wells to be sampled and the parameters to be analyzed.

1.0 INTRODUCTION

This Operating Properly and Successfully (OPS) Report has been prepared by Stone & Webster Environmental Technology & Services (Stone & Webster) under Contract Number DACW33-94-D-0007 for the U.S. Army Corps of Engineers, New England District (USACE-NAE). The purpose of this OPS Report is to demonstrate that selected remedies for the Defense Reutilization and Marketing Office Yard (DRMO), Area of Contamination (AOC) 32, and the former Petroleum, Oils, and Lubricants (POL) Storage Area, AOC 43A are functioning in such a manner that it is expected to adequately protect human health and the environment when completed.

1.1 OPS DEFINITION

The OPS definition taken from the EPA Guidance Document dated June 1996 (EPA, 1996) states, "The phrase operating properly and successfully involves two separate concepts. A remedial action is operating properly if it is operating as designed. The system is operating "successfully" if its operation will achieve the cleanup levels or performance goals delineated in the decision document. Additionally, in order to be successful that remedy must be protective of human health and the environment." This definition will be used in this report.

2.0 SITE HISTORY

Fort Devens was placed on the National Priority List on December 21, 1989, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). In 1991, the Army conducted a Site Investigation (SI) at AOC 32 and reported contamination exceeding screening levels for soil and groundwater. An SI was also conducted by the Army at AOC 43A in 1992, and reported a low level of xylene and elevated petroleum hydrocarbons in subsurface soils.

A Remedial Investigation (RI) was initiated to determine the nature and distribution of contamination at each AOC, assess the risk to human health and provide a basis for conducting feasibility studies. The final RI report issued in 1994 concluded that soil contamination at AOC 32 and groundwater contamination at both AOCs required a remedial action evaluation.

A Feasibility Study (FS) designed to develop and analyze potential remedial alternatives for cleanup at each AOC leading to a Record of Decision (ROD) was issued in January 1997. Following submission of the Army's Proposed Plan and receipt of public comments on the preferred remedial alternatives for each AOC, the Army issued a ROD, documenting the final choice of a remedy for cleanup of the two sites. In the ROD, AOC 32 and AOC 43A were addressed as three operable units. The three operable units with the respective selected remedy and objectives include:

- *AOC 32 Soils Operable Unit.* The selected remedy is excavation and off-site disposal of contaminated soils. The objective of this remedy is to remove soils identified as contaminated and reduce the potential risk of future site worker exposure to contaminated soils;
- *AOC 32 (Underground Storage Tank #13) Groundwater Operable Unit; and*
- *DRMO/POL (AOC 32/43A) Groundwater Operable Unit.* The selected remedy for both AOCs is MNAA. The objective of this remedy is to mitigate existing groundwater contamination through the use of restrictions and natural attenuation, thereby reducing the potential risk of exposure to contaminated groundwater.

2.1 BACKGROUND & PHYSICAL SETTING

2.1.1 AOC 32

AOC 32 is located in the northeast corner of the former Main Post at Fort Devens. Shepley's Hill Landfill borders this site on the north. To the south across Market Street are the POL Storage Area (AOC 43A) and the remainder of the former Main Post, which consists of buildings, roads, and mowed grass lots.

The DRMO was used as a materials storage facility. Operational records indicate that the facility was active from at least 1964 to 1995. The nature of materials that were handled and the activities conducted in this yard varied significantly. AOC 32 consists of three fenced areas (Figure 2-1). The DRMO Yard on the west side of Cook Street (West Yard) contained used equipment, including lead-acid batteries, telecommunications equipment, and administrative equipment. The yard on the east side of Cook Street (East Yard) was used for disassembling vehicles for reusable parts and previously contained scrap metal, tires, stored items ready for sale, and used photographic solutions. The only unpaved, fenced area is located just north of the East Yard and was used to store and recycle tires. A former Underground Storage Tank site (UST #13) has been incorporated into AOC 32. This UST was used to store waste oil and was located just northeast of the DRMO Office. UST #13 and the remainder of AOC 32 appear to be in separate groundwater regimes.

2.1.2 AOC 43A

AOC 43A is located in the northeast corner of the former Main Post at Fort Devens across Market Street just to the south of AOC 32. AOC 43A is bounded on the south, west, and north by Antietam Street, Cook Street, and Market Street. AOC 43A consists of a fenced lot located within a developed industrial area (Figure 2-2).

The POL Storage Area served as the central distribution point for all gasoline stations at Fort Devens during the 1940s and 1950s. It was subsequently used to store fuels for various purposes. The distribution facility formerly consisted of a main gasoline station building (T401), a pump house, four 12,000 gallon USTs, one 10,000 gallon UST, two 12,000 gallon aboveground storage tanks (ASTs), and two 8,000 gallon ASTs. Gasoline was delivered to the facility by rail car and transferred to the tanks.

AOC 43A consists of a fenced lot located within a developed industrial area of buildings, roads, and grass lots, with the exception of the east side of the site, which is bounded by a wooded area on a rock outcrop. A set of railroad tracks, formerly used to transport fuels to the site, forms the site's northern boundary. The UST area is fenced. An asphalt driveway leads into the POL Storage Area from Antietam Street. The driveway is bermed to contain any spills. A pump station is located in the center of the fenced area and the previous USTs (removed in October 1998) were located on the eastern side.

2.2 REMOVAL ACTIONS

2.2.1 AOC 32

Because vehicle scrap was found in the East Yard, a radiation survey was performed, indicating twelve "hot spots". All hot spots were located in the north end of the East Yard and were remediated in 1996 by removing radium-contaminated soil or radium dials.

A pit located in the East Yard that was reported to be part of the remediation of a PCB contaminated rectifier oil spill in 1990. Approximately 600 gallons of liquid from the remaining electrical units and 40 cubic yards of potentially contaminated asphalt and soil were removed from the site. The oil was analyzed and found not to contain Polychlorinated Biphenyls [PCBs (minimum detection level of 21 parts per million (ppm))]. The removed material was, therefore, handled as oil-contaminated waste.

UST #13 which was removed in 1992, was used to store waste oil and was located just northeast of the DRMO Office. Three trenches were excavated around the former UST #13 site during the RI in an attempt to characterize any hydrocarbon plume that may have migrated from the former tank. Two of the three trenches were found to be clean based on field screening for organic vapors. The third trench was extended to a drainfield, where approximately two cubic yards of petroleum-contaminated soil were encountered. The source of the contamination was found to be waste debris that included oil filters.

2.2.2 AOC 43A

Between 1965 and 1972, four ASTs located in a pit behind T-401 were removed. In 1989 and 1990, five USTs located near the pump house were excavated at the site. All five tanks were listed as storage tanks for fuel oil. In 1989 and 1990, three USTs and 800 cubic yards of soil beneath the pump house were excavated. The excavated soil was analyzed for TPH. The highest TPH concentration was 237 (mg/kg).

2.3 RECORD OF DECISION

A Final ROD was signed for AOC 32 and AOC 43A in February 1998, documenting the final choice of a remedy for cleanup of the two sites. In the ROD, AOC 32 and AOC 43A were addressed as three operable units. The three operable units with the major components of the selected remedy are listed below.

AOC 32 Soils Operable Unit. The selected remedy is excavation and off-site disposal of contaminated soils. The major components of this remedy include:

1. Excavating contaminated soil (approximately 1,300 cubic yards, confirmatory sampling will be conducted prior to backfilling).
2. Immediately transporting soils to an off-site, non-hazardous landfill for disposal.
3. Backfilling the excavated area with clean material and revegetating the area.
4. Monitoring groundwater on an annual basis and reviewing the site at 5-year intervals for 30 years or until contamination is reduced to acceptable concentrations.

Remedial Action

Contaminated soils, asphalt and tire debris were excavated, removed from the site, and disposed of at appropriate off-site disposal facilities. Based on analytical results of confirmatory soil samples collected from excavated areas, and the off-site disposal of excavated material and metal debris, site cleanup goals and remedial action objectives have been satisfied. The area of excavation was backfilled with clean material and revegetated. This remedial action which was conducted between October 1998 and December 1998 satisfies Component Nos. 1, 2, and 3 listed above. Component No. 4 will be addressed in Section 6.1. This removal action is detailed in *Final Soils Remedial Action Operable Unit Completion Report, AOC 32, Devens, Massachusetts* (Roy F. Weston, 2000).

AOC 32 (Underground Storage Tank #13) Groundwater Operable Unit and DRMO/POL (AOC 32/43A) Groundwater Operable Unit. The selected remedy for both AOCs was MNA. The major components of this remedy include:

1. Establishing institutional controls
2. Installing additional groundwater monitoring wells
3. Providing for monitored natural attenuation
4. Collecting data on monitored natural attenuation, assessing the data, and performing groundwater modeling
5. Performing long-term groundwater monitoring on an annual basis
6. Reviewing the site at 5-year intervals for 30 years or until contamination is reduced to acceptable concentrations
7. Providing annual data reports to United States Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protections (MADEP)

Remedial Action
MNA was initiated in January 1999 as the primary component in the selected remedy to meet the cleanup criteria specified in the ROD. Component No. 1 will be met by establishing institutional controls on the properties before they are transferred (see Section 7). These restrictions will be implemented to restrict the exposure pathways for contaminants of concern. The MNAA has met Component Nos. 2 and 3. Component No. 4 is currently in progress, as the monitoring and assessment are ongoing activities. These components are further discussed in Section 3.0. Component Nos. 5, 6, and 7 will be further discussed in Section 7.1.

The selected remedies for the three operable units will permanently reduce the risks to human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. The principal soil threat at AOC 32 is exposure of site workers to contaminated soil. The contaminated soil was removed and disposed of off-site. The principal groundwater threat at AOC 32 and 43A is potential consumption of unfiltered groundwater. Due to the saturated thickness of the overburden aquifer under AOC 32, the use of groundwater is impractical. The reuse of these portions of Devens shall be controlled by zoning and deed restrictions, which would prevent the use of drinking unfiltered groundwater from the aquifer, resulting in reduced potential for exposure.

2.4 CLEANUP GOALS

2.4.1 Groundwater Cleanup Goals

The main post groundwater cleanup goals were developed from numerous sources and were presented in the ROD. These cleanup levels were used to screen groundwater data from both AOC 32 (Underground Storage Tank #13) and DRMO/POL (AOC 32/43A). Groundwater cleanup goals for contaminants of concern are shown in Table 2-1. When available, the most stringent of the Applicable or Relevant and Appropriate Requirements (ARARs) was selected as a potential candidate cleanup goal. If no ARAR was available, the site-specific risk value was selected. If site-specific risk values were not established, then the most stringent of the USEPA Office of Drinking Water Health Advisories, USEPA Region III tap water criteria, or the MADEP Office of Research and Standards Guidance for chemicals for which Massachusetts MCLs have not been promulgated was selected. If measurable concentrations were below background levels, the background concentration was established as the candidate cleanup goal. (Background levels were determined statistically during the RI). For inorganic contaminants, data from filtered samples were used to develop cleanup goals. Since cleanup goals were not established in the ROD for EPH/VPH, the Massachusetts Contingency Plan (MCP) GW-1 standard was used as the cleanup goal.

2.4.2 Soil Cleanup Goals

Cleanup goals for soils are included in Table 2-2. These values were calculated from the risk assessment as candidate goals for all contaminants except PCBs. The PCB cleanup goal is an ARAR that existed from Toxic Substance Control Act (TSCA). Other contaminants not addressed by these two sources used the lower value of the USEPA Region III risk-based concentration (RBCs) or the Resource Conservation and Recovery Act (RCRA) corrective action level was selected. If these values were below the background concentration, the background level was used as the cleanup goal. Since cleanup goals were not established in the ROD for EPH/VPH, the Massachusetts Contingency Plan (MCP) S-2 standard was used as the cleanup goal.

3.0 REMEDIAL ACTION FIELD TASKS

Sections 3.1 and 3.2 summarize the field tasks associated with the remedial action for the AOC 32 Soils Operable Unit and the AOC 32 (UST #13) Groundwater Operable Unit and the AOC 32 and 43A Groundwater Operable Units.

3.1 SOIL REMOVAL AT AOC 32

The selected soil remedial action is excavation and off-site disposal. This remedial action is expected to provide a permanent, long-term solution for the site and will eliminate the hazard associated with the site. The excavation and disposal activities which were completed between October and December 1998 are summarized below:

- Removal and disposal of approximately 50 cubic yards of metal debris;
- Removal and disposal of approximately 1,200 cubic yards of petroleum-contaminated soil;
- Removal and disposal of approximately 800 cubic yards of non-hazardous soil with shredded tire scrap;
- Removal and disposal of approximately 400 cubic yards of soil contaminated with lead and containing shredded tire scrap; and
- Removal and disposal of approximately 600 cubic yards of soil and asphalt contaminated with low levels of PCBs and pesticides.

The location of the proposed removal areas and stockpile locations are shown on Figure 3-1.

3.1.1 Excavation of Soils and Confirmatory Sampling

A grid system was laid out in the field in order to track excavation and sampling activities, and to ensure uniform frequency of sampling. The grid layout and grid identification numbers are shown in Figures 3-2 and 3-3. Each grid had an area of approximately 1,500 square feet (ft^2) or less.

Excavation of soils were done in four different locations at the site: along the western fenceline of the site; along the eastern fenceline of the site; the tire recycling yard in the northern portion of the fence, and excavation of asphalt in the middle of the paved area.

Excavation areas showing no exceedance of the field-screening goal of 1,000 ppm total petroleum hydrocarbons (TPH) were sampled for confirmatory soil testing. Confirmatory soil samples were collected by compositing up to five evenly spaced grab samples from the floor and sidewalls of each grid. These soil samples were sent for analyses at Recra Environmental Inc. (now Severn Trent Laboratories) in University Park, Illinois, the off-site laboratory for analyses of total arsenic and total lead (by EPA Method 6010), pesticides (by EPA Method 8081A) and PCBs (by EPA Method

8082). Splits from these confirmatory soil samples were also sent to AMRO Environmental Laboratories in Merrimack, New Hampshire for analyses by the MADEP Method for EPH/VPH. Analytical results were to be compared to the cleanup goals provided in Table 2-2. QA sample splits were sent to Severn Trent Laboratories in Colchester, VT. The analytical results were compared to the cleanup goals provided in Table 2-2. Confirmatory samples indicated that not only were site cleanup goals met, sample results were actually lower then the more stringent MCP S-1 residential criteria. A summary of the analytical results from confirmatory soil samples is shown in Table 3-1 of this document.

3.1.2 Backfilling of Excavated Areas

After confirmatory samples indicated that site cleanup goals had been met, excavated areas along the eastern and western fence lines of the site were backfilled with gravel and stone dust. Since the excavations were very shallow, the backfilled areas were compacted using the excavator and front-end loader by placing the backfill material in lifts of 4-6 inches thickness. The excavation in grid AOC-32-08 which was approximately 8 feet in depth was backfilled in lifts of 1 foot thickness and compacted using the track excavator.

3.1.3 Excavated Soil Storage

Excavated soils showing petroleum contamination in excess of the field-screening goal of 1,000 ppm were stockpiled in a temporary staging area inside the southern fence of the site (along Market Street). Soils excavated from the eastern and western fence line were staged in this stockpile. Approximately 1200 cy^3 of soil were excavated from grids AOC-32-01 through AOC-32-17, and AOC-32-19 (stockpile IDs AOC-32-STOCK-01 through AOC-32-STOCK-06). Soils from grid AOC-32-18 were staged in a separate stockpile (stockpile ID AOC-32-STOCK-13).

Approximately 1200 cubic yards of soils excavated from the Tire Recycling Yard were staged separately. Approximately 200 cubic yards of soil excavated from grid AOC-32-18, grids AOC-32-ASPH-03 through AOC-32-ASPH-08 from the asphalt pavement excavation areas were stockpiled separately. Approximately 300 cubic yards of asphalt pavement removed from grids AOC-32-ASPH-03 through AOC-32-ASPH-08 were stockpiled separately. All stockpiled material (soil and asphalt) were sampled for waste characterization analyses at a frequency of one sample per 200 cubic yards as established in the Remedial Action Workplan. These samples were analyzed at Recra Environmental Inc., University Park, IL, (the off-site laboratory of record for the project) for the following parameters: VOCs (USEPA Method 8260), TPH (USEPA Method 8015), SVOCs (USEPA Method 8270B), Pesticides/PCBs (USEPA Method 8081A/8082), Total RCRA Metals (USEPA Methods 6010/7061/7471), Corrosivity (USEPA Method 9045), Reactivity (Methods 7.3.3.2, 7.3.4.2), and Ignitability (Method 1010). All contaminated soils and debris was disposed of at an approved permitted disposal facility.

3.2 MONITORED NATURAL ATTENUATION FIELD TASKS

The principal risk to human health and the environment associated with groundwater at AOCs 32 and 43A is the potential for consumption of unfiltered contaminated groundwater. MNA is the selected remedy to permanently reduce these risks by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. The ultimate goal of MNA is to demonstrate degradation of contaminants in the groundwater to a level below cleanup criteria within 30 years.

The MNA field activities performed at AOC 32 and AOC 43A are summarized below:

- Four rounds of quarterly groundwater sampling were conducted.
- Four rounds of groundwater level measurements, taken before each round of groundwater sampling. These measurements were taken to determine the depth to the water table and confirm groundwater flow direction (Table 3-2 and 3-3 show the groundwater elevations and Figures 3-4, 3-5, and 3-6 shows groundwater contours).
- Four microwells (43MA-99-12X, 43MA-99-13X, 43MA-99-14X, 43MA-99-15X) were installed in AOC 43A between March 29 and March 31, 1999 to investigate the presence or absence of chlorinated Volatile Organic Compounds (VOCs).
- Two piezometers (32Z-99-01X and 32Z-99-02X) were installed between March 31 and April 1, 1999 to provide additional information regarding water table elevation and the direction of groundwater flow.
- Five monitoring wells (32M-99-08X, 32M-99-09X, 32M-99-10X, 32M-99-11X, and 43MA-99-11X) were installed between April 2 and April 8, 1999 to provide additional points of groundwater quality and confirm water table elevation and groundwater flow direction. Permeability tests were conducted on two of the newly installed overburden monitoring wells (32M-99-10X and 32M-99-11X) on May 6, 1999 to provide information regarding the ability of groundwater to flow through the soil matrix.

3.3 GROUNDWATER SAMPLING PROGRAM

Groundwater sampling activities were conducted at AOCs 32 and 43A in January 1999, April 1999, July 1999, and October 1999 in accordance with United States Environmental Protection Agency (USEPA) Region I Low Stress (low flow) Purging and Sampling Guidelines (USEPA, 1996) and the guidelines presented in Subsection 4.6 of the Fort Devens Project Operations Plan (POP) (Stone & Webster, 1995). During the first round of sampling in January 1999 a total of 14 existing monitoring wells (six monitoring wells at AOC 32 and eight monitoring wells at AOC 43A) were sampled. During the second and third sampling rounds (April 1999 and July 1999) a total of 23 monitoring wells (13 monitoring wells at AOC 32 and 10 monitoring wells at AOC

43A), and four microwells at AOC 43A were sampled. During the fourth sampling round (October 1999) a total of 23 monitoring wells (13 monitoring wells at AOC 32 and 10 monitoring wells at AOC 43A), were sampled.

Field measurements for pH, temperature, specific conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity were collected from each monitoring well in accordance with USEPA low flow guidelines (USEPA, 1996) and the POP (Stone & Webster, 1995). Measurements for carbon dioxide and soluble ferrous iron were collected upon completion of purging at each monitoring well. A Photoionization Detector (PID) was used at each monitoring well to monitor background conditions and monitoring well organic vapor levels.

Groundwater samples collected from all monitoring wells were analyzed by an off-site laboratory (Katahdin Analytical Services) for analytical parameters including; Extractable Petroleum Hydrocarbons (EPH)/Volatile Petroleum Hydrocarbons (VPH), VOCs (VOCs reported include Trichloroethene (TCE), trichloroethane (TCA), vinyl chloride, 1,2 dichloroethylene (DCE) cis and trans), PCBs, lead, arsenic, manganese, and numerous natural attenuation parameters. Groundwater samples collected from all microwells were analyzed for VOCs only. Refer to Table 3-4 for the complete list of sample parameters and Method numbers.

The analytical results from Round 1 (January 1999) indicated high inorganic concentrations for a number of monitoring wells for which typically, low flow could not be established. Based on these results, groundwater samples from monitoring wells 32M-92-04X, 32M-92-05X, 32M-92-06X, and 43M-93-10X were filtered in the field for groundwater sampling Round 2. Monitoring wells 32M-92-06X, SHL-15, 43MA-10X, and POL-2 were filtered in the field for groundwater sampling Round 3. Monitoring wells 32M-92-04X, 32M-92-06X, SHL-15, and 43MA-93-10X were filtered in the field for groundwater sampling Round 4. Groundwater samples were filtered using an inline 0.45 micron filter to confirm the actual dissolved inorganic concentrations. Groundwater samples from these monitoring wells were analyzed for both total and dissolved inorganics.

Groundwater samples collected from all microwells were first analyzed for VOCs by an onsite EPA mobile Gas Chromatograph (GC) laboratory. Confirmatory samples were also sent to an off-site laboratory for VOC analysis.

4.0 GROUNDWATER DATA RESULTS

4.1 ANALYTICAL RESULTS

As part of the Remedial Investigation (RI) for these sites groundwater samples were collected in November 1992, March 1993 and June 1993. The first two rounds of samples were analyzed for target analyte list (TAL) organics, TAL metals, TPH, and hardness. A few samples were also analyzed for dissolved TAL metals. The third round of samples were analyzed for total and dissolved TAL metals, explosives, and hardness. During the four MNAA sampling rounds there were few contaminant exceedances. The sample results along with results from the RI are summarized below.

4.1.1 AOC 32

Organics

During the first sampling round, organic compounds that exceeded cleanup goals were detected in groundwater samples collected from the source monitoring wells 32M-92-04X and 32M-92-06X. For monitoring well 32M-92-04X, exceedances consisted of EPH (C19-C36 Aliphatics at 10,000 µg/l and C11-C22 Aromatics at 880 µg/l), and PCB 1260 at 1.9 µg/l. For monitoring well 32M-92-06X, exceedances consisted of VOCs (1,4 Dichlorobenzene at 77 µg/l and 1,2 Dichlorobenzene at 740 µg/l), and VPH (C9-C10 Aromatics at 910 µg/l).

During the second round of sampling, organic compounds that exceeded the cleanup goals were found in monitoring well 32M-92-06X. Exceedances consisted of VOCs (1,2 Dichlorobenzene at 930 µg/l); VPH (C9-C10 Aromatics at 890 µg/l); EPH (C11-C22 Aromatics at 670 µg/l); and PCB 1260 at 0.7J µg/l.

During the third sampling round, the only organic compound that exceeded cleanup goals was VPH (C9-C10 Aromatics at 700 µg/l) detected in monitoring well 32M-92-06X.

During the fourth sampling round, organic compounds that exceeded cleanup goals were detected in groundwater samples collected from the source monitoring wells 32M-92-04X and 32M-92-06X. For monitoring well 32M-92-04X, exceedances consisted of EPH (C11-C22 Aromatics at 310 µg/l), and PCB 1260 at 0.57 µg/l. For monitoring well 32M-92-06X, exceedances consisted of VOCs (1,4 Dichlorobenzene at 100 µg/l and 1,2 Dichlorobenzene at 880 µg/l), and VPH (C9-C10 Aromatics at 1,300 µg/l).

Inorganics

During the first sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from the source monitoring wells 32M-92-04X, 32M-92-05X, and 32M-92-06X. For monitoring well 32M-92-04X, exceedances consisted of lead at 53.8 µg/l. For monitoring well 32M-92-05X, exceedances consisted of lead at 32.4 µg/l. For monitoring well 32M-92-06X, exceedances consisted of ; arsenic at 240 µg/l, and manganese at 4,830 µg/l.

During the second sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from the source monitoring wells 32M-92-06X and SHL-15. For monitoring well 32M-92-06X, exceedances consisted of total arsenic at 145 µg/l and dissolved arsenic at 66.9 µg/l. For SHL-15, exceedances consisted of total arsenic at 104 µg/l.

During the third sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from the monitoring wells 32M-92-06X and SHL-15. For monitoring well 32M-92-06X, exceedances consisted of total and dissolved arsenic (total arsenic at 106 µg/l and dissolved arsenic at 96.9 µg/l) and total and dissolved manganese (total manganese at 3,700 µg/l and dissolved manganese at 3,810 µg/l). Monitoring well SHL-15 exceedances consisted of total and dissolved arsenic (total arsenic at 63.9 µg/l and dissolved arsenic at 60.8 µg/l).

During the fourth sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from the monitoring wells 32M-92-01X, 32M-92-06X, 32M-99-11X and SHL-15. For monitoring well 32M-92-01X, the exceedance was total lead detected at 19.7 µg/l. For monitoring well 32M-92-06X, exceedances consisted of total and dissolved arsenic (total arsenic at 171 µg/l and dissolved arsenic at 161 µg/l) and total and dissolved manganese (total manganese at 3,540 µg/l and dissolved manganese at 3,440 µg/l). For monitoring well SHL-15 exceedances consisted of total arsenic and dissolved arsenic (total arsenic at 327 µg/l and dissolved arsenic at 287 µg/l) and total and dissolved manganese (total manganese at 6,200 µg/l and dissolved manganese at 6,010 µg/l).

4.1.2 Analytical Results for AOC 43A

Organics

During the first sampling round, organic compounds that exceeded cleanup goals were detected in groundwater samples collected from two monitoring wells 43MA-93-10X and POL-3. For monitoring well 43MA-93-10X, exceedances consisted of EPH (C11-C22 Aromatics at 250 µg/l). For monitoring well POL-3, exceedances consisted of VOCs (TCE at 5 µg/l).

During the second sampling round, the only organic compound that exceeded cleanup goals was EPH (C11-C22 Aromatics at 450 µg/l) collected from monitoring well 43MA-93-10X.

During the third sampling round, organic compounds that exceeded cleanup goals were detected in groundwater samples collected from two monitoring wells 43MA-93-10X and POL-3. For monitoring well 43MA-93-10X, exceedances consisted of EPH (C11-

C22 Aromatics at 260 µg/l) and VPH (C9-C10 Aromatics at 210 µg/l). For monitoring well POL-3, exceedances consisted of VOCs (TCE at 5 µg/l).

During the fourth sampling round the only organic compound that exceeded cleanup goals was EPH (C11-C22 Aromatics at 400 µg/l) collected from monitoring well 43MA-93-10X.

Inorganics

During the first sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from monitoring wells 43MA-93-10X and POL-2. For monitoring well 43MA-93-10X, exceedances consisted of arsenic at 83.1 µg/l. For monitoring well POL-2, exceedances consisted of arsenic at 841 µg/l, lead at 28.1 µg/l, and manganese at 8,720 µg/l.

During the second sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from monitoring wells 43MA-93-10X and POL-2. For monitoring well 43MA-93-10X, exceedances consisted of total arsenic and dissolved arsenic (total arsenic at 88.1 µg/l and dissolved arsenic at 79.3 µg/l) and total lead at 17.5 µg/l (dissolved lead was only 10.9 µg/l). For monitoring well POL-2, the only exceedance was total arsenic at 62 µg/l.

During the third sampling round, inorganic compounds that exceeded cleanup goals were detected in groundwater samples collected from monitoring wells 43MA-93-10X and POL-2. For monitoring well 43MA-93-10X, exceedances consisted of total and dissolved arsenic (total arsenic at 134 µg/l and dissolved arsenic at 120 µg/l). For monitoring well POL-2, the only exceedance was total arsenic at 240 µg/l (dissolved arsenic was only 22.7 µg/l).

During the fourth sampling round, the only inorganic compound that exceeded cleanup goals was total and dissolved arsenic was detected monitoring well 43MA-93-10X. Total arsenic was detected at 103 µg/l and dissolved arsenic was detected at and 101 µg/l.

oxidation. When chlorine is removed from the organic compound, cleavage of the molecular ring structure leads to the generation of methane and carbon dioxide (Suthersan, 1997).

A limited number of chlorinated organic compounds have been detected, above the cleanup goals, over the years in a few wells at AOCs 32 and 43A. A summary of these monitoring well/contaminant pairings are presented in Table 5-2, which also lists the cleanup goals for each specific contaminant. The data show that concentrations of dichlorobenzene (DCB) have decreased over time in well 32M-92-04X. Likewise, concentrations of trichloroethene (TCE) have decreased over time in wells 32M-92-06X and POL-3. These decreases in concentration suggests that biodegradation may be occurring within these areas. While concentrations of dichlorobenzene have remained fairly constant in well 32M-92-06X, it is believed that biodegradation is also occurring to some extent within this area. This is evidenced by the observed concentration decreases of TCE within this well, and by geochemical parameters, which are indicators of biodegradation (discussed in Section 5.2). Biodegradation parameters are suggestive of an anaerobic condition within monitoring well 32M-92-06X. This is noted by a depletion of DO where DO is nearly exhausted (1.07 mg/l), and a noticeable concentration of methane and ferrous iron. However, the concentrations of dichlorobenzene has been fairly constant throughout 1999. It is believed that with time the dichlorobenzene concentrations will begin to attenuate as anaerobic bacteria utilize the available methane as an electron acceptor to reduce the concentration.

In general, chlorinated organic compounds such as TCE can biodegrade under both aerobic and anaerobic conditions. Dichlorobenzene utilizes other chlorinated organic compounds as an electron acceptor to biodegrade under anaerobic conditions, however, as levels of TCE diminish, dichlorobenzene concentrations may not readily degrade. However, it is possible that *methanotrophic* bacteria may assist in reducing the concentrations of dichlorobenzene in groundwater.

5.2 SUPPORTING EVIDENCE FOR PROPER AND SUCCESSFUL OPERATION OF MNA

Microorganisms preferentially utilize electron acceptors while metabolizing organic compounds (i.e., fuel hydrocarbons and chlorinated solvents). Dissolved oxygen (DO) is utilized first as the primary electron acceptor. After DO is consumed, anaerobic microorganisms begin using electron acceptors in the following order of preference: nitrate, ferric iron, sulfate, and finally carbon dioxide. Anaerobic destruction of the organic compounds is associated with the accumulation of organic acids, production of methane, solubilization of iron, and reduction of nitrate and sulfate. The utilization of electron acceptors is generally based on the energy of the reaction and the availability of the electron acceptor at the site. While the energy of each reaction is based on thermodynamics, the distribution of electron acceptors is dependent on site-specific hydrogeochemical processes and can vary significantly among sites. A discussion of electron acceptor and metabolic by-product concentrations observed in groundwater at the AOCs 32 and 43A is presented below. This data is summarized in Tables 5-3, 5-4, and 5-5.

5.2.1 Dissolved Oxygen

Figure 5-1 shows areas of low DO concentrations in groundwater. Depleted DO concentrations are observed in two areas where elevated organic concentrations are present in groundwater. One area at AOC 43A is close to being anaerobic (i.e., DO concentrations are approaching zero). These observations are strong indications that aerobic biodegradation of aliphatic/aromatic organic contaminants may be occurring, and based on the moderately high background DO levels (7-16 mg/l), it is likely that DO is an important electron acceptor.

5.2.2 Nitrate

Nitrate depletion does appear to be occurring in the area where elevated levels of chlorinated organic compounds are present in groundwater. It does appear that denitrification is occurring, which is indicative of anaerobic biodegradation. The levels of nitrate in the source area are lower compared to the background concentrations at both AOC 43A and AOC 32 sites. This suggests that biodegradation is occurring at the sites. However, based on the low background levels of nitrate in the groundwater, it is likely that nitrate is not an important electron acceptor. Nitrate/nitrite information for AOC 32 and AOC 43A are presented in Tables 5-5 and 5-6, respectively.

5.2.3 Sulfate

Figure 5-2 shows an area of low sulfate concentrations in groundwater, as measured during both January and October of 1999. Low sulfate concentrations are observed around an area surrounding wells 32M-92-04X and 32M-92-06X where detectable concentrations of both aliphatic/aromatic and chlorinated organic compounds are present. This data suggests that anaerobic biodegradation of organic compounds is occurring through the microbial-mediated process of sulfanogenesis. Tables 5-3 and 5-5 present sulfate data for the two AOCs.

5.2.4 Redox Potential (Eh)

The redox potential (Eh) of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons. Oxidation-reduction reactions in groundwater containing organic compounds (natural or anthropogenic) are usually biologically mediated, and therefore, the Eh of a groundwater system depends upon and influences rates of biodegradation. Knowledge of groundwater Eh also is important because some biological processes operate only within a prescribed range of Eh conditions. The Eh of groundwater at the site ranges from approximately +315 mV to –93.2 mV, refer to Tables 5-3 and 5-4.

Figure 5-3 shows three areas where low Eh groundwater occurs. With the exception of SHL-15, two areas (near well 32M-92-06X and wells 43MA93-10X and POL-2) coincide with areas showing detectable concentrations of both aliphatic/aromatic and chlorinated organics in groundwater. This data suggests that dissolved organics in groundwater may be undergoing some form of biodegradation.

These aliphatic/aromatic and chlorinated organic constituents were not detected in the groundwater at well SHL-15, however low levels of Eh were detected during field activities. The low Eh could possibly be attributed to naturally occurring organics within the subsurface. Additionally, well SHL-15 is relatively close to Shepley's Hill Landfill and groundwater from this well has been reported to have a strong septic like odor, which could also be impacting this area. The total organic carbon (TOC) has also increased in SHL-15, which may indicate that the leachate from the landfill is influencing the groundwater in the vicinity of the well.

5.2.5 Ferrous Iron

In some cases, ferric iron (Fe^{3+}) is used as an electron acceptor during anaerobic biodegradation of organic carbon. During this process, Fe^{3+} is reduced to ferrous iron (Fe^{2+}), which may be soluble in water. Thus, ferrous iron concentrations can be used as an indicator of anaerobic degradation of organic compounds.

Figure 5-4 shows three areas having elevated ferrous iron (Fe^{2+}) concentrations in groundwater, as measured in October 1999. With the exception of SHL-15, two areas (near well 32M-92-06X and wells 43MA93-10X and POL-2) coincide with areas showing detectable concentrations of organics in groundwater. This indicates that ferric iron (Fe^{3+}) is possibly being reduced to ferrous iron during biodegradation of organic compounds.

Organic constituents were not detected in the groundwater at well SHL-15, however elevated levels of ferrous iron was detected during field activities. The elevated levels of ferrous iron concentrations could possibly be attributed to natural organics, organics leaching from the Shepley's Hill Landfill, or groundwater migrating from an upgradient location where there is a reducing environment. SHL-15 is relatively close to Shepley's Hill Landfill and groundwater from this well was been reported to have a strong septic like odor. The TOC has also increased in SHL-15, which may indicate that the leachate from the landfill is influencing the groundwater in the area. Lastly, low Eh of the groundwater in this area could also be causing the dissolution of iron-bearing minerals within the subsurface deposits, thus elevating ferrous iron concentrations through non-biological processes, refer to Tables 5-5 and 5-6.

5.2.6 Methane

The presence of methane in groundwater is indicative of reducing conditions. Because methane is not present in fuel, the presence of methane above background concentrations in groundwater in contact with fuels is indicative of microbial degradation of hydrocarbons. Methane also is associated with spills of pure chlorinated solvents. It is not known if the methane comes from chlorinated solvent carbon or from native dissolved organic carbon produced from organic decay.

Background levels of methane in groundwater at AOCs 32 and 43A appear to be less than 5 μg/l. Higher concentrations, exceeding 5 μg/l, were observed at four locations, namely, wells 32M-92-06X, SHL-15, 43MA-93-10X, and POL-3 (refer to Figure 5-5). It is noted that methane was detected in wells SHL-15 and POL-3 in January 1999 but not in April 1999. With the exception of SHL-15, the three remaining areas coincide with areas showing detectable concentrations of organics in groundwater. This suggests that anaerobic biodegradation of organic compounds is occurring to some extent, through the microbial-mediated process of methanogenesis.

Organic constituents were not detected in the groundwater at well SHL-15, however elevated levels of methane were detected during field activities, refer to Table 5-4. The methane detected in groundwater could possibly be attributed to decay of naturally occurring organics leaching from the Shepley's Hill Landfill at well SHL-15. As noted above, well SHL-15 is relatively close to Shepley's Hill Landfill and groundwater from this well has been reported to have a strong septic like odor, which could also be impacting the groundwater to some extent. Although, aliphatic/aromatic and chlorinated organics have not been detected in monitoring well SHL-15 above cleanup levels, TOC has been detected in this well, refer to Table 5-3. The presence of higher levels of TOC in groundwater indicates that leachate breakouts from Shepley's Hill Landfill, containing organic compounds from decay processes is likely contributing to the presence of the TOC. The elevated level of TOC in SHL-15 monitoring well and the elevated levels of carbon dioxide may indicate that anaerobic bacteria is utilizing the available CO_2 to produce methane. A review of the geochemical data, refer to Tables 5-3 and 5-5 indicate that some sort of anaerobic biodegradation is occurring as noted by the presence of CO_2 and methane in well SHL-15.

5.2.7 Total Organic Carbon and Chemical Oxygen Demand

Total Organic Carbon (TOC) a measure of the amount of organic compounds present in groundwater from natural or man-made sources, is decreasing in the monitoring wells (32M-92-04X, 32M-92-06X, 43MA-93-10X and POL-3) where elevated organic levels were detected in groundwater. The decrease in TOC is indicative of degradation of organic compounds, refer to Table 5-3 and 5-4.

As shown on Table 5-3, TOC is present in monitoring well SHL-15 along with the presence of chemical oxygen demand (COD). COD is a measure of the amount of oxidizable organic material present in a sample. The presence of TOC, COD, CO_2 and methane, refer to Tables 5-3 and 5-5 in monitoring well SHL-15 indicates that organic material is present, and the presence of the natural attenuating parameters coincide with the likely presence of organic material being degraded. The source of the TOC is likely Shepley's Hill Landfill. It is important to note that since this well did not detect any organic COCs, the source is likely from leachate generated from the landfill.

5.3 ARSENIC AND LEAD CONTAMINATION AT AOCS 32 AND 43A

5.3.1 Arsenic

In general, high arsenic concentrations in groundwater are thought to inhibit natural attenuation of chlorinated organics. In most soil-groundwater environments, aqueous species of arsenic can occur in two forms: as arsenate, As^{5+} [AsO_4^{3-}], or arsenite, As^{3+} [AsO_2^-]. Arsenite is the more toxic form of arsenic. Arsenate forms insoluble precipitates with iron, aluminum, and calcium. Iron in soils is most effective in controlling arsenate's mobility (McLean and Bledsoe, 1992). Arsenite compounds are reported to be 4 to 10 times more soluble than arsenate compounds. Maximum adsorption of arsenate by kaolinite and montmorillonite clays has been found to occur at an approximate pH of 5. Maximum adsorption of arsenate by aluminum and iron oxides occurs at a pH range of 3 to 4 followed by a gradual decrease in adsorption with increasing pH.

The adsorption of arsenite, As^{3+}, is also strongly pH-dependent. Increases in sorption of As^{3+} by kaolinite and montmorillonite have been observed over a pH range of 3 to 9. Maximum adsorption of As^{3+} by iron oxide occurs at pH 7. Studies have indicated that iron oxide concentration, redox condition, and pH is the most important factors in controlling arsenite adsorption by soils.

Both pH and redox are important in assessing the fate of arsenic in soil. At high redox levels, As^{5+} predominates and arsenic mobility is low. As pH increases or redox decreases, As^{3+} predominates. The reduced form of arsenic, As^{3+}, is more subject to leaching because of its high solubility. Arsenite, As^{3+}, can be oxidized to As^{5+}. Manganese oxides are the primary electron acceptors in this oxidation.

During the 1999 groundwater sampling, arsenic in groundwater was detected in five monitoring wells: 32M-92-06X, 32M-99-11X, SHL-15, 43MA-93-10X, and POL-2. In all cases, the elevated concentrations coincide with areas where the groundwater has a relatively low Eh, refer to Figure 5-3, which indicates that redox conditions are controlling the solubility of arsenic. More important here, however, is the mobility and transport of arsenic. The data suggests that as groundwater moves from areas of low Eh to areas of high Eh, the concentration of arsenic in solution should decrease, probably due to precipitation and formation of solid phases. As indicated in Table 5-5 and 5-6, low Eh conditions are associated with detection's of ferrous iron. These trends are present in monitoring wells 32M-92-06X, SHL-15, and 43MA-93-10X. Areas depicting low levels of Eh are presented in Figure 5-5. Similarly, levels of arsenic above the cleanup goal of 50 µg/l appear to be present in the same monitoring wells, refer to Table 5-7.

As stated, conditions that reduce Fe^{+3} to Fe^{+2} and As^{+5} to As^{+3} increase the mobility of arsenic. Geochemical parameters from the site indicate that the presence of arsenic in groundwater in these monitoring wells are associated with low Eh conditions and the presence of Fe^{+2}. Eh/pH diagrams indicate that as the Eh of the groundwater becomes more oxidizing, approximately 100 mV and a pH in the 6 to 7 range, arsenic is found in +5 valence state, which then tends to sorb/retard arsenic to ferric hydroxides particles, and therefore limits the mobility of arsenic.

5.3.2 Lead

The primary form of lead in aqueous solution is the Pb^{2+} species. Lead readily adsorbs to clayey soils and other mineral surfaces. The predominant solid phases occurring in the environment include lead carbonate, lead hydroxide, and lead sulfate, all having very low solubilities. Under most environmental conditions, lead is not expected to migrate significantly unless it moves as an organic colloid (McLean and Bledsoe, 1992).

During the 1999 groundwater sampling, lead was detected above the cleanup goals in six monitoring wells (32M-92-01X, 32M-92-04X, 32M-92-05X, 32M-99-11X, 43MA-93-10X and POL-2) in the four 1999 sampling rounds. Lead was only detected once and not repeatedly in all of the aforementioned monitoring wells. One explanation for the widespread fluctuations is that the samples may have contained small amounts of solid material (e.g., micro-particles and colloids) which probably contained trace amounts of sorbed lead. In any case, the data indicate that the occurrence and mobility of lead at AOCs 32 and 43A is not a concern. A summary of lead in groundwater is presented in Table 5-8.

6.0 INSTITUTIONAL CONTROL IMPLEMENTATION AND MONITORING

6.1 AOC 32 SOIL

The Removal Action for AOC 32 conducted by the Army in October and November 1998 has permanently achieved three of the four remedial action objectives (RAOs) specified in the ROD. The final confirmation data results indicate that not only were cleanup levels met, sample concentrations were actually lower then the more conservative MCP S-1 criteria. The fourth remedial action objective is to monitor the groundwater and review the site after five years. This objective will be met as part of the groundwater long-term monitoring.

6.2 AOC 32 AND 43A GROUNDWATER

One of the major components of the remedial action for AOC 32 Groundwater Operable Unit and AOC 32/43A Groundwater Operable Unit is the implementation of institutional controls. The human health risk at these two Groundwater Operable Units is associated with the consumption of unfiltered groundwater. Due to the thin saturated overburden aquifer under AOC 32, the use of groundwater is impractical. Nevertheless, institutional controls will be implemented at AOC 32 and 43A to limit the potential exposure to the groundwater under both existing and future site conditions. These institutional controls will ensure that exposure to and the extraction of groundwater from the site for industrial and/or potable water supply would not be permitted. The institutional controls for AOC 32 and 43A will be incorporated either in full or by reference into all deeds, easements, mortgages, leases or any other instruments of transfer.

6.2.1 Institutional Controls

When the parcels containing AOC 32 and 43A are transferred by the Army, institutional controls will be consisted of in their respective conveyance documents as necessary and appropriate under Section 120 of CERCLA and Massachusetts General Law (M.G.L.) 21E. The conveyance documents will include the following:

1. Language ensuring that groundwater will not be extracted and used for industrial and/or potable water supply;
2. Language barring the installation of any drinking water wells on the AOCs;
3. Language ensuring that any grantee, successor and/or assignee shall comply with the institutional controls established in the conveyance documents;
4. A provision requiring the grantee, successor and/or assignee, obtain prior

approval from EPA, Department of Environmental Protection (MADEP) and MassDevelopment of any modification to or release a of institutional controls;

5. A provision requiring the proper recording of the institutional controls and any future modification or release of any institutional controls; and

6. A provision requiring annual monitoring and inspection of the AOCs to ensure that the institutional controls are being followed.

6.2.2 Institutional Control Monitoring

Existing land use and site conditions will be evaluated annually to ensure that the institutional control requirements are still being met. This inspection will be conducted as part of the long-term groundwater monitoring. If the future proposed land use at AOC 32 and 43A is inconsistent with these institutional controls, then the site exposure scenarios to human health and the environment will be re-evaluated at the five-year reviews to ensure that this response action is appropriate. Institutional control inspections will include the checklist components described in the following subsections.

6.2.3 Interview

The groundwater monitoring field crew leader will contact the property owner of the site, its manager or other designee with knowledge of the day-to-day activities of the property to make arrangements for groundwater sampling and to review compliance with the institutional controls. As part of the review, the monitoring crew will inquire regarding:

1. The owner's familiarity regarding institutional controls imposed upon the property and documentation of these controls.

2. Source of public drinking water for the property.

6.2.4 Physical On-Site Inspection

After the monitoring crew has contacted the property owner, groundwater monitoring will be performed as well as a physical on-site inspection of the property to determine compliance with the institutional controls. The physical on-site inspection shall include examination for evidence that there have been no groundwater extraction wells installed on the premises.

After the inspection is complete, the Army will provide a copy of the annotated inspection checklist, a written summary of the findings and all supporting documentation to the DEC, DEP, EPA, and MassDevelopment. This inspection report will be transmitted with the annual report. The inspection report shall explain the basis of any known or suspected violation identified during the inspection.

5. Elevated concentrations of arsenic in groundwater coincide with areas where the groundwater has a relatively low Eh, which indicates that redox conditions are controlling the solubility of arsenic. The data suggests that as groundwater moves from areas of low Eh to areas of high Eh, the concentration of arsenic in solution should decrease, as a result of precipitation and formation of solid phases. Thus, the mobility and transport of arsenic in groundwater should be limited at AOCs 32 and 43A.

6. Elevated lead concentrations that were observed in a limited number of wells is believed to be the result of small amounts of solid phase material (e.g., micro-particles and colloids) present in the groundwater samples, which probably contained trace amounts of sorbed lead. The data indicate that the occurrence and mobility of lead at AOCs 32 and 43A is not a concern.

7. Institutional controls will be imposed on the properties to limit the potential exposure to the groundwater under both existing and future site conditions. These institutional controls will ensure that exposure to and the extraction of groundwater from the site for industrial and/or potable water supply would not be permitted. The institutional controls for AOC 32 and 43A will be incorporated either in full or by reference into all deeds, easements, mortgages, leases or any other instruments of transfer.

7.1 CONTINUED GROUNDWATER MONITORING

The Army shall continue to perform short- and long-term groundwater monitoring as described below.

7.1.1 Short-Term Monitoring

During 2000, two rounds of groundwater sampling is scheduled. During this semi-annual sampling the number of monitoring wells will be reduced from the 23 monitoring wells sampled during 1999. The Army is currently discussing the revised sampling plan which was presented in the Round 4-Data Report (Stone & Webster, 1999d) with the MADEP and the USEPA. The resolution of these discussions will be presented in the Draft Annual Report which is scheduled to be submitted in March 2000.

7.1.2 Installation of Additional Monitoring Wells

As required by the ROD, additional micro and monitoring wells were installed in April 1999. Data from the 1999 groundwater sampling suggests that the area of contamination has been adequately delineated and no new monitoring wells are required.

7.1.3 Long-Term Monitoring and Reporting

The criteria set forth in the ROD states that long-term groundwater monitoring should be performed on an annual basis; site reviews shall be conducted on 5-year intervals for 30 years or until contamination is reduced to acceptable concentrations; and annual data reports shall be provided to the United States Environmental Protection Agency (USEPA) and the MADEP. After the MNAA is completed and documented in the 2000 Annual Report, a long-term monitoring plan (LTMP) which specifies the monitoring wells to be sampled and the parameter to be analyzed will be developed.

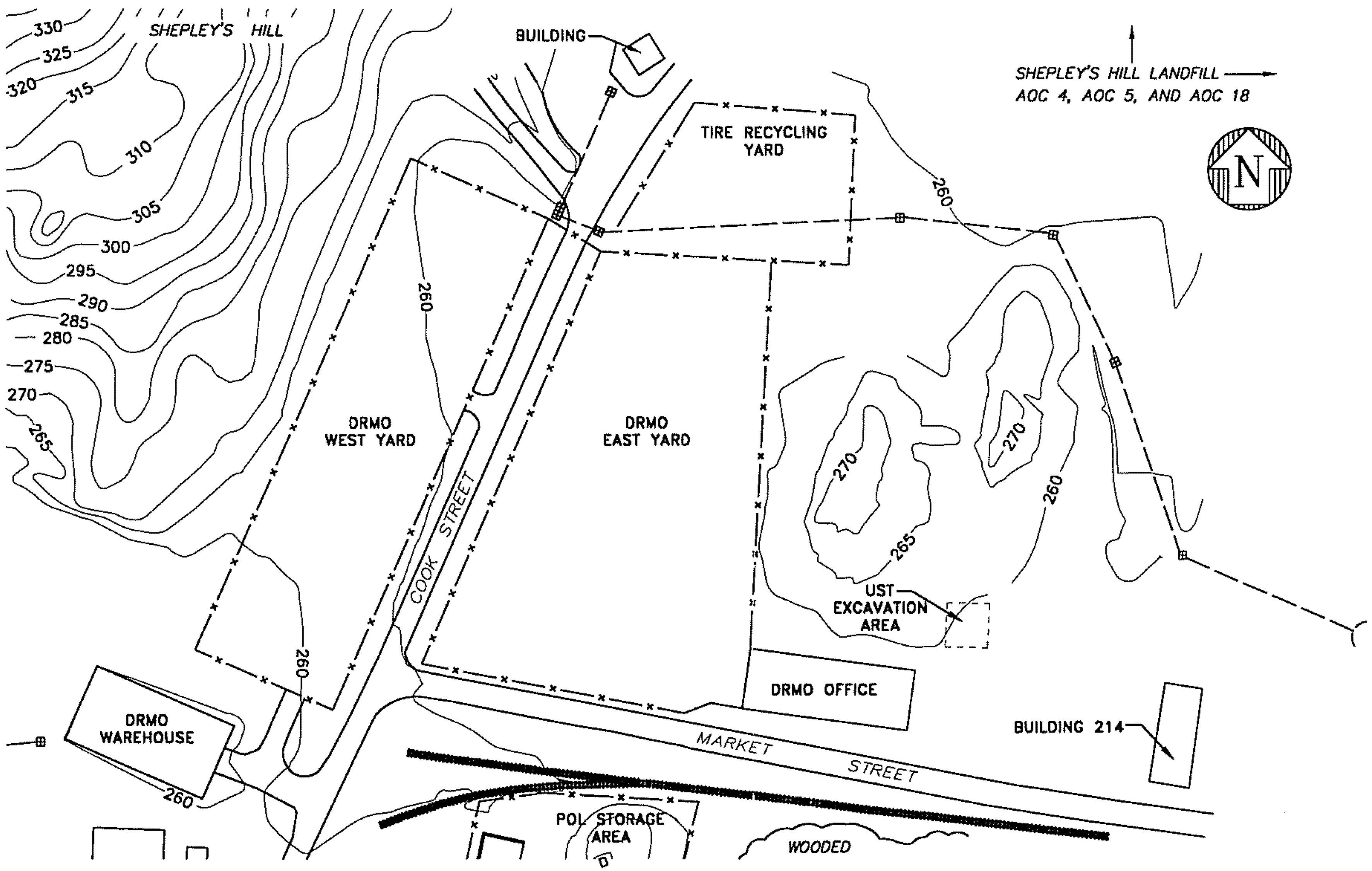
GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground Storage Tank
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DCE	1,2 Dicholoroethylene
DEC	Devens Enterprise Commission
DRMO	Defense Reutilization and Marketing Office
EPH	Extractable Petroleum Hydrocarbons
FS	Feasibility Study
GC	Gas Chromatograph
IDL	Instrument Detection Limit
IDW	Investigation-Derived Waste
IRA	Intrinsic Remediation Assessment
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LNAPL	Light Non-Aqueous Phase Liquid
MNA	Monitored Natural Attenuation
MNAA	Monitored Natural Attenuation Assessment
MCP	Massachusetts Contingency Plan
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAE	New England District
OPS	Operating Properly and Successfully
PCBs	Polychlorinated Biphenyl
PID	Photoionization Detector
POL	Petroleum, Oils, and Lubricants
POP	Project Operations Plan
PPM	Part per Million
PQL	Practical Quantitation Level
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization

GLOSSARY OF ABBREVIATIONS AND ACRONYMS (continued)

SI	Site Investigation
TCA	tricholorethane
TCE	trichloroethylene or trichloroethene
USACE-NAE	United States Army Corps of Engineers – New England District
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound
VPH	Volatile Petroleum Hydrocarbons

FIGURES



LEGEND

— 265 — TOPOGRAPHIC CONTOUR

═ IMPROVED ROAD

—x— CHAINLINK FENCE

▦ RAILROAD TRACK

— —⊞— — — STORM DRAIN WITH CATCH BASIN

SOURCE: REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

23-JULY-99

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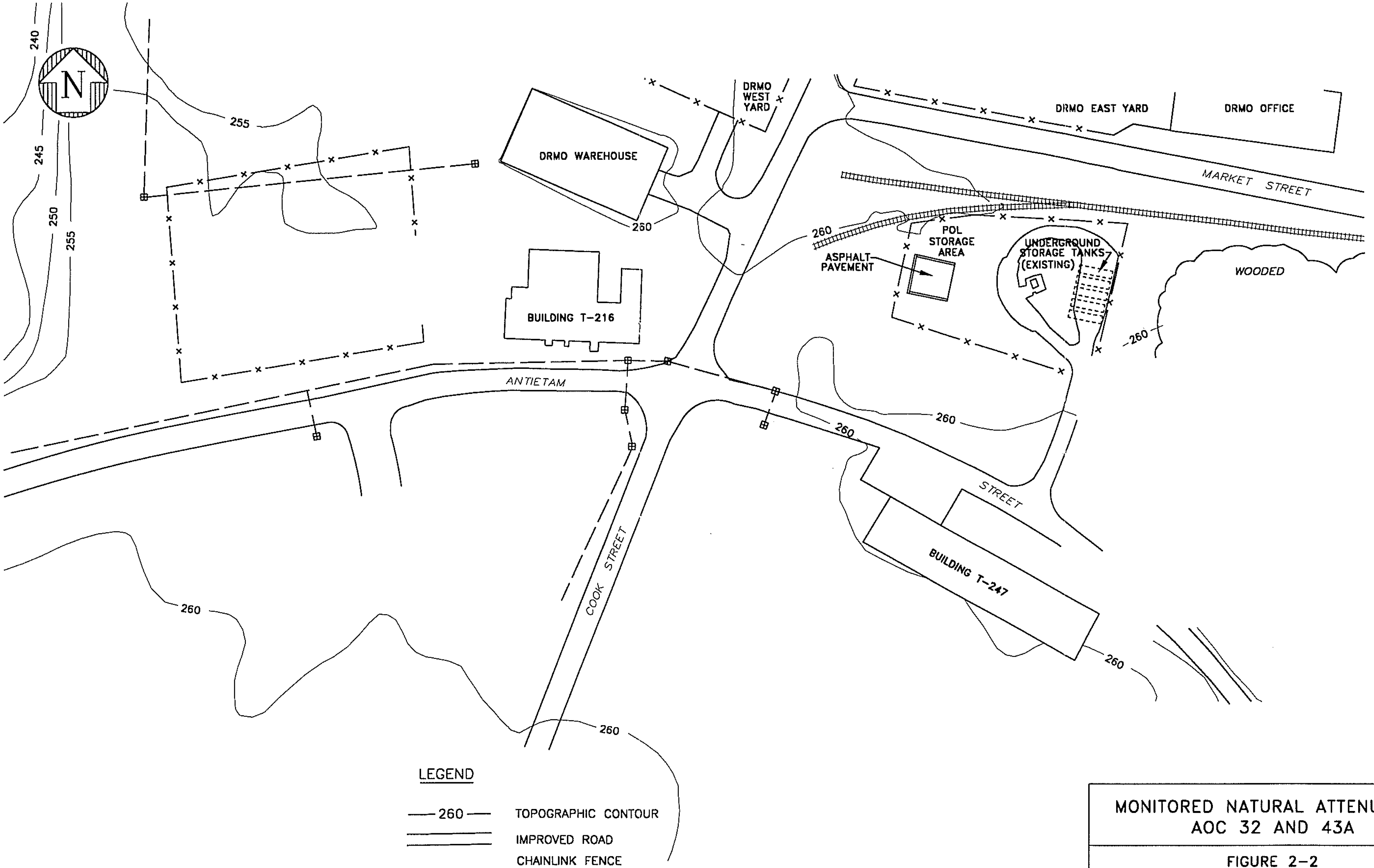
MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 2-1

SITE MAP OF – AOC 32

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS
FEBRUARY 2000



LEGEND

—260—	TOPOGRAPHIC CONTOUR
═	IMPROVED ROAD
—×—	CHAINLINK FENCE
┼┼┼┼┼┼┼┼	RAILROAD TRACK
— —⊞— —	STORM DRAIN WITH CATCH BASIN

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 2-2

SITE MAP OF AOC 43A

STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

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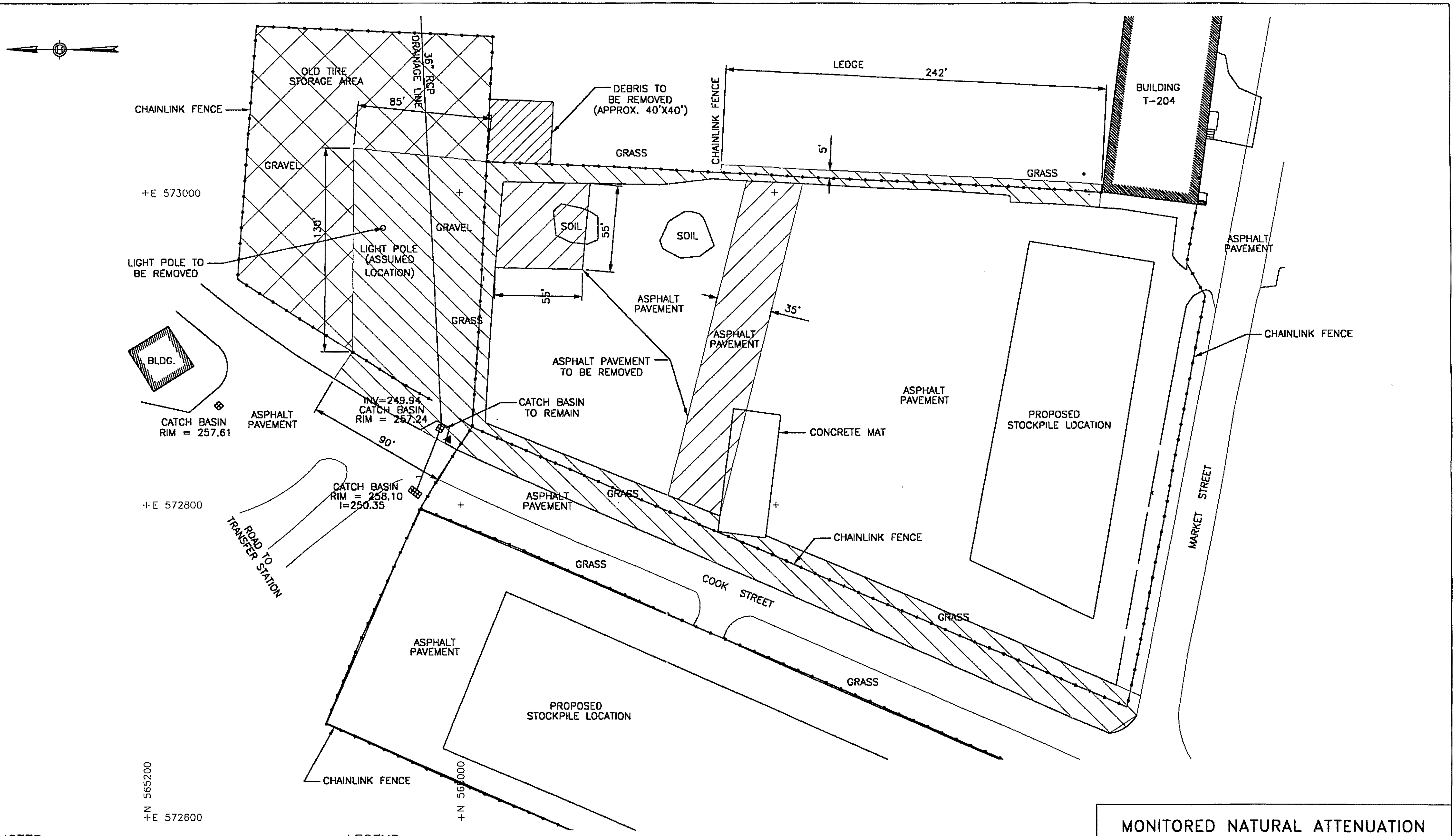

16-February-2000

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NOTES:

1. REMOVE CHAINLINK FENCE AT AREAS OF EXCAVATION AND ALONG MARKET STREET (1900 LINEAR FEET).
2. TAKEN FROM COMPLETION REPORT SOIL, ASPHALT, AND DEBRIS REMOVAL AOC32, DEVENS, MASS. PREPARED BY ROY F. WESTON, 1999.

LEGEND:

▨ REMOVE 1' OF CONTAMINATED SOIL (1150 CY)
▩ REMOVE 6" OF SOIL AND DEBRIS (350 CY)
▧ REMOVE DEBRIS (20 CY)
▧ REMOVE BIT. CONC (120 CY)

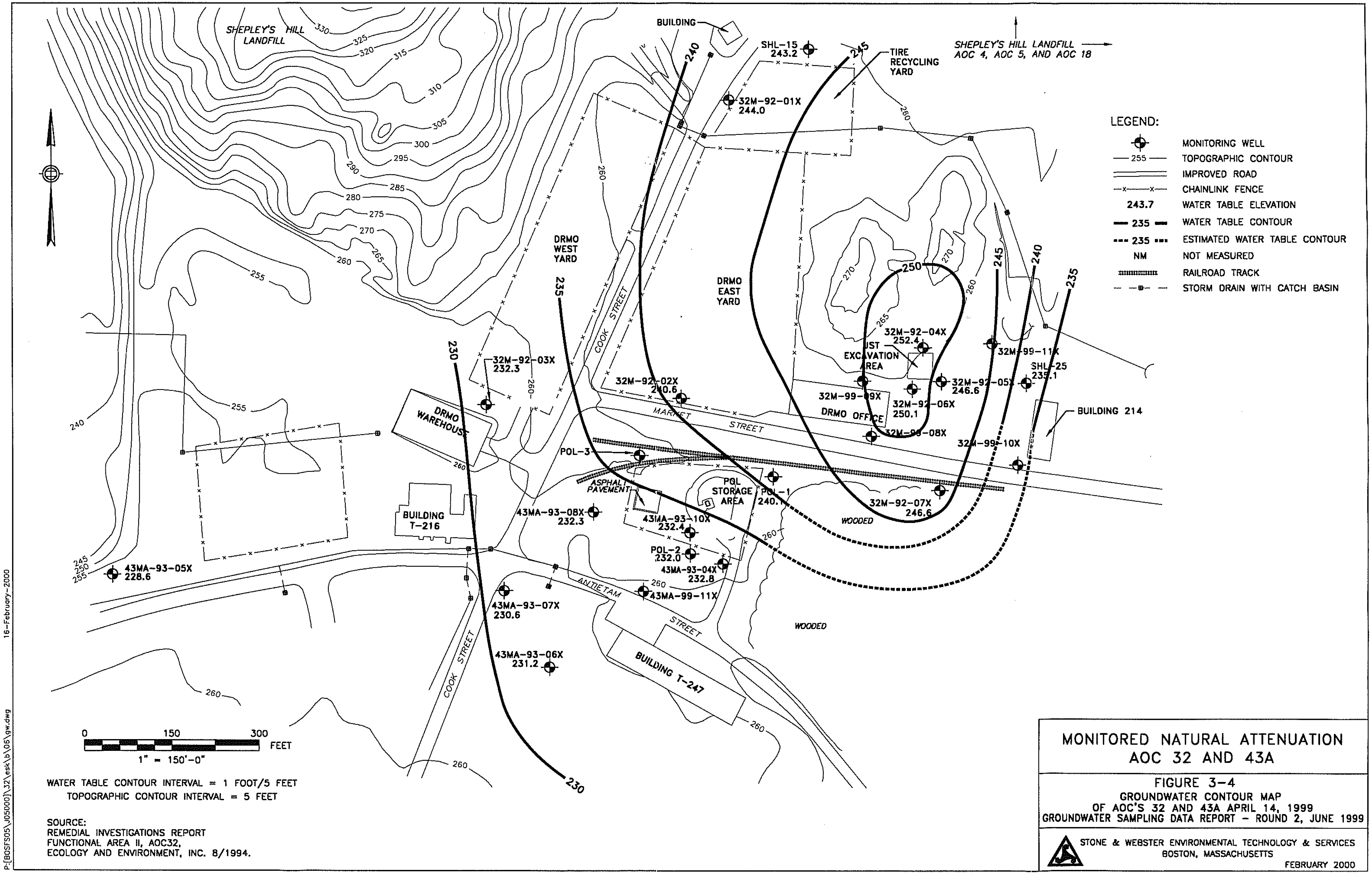
0 60 120 FEET
1" = 60'-0"

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 3-1 PROPOSED REMOVAL AREAS AND STOCKPILE LOCATIONS

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS

FEBRUARY 2000



WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

16-February-2000

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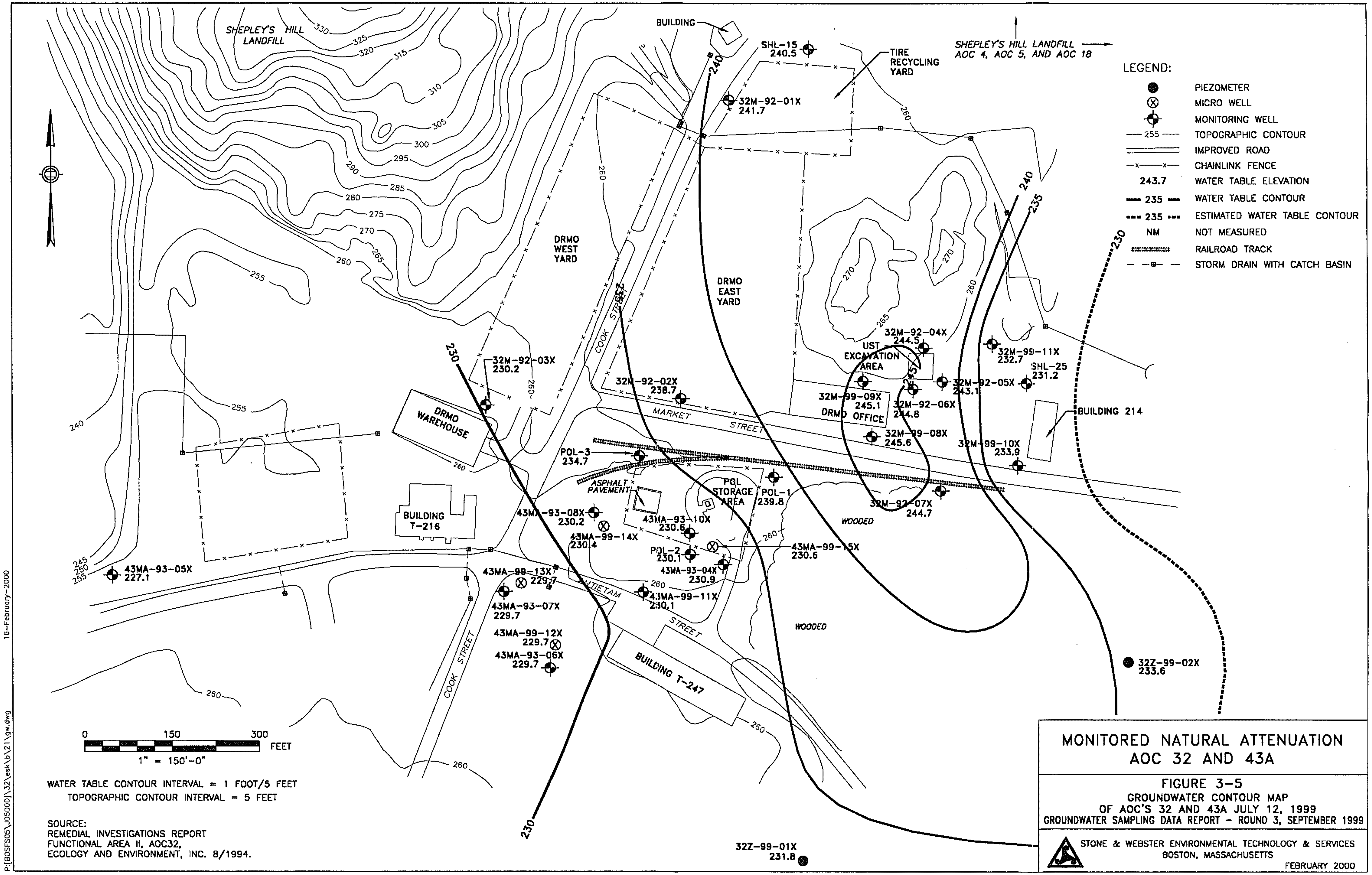
MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 3-4
GROUNDWATER CONTOUR MAP
OF AOC'S 32 AND 43A APRIL 14, 1999
GROUNDWATER SAMPLING DATA REPORT - ROUND 2, JUNE 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000



WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 3-5
GROUNDWATER CONTOUR MAP
OF AOC'S 32 AND 43A JULY 12, 1999
GROUNDWATER SAMPLING DATA REPORT - ROUND 3, SEPTEMBER 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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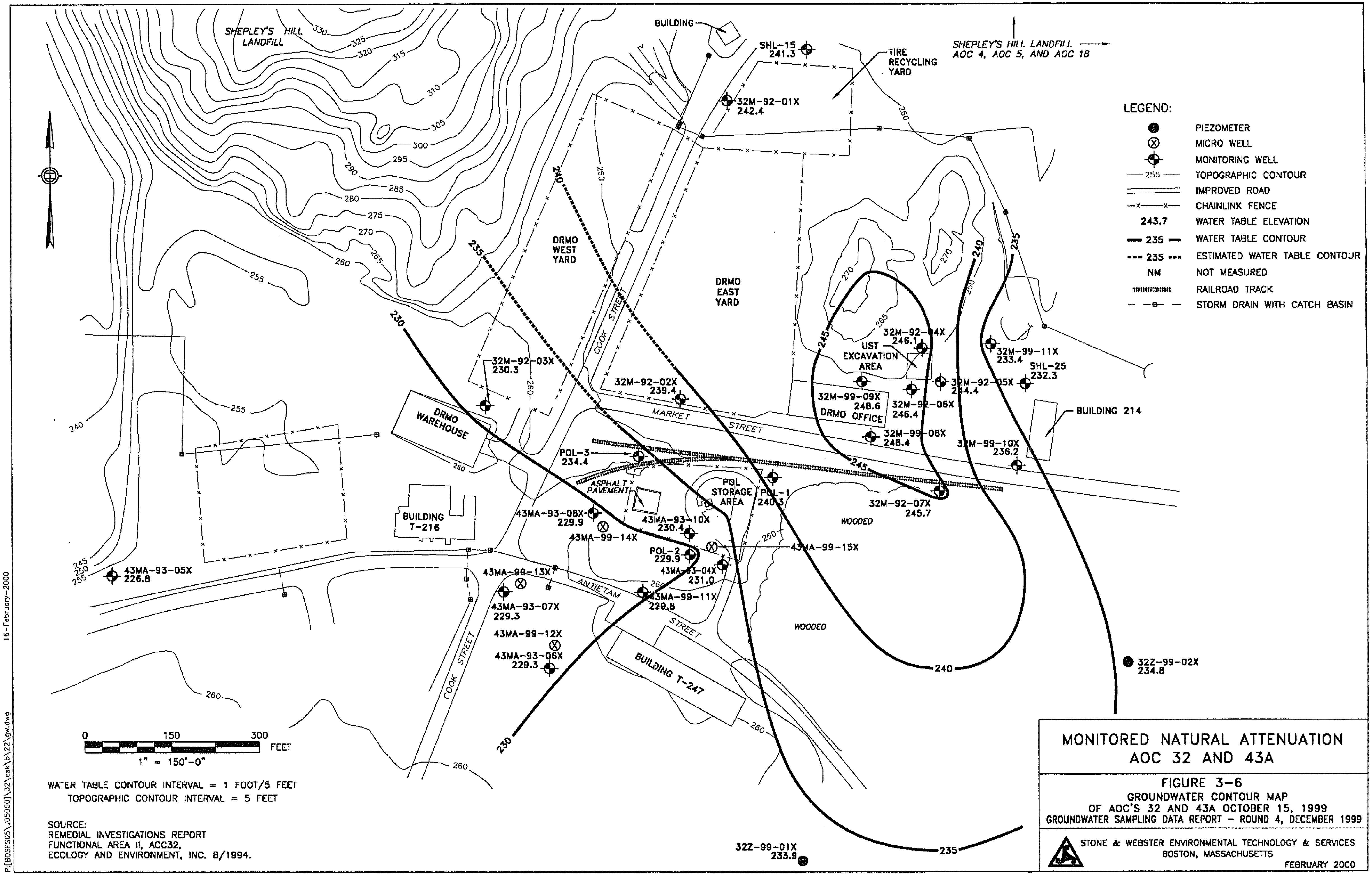

WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 3-6
GROUNDWATER CONTOUR MAP
OF AOC'S 32 AND 43A OCTOBER 15, 1999
GROUNDWATER SAMPLING DATA REPORT - ROUND 4, DECEMBER 1999

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BOSTON, MASSACHUSETTS
FEBRUARY 2000

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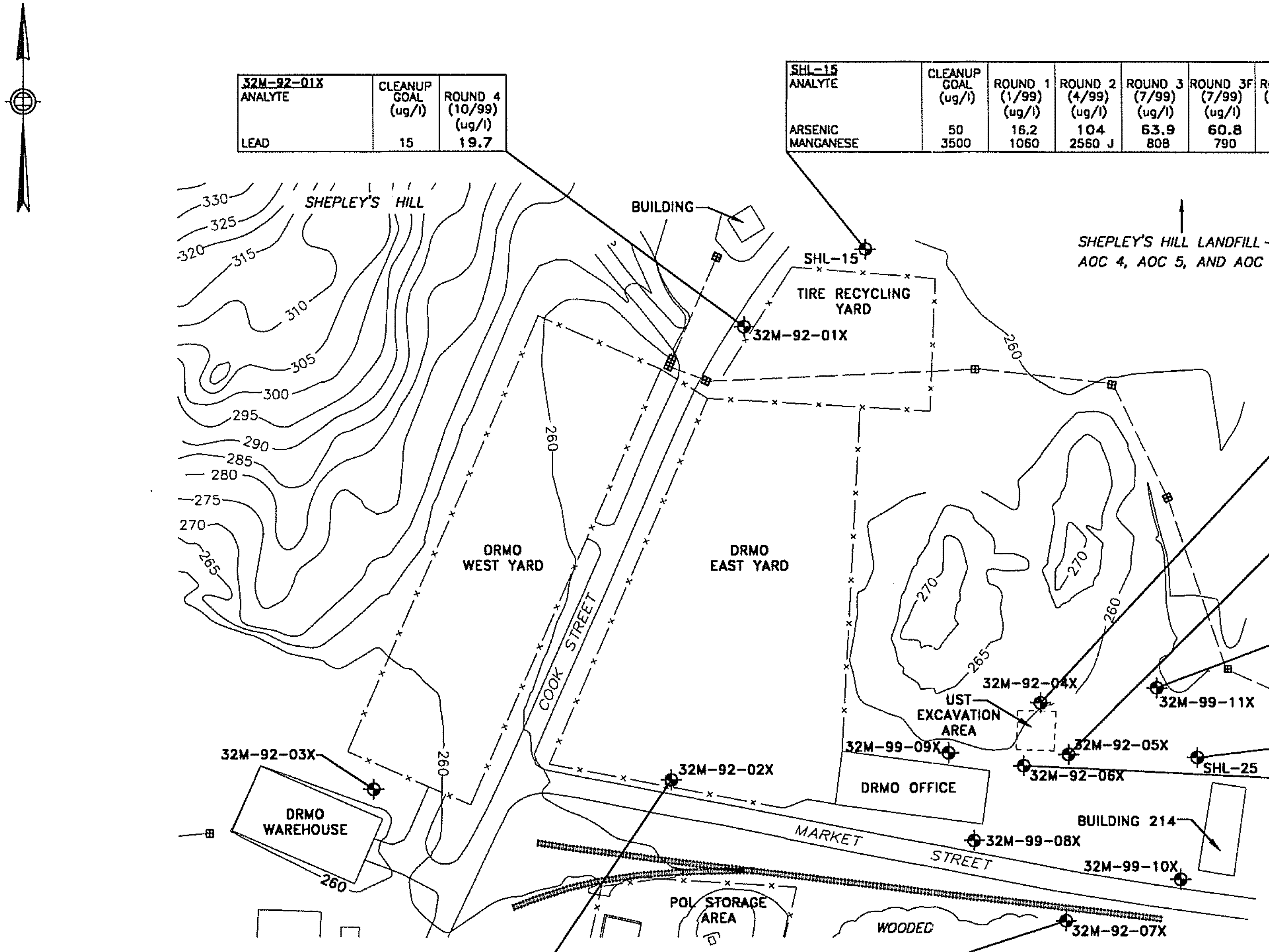

32M-92-01X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 4 (10/99) (ug/l)
LEAD	15	19.7

SHL-15 ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 3F (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)	ROUND 4F (10/99) (ug/l)
ARSENIC	50	16.2	104	63.9	60.8	327	287
MANGANESE	3500	1060	2560 J	808	790	6200	6010

43MA-93-04X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
LEAD	15	53.8	1.90 u	NC	3.3 u
PCBs	0.5	1.9	0.5 u	NC	0.57
C9-C18 ALIPHATICS	4000	1400	78 J	NC	460
C19-C36 ALIPHATICS	5000	10000	680 JEB	NC	3400
C11-C22 AROMATICS	200	880	180 u	NC	310
C9-C10 AROMATICS	200	10 u	10 u	NC	51
1,3 DICHLOROBENZENE	600	1 u	1 u	NC	5
1,4 DICHLOROBENZENE	75	1 u	1 u	NC	3
1,2 DICHLOROBENZENE	600	1 u	1 u	NC	22

32M-92-05X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 2F (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
LEAD	15	32.4	4.0 u	1.5 u	NC	4.6 u

32M-92-11X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 4 (10/99) (ug/l)
ARSENIC	50	196
LEAD	15	25.9
TCE	5	3.0

SHL-25 ANALYTE	CLEANUP GOAL (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
C5-C8 ALIPHATICS	400	240	40 u

32M-92-06X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 2F (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 3F (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)	ROUND 4F (10/99) (ug/l)
ARSENIC	50	240	145	66.9	106	96.9	171	161
MANGANESE	3500	4830	2880 J	3160	3700	3810	3540	3440
1,2 DICHLOROETHANE (CIS)	55	27.0	1 u	N/A	5	N/A	4	N/A
1,3-DICHLOROBENZENE	600	130.0	140	N/A	120	N/A	190	N/A
1,4-DICHLOROBENZENE	75	77.0	72	N/A	61	N/A	100	N/A
1,2-DICHLOROBENZENE	600	740	930	N/A	560	N/A	880	N/A
C5-C8 ALIPHATICS	400	400 u	52	N/A	55	N/A	42 u	N/A
C9-C12 ALIPHATICS	4000	100 u	25 E	N/A	10 u	N/A	100 u	N/A
C9-C10 AROMATICS	200	910.0	890	N/A	700	N/A	1300	N/A
C9-C18 ALIPHATICS	4000	250	940 J	N/A	300 J	N/A	220	N/A
C11-C22 AROMATICS	200	160 u	670	N/A	180	N/A	160 u	N/A
C19-C36 ALIPHATICS	5000	160	3600 J	N/A	780	N/A	320 u	N/A
PCBs	0.5	0.5 u	0.71 J	N/A	0.5 u	N/A	0.5 u	N/A

32M-92-02X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 4 (10/99) (ug/l)
TCE	5.0	1.0

32M-92-07X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
C11-C22 AROMATICS	200	170	160 u

VALUES REPORTED IN BOXES INCLUDE:
ORGANICS – POSITIVE DETECTIONS
INORGANICS – EXCEEDS CLEANUP GOAL

0 150 300 FEET
1" = 150'-0"

NOTE: NO CLEANUP GOAL HAS BEEN ESTABLISHED FOR TPH.

SOURCE: REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

LEGEND

⌖	MONITORING WELL
—265—	TOPOGRAPHIC CONTOUR
═	IMPROVED ROAD
—x—x—	CHAINLINK FENCE
▨	RAILROAD TRACK
—▣—	STORM DRAIN WITH CATCH BASIN

ND	NON-DETECT
N/A	NOT ANALYZED
C	CONFIRMED BY REANALYSIS (SECOND COLUMN)
B	ATTRIBUTABLE TO FIELD OR LAB CONTAMINATION
J, E	ESTIMATED VALUES
F	FILTERED SAMPLE
EB	CONTAMINATION IN FIELD BLANK

MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 4-1
INORGANICS AND ORGANICS DETECTED IN SAMPLING ROUNDS 1-4 – AOC 32

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BOSTON, MASSACHUSETTS
FEBRUARY 2000

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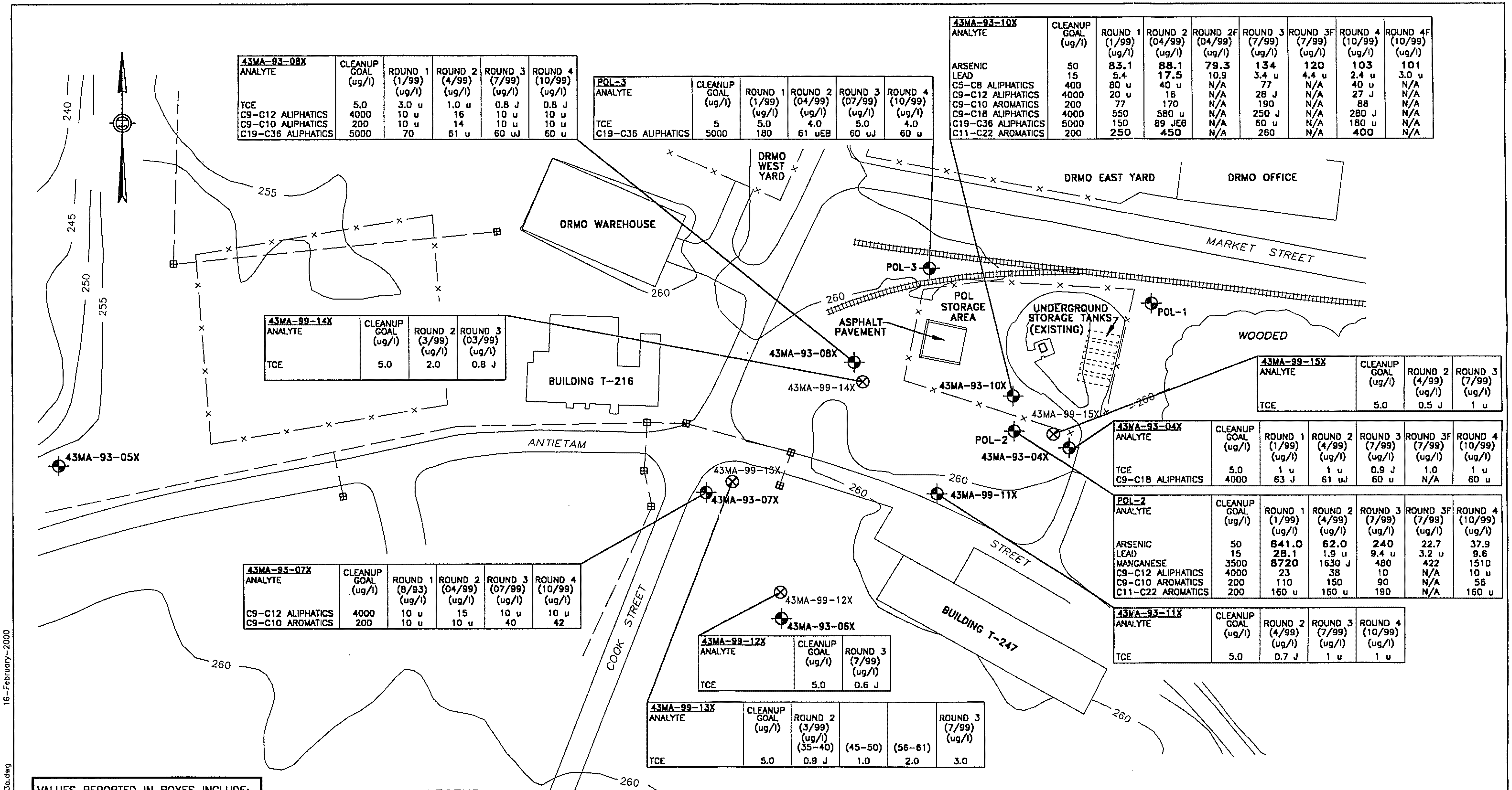

43MA-93-08X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
TCE	5.0	3.0 u	1.0 u	0.8 J	0.8 J
C9-C12 ALIPHATICS	4000	10 u	16	10 u	10 u
C9-C10 ALIPHATICS	200	10 u	14	10 u	10 u
C19-C36 ALIPHATICS	5000	70	61 u	60 uJ	60 u

POL-3 ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (04/99) (ug/l)	ROUND 3 (07/99) (ug/l)	ROUND 4 (10/99) (ug/l)
TCE	5	5.0	4.0	5.0	4.0
C19-C36 ALIPHATICS	5000	180	61 uEB	60 uJ	60 u

43MA-93-10X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (04/99) (ug/l)	ROUND 2F (04/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 3F (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)	ROUND 4F (10/99) (ug/l)
ARSENIC	50	**83.1**	**88.1**	**79.3**	**134**	**120**	**103**	**101**
LEAD	15	5.4	**17.5**	10.9	3.4 u	4.4 u	2.4 u	3.0 u
C5-C8 ALIPHATICS	400	80 u	40 u	N/A	77	N/A	40 u	N/A
C9-C12 ALIPHATICS	4000	20 u	16	N/A	28 J	N/A	27 J	N/A
C9-C10 AROMATICS	200	77	170	N/A	190	N/A	88	N/A
C9-C18 ALIPHATICS	4000	550	580 u	N/A	250 J	N/A	280 J	N/A
C19-C36 ALIPHATICS	5000	150	89 JEB	N/A	60 u	N/A	180 u	N/A
C11-C22 AROMATICS	200	**250**	**450**	N/A	260	N/A	**400**	N/A

43MA-99-14X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 2 (3/99) (ug/l)	ROUND 3 (03/99) (ug/l)
TCE	5.0	2.0	0.8 J

43MA-99-15X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)
TCE	5.0	0.5 J	1 u

43MA-93-04X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 3F (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
TCE	5.0	1 u	1 u	0.9 J	1.0	1 u
C9-C18 ALIPHATICS	4000	63 J	61 uJ	60 u	N/A	60 u

POL-2 ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (1/99) (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 3F (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
ARSENIC	50	**841.0**	**62.0**	**240**	22.7	37.9
LEAD	15	**28.1**	1.9 u	9.4 u	3.2 u	9.6
MANGANESE	3500	**8720**	1630 J	480	422	1510
C9-C12 ALIPHATICS	4000	23	38	10	N/A	10 u
C9-C10 AROMATICS	200	110	150	90	N/A	56
C11-C22 AROMATICS	200	160 u	160 u	190	N/A	160 u

43MA-93-11X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 2 (4/99) (ug/l)	ROUND 3 (7/99) (ug/l)	ROUND 4 (10/99) (ug/l)
TCE	5.0	0.7 J	1 u	1 u

43MA-93-07X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 1 (8/93) (ug/l)	ROUND 2 (04/99) (ug/l)	ROUND 3 (07/99) (ug/l)	ROUND 4 (10/99) (ug/l)
C9-C12 ALIPHATICS	4000	10 u	15	10 u	10 u
C9-C10 AROMATICS	200	10 u	10 u	40	42

43MA-99-12X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 3 (7/99) (ug/l)
TCE	5.0	0.6 J

43MA-99-13X ANALYTE	CLEANUP GOAL (ug/l)	ROUND 2 (3/99) (ug/l) (35-40)	(45-50)	(56-61)	ROUND 3 (7/99) (ug/l)
TCE	5.0	0.9 J	1.0	2.0	3.0

VALUES REPORTED IN BOXES INCLUDE:
ORGANICS – POSITIVE DETECTIONS
INORGANICS – EXCEEDS CLEANUP GOAL

0 100 200 FEET
1" = 100'-0"

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

LEGEND

⊕	MONITORING WELL
⊕	MICROWELL
—— 260 ——	TOPOGRAPHIC CONTOUR
═══	IMPROVED ROAD
×——×——×	CHAINLINK FENCE
┼┼┼┼┼┼┼	RAILROAD TRACK
——⊞——	STORM DRAIN WITH CATCH BASIN

ND	NON-DETECT
N/A	NOT ANALYZED
C	CONFIRMED BY REANALYSIS (SECOND COLUMN)
B	ATTRIBUTABLE TO FIELD OR LAB CONTAMINATION
J, E	ESTIMATED VALUES
U	UNCONFIRMED (REANALYSIS PERFORMED, COMPOUND NOT FOUND)
F	FILTERED SAMPLE
EB	CONTAMINATION IN FIELD BLANK

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 4-2
INORGANICS AND ORGANICS DETECTED IN SAMPLING ROUNDS 1-4 – AOC 43A

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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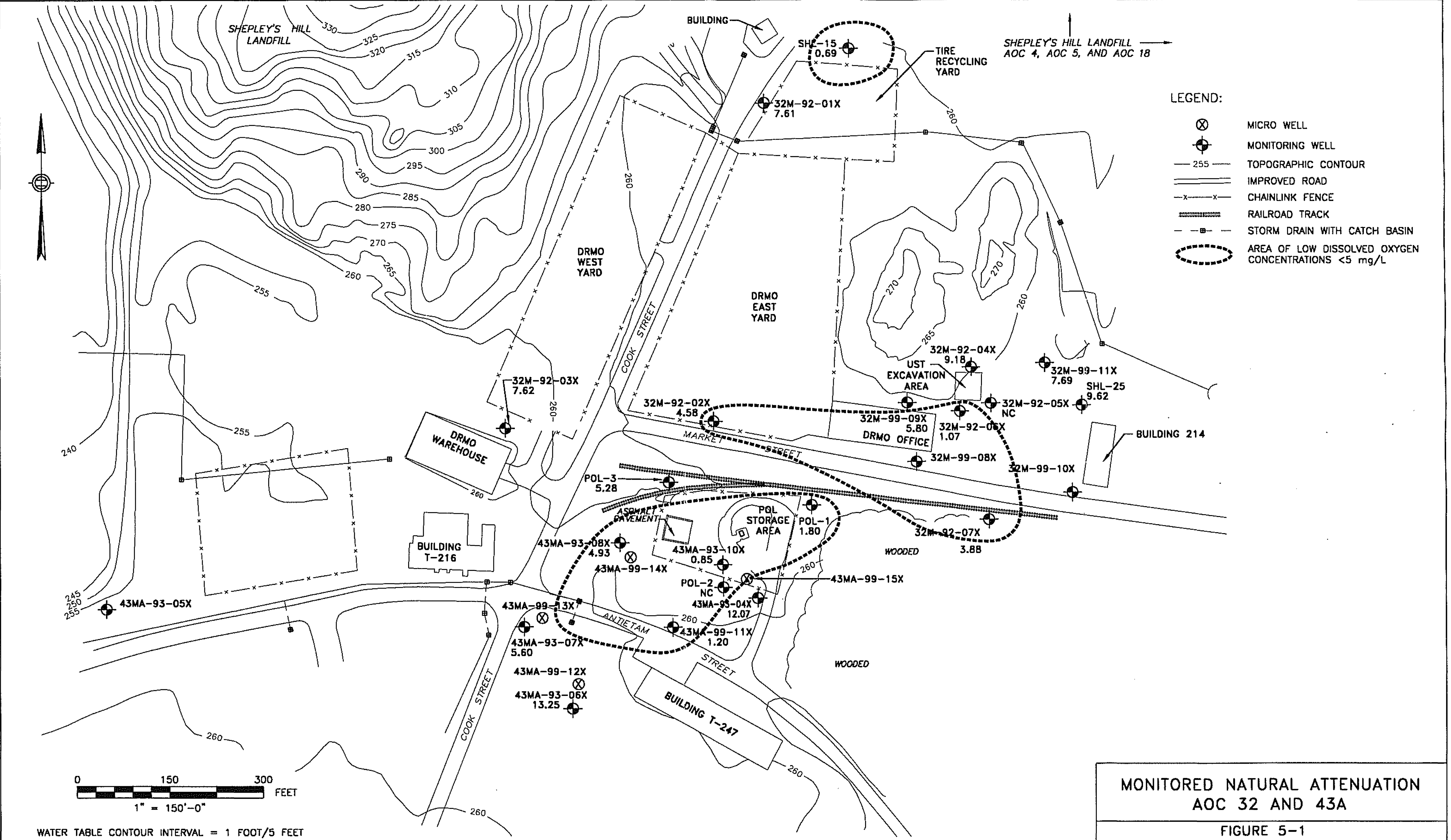

WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 5-1

AREA OF LOW DISSOLVED OXYGEN CONCENTRATIONS
OCTOBER 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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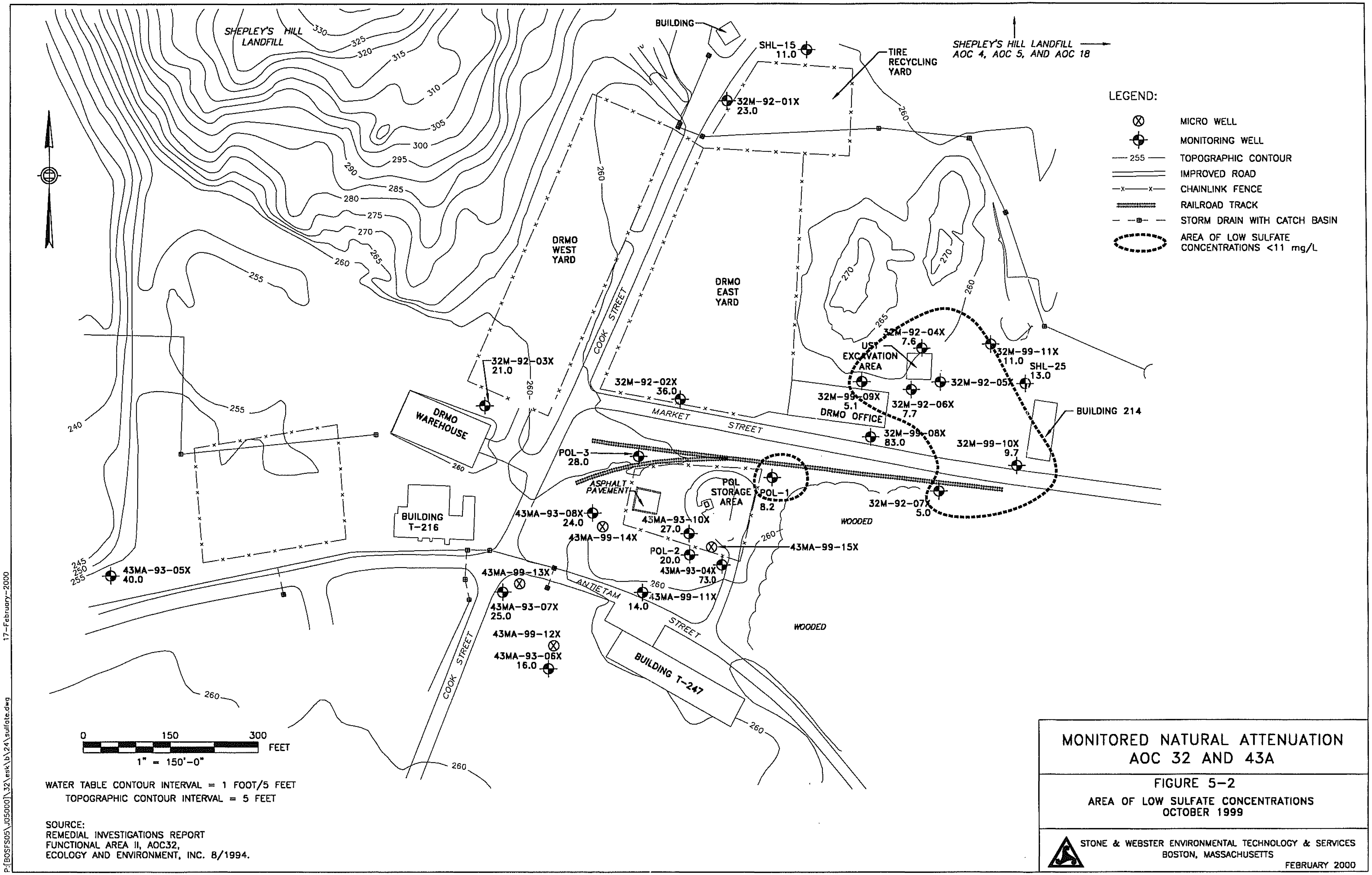
17-February-2000



WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 5-2

AREA OF LOW SULFATE CONCENTRATIONS
OCTOBER 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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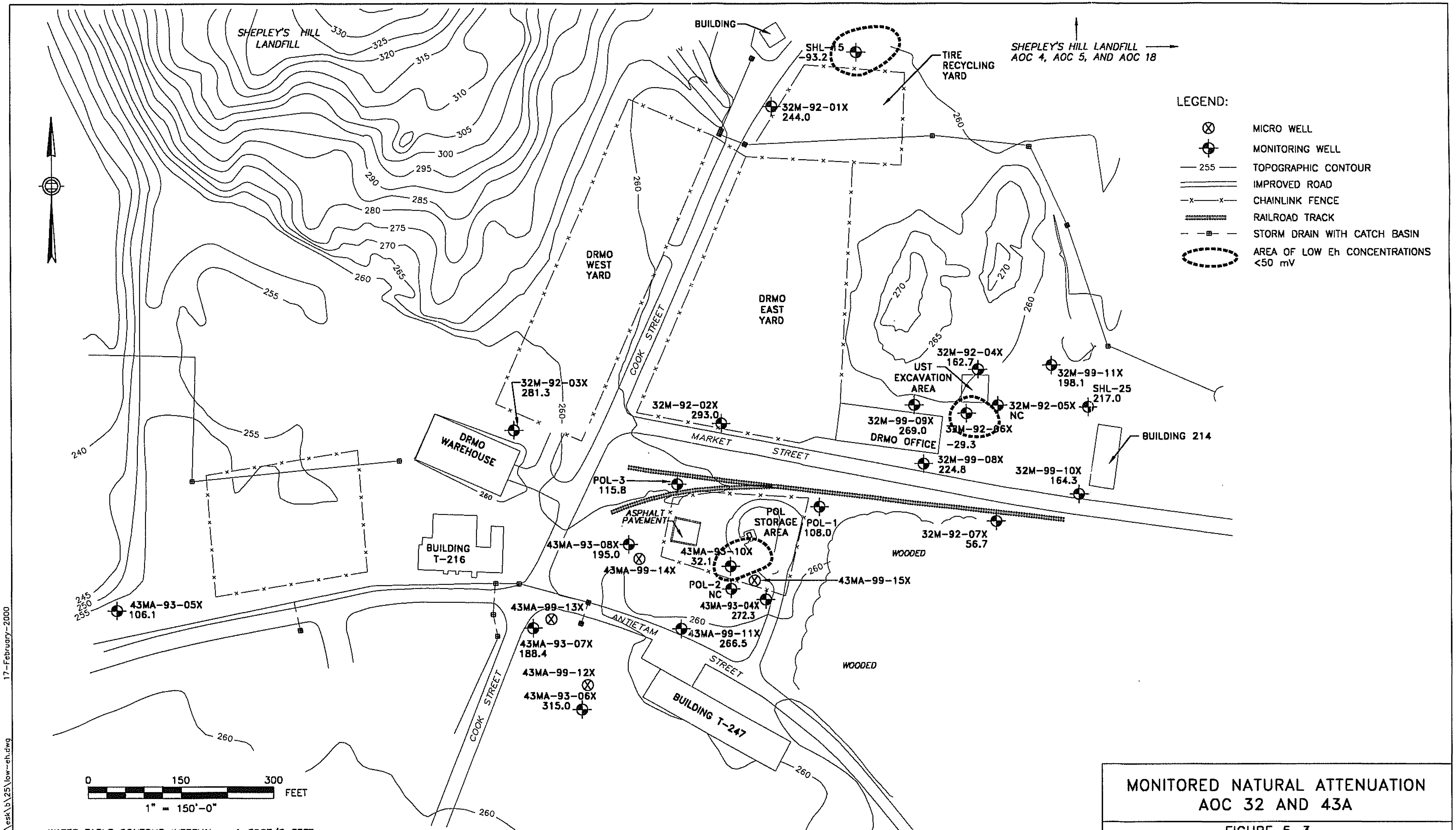

WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 5-3

AREA OF LOW Eh CONCENTRATIONS
OCTOBER 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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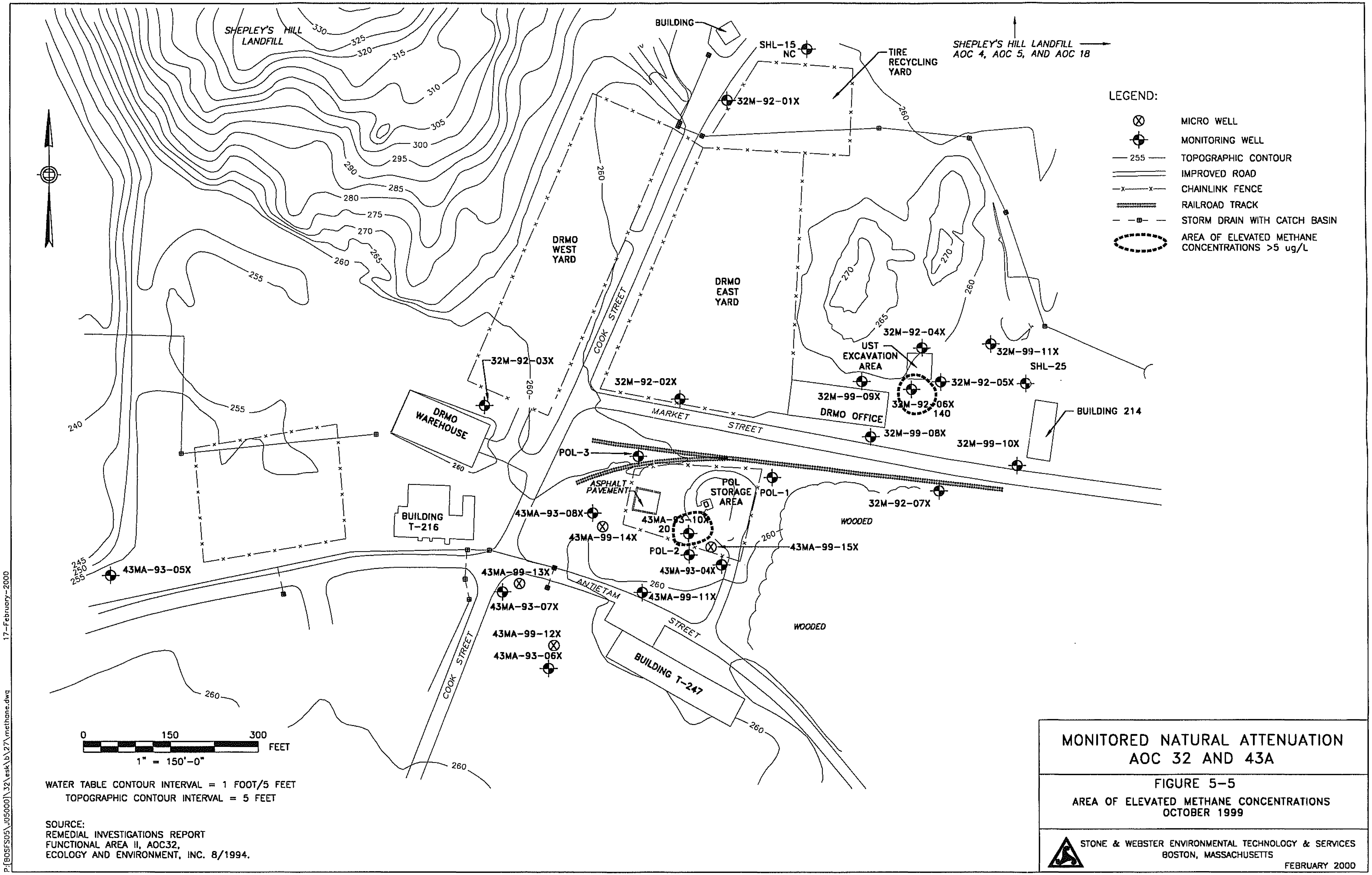

WATER TABLE CONTOUR INTERVAL = 1 FOOT/5 FEET
TOPOGRAPHIC CONTOUR INTERVAL = 5 FEET

SOURCE:
REMEDIAL INVESTIGATIONS REPORT
FUNCTIONAL AREA II, AOC32,
ECOLOGY AND ENVIRONMENT, INC. 8/1994.

MONITORED NATURAL ATTENUATION
AOC 32 AND 43A

FIGURE 5-5

AREA OF ELEVATED METHANE CONCENTRATIONS
OCTOBER 1999

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS
FEBRUARY 2000

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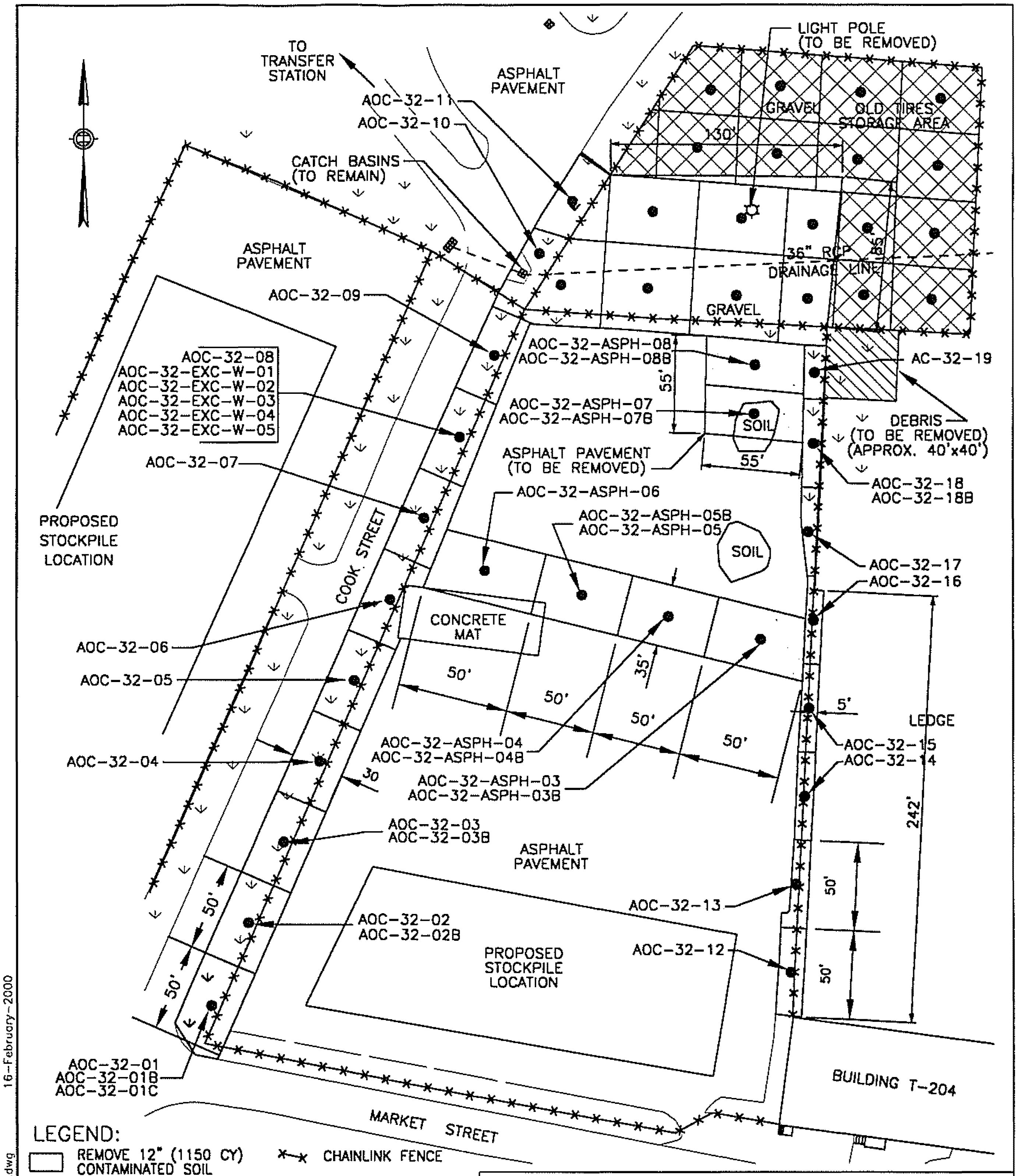

LEGEND:

▭ REMOVE 12" (1150 CY) CONTAMINATED SOIL

☒ REMOVE 6" (350 CY) SOIL AND DEBRIS

▨ REMOVE DEBRIS (20 CY)

▭ REMOVE BITUMINOUS CONCRETE (120 CY)

x—x CHAINLINK FENCE

ᵛ GRASSY AREA

● 5-pt. CONFIRMATORY SAMPLE

NOTE:

TAKEN FROM COMPLETION REPORT
SOIL, ASPHALT, AND DEBRIS REMOVAL
AOC32, DEVENS, MASS.
PREPARED BY ROY F. WESTON, 1999.

0 80 160 FEET
1" = 80'-0"

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 3-2
EXCAVATION SOIL SAMPLE LOCATIONS DRMO EAST AND WEST YARD

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS

FEBRUARY 2000

16-February-2000

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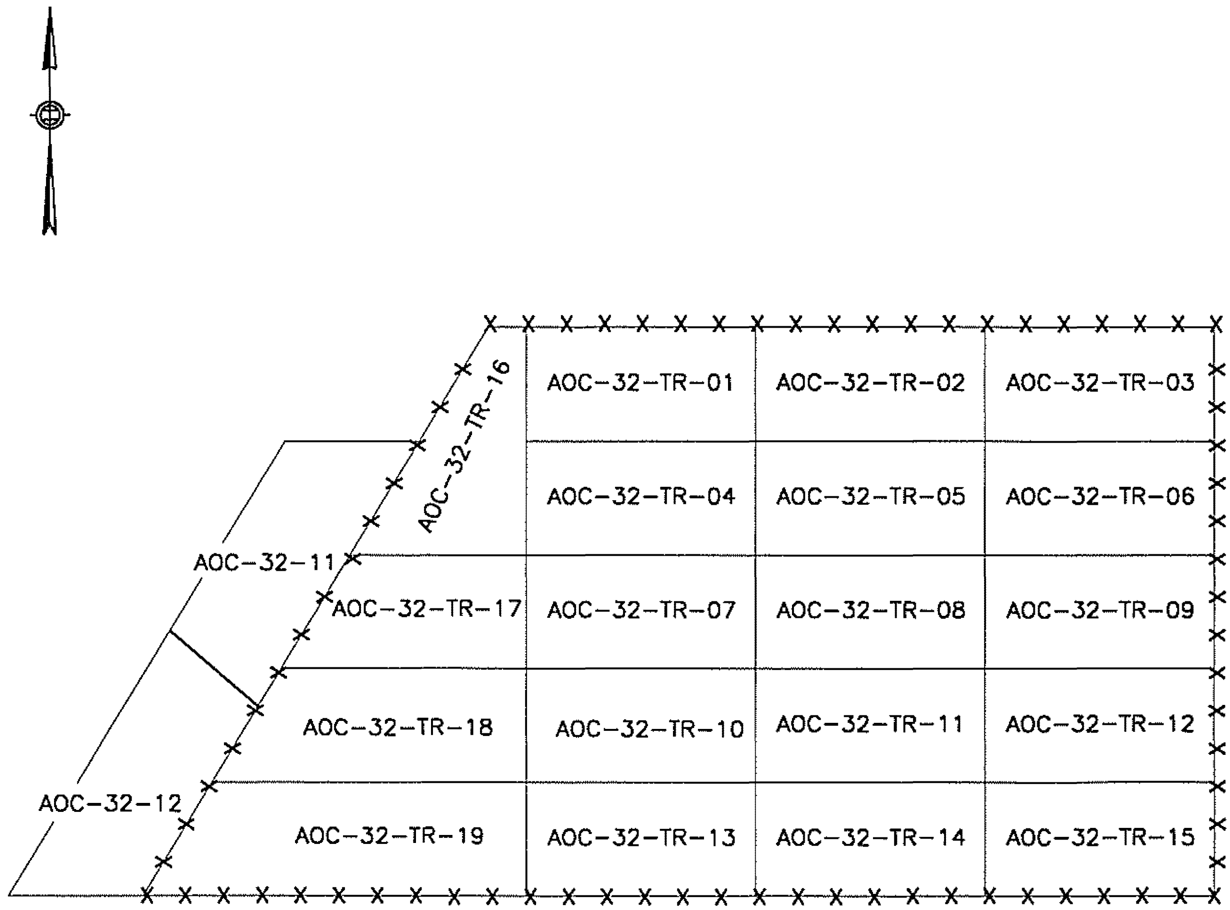

LEGEND:

-X-X-X-X-X-	FENCE LINE
AOC-32-TR-01	PLOT ID NUMBER

NOTE:

TAKEN FROM COMPLETION REPORT
SOIL, ASPHALT, AND DEBRIS REMOVAL
AOC32, DEVENS, MASS.
PREPARED BY ROY F. WESTON, 1999.

0 50 100 FEET
1" = 50'-0"

MONITORED NATURAL ATTENUATION AOC 32 AND 43A

FIGURE 3-3
TIRE RECYCLING YARD SITE EXCAVATION SOIL SAMPLE LOCATIONS

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES
BOSTON, MASSACHUSETTS

FEBRUARY 2000

16-February-2000

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TABLES

TABLE 2-1
Cleanup Goals for Chemicals of Concern in Groundwater

Analytes	Cleanup Goal µg/l
Volatile Organic Compounds	
1,2-Dichloroethene (total)	55
1,1,1 Trichloroethane	5
Trichlorothene (TCE)	5
1,2-Dichlorobenzene	600
1,3-Dichlorobenzene	600
1,4-Dichlorobenzene	75
Volatile Petroleum Hydrocarbons	
Benzene	5
C5-C8 Aliphatics*	400
C9-C12 Aliphatics*	4,000
C9-C10 Aromatics*	200
Extractable Petroleum Hydrocarbons	
C9-C18 Aliphatics*	4,000
C19-C36 Aliphatics*	5,000
C11-C22 Aromatics*	200
Polychlorinated Biphenyls	
PCB-1260	0.5
Inorganics	
Arsenic	50
Manganese	3,500

Note: * No cleanup goal was established for this analyte in the Record of Decision.
The Massachusetts Contingency Plan GW-1, standard is being used in lieu of a cleanup goal.

TABLE 2-2
Surface/Subsurface Soil Cleanup Goals for Chemicals of Concern

Analytes	**Cleanup Goal (ppm)**
Extractable Petroleum Hydrocarbons	
C_9 - C_{18} Aliphatics*	2,500 ppm
C_{19} - C_{36} Aliphatics*	5,000 ppm
C_{11} - C_{22} Aromatics*	200 ppm
Volatile Petroleum Hydrocarbons	
C_5 - C_8 Aliphatics*	500 ppm
C_9 - C_{12} Aliphatics*	2,500 ppm
C_9 - C_{10} Aromatics*	300 ppm
Pesticides	
DDD	3 ppm
DDE	2 ppm
DDT	2 ppm
Polychlorinated Biphenyls	
Aroclor 1254	2 ppm
Aroclor 1260	2 ppm
Inorganics	
Arsenic	24 ppm
Lead	426 ppm

Notes:
ppm = parts per million
* No cleanup goal was established for this analyte in the Record of Decision.
The Massachusetts Contingency Plan S-2, standard is being used in lieu of a cleanup goal

Table 3-1 AOC-32 Confirmatory Sampling Results

	Cleanup Goal	AOC-32-01-C	AOC-32-02B	AOC-32-03B	AOC-32-04	AOC-32-05	AOC-32-06	AOC-32-07	AOC-32-08	AOC-32-EXC-W-01
EPH PARAMETERS	(ppm)	(final grid sample)								(Grid AOC-32-08)
C9-C18 Aliphatics	**2,500**	<51	<53	<56	<56	<57	<53	<56	<55	<54
C19-C36 Aliphatics	**5,000**	<51	<53	<56	380	<57	180	110	<55	<54
C10-C22 Aromatics	**200**	<51	<53	<56	<56	<57	<53	<56	<55	<54
Naphthalene	**4**	<0.26	<0.27	<0.28	<0.28	<0.28	0.35	0.41	<0.27	<0.27
2-Methylnaphthalene	**0.70**	<0.26	<0.27	<0.28	<0.28	<0.28	0.49	0.55	<0.27	<0.27
Acenaphthylene	**100**	<0.26	<0.27	<0.28	<0.28	<0.28	<.27	<0.28	<0.27	<0.27
Acenaphthene	**20**	<0.26	<0.27	<0.28	<0.28	<0.28	<.27	<0.28	<0.27	<0.27
Flourene	**400**	<0.26	<0.27	<0.28	<0.28	<0.28	<.27	<0.28	<0.27	<0.27
Phenanthrene	**700**	<0.26	<0.27	<0.28	<0.28	<0.28	0.62	0.76	<0.27	<0.27
Anthracene	**2,500**	<0.26	<0.27	<0.28	<0.28	<0.28	<0.27	<0.28	<0.27	<0.27
Fluoranthene	**2,000**	<0.26	<0.27	<0.28	0.75	<0.28	0.94	0.89	0.3	<0.27
Pyrene	**1,000**	<0.26	<0.27	<0.28	0.63	<0.28	0.69	0.78	0.25	<0.27
Benzo (a) anthracene	**1.00**	<0.26	<0.27	<0.28	0.57	<0.28	0.41	0.56	<0.27	<0.27
Chrysene	**10**	<0.26	<0.27	<0.28	0.58	<0.28	0.61	0.69	<0.27	<0.27
Benzo (b) fluoranthene	**1.00**	<0.26	<0.27	<0.28	0.81	<0.28	0.88	0.92	0.36	<0.27
Benzo (k) fluoranthene	**10**	<0.26	<0.27	<0.28	0.29	<0.28	0.28	<0.28	<0.27	<0.27
Benzo (a) pyrene	**0.70**	<0.26	<0.27	<0.28	0.53	<0.28	0.41	0.62	<0.27	<0.27
Dibenzo (a,h) anthracene	**0.70**	<0.26	<0.27	<0.28	<0.28	<0.28	<0.27	<0.28	<0.27	<0.27
Indeno (1,2,3-cd) pyrene	**1**	<0.26	<0.27	<0.28	0.43	<0.28	0.51	0.46	<0.27	<0.27
Benzo (g,h,i) perylene	**2,500**	<0.26	<0.27	<0.28	0.41	<0.28	0.43	0.39	<0.27	<0.27
VPH PARAMETERS										
C5-C8 Aliphatics	**500**	5.7	<3.8	<3.4	<3.2	<3.8	<3.4	<2.9	2.4	3.5
C-9-C12 Aliphatics	**2,500**	2.2	1.5	<.86	<0.81	<0.96	<0.86	<0.73	<0.6	<0.87
C9-C10 Aromatics	**300**	4.3	2	<0.86	<0.81	<0.96	<0.86	<0.73	<0.6	<0.87
Methyl-tert-butylether	**0.3**	<0.069	<0.069	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
Benzene	**10**	0.26	0.13	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
Toluene	**90**	0.82	0.44	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
Ethylbenzene	**80**	0.17	0.09	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
m,p-Xylenes	**I**	0.7	0.38	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
o-Xylene	**800**	0.55	0.29	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
Naphthalene	**4**	0.68	0.35	<0.069	<0.065	<0.065	<.069	<0.059	<0.049	<0.07
INORGANICS										
Arsenic	**24**	20.5	17.3	14.9	9.4	9.8	14.3	9	12.8	9.7
Lead	**426**	84.8	96.3	63.2	24.5	4.9	130	261	37.2	5.3
PESTICIDES										
DDD	**3**	<0.051	<0.025	<0.025	<0.026	<0.028	<0.054	<0.054	<0.011	<0.0052
DDE	**2**	0.12	<0.052	<0.052	<0.026	<0.028	<0.054	<0.054	<0.011	<0.0052
DDT	**2**	0.58	0.28	0.28	<0.026	<0.028	0.19	<0.054	<0.011	<0.0052
PCBs										
Aroclor 1254	**2**	<0.26	<0.12	<0.14	<0.13	<0.14	<0.27	<0.27	<0.055	<0.026
Aroclor 1260	**2**	<0.26	<0.12	<0.14	<0.13	<0.14	<0.27	<0.27	<0.055	<0.026

Table 3-1 AOC-32 Confirmatory Sampling Results

	Cleanup Goal	AOC-32-EXC-W-02	AOC-32-EXC-W-03	AOC-32-EXC-W-04	AOC-32-EXC-FLR-05	AOC-32-09	AOC-32-10	AOC-32-11	AOC-32-12
EPH PARAMETERS	(ppm)	(Grid AOC-32-08)	(Grid AOC-32-08)	(Grid AOC-32-08)	(Grid AOC-32-08)				
C9-C18 Aliphatics	**2,500**	<53	<51	<53	<52	<52	<54	<54	<57
C19-C36 Aliphatics	**5,000**	<53	<51	<53	<52	<63	610	<54	<57
C10-C22 Aromatics	**200**	<53	<51	<53	<52	<52	<54	<54	<57
Naphthalene	**4**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
2-Methylnaphthalene	**0.70**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Acenaphthylene	**100**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Acenaphthene	**20**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Flourene	**400**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Phenanthrene	**700**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Anthracene	**2,500**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Fluoranthene	**2,000**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Pyrene	**1,000**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Benzo (a) anthracene	**1.00**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Chrysene	**10**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Benzo (b) fluoranthene	**1.00**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Benzo (k) fluoranthene	**10**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Benzo (a) pyrene	**0.70**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Dibenzo (a,h) anthracene	**0.70**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Indeno (1,2,3-cd) pyrene	**1**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
Benzo (g,h.i) perylene	**2,500**	<0.27	<0.26	<0.26	<0.26	<0.26	<0.27	<0.27	<0.28
VPH PARAMETERS									
C5-C8 Aliphatics	**500**	2.5	2.4	2.1	2.5	3.1	<2.7	<2.2	<3.4
C-9-C12 Aliphatics	**2,500**	<0.63	<0.61	<0.53	<0.63	<0.78	<0.67	<0.55	<0.84
C9-C10 Aromatics	**300**	<0.63	<0.61	<0.53	<0.63	<0.78	<0.67	<0.55	<0.84
Methyl-tert-butylether	**0.3**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
Benzene	**10**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
Toluene	**90**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
Ethylbenzene	**80**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
m,p-Xylenes	**l**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
o-Xylene	**800**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
Naphthalene	**4**	<0.051	<0.049	<0.043	<0.051	<0.063	<0.054	<0.044	<0.057
INORGANICS									
Arsenic	**24**	23.7	21.4	18.5	9.1	9.3	10	9.9	9.7
Lead	**426**	12.3	7	12.1	5.3	7.6	11.1	6.1	25.3
PESTICIDES									
DDD	**3**	<0.051	<0.0052	<0.0049	<0.0048	<0.01	<0.051	<0.051	<0.0055
DDE	**2**	<0.051	<0.0052	<0.0049	<0.0048	<0.01	<0.051	<0.051	<0.0055
DDT	**2**	<0.01	<0.0052	<0.0049	<0.0048	<0.01	<0.051	<0.051	<0.0055
PCBs									
Aroclor 1254	**2**	<0.025	<0.026	<0.024	<0.024	<0.052	<0.25	<0.25	<0.028
Aroclor 1260	**2**	<0.025	<0.026	<0.024	<0.024	<0.052	<0.25	<0.25	<0.028

Table 3-1 AOC-32 Confirmatory Sampling Results

	Cleanup Goal	AOC-32-13	AOC-32-14	AOC-32-15	AOC-32-16	AOC-32-17	AOC-32-18B	AOC-32-19	AOC-32-TR-01	AOC-32-TR-02
EPH PARAMETERS	**(ppm)**									
C9-C18 Aliphatics	**2,500**	<55	<56	<57	<57	<55	<56	<54	<53	<55
C19-C36 Aliphatics	**5,000**	<55	<56	<57	<57	<55	170	140	<53	<55
C10-C22 Aromatics	**200**	<55	<56	<57	<57	<55	<56	<54	<53	<55
Naphthalene	**4**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
2-Methylnaphthalene	**0.70**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Acenaphthylene	**100**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Acenaphthene	**20**	<0.28	<0.28	<0 29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Flourene	**400**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Phenanthrene	**700**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0 26	<0.28
Anthracene	**2,500**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Fluoranthene	**2,000**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Pyrene	**1,000**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Benzo (a) anthracene	**1.00**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Chrysene	**10**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Benzo (b) fluoranthene	**1.00**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Benzo (k) fluoranthene	**10**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Benzo (a) pyrene	**0.70**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Dibenzo (a,h) anthracene	**0.70**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Indeno (1,2,3-cd) pyrene	**1**	<0.28	<0.28	<0.29	<0.28	<0.27	<0.28	<0.27	<0.26	<0.28
Benzo (g,h.i) perylene	**2,500**	<0.28	<0.28	<0.29	<0.28	<0.27	<0 28	<0.27	<0.26	<0.28
VPH PARAMETERS										
C5-C8 Aliphatics	**500**	<3.1	<2.9	<3.1	<2.8	<2.6	<3 7	<2.5	<2.4	<4.0
C-9-C12 Aliphatics	**2,500**	<0.77	<0.71	<0.77	<0.69	<0.65	<0.78	<0.63	<0.59	<0 99
C9-C10 Aromatics	**300**	<0.77	<0.71	<0.77	<0.69	<0.65	<0.78	<0.63	<0.59	<0.99
Methyl-tert-butylether	**0.3**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
Benzene	**10**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
Toluene	**90**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
Ethylbenzene	**80**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
m,p-Xylenes	**|**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
o-Xylene	**800**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
Naphthalene	**4**	<0.062	<0.057	<0.062	<0.056	<0.052	<0.063	<0.051	<0.047	<0.08
INORGANICS										
Arsenic	**24**	8.6	9.9	10	9.4	8.5	9	8.7	9.9	9.9
Lead	**426**	25.8	5.5	59.1	16.5	77.8	9.7	15.6	12.8	20.1
PESTICIDES										
DDD	**3**	<0.0044	<0.0055	<0.0057	<0.0056	<0.01	<0.0096	<0.053	<0.0052	<0.01
DDE	**2**	<0.01	<0.0055	<0.0034	<0.0056	<0.01	<0.0096	<0.053	<0.0052	<0.013
DDT	**2**	<0.028	<0.0055	<0.022	<0.016	<0.048	<0.036	<0.053	<0.0052	<0.021
PCBs										
Aroclor 1254	**2**	<0.028	<0.028	<0.028	<0.028	<0.053	<0.048	<0.26	<0.026	<0.052
Aroclor 1260	**2**	<0.028	<0.028	<0.028	<0.028	<0.053	<0.14	<0.26	<0.026	<0.052

Table 3-1 AOC-32 Confirmatory Sampling Results

	Cleanup Goal	AOC-32-TR-11	AOC-32-TR-12	AOC-32-TR-13	AOC-32-TR-14	AOC-32-TR-15	AOC-32-TR-16	AOC-32-TR-17	AOC-32-TR-18
EPH PARAMETERS	(ppm)								
C9-C18 Aliphatics	**2,500**	67	<52	<51	<51	<55	<57	<53	<53
C19-C36 Aliphatics	**5,000**	<51	<52	96	65	55	<57	610	<53
C10-C22 Aromatics	**200**	<51	<52	<51	<51	<55	<57	<53	<53
Naphthalene	**4**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
2-Methylnaphthalene	**0.70**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Acenaphthylene	**100**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Acenaphthene	**20**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Flourene	**400**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Phenanthrene	**700**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Anthracene	**2,500**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Fluoranthene	**2,000**	<0.25	<0.26	0.37	<0.25	0.29	0.29	<0.26	<0.27
Pyrene	**1,000**	<0.25	<0.26	0.32	<0.25	<0.28	<0.28	<0.26	<0.27
Benzo (a) anthracene	**1.00**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Chrysene	**10**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Benzo (b) fluoranthene	**1.00**	<0.25	<0.26	0.3	<0.25	<0.28	<0.28	<0.26	<0.27
Benzo (k) fluoranthene	**10**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Benzo (a) pyrene	**0.70**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Dibenzo (a,h) anthracene	**0.70**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Indeno (1,2,3-cd) pyrene	**1**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
Benzo (g,h,i) perylene	**2,500**	<0.25	<0.26	<0.26	<0.25	<0.28	<0.28	<0.26	<0.27
VPH PARAMETERS									
C5-C8 Aliphatics	**500**	<2.3	<2.2	3.2	<2.3	<3.9	<3.1	<3.2	<3.2
C-9-C12 Aliphatics	**2,500**	<0.57	<0.55	<0.81	<0.58	<0.96	<0.78	<0.8	<0.8
C9-C10 Aromatics	**300**	<0.57	<0.55	<0.81	<0.58	<0.96	<0.78	<0.8	<0.8
Methyl-tert-butylether	**0.3**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
Benzene	**10**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
Toluene	**90**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
Ethylbenzene	**80**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
m,p-Xylenes	|	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
o-Xylene	**800**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
Naphthalene	**4**	<0.046	<0.044	<0.065	<0.046	<0.078	<0.063	<0.064	<0.064
INORGANICS									
Arsenic	**24**	10	14.3	15.7	13.3	9.3	12.1	9.4	15.7
Lead	**426**	150	83.3	101	160	95	7.9	5.5	54.3
PESTICIDES									
DDD	**3**	0.36	<0.0089	<0.092	0.15	<0.016	<0.0056	<0.005	<0.0053
DDE	**2**	0.11	<0.0098	<0.076	0.1	<0.045	<0.0056	<0.005	<0.0053
DDT	**2**	1.7	<0.052	0.45	0.87	0.11	<0.0056	<0.005	<0.0053
PCBs									
Aroclor 1254	**2**	<0.049	<0.049	<0.25	<0.049	<0.051	<0.028	<0.025	<0.027
Aroclor 1260	**2**	<0.049	<0.049	<0.25	<0.049	<0.051	<0.028	<0.025	<0.027

Table 3-1 AOC-32 Confirmatory Sampling Results

	Cleanup Goal	AOC-32-TR-19	AOC-32-ASPH-03B	AOC-32-ASPH-04B	AOC-32-ASPH-05B	AOC-32-ASPH-06B	AOC-32-ASPH-07B	AOC-32-ASPH-08B
EPH PARAMETERS	(ppm)							
C9-C18 Aliphatics	**2,500**	<54	<54	<56	<53	<52	<53	<55
C19-C36 Aliphatics	**5,000**	<54	<54	100	230	<52	69	<55
C10-C22 Aromatics	**200**	<54	<54	<56	<53	<52	<53	<55
Naphthalene	**4**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
2-Methylnaphthalene	**0.70**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Acenaphthylene	**100**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Acenaphthene	**20**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Flourene	**400**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Phenanthrene	**700**	<0.27	0.85	<0.28	<0.26	<0.26	<0.26	<0.28
Anthracene	**2,500**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Fluoranthene	**2,000**	<0.27	1.8	0.35	<0.26	<0.26	<0.26	<0.28
Pyrene	**1,000**	<0.27	1.3	0.29	<0.26	<0.26	<0.26	<0.28
Benzo (a) anthracene	**1.00**	<0.27	0.93	<0.28	<0.26	<0.26	<0.26	<0.28
Chrysene	**10**	<0.27	0.89	<0.28	<0.26	<0.26	<0.26	<0.28
Benzo (b) fluoranthene	**1.00**	<0.27	1.1	<0.28	<0.26	<0.26	<0.26	<0.28
Benzo (k) fluoranthene	**10**	<0.27	0.43	<0.28	<0.26	<0.26	<0.26	<0.28
Benzo (a) pyrene	**0.70**	<0.27	0.81	<0.28	<0.26	<0.26	<0.26	<0.28
Dibenzo (a,h) anthracene	**0.70**	<0.27	<0.27	<0.28	<0.26	<0.26	<0.26	<0.28
Indeno (1,2,3-cd) pyrene	**1**	<0.27	0.54	<0.28	<0.26	<0.26	<0.26	<0.28
Benzo (g,h,i) perylene	**2,500**	<0.27	0.53	<0.28	<0.26	<0.26	<0.26	<0.28
VPH PARAMETERS								
C5-C8 Aliphatics	**500**	<2.4	<3.8	<4.6	<2.3	<2.5	<4.4	<3.8
C-9-C12 Aliphatics	**2,500**	<0.61	0.99	<1.2	<0.57	<0.62	1.9	<0.94
C9-C10 Aromatics	**300**	<0.61	<0.96	<1.2	<0.57	<0.62	2.2	<0.94
Methyl-tert-butylether	**0.3**	<0.049	<0.077	<0.093	<0.046	<0.05	<0.088	<0.076
Benzene	**10**	<0.049	<0.077	<0.093	<0.046	<0.05	<0.088	<0.076
Toluene	**90**	<0.049	<0.077	<0.093	<0.046	<0.05	0.26	<0.076
Ethylbenzene	**80**	<0.049	<0.077	<0.093	<0.046	<0.05	<0.088	<0.076
m,p-Xylenes	**|**	<0.049	<0.077	<0.093	<0.046	<0.05	0.28	<0.076
o-Xylene	**800**	<0.049	<0.077	<0.093	<0.046	<0.05	0.17	<0.076
Naphthalene	**4**	<0.049	<0.077	<0.093	<0.046	<0.05	0.16	<0.076
INORGANICS								
Arsenic	**24**	12.7	10.6	9	20.8	23.5	13.8	9.8
Lead	**426**	30.9	52	99.7	108	76.3	5.8	5.5
PESTICIDES								
DDD	**3**	<0.05	0.37	<0.053	<0.52	<0.051	<0.0052	<0.054
DDE	**2**	<0.05	0.76	<0.053	<0.52	<0.051	<0.0052	0.59
DDT	**2**	<0.05	0.34	<0.024	<0.52	<0.071	<0.0052	1.7
PCBs								
Aroclor 1254	**2**	<0.25	<0.26	<0.26	<<0.27	<0.25	<0.28	<0.27
Aroclor 1260	**2**	<0.25	<0.26	<0.26	<<0.27	<0.25	<0.28	<0.27

TABLE 3-2
AOC 32 - GROUNDWATER ELEVATIONS

STATION/ WELL NO.	REF. POINT TOPVC	REF. POINT - TOC (ft msl)	HEIGHT OF STAND PIPE (ft)	ELEVATION OF GROUND SURFACE (ft msl)	GROUNDWATER ELEVATION (ft msl)							
					Nov-92	Mar-93	Jun-93	Nov-93	Jan-99	Apr-99	Jul-99	Oct-99
32M-92-01X	260.93	261.2	2.8	258.4	240.8	242.9	NM	239.9	241.2	244.0	241.7	242.4
32M-92-02X	261.98	262.2	2.6	259.6	237.9	239.9	240.3	237.2	237.9	240.6	238.7	239.4
32M-92-03X	260.99	261.0	2.2	258.8	230.3	231.4	232.9	NM	231.0	232.3	230.2	230.3
32M-92-04X	262.28	263.0	2.6	260.4	NM	248.1	248.0	NM	250.4	252.4	244.5	246.1
32M-92-05X	262.04	262.2	3.3	258.9	243.6	245.2	245.0	NM	245.8	246.6	243.1	244.4
32M-92-06X	261.69	262.1	2.9	259.2	245.0	248.9	247.4	246.5	247.0	250.1	244.8	246.4
32M-92-07X	260.86	261.0	1.9	259.1	243.8	246.6	246.2	243.8	244.4	246.6	244.7	245.7
32M-99-08X	258.90	259.2	0.0	259.2	NM	NM	NM	NM	NM	250.1	245.6	248.4
32M-99-09X	262.02	262.5	2.9	259.6	NM	NM	NM	NM	NM	251.4	245.1	248.6
32M-99-10X	260.99	261.3	2.7	258.6	NM	NM	NM	NM	NM	238.9	233.9	236.2
32M-99-11X	257.30	258.2	2.6	255.6	NM	NM	NM	NM	NM	227.2	232.7	233.4
SHL-15*	260.75	259.0	1.3	259.0	240.4	242.2	NM	241.8	240.1	243.2	240.5	241.3
SHL-25*	258.87	257.1	2.0	257.1	230.5	233.4	NM	231.8	230.4	235.1	231.2	232.3
32Z-99-01X	262.05	262.2	2.0	259.3	NM	NM	NM	NM	NM	NM	231.8	233.9
32Z-99-02X	260.79	260.9	2.0	258.4	NM	NM	NM	NM	NM	NM	233.6	234.8

Note:

1.) Water elevation data collected between November, 1992 and November, 1993, and survey data was obtained from Ecology and Environment, Inc. 1993.

2.) Groundwater elevations in bold type indicate water level measurements recorded prior to commencing low flow sampling of an individual well as opposed to the initial water elevation survey conducted at the beginning of the sampling round.

3.) NM - Not Measured.

4.) --- Dashed line indicates that reference data was unavailable.

5.) TOC - Top of Casing

6.) ft msl - feet above mean sea level

* Reference point is from ground surface elevation

TABLE 3-3
AOC 43A - GROUNDWATER ELEVATIONS

STATION/ WELL NO.	REF. POINT TOPVC	REF. POINT - TOC (ft msl)	HEIGHT OF STAND PIPE (ft)	ELEVATION OF GROUND SURFACE (ft msl)	GROUNDWATER ELEVATION (ft msl)								
					Nov-92	Mar-93	Jun-93	Aug-93	Nov-93	Jan-99	Apr-99	Jul-99	Oct-99
43MA-93-04X	261.37	261.5	2.6	258.9	NM	NM	NM	231.3	230.8	230.8	232.8	230.9	231.0
43MA-93-05X	260.55	260.9	2.5	258.4	NM	NM	NM	227.7	227.2	227.0	228.6	227.1	226.8
43MA-93-06X	262.89	263.4	3.2	260.2	NM	NM	NM	230.4	229.6	229.7	231.2	229.7	229.3
43MA-93-07X	259.63	259.9	0.1	259.8	NM	NM	NM	230.3	229.5	229.6	230.6	229.7	229.3
43MA-93-08X	260.29	261.2	2.8	258.3	NM	NM	NM	230.8	230.1	230.0	232.3	230.2	229.9
43MA-93-10X	260.41	261.1	2.6	258.5	NM	NM	NM	NM	230.6	230.5	232.4	230.6	230.4
43MA-99-11X	262.60	262.8	3.0	259.8	NM	NM	NM	NM	NM	NM	231.7	230.1	229.8
43MA-99-12X	260.37	260.5	0.0	260.5	NM	NM	NM	NM	NM	NM	NM	229.7	NM
43MA-99-13X	259.54	259.9	0.0	259.9	NM	NM	NM	NM	NM	NM	NM	229.7	NM
43MA-99-14X	258.12	258.3	0.3	258.0	NM	NM	NM	NM	NM	NM	NM	230.4	NM
43MA-99-15X	259.04	259.2	0.4	258.8	NM	NM	NM	NM	NM	NM	NM	230.6	NM
POL-1		---	2.2	257.8	239.4	240.3	240.5	239.6	240.5	239.7	240.1	239.8	240.3
POL-2		---	2.1	258.7	229.8	230.7	230.8	230.8	230.2	230.1	232.0	230.1	229.9
POL-3		---	2.1	260.2	234.7	235.7	236.4	234.6	233.5	234.5	237.2	234.7	234.4

Note:

1.) Water elevation data collected between November, 1992 and November, 1993, and survey data was obtained from Ecology and Environment, Inc. 1993.

2.) Groundwater elevations in bold type indicate water level measurements recorded prior to commencing low flow sampling of an individual well as opposed to the initial water elevation survey conducted at the beginning of the sampling round.

3.) NM - Not Measured.

4.) --- Dashed line indicates that reference data was unavailable.

5.) TOC - Top of Casing

6.) ft msl - feet above mean sea level

TABLE 4-1

Notes:

B - Attributable to field or laboratory contamination.
EB - Reported contamination in the equipment blank
C - Confirmed by reanalysis.
F - Sample was filtered.
J - Estimated Value.
N/A - Not Analyzed.
U - The compound was not detected. The associated numerical value is the compound quantitation limit.
UJ - The compound was not detected. The compound quantitation limit is an estimated value.
NC = Not Collected due to limited water volumes in wells.

1. *No cleanup goal has been established for this analyte, the MCP GW-1 standard is being used in lieu of a clean-up goal.
2. ** Round 1 and 2 sampling events occurred November 20, 1992 and March 4, 1993 respectively. Round 3 and 3f are for POL 1, 2, & 3 only.
3. Highlighted concentrations exceed Site cleanup goals as established in the ROD, prepared by Horne Engineering Servises, Inc., 1998.
4. For groundwater sampling rounds conducted in 1992 and 1993, only select data for relevant parameters is shown and was taken from the ROD prepared by Horne Engineering Services, Inc., February 1998.
5. There are no cleanup goals established fri beryllium, chromium, and nickel. They have been highlighted when the concentrations exceeded the screening values, established in the RI.
6. A screening value of 1,000 ppm was used for TPH. Since the groundwater will be sampled for EPH and VPH there has been no cleanup goal established for TPH.
7. Total Iron was not analyzed for the January, 1999 sampling round, however, Ferris Iron (Fe2+) was determined in the field using a Hach Test kit.
8. IRA data for the January, 1999 sampling round was not validated.
10. *** - C11-C22 Aromatics exclude the concentration of target PAH analytes.
11. IRA Data was not validated.
12. /1 = concentration for 1,2 dichlorobenzene is reported from the dilution run (DF=5.0).
13. /2 = concentration for VPH(C9-C10 Aromatics) is reported from the dilution run (DF=10.0).
14. (1) All range results exclude concentratons of surrogates and /or internal standards eluting in that range.
15. (2) C5-C8 Aliphatic hydrocarbons exclude the concentration of target analyteds eluting in that range.
16. (3) C9-C12 Aliphatic hydrocarbons exclude the concentration of target analytes eluting in that range and the concentration of C9-C10 Aromatics aromatic hydrocarbons.

TABLE 4-2

Notes:

B - Attributable to field or laboratory contamination.
EB - Reported contamination in the equipment blank
C - Confirmed by reanalysis.
F - Sample was filtered.
J - Estimated Value.
N/A - Not Analyzed.
U - The compound was not detected. The associated numerical value is the compound quantitation limit.
UJ - The compound was not detected. The compound quantitation limit is an estimated value.
NC = Not Collected due to limited water volumes in wells.
N/A$^{/1}$= Both sample bottles were broken during the login process at the laboratory. PCB analysis could not be performed.

1. *No cleanup goal has been established for this analyte, the MCP GW-1 standard is being used in lieu of a clean-up goal.
2. ** Round 1 and 2 sampling events occurred November 20, 1992 and March 4, 1993 respectively. Round 3 and 3f are for POL 1, 2, & 3 only.
3. Highlighted concentrations exceed Site cleanup goals as established in the ROD, prepared by Horne Engineering Servises, Inc., 1998.
4. For groundwater sampling rounds conducted in 1992 and 1993, only select data for relevant parameters is shown and was taken from the ROD prepared by Horne Engineering Services, Inc., February 1998.
5. There are no cleanup goals established fri beryllium, chromium, and nickel. They have been highlighted when the concentrations exceeded the screening values, established in the RI.
6. A screening value of 1,000 ppm was used for TPH. Since the groundwater will be sampled for EPH and VPH there has been no cleanup goal established for TPH.
7. Total Iron was not analyzed for the January, 1999 sampling round, however, Ferris Iron (Fe2+) was determined in the field using a Hach Test kit.
8. IRA data for the January, 1999 sampling round was not validated.
9. * - Excludes benzene, toluene, and MTBE
10. ** - Excludes ethylbenzene, total xylenes, and C9-C10 aromatics
11. *** - C11-C22 Aromatics exclude the concentration of target PAH analytes.
12. IRA Data was not validated.
13. Due to slow groundwater recharge, problems occurred in providing the laboratory with the required volume of water sample. As a result, some reporting limits are above cleanup goals.

Table 5-1
Aliphatic and Aromatic Compounds in Groundwater

Contaminant/Well	Jan-99	Apr-99	Jul-99	Oct-99
C9-C10 Aromatics				
(cleanup goal = 200 ug/L)				
32M-92-06X	**910**	**890**	**700**	**1,300**
43MA-93-10X	77	170	190/**210**	88/90
C19-C36 Aliphatics				
(cleanup goal = 5000 ug/L)				
32M-92-04X	**10,000**	680	210	3,400
32M-92-06X	160	3,600	780	320U
43MA-93-10X	150	89	60U	140U
C11-C22 Aromatics **				
(cleanup goal = 200 ug/L)				
32M-92-04X	**880**	180U	200U	**310**
32M-92-06X	160U	**670**	180	160U
43MA-93-10X	**250**	**450**	**260**	**400**

Notes:
U = not detected above analytical detection limits
** excludes the concentration of target PAH analytes
Bold indicates concentrations exceeds cleanup goal

Table 5-2
Chlorinated Organics in Groundwater

Contaminant/Well	Nov-92	Mar-93	Jun-93	Aug-93	Nov-93	Jan-99	Apr-99	Jul-99	Oct-99
1,2-dichlorobenzene									
(cleanup goal = 600 ug/L)									
32M-92-04X	**6000**	200	N/A	N/A	N/A	0.5	0.5	NC	22
32M-92-06X	**1000**	**700**	N/A	N/A	N/A	**740**	**930**	560	**880**
1,3-dichlorobenzene									
(cleanup goal = 600 ug/L)									
32M-92-04X	**1000**	60	N/A	N/A	N/A	0.5	0.5	NC	5
1,4-dichlorobenzene									
(cleanup goal = 75 ug/L)									
32M-92-04X	**600**	40	N/A	N/A	N/A	0.5	0.5	NC	3
32M-92-06X	**120**	70	N/A	N/A	N/A	**77**	72	61	**100**
trichloroethene									
(cleanup goal = 5.0 ug/L)									
32M-92-06X	**200**	**140**	N/A	N/A	N/A	2U	1U	1U	1U
POL-3	N/A	N/A	N/A	**19**	**17**	**5**	4	**5**	4

Notes:
N/A = not analyzed
NC = not collected
U = not detected above analytical detection limits
Bold indicates concentrations exceeds cleanup goal

TABLE 5-3
AOC 32 GROUNDWATER FIELD PARAMETERS

Monitoring Well	Temperature (C)		Specific Conductivity (ms/cm)		pH		ORP/Eh (mv)		Turbidity (NTV)		Dissolved Oxygen (mg/L)		CarbonDioxide (mg/L)		Ferrous Iron (mg/L)		Comments	
Date of Sample	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99
32M-92-01X	7.63	16.14	0.171	0.161	6.15	5.68	192.3	244	4.66	44	3.29	7.61	15	25	0	0		
32M-92-02X	7.59	14.57	0.106	0.137	5.33	4.76	249.9	293	3.58	4	5.21	4.58	NC	60	NC	0		
32M-92-03X	8.06	13.24	0.108	0.095	5.34	5.02	278.4	281.3	1.86	5.7	7.79	7.62	10	50	0	0		
32M-92-04X	8.79	14.12	0.03	0.029	6.21	6.23	177.1	162.7	20	34	14.48	9.18	10	10	0	0		
32M-92-05X*	17.91	NC	**2.443**	NC	6.35	NC	133.9	NC	NC	NC	6.41	NC	15	NC	0	NC		
32M-92-06X	6.18	19.67	0.121	0.121	6.41	6.62	19	-29.3	15.6	8.6	4.44	1.07	15	NC	4.2	5		
32M-92-07X*	10.18	12.61	0.05	0.082	5.97	7.51	14.3	56.7	3.85	4.81	10.81	3.88	5	0	0	1		
32M-99-08X**	12.76	16.75	**2.873**	0.358	6.78	5.69	145	224.8	5	1.5	5.85	16.57	10	NC	0	NC		(2)
32M-99-09X**	9.92	15.4	1.138	0.035	6.4	4.28	155.6	269	3.17	2.43	9.5	5.8	30	51	0	0		
32M-99-10X**	11.62	14.14	1.778	0.087	5.88	5.37	169.2	164.3	6.1	62	10.37	100.64	5	15	0	0		(1) and (2)
32M-99-11X**	10.29	11.42	1.372	0.12	5.72	6.02	190.9	198.1	4.5	168.3	10.23	7.69	10	15	0	0		(1)
SHL-15	8.17	12.63	0.158	0.344	5.61	6.73	91.7	-93.2	<1	19.1	0.6	0.69	25	45	1.6	3.2		
SHL-25	8.91	11.8	0.096	0.086	6.11	5.49	223.1	217	1.3	2.5	3.06	9.62	10	10	0	0		

Notes:
* Field Parameters were not collected in January 1999. April 1999 field parameters are recorded.
**Monitoring Well was not installed in January 1999. April 1999 field parameters are recorded.
(1) Monitoring well was pumped dry
(2) Dissolved oxygen and specific conductivity are erroneous. A problem was noted with the meter membrane and it was replaced at the end of the day.

TABLE 5-4
AOC 43A GROUNDWATER FIELD PARAMETERS

Monitoring Well	Temperature (C)		Specific Conductivity (ms/cm)		pH		ORP/Eh (mv)		Turbidity (NTV)		Dissolved Oxygen (mg/L)		CarbonDioxide (mg/L)		Ferrous Iron (mg/L)		Comments	
Date of Sample	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99
43MA-93-04X	7.63	13.01	0.17	0.53	6.15	3.78	192.3	272.3	4.66	1.00	3.29	12.07	15.0	90.0	0.0	0.0		
43MA-93-05X	7.59	12.01	0.11	3.56	5.33	4.61	249.9	106.1	3.58	4.70	5.21	79.05	NC	NC	NC	NC		(2)
43MA-93-06X	8.06	11.70	0.11	0.21	5.34	3.37	278.4	315.0	1.86	0.60	7.79	13.25	10.0	59.0	0.0	0.0		
43MA-93-07X	8.79	14.32	0.03	0.36	6.21	5.82	177.1	188.4	20.00	4.98	14.48	5.60	10.0	30.0	0.0	0.0		
43MA-93-08X*	12.43	12.63	0.14	0.14	5.50	7.88	178.5	195.0	<1	1.50	6.57	4.93	15.0	15.0	0.0	0.0		
43MA-93-10X	6.18	17.54	0.12	0.36	6.41	5.89	19.0	32.1	15.60	29.00	4.44	0.85	15.0	85.0	4.2	3.0		
43MA-99-11X**	14.97	13.07	27.81	0.29	5.35	7.91	236.1	266.5	5.00	0.62	8.54	1.20	20.0	116.0	0.0	0.0		
POL-1	6.69	11.10	0.12	0.10	6.24	7.02	217.2	108.0	4.66	7.40	4.74	1.80	5.0	5.0	0.0	0.0		
POL-2	13.60	NC	1.23	NC	5.93	NC	53.5	NC	1.25	NC	0.67	NC	50.0	20.0	3.6	0.8		(1)
POL-3	10.96	12.97	0.18	0.19	5.89	6.63	205.2	115.8	40.40	3.20	10.96	5.28	15.0	30.0	0.0	0.0		

Notes:

* Field Parameters were not collected in January 1999. April 1999 field parameters are recorded.

**Monitoring Well was not installed in January 1999. April 1999 field parameters are recorded.

(1) Monitoring well was pumped dry

(2) Dissolved oxygen and specific conductivity are erroneous. A problem was noted with the meter membrane and it was replaced at the end of the day.

TABLE 5-6
AOC 43A GROUNDWATER GEOTECHNICAL PARAMETERS

Monitoring Well	Nitrate (mg/l)		Nitrite (mg/l)		Sulfate (mg/l)		Sulfide (mg/l)		Methane (ug/l)		Total Organic Carbon (ug/l)		Chemical Oxygen Demand (ug/l)		Comments	
Date of Sample	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Apr-99	Jan-99	Oct-99	Jan-99	Oct-99	Jan-99	Oct-99
43MA-93-04X	1.40	0.89	<.050	<.050	20.00	73.00	<2	<4	5.2U	5.2U	1.0	1.1	<15	<15		
43MA-93-05X	3.30	2.60	<.050	<.050	46.00	40.00	<1.6	3.40	5.2U	5.2U	2.7	<1	<15	<15		
43MA-93-06X	0.74	1.30	<.050	<.050	20.00	16.00	<1	<2	5.2U	5.2U	1.4	<1	<15	<15		
43MA-93-07X	0.67	0.86	<.050	<.050	21.00	25.00	<1.6	<2	5.2U	5.2U	1.4	1.2	<15	<15		
43MA-93-08X	1.10	1.30	NC	NC	31.00	24.00	<1.6	<2	5.2U	5.2U	1.8	<1	<15	<15		
43MA-93-10X	<.050	0.06	<.050	<.050	19.00	27.00	<2.7	<4	5.2U	20.00	5.2	2.4	<15	<15		
43MA-99-11X**	1.20	0.06	<.050	<.050	38.00	14.00	<2	2.50	NC	5.2U	<1	1.7	<15	<15		
POL-1	0.35	0.72	<.050	<.050	9.60	8.20	<1.6	<2.0	5.2U	5.2U	1.3	<1	<15	<15		
POL-2*	0.07	0.07	<.050	<.050	18.00	20.00	<2	<2	NC	5.2U	2.7	2.9	<15	<15		(1)
POL-3	1.10	1.10	<.050	<.050	33.00	28.00	<2.7	<4	190.00	5.2U	1.4	<1	<15	<15		

Notes:
* Field Parameters were not collected in January 1999. April 1999 field parameters are recorded
**Monitoring Well was not installed in January 1999. April 1999 field parameters are recorded A10
(1) Monitoring well was pumped dry

RESPONSE TO COMMENTS
FROM THE USEPA/MADEP
Draft Demonstration of Remedial Actions
Operating Properly and Successfully
AOCs 32 and 43A, DRMO and POL,
Devens, Massachusetts, July 1999

Comments received from USEPA September 21, 1999:

General Comments

Comment 1. There is certainly strong evidence that some site contaminants (e.g., trichloroethene (TCE) at well 32M-92-06X; dichlorobenzene (DCB) at 32M-92-04X) were attenuated dramatically between 1992/1993 sampling and 1999 sampling. Also, certain site geochemical conditions (e.g., reducing conditions locally in areas of higher contaminant concentrations) seem to favor continued biodegradation. However, there remain a few exceedances of the cleanup goals, and a case has not been made that these exceedances will be reduced to remedial targets within the 30 year time frame stipulated in the Record of Decision (ROD). The two rounds of MNA-assessment data in hand at the time of preparation of the OPS document are simply inadequate to allow for a meaningful projection of the time frame for cleanup.

Response 1. The Final OPS Report includes four rounds of data from 1999 and data from the 1992/1993 sampling. Groundwater monitoring is scheduled to continue on a long-term basis with reviews conducted on a 5-year basis to evaluate the progress of MNA.

Comment 2. There are no clear indications that the remedy is *not* successful, certain "core criteria" [1, page 10] are not met at this time. One core criterion is stated in the guidance [1, page 10] as paraphrased in the following:

> [It] should be demonstrated ... that natural attenuation is working. [I]nformation required [includes] documentation that contaminant levels have been reduced as expected, [and] the estimated rate of contaminant loss has been established...

With regard to this criterion, the persistent DCB at 32M-92-06X is particularly troublesome, in that it has clearly not been demonstrated that natural attenuation is working to reduce this contaminant at this monitoring point. Furthermore, while the decline in DCB at another well (32M-92-04X) suggests that local site conditions *can* lead to attenuation, it appears that these conditions are not well understood at this time, and a credible prediction regarding the fate of DCB at the remaining hot spot (e.g., via modeling) is not possible at present.

Response 2. It is true that the DCB concentration at monitoring well 32M-92-06X has not been dramatically reduced at this time. However, this is the only exceedance of chlorinated organics at both AOC 32 and 43A. Long-term monitoring will continue at AOC 32 and 43A with reviews conducted at 5-year intervals. If, after further monitoring, it appears that the DCB at this monitoring well will not be below the cleanup goal in 30 years an alternative remedial approach will be investigated.

Comment 3. The OPS document includes no discussion of "protectiveness" to human health and the environment. Since it is difficult to demonstrate that the cleanup goals will indeed be met for every contaminant of concern throughout the sites, it may be useful to perform a careful analysis of the human-health and ecological risks associated with residual contamination under conservative assumptions.

Response 3. The following text shall be added following the last paragraph in Section 2.3; "The selected remedies for the three operable units will permanently reduce the risks to human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering and institutional controls. The principal soil threat at AOC 32 is exposure of site workers to contaminated soil. The contaminated soil was removed and disposed of off-site. The principal groundwater threat at AOC 32 and 43A is potential consumption of unfiltered groundwater. Due to the saturated thickness of the over burden aquifer under AOC 32, the use of groundwater is impractical. The reuse of these portions of Devens shall be controlled by zoning and deed restrictions, which would prevent the use of drinking unfiltered groundwater from the aquifer, resulting in reduced potential for exposure."

Comment 4. While the OPS concept was developed by EPA to facilitate property transfer at sites where remedial actions are under way, but cleanup goals have not yet been met, it must be emphasized that the Army remains responsible for completion of the remedy. This includes completion of the MNA assessment, design and implementation of a Long-Term Monitoring Plan (LTMP), and provision for additional active remedial actions should MNA fail to meet its objectives of reducing contaminants of concern to the established cleanup goals within 30 years. The EPA guidance states [1, page 5], "... federal agencies remain obligated to complete remedial actions pursuant to those performance requirements specified by a ROD... ."

Response 4. To following sentence shall be added to Section 6.1; " The Army shall continue to perform short- and long-term groundwater monitoring as described below."

Comment 5. The OPS report solely evaluates whether MNA is working and there is little discussion of institutional controls (ICs). The ROD specifically states that ICs will be established. Therefore, please include a section that discusses the ICs Memorandum of Agreement (MOA) between the Army, EPA, DCC/DEC, and MADEP.

Response 5. A new section (Section 6) will be added called Institutional Controls Implementation and Monitoring.

Comment 6. We believe the sites are candidates for Operating Properly and Successfully (OPS). However, several actions need to be completed before EPA can approve of the Army demonstration. First, the Army must provide and EPA must concur on the AOC 32 Removal Report. Second, the Army should include the third round of data in the OPS evaluation. Thirdly, the signature of the Institutional Controls, Memorandum of Agreement would qualify as the requirement of the ROD.

Response 6. The third and fourth round of data has been included in the OPS Report. In meetings with the Army and USEPA, subsequent to the issuance of the Draft OPS Report, it was agreed that the signature of the ICMOA would not be required. Rather, the deed restrictions and the implementation of the deed restrictions were to be outlined in the Final OPS.

Specific Comments

Comment 1. Page ES-1, paragraph 1: Please refer to the reference below for EPAs August 1996, OPS Determination Guidance.

Response 1. The following document shall be referenced on page ES-1, paragraph 1 and page 1-1 Section 1.1; "EPA Office of Solid Waste and Emergency Response, A Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3), August 1996."

Comment 2. Page ES-2, paragraph 1: Please include quantity removed.

Response 2. The quantity of materials removed shall be added to ES-2, paragraph 2.

Comment 3. Page ES-2, paragraph 2: Bracket MNA Assessment (MNAA) and remove the extra "A" from MNAA in the second sentence.

Response 3. In the first sentence of the third paragraph on page ES-2, MNA Assessment shall be bracketed (MNAA) and the extra A from MNAA in the second sentence shall be removed.

Comment 4. Page ES-2, bullet 1: The list states that three rounds of quarterly sampling have been done. While this may be so, it appears that the results of the third round were not yet available at the time of preparation of the OPS document, as evidenced in the tables (Appendix A). Also, this statement conflicts with that given in section 3.2, page 3-2, which notes that *two* rounds have been conducted. Please check for internal consistency. The third round of data needst be included with the revised OPS document.

Response 4. Four rounds of sampling will be included.

Comment 5. Page ES-3, paragraph 3: The text states, A The data show that concentrations of ... dichlorobenzene (DCB) ... have decreased over time." While DCB concentrations have clearly decreased in 32M-92-04X, one of the two wells in which DCB exceedances were detected in 1992, DCB has remained essentially unchanged in 32M-92-06X (Table 5-2). The statement that DCB has decreased over time is stronger than warranted, in that it is true for only one of two wells where DCB has been a concern. Please clarify.

Response 5. Please refer to General Response 2.

Comment 6. Page ES-4, paragraph 1: *typo:* Please change "... in the same general are where ..." to "... in the same general area where ..."

Response 6. Acknowledged. The text "... in the same general area where ..." shall replace A... in the same general are where ..." in the first paragraph on page ES-4.

Comment 7. Page ES-4, paragraph 1: *typo(?):* The text states that the data summarized indicate that "... *aerobic* biodegradation ... may be occurring." Was the intent to state that *anaerobic* degradation may be occurring? Aerobic microbial activity is clearly present in the system in order to deplete the oxygen and sustain the anaerobic conditions, but the indicators described seem to point toward anaerobic degradative processes.

Response 7. Acknowledged. "aerobic" shall be replaced with "anaerobic" in the first paragraph on page ES-4.

Comment 8. Page ES-4, paragraph 2: Please clarify the statement that lead will not impact natural attenuation occurring at the site.

Response 8. Except for the exceedence of 19.7 ug/L detected in monitoring well 32M-92-01X in October 1999, exceedances of lead only occurred at monitoring wells for which low flow sampling in accordance with the USEPA *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples From monitoring wells (1996),* could not be achieved. These wells were either pumped dry and then sampled or hand bailed due to falling water levels at the lowest sustainable pumping rate. As a result, these data are not indicative of inorganic loads at ambient flow conditions.

Comment 9. Page ES-4, paragraph 3: The text does not discuss that MNA assessment will continue. Please see general comment 4.

Response 9. To clarify the intent of paragraph 3 on page ES-4, the first sentence shall be revised as follows: "The criteria set forth in the ROD states that MNA assessment which includes long-term groundwater monitoring shall be performed on an annual basis; site reviews shall be conducted on 5-year intervals for 30 years or until contamination is reduced to acceptable concentrations; and annual data reports shall be provided to..."

Comment 10. Page 1-1, paragraph 2: Please see specific comment #1.

Response 10. Please refer to Response 1 associated with specific comment 1.

Comment 11. Page 1-1, paragraph 2: Please include a new section 2.0 Real Estate Issues. This section should contain information regarding to proposed property for transfer, deed restrictions/covenants, and adjacent properties that could affect the property.

Response 11. A new section titled Institutional Control Implementation and Monitoring will be added to the text.

Comment 12. Page 2-2, paragraph 2: The figures for AOC 32 and 43A are 2-1 and 2-2, respectively, please correct text.

Response 12. The figure numbers shall be corrected on page 2-2.

Comment 13. Page 2-2, section 2.1.2, paragraph 3: The text states that "... the *new* USTs are located on the eastern side." The description of the site given up to this point in the document does not discuss the relative age of any of the USTs. Perhaps this reference to the "new" USTs could be clarified with reference to the sizes listed in the previous paragraph, and with a statement that these tanks remain in place (if that is indeed the case).

Response 13. These USTs were removed on October 17, 1998.

Comment 14. Page 2-2, section 2.2.1, paragraph 1: All removal actions done at each site should be presented (highlighted) in the figures. Also, locate the drain field on figures.

Response 14. This information was taken from the Remedial Investigation Report prepared by ecology and environment, inc., 1994. These locations were not shown on figures but described in the text.

Comment 15. Page 2-4, paragraph 1: Please see general comment #6.

Response 15. Acknowledged. Please refer to Responses 1 and 5.

Comment 16. Page 2-4, section 2.3, Remedial Action: The text states, "The MNAA has met Component Nos. 2, 3, and 4." It might be more precise to state that Component No. 4 is currently in progress, as the monitoring and assessment are ongoing activities.

Response 16. Acknowledged. The sentence shall be revised as follows: "The MNAA has met Component Nos. 2 and 3. Component No. 4 is currently in progress, as the monitoring and assessment are ongoing activities."

Comment 17. Page 2-4, section 2.4.1: typo: Please change "... (AOC 32/43A) groundwater cleanup ..." to "... (AOC 32/43A). Groundwater cleanup ..."

Response 17. On page 2-4 in section 2.4.1, "... (AOC 32/43A) groundwater cleanup ..." shall be revised as follows; "... (AOC 32/43A). Groundwater cleanup ..."

Comment 18. Page 3-1, section 3.1, paragraph 2: Please include a figure to illustrate the removal.

Response 18. A figure has been included which shows the removal locations and sample grid.

Comment 19. Page 3-1 (bottom), section 3.1: Please check text editing for the last two paragraphs, which are somewhat redundant.

Response 19. Acknowledged. The last paragraph on page 3-1 shall be revised as follows; "...Splits from these confirmatory soil samples were also sent to AMRO Environmental Laboratories in Merrimack, New Hampshire for analyses by the MADEP Method for EPH/VPH. Analytical results were to be compared to the cleanup goals provided in Table 2-2. All contaminated soils and debris was disposed of at an approved permitted disposal facility."

Comment 20. Page 3-2, section 3.2, paragraph 2: *omitted word?* "... activities performed at AOC 32 and AOC 43A to *date* have included:"?

Comment 31. Page 5-2, section 5.2.1: On Figure 5-3 (and succeeding figures), well 43MA-99-11X is shown as a permanent monitoring well, while on Figure 4-2, this well is shown as a microwell. Please check for internal consistency.

Response 31. Acknowledged. All figures shall be reviewed and the designation for 43MA-99-11X shall be revised to indicate a monitoring well.

Comment 32. Page 5-3, section 5.2.3, paragraph 3: It is agreed that the reducing conditions observed at SHL-15 are probably unrelated to the organic contaminants known to be present to the south and southeast in AOCs 32 and 43A. The proximity of this well to Shepley's Hill Landfill is mentioned. However, it is noted that the effort to rationalize observations at SHL-15 highlights the problems with the groundwater flow field shown in Figure 3-1 (see previous comment). As shown on Figure 3-1, SHL-15 appears to be directly downgradient of the former UST just northeast of the DRMO office, which appears to weaken the argument that SHL-15 is not influenced by contamination from AOCs 32 and 43A, and the suggestion that it may be influenced by the landfill. It seems likely that the groundwater contours in Figure 3-1 are simply incorrect, and that the flow field in the northern portion of the map may be quite different than that indicated by the potential as drawn.

Response 32. Please refer to Response 21. The groundwater flow direction at AOCs 32 and 43A generally mimics both surfical topography and bedrock gradients. A new figure (3-1b) shall be added which illustrates the top of the unweathered bedrock. From both figures 3-1 and 3-1b, a clear groundwater divide exists just north of the former UST in AOC 32. This divide prevents the migration of contaminants from the source area in AOC 32 to the north.

Comment 33. Page 6-2, second paragraph: The text discusses deed restrictions, please see general comment 5.

Response 33. Please refer to General Response 5.

Comments received from MADEP August 30, 1999:

Comment 1 Section 2.3 Record of Decision – The purpose of the OPS report is to demonstrate that the selected remedies are operating as designed. One of the major components of the selected remedy for Groundwater Operable Unit for AOC 32.43A is the establishment of institutional controls. The proposed method is imposing a deed restriction on the properties before they are transferred. The restrictions will be implemented to restrict the exposure pathways for contaminants of concern. At this time, no deed restriction exists on the parcel to be transferred. As a major component of the remedy, the institutional controls must be in place for the remedial action to be operating properly and successfully and thus protective of human health and the environment. Upon implementation of the institutional controls, Component 1, which is an integral part of the selected remedy, will be met.

Response 1. A new section will be added titled "Institutional Controls Implementation and Monitoring.

Comment 2 Section 2.2.1 AOC 32 – Second paragraph – Please elaborate on whether the "drainfield", the two cubic yards of petroleum-contaminated soil, and the waste debris with oil filters were removed and disposed of. In addition, the exact locations of these test pits and the "drainfield" are unclear.

Response 2. This information was taken from the Remedial Investigation Report prepared by ecology and environment, inc., 1994. These locations were not shown on figures but described in the text.

Comment 3. Section 3.3 Groundwater Sampling Program – The text specifies that during the second sampling round wells were sampling in accordance with specified guidelines, however, no methodology is specified for the first round. This implies that a different methodology was used for the first round and is misinterpreted by the reader. Please modify the sentence to indicate that both or all sampling rounds performed as part of the MNAA are conducted in accordance with the specified methodologies and guidelines.

Response 3. The first paragraph in Section 3.3 shall be revised as follows; "Groundwater sampling activities were conducted at AOCs 32 and 43A in January 1999, April 1999, July 1999, and October 1999, in accordance with United States Environmental Protection Agency (USEPA) Region I Low Stress (low flow) Purging and Sampling Guidelines (USEPA, 1996) and the guidelines presented in Subsection 4.6 of the Fort Devens Project Operations Plan (POP) (Stone & Webster, 1995)."

Comment 4 Section 4.1 Analytical Results: The text indicates that groundwater samples were analyzed for a number of parameters including harness and explosives and refers to the sample results in Appendix A. No results for these two parameters were found in Appendix A. Is Appendix A supposed to be a "hits only" presentation of data? If so, please indicate it in the text.

Response 4. Note number 11 listed on the Notes page of Appendix A identifies that the data presented from 1992 and 1993 includes select data from relevant parameters. The analysis performed in 1992/1993 were much more broad in scope than the analysis performed in 1999.

Comment 5. Section 5.2 Supporting Evidence For Proper and Successful Operation of MNA – The text discusses that after DO is consumed, anaerobic microorganisms begin using electron acceptors in the following order of preference: nitrate, ferric iron, sulfate, and finally carbon dioxide. The subsequent subsections further discuss these electron acceptors and associated analytical data results collected during groundwater monitoring with the exception of nitrate depletion even though this data was collected. Our review of the nitrate data indicates this data may support conclusions that denitrification in groundwater, indicative of anaerobic biodegradation, is occurring at these sites. A review of the DO and sulfate data clearly indicates that aerobic respiration is occurring, as well as sulfate reduction through anaerobic biodegradation.

Response 5. Nitrate depletion does appear to be occurring in the area where elevated levels of organic compounds are present in groundwater. A discussion of the nitrate depletion will be added.

Comment 6 Figure 3-1 Groundwater Contour Map – MADEP reiterates our previous comments relative to this figure as shown in the Groundwater Sampling Data Report Round 2 – April 1999 (Stone & Webster, June 1999). The groundwater elevations at SHL-15 and 32M-92-01X are 243.2 and 244.0, respectively which implies there is a vector flow northerly or easterly toward Shepley's Hill Landfill. However, the contours shown on the figure show groundwater flowing northwesterly toward Shepley's Hill while the groundwater flow direction arrows drawn on the figure indicate groundwater flows southwesterly in the vicinity of these wells.

In addition, groundwater contours were drawn south of 32M-92-07X and east of 43MA93-04X which indicate a southerly flow toward what is known to be a topographic high with exposed bedrock. Contours in this area should be omitted from the figure since there is currently a lack of hydrologic control southeast of these wells and there has been a hydrogeologic divide historically interpreted in this area.

This figure should also show the newly installed piezometers and monitoring wells including their recent groundwater elevations and contours shown as appropriate. The Executive Summary (Page ES-2) emphasizes that the piezometers and wells were installed to provide additional water table elevation and direction of groundwater flow.

Response 6. Acknowledged. Directional arrows indicating inferred groundwater flow were incorrectly placed on this figure. These arrows were a carry over from a previous drawing and should have been omitted. Figure 3-1 shall be revised to reflect recent (Round 3) groundwater elevations and an appropriate flow direction shall be inferred.

Comment 7 Table 2-2 - Typo, abbreviation for Volatile Petroleum Hydrocarbons is VPH.

Response 7. Acknowledged. In Table 2-2, the abbreviation for Volatile Petroleum Hydrocarbons shall be revised to VPH.

Comment 8. Table 3-1 - Two round of water table are shown for Apr-99. Is this a typo or should the second round be for Jul-99? Please be consistent with the font size of the data. Please explain why the symbol "---" is used to indicate that reference data was unavailable, yet groundwater elevations are included for wells SHL-15 and SHL-25

Response 8. Table 3-1 shall be revised. The second "Apr-99" shall be replaced with "Jul-99". Font size will be consistent throughout the table. Three reference points are determined when each well is surveyed (top of casing, top of PVC, and ground surface). In some cases the top of casing reference point was not available. When this occurred, the ground surface elevation was used to determine the current groundwater elevation.

Comment 9 Table 3-2 - Please explain why the symbol "---" is used to indicate that reference data was unavailable, yet groundwater elevations are included for wells POL-1 through –3. The column heading "GROUNDWATER ELEVATION" is abruptly truncated.

Response 9. Please refer to Response 8. The tables shall be reformatted for the final report.

Comment 10. Table 5-3 – Methane is misspelled in the legend. It appears as thought the "Bold" data also reflects numbers "higher" for Fe^{2+} in addition to the methane.

Response 10. Acknowledged. The footnote in bold shall be revised as follows; "Bold reflects numbers lower than background (or higher for Methane and Iron) which indicate areas where biodegradation is possibly occurring."