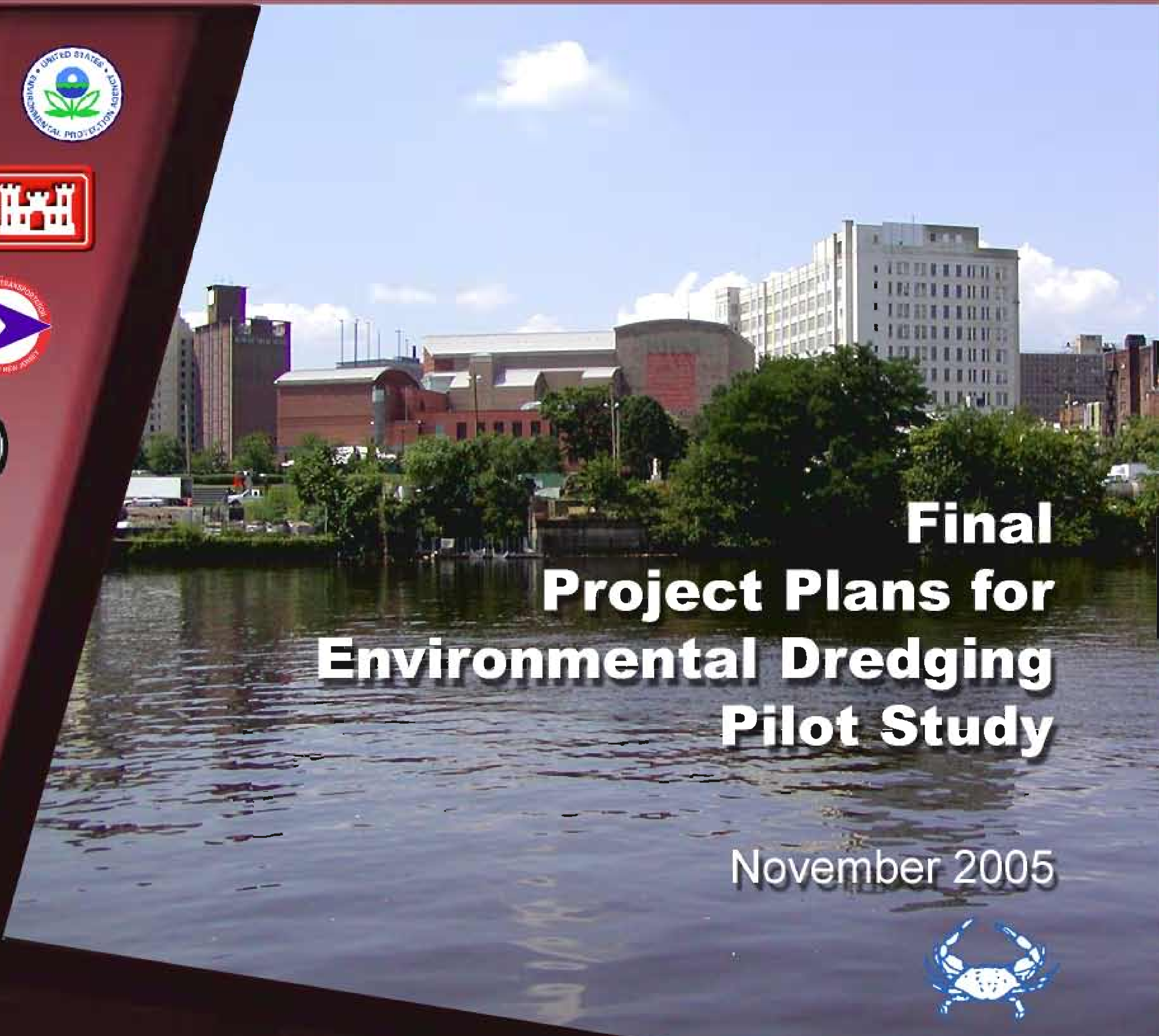
Lower Passaic River Restoration Project



Final Project Plans for Environmental Dredging Pilot Study

November 2005

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ENVIRONMENTAL DREDGING PILOT STUDY WORK PLAN

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1.0 INTRODUCTION

1.1 AUTHORIZATION

These Project Plans for the Environmental Dredging Pilot Study for the Lower Passaic River Restoration Project have been prepared by TAMS Consultants, Inc., *an Earth Tech Company* (TAMS/ET) and their subconsultant Malcolm Pirnie, Inc. (MPI) for the New Jersey Department of Transportation – Office of Maritime Resources (NJDOT-OMR) as authorized under NJDOT Agreement No. 2001-NJMR02 Task Order #OMR-03-3.

1.2 PURPOSE OF PILOT STUDY

The purpose of this task, which is described in this Work Plan, is to conduct an Environmental Dredging Demonstration and Sediment Decontamination Technology Demonstration. This work is part of the Lower Passaic River Restoration Feasibility Study, a joint effort of Federal and State Agencies to remediate and restore the Lower Passaic River Basin. The purpose of the overall Feasibility Study is to develop a comprehensive watershed-based plan for the remediation and restoration of the Lower Passaic River. During this pilot-scale demonstration project, approximately 5,000 cubic yards of contaminated sediment will be dredged from the Harrison Reach of the Passaic River (see Figure 1-1). This dredging was scheduled for the last week in October 2005, but has been postponed due to construction delays at the sediment unloading facility and very heavy rainfall in the Hackensack-Passaic watershed resulting in flood conditions in the river. It is now anticipated that this dredging will be performed in early December 2005.

The objective of the dredging demonstration project is to study dredging productivity and sediment resuspension for the Lower Passaic River. Evaluating the feasibility of dredging requires the collection of data to determine the resuspension production rate, the resuspension release rate, and the resuspension export rate and to perform a mass balance. In addition, equipment performance, dredging production rates, and turbidity levels will be evaluated. Dredging residuals will not be quantitatively monitored as part of this pilot study. However, Sediment Profile Imagery (SPI) technology will be utilized to qualitatively evaluate the residual layer following dredging.

The Institute of Marine and Coastal Sciences at Rutgers University, the Water Resources Division of the United States Geological Survey, United States Environmental Protection Agency (USEPA), United States Army Corps of Engineers (USACE), and United States Fish and Wildlife Service (USFWS) will assist NJDOT-OMR in the sampling, monitoring, and other activities to be conducted during the Environmental Dredging Pilot Study.

The objective of the sediment decontamination technology demonstration project is to show that Passaic River sediments, contaminated with dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, pesticides, herbicides, and other contaminants can be treated to meet applicable criteria for the appropriate beneficial use end product (e.g., cement, light weight aggregate, manufactured soil, glass, etc.). The decontamination project will collect data to perform a contaminant mass balance and determine the economic viability of the treatment process for commercial scale applications.

1.3 DESCRIPTION OF PILOT STUDY SURVEY AREA

The Passaic River is the principal river in the Hackensack-Passaic Watershed a 935 square mile watershed located in northern New Jersey and southern New York states (see Figure 1-2). The Lower Passaic River is considered to be the 17-mile tidally influenced portion of the river from the mouth of the confluence at Newark Bay up to the Dundee Dam. All or portions of 117 municipalities in eight New Jersey counties, and 15 municipalities in two New York counties are located within the Passaic watershed. Due to historical contaminant releases, the Lower Passaic River sediments are contaminated with dioxins, PCBs, PAHs, metals, pesticides and other contaminants. As a result of bioaccumulation of PCBs, dioxins, and mercury in edible species, the New Jersey Department of Environmental Protection (NJDEP) has instituted a 'do not eat' advisory/prohibition for both fish and shellfish that inhabit the Passaic River (NJDEP and NJDHSS, 2004).

The Harrison Reach of the river was selected as the location for the Environmental Dredging Pilot Study (see Figure 1-3). The Harrison Reach extends approximately two miles from the NJ Turnpike Bridge to the Jackson Street Bridge that connects Harrison with Newark. The Pilot Study Survey Area, an approximately 1000-ft long stretch within the Harrison Reach, is bordered to the north by the City of Kearny in Hudson County and to the south by the City of Newark in Essex County (Figure 1-3).

The selection of this location was based on consideration of the following factors:

- In-river location: The preferred river configuration for the dredging demonstration is a reach without bends. The Passaic River is aligned in a nearly true east-west direction in the central portion of the Harrison Reach. Upstream and downstream of this central area, the River exhibits a series of bends. Dredging operations will be conducted in a relatively straight portion of the Harrison Reach that is more typical of the Lower Passaic River in general. Conducting the dredging in a relatively straight section (without significant bends) has the additional advantage of reducing the complexity of estimating and evaluating water quality impacts because of reduced lateral mixing.

- Contaminated sediment: The target dredging area must provide sufficient material to allow a reasonable assessment of both the selected dredging technology and the available sediment decontamination systems. Targeted sediments should have moderately elevated contamination levels in comparison to other sediments within the Harrison Reach which are highly contaminated to evaluate decontamination technologies, though not levels that would create major handling problems or unnecessarily increase risk from sediment releases. Also, the targeted sediments should have geotechnical properties typical of those throughout the river. Sediments within the Harrison Reach and surrounding reaches are among the most severely contaminated in comparison to other sections of the river. In addition, several of the principal sources of contaminants to the river also are/were situated here. This reach provides an opportunity to handle and process the widest range of contaminated sediments and, therefore, the results obtained from the pilot program can be expected to have the broadest applicability to ultimate remediation of the river system.

- Access: Sufficient air and water draft must be available to enable access to the work area by the selected dredging equipment and the associated tugboats and barges/scows. In particular, it is expected that ten feet of water under low water conditions will be required for scows and towboats to gain access to the work area.
- River currents: High river velocities can impact dredging operations by making equipment anchoring and maneuvering difficult. Average velocities in the Study Area do not appear to pose a major problem for the pilot program.

In addition to generally conforming to the above requirements, the Harrison Reach has relatively light river traffic, thereby enabling any dredging work to proceed largely unimpeded. It is anticipated that the pilot scale dredging and decontamination program would result in removal and treatment of approximately 5,000 cubic yards of contaminated river sediments from the Harrison Reach. In a separate evaluation, mechanical dredging was selected as the most suitable technology for the pilot program (TAMS/ET and MPI, June 2004b).

1.4 PILOT STUDY COMPONENTS

The Pilot Study consists of the following components:

1. Data Collection and Background – In order to establish baseline conditions and evaluate applicable technologies, several data collection and background activities have been completed. These activities include both general and site specific studies. Project Plans for Geophysical Surveys and Sediment Coring as well as a Dredging Technology Review Report have been prepared by TAMS/ET and MPI (TAMS/ET and MPI, 2004a and 2004b). A detailed characterization of the Pilot Study Survey Area has been presented in the Final Data Summary and Evaluation Report (DSER) (TAMS/ET and MPI, 2005).
2. Hydrodynamic Modeling – A hydrodynamic model (in support of the dredging pilot study) has been developed to provide an estimate of the amount of sediment leaving the study area and to aid in determining the placement of monitoring equipment. Modeling results are presented in the Environmental Dredging Pilot Study Hydrodynamic Modeling Report (ET, 2005).
3. Dredging Design – A design, including plans, specifications, and the NJDOT bid package (NJDOT-OMR, TAMS/ET and MPI; 2005), has been developed for the removal of approximately 5,000 cubic yards of contaminated river sediment from the Harrison Reach. NJDOT-OMR has used this design to procure the dredging contractor (Jay Cashman, Inc).

4. Monitoring Plan – A monitoring plan has been prepared to outline procedures for the collection of data related to resuspension. The details of the monitoring plan are documented herein.
5. Decontamination – Two separate technologies, sediment washing and thermal treatment, will be employed to gather data regarding the effectiveness of decontamination. The decontamination technology vendors have prepared separate work plans that describe these efforts (BioGenesis, 2005).

1.5 PROJECT TEAM

Figure 1-4 displays the organizational chart for the project.

1.6 WORK PLAN ORGANIZATION

This Work Plan is organized as follows:

- Section 1 presents an Introduction;
- Section 2 presents the Site Conditions including a site history, site description and physical characteristics;
- Section 3 contains the Work Plan Rationale including the overall project objectives, and the general approach to the Work Plan;
- Section 4 contains the proposed Detailed Description of Work;
- Section 5 gives an overview of the Report that will be prepared at the completion of the pilot study; and
- Section 6 presents the Project Schedule.
- Section 7 provides the References used in development of the Work Plan.

The following documents are attached to this Work Plan: a Quality Assurance Project Plan (QAPP); and Site-Specific Safety and Health Plans (SSHPs) to be used by TAMS/ET and MPI.

2.0 SITE CONDITIONS

2.1 BACKGROUND

The USEPA, USACE, NJDOT-OMR, and the Trustees for Natural Resources [NJDEP, USFWS, and National Oceanic and Atmospheric Administration (NOAA)] have partnered to conduct a comprehensive study of the Lower Passaic River. The Lower Passaic River is the 17-mile tidally influenced stretch of the river from the Dundee Dam south to Newark Bay. The Lower Passaic River Restoration Project is an integrated, joint effort among state and federal agencies that will take a comprehensive look at the problems within the Lower Passaic River Basin and identify remediation and restoration options to address those problems. This multi-year study will provide opportunities for input from the public at all phases of development.

In 1994, Occidental Chemical Company (OCC) entered into an Administrative Order on Consent with USEPA. Chemical Land Holdings (CLH), on behalf of OCC, designed and executed a RI/FS work plan, which addressed the contaminated sediments of the Lower Passaic River in the vicinity of the former OCC facility in Newark, New Jersey. The RI/FS primarily focused on the six mile reach of river extending upstream from the abandoned Conrail Railroad Bridge; that area has been designated the Passaic River Study Area (PRSA).

The contaminated sediments underlying the Lower Passaic River are of concern to various federal and state regulatory agencies because they can induce a number of negative consequences in the following areas:

- ecological health effects;
- human health effects; and
- economic impacts on navigational dredging and disposal costs in the NY/NJ Harbor.

As water quality, sediment quality and biological data from the RI/FS have become available, the scientific understanding of the Passaic River system has evolved and the potential importance of the inter-relationship of the 11 miles of the Lower Passaic River upstream of the PRSA and Hackensack River-Newark Bay system has become apparent. During the summer of 2001, USACE NY District completed a reconnaissance survey of the Lower Passaic River as part of their Hudson-Raritan Estuary Restoration Initiative. The USACE, USEPA Region 2 and NJDOT-OMR completed a Lower Passaic River Remediation and Ecosystem Restoration Project Management Plan (PMP) in April 2003. A National Memorandum of Understanding (MOU) was signed in July 2002 between USEPA and USACE. A Memorandum of Agreement among all of the agencies is pending.

NJDOT-OMR, USEPA, USACE, and the Trustees for Natural Resources, recognizing the importance of the Lower Passaic River as an integral component of the Passaic - Hackensack - Newark Bay complex, have committed to better understand this system. The most significant potential benefit of addressing the environmental concerns facing the Lower Passaic River via a unified watershed approach is that the primary contaminants of concern can be addressed more effectively.

2.2 PILOT STUDY SURVEY AREA CHARACTERISTICS

The USACE had historically designated a 300-foot wide navigation channel within the Harrison Reach with a project depth of 20 ft (MLW). Based on a hydrographic survey conducted by USACE in 1989, water depths in the Reach ranged from 21.1 ft (MLW) at the downstream end of the Reach to approximately 19.2 feet (MLW) at the upstream end. However, a more recent USACE channel condition report (USACE, 2005) noted significant shoaling. According to Ianuzzi et al. (2002), the most recent dredging event in the Harrison Reach between the Point-No-Point Conrail Bridge and the Jackson Street Bridge was performed in 1937 to the project depth of 20 ft. The results of the most recent hydrographic surveying can be found in the Final Data Summary and Evaluation Report (DSER; TAMS/ET and MPI, May 2005). Water depths in the Pilot Study Survey Area ranged from 12.8 ft (MLW) at the downstream end to 11.8 ft (MLW) at the upstream end.

2.2.1 Downstream Accessibility

In order to access the Harrison Reach from the Newark Bay, there are a series of low and high bridges beneath which demonstration project equipment must navigate. Table 2-1 lists the possible bridges starting from the Garden State Parkway Bridge, across the Raritan River (near a potential decontamination demonstration site), to the New Jersey Turnpike (NJTP) Bridge within the Harrison reach. Photographs of the Jackson Street Bridge, NJTP Bridge and the Point-No-Point Conrail Bridge are presented in Figure 2-1. Given that tugboats hauling barges laden with project sediments will generally require 25 feet of air draft, a number of the low bridges will be required to open to enable project equipment to pass. The bridge opening notification periods required by 33CFR Part 117 are also presented in Table 2-1.

2.2.2 Geologic Setting

The Lower Passaic River is situated within the Newark Basin portion of the Piedmont physiographic province. The province is located between the Atlantic Coastal Province and the Appalachian Province. The Newark Basin is underlain by sedimentary rocks (sandstones, shales, limy shales, and conglomerates), igneous rocks (basalt and diabase) and metamorphic rocks (schists and gneiss). These rocks are from the mid-Triassic to early Jurassic periods. Bedrock underlying the area is the Passaic Formation (Olsen et al. 1984; Nichols 1968), which consists of interbedded redbrown sandstones and shales. Almost the entire Passaic River Basin, including the area, was subjected to glacial erosion and deposition as a result of the last stage of the Wisconsin glaciation. Considerable quantities of stratified sand, silt, gravel and clay were deposited in a glacial lake covering the area. These glaciofluvial deposits overlie bedrock and underlie the meadowlands section of the Newark Basin.

2.2.3 Hydrology

The Lower Passaic River is influenced by tidal flows for approximately 17 miles, extending from Dundee Dam downstream to the confluence with Newark Bay. The mean tidal range (difference in height between mean high water and mean low water) at the New Jersey Turnpike Bridge (approximately 1.5 miles upstream from Newark Bay) is 5.1 ft (NOAA 1972) with a mean tide level (midway between mean low water and mean high water) at elevation 2.5 feet (NOAA 1972). The mean spring tide range (average semi-diurnal range occurring during the full and new moon periods) is 6.1 feet. Both saline and freshwater conditions may exist within the Harrison Reach. The cross-sectional average river velocity due to freshwater flow in the Site is approximately 1 ft per second (fps) and the typical maximum tidal velocity is approximately 3 fps.

Coastal storms are the dominant source of floods within the lower Passaic. The Flood Insurance Study for the Town of Harrison indicates an annual tide elevation of 5.7 ft National Geodetic Vertical Datum (NGVD 29). For a two-year recurrence interval, the predicted tide is 6.2 ft NGVD. Additional predicted tide elevations are 6.9 ft for a 5-year recurrence, 7.5 ft for a 10-year recurrence, 8.2 ft for a 20-year recurrence, 9.3 ft for a 50-year recurrence and 10.2 ft for a 100-year recurrence interval (tide elevations are referenced to NGVD). The maximum recorded tide level on the Passaic River is 8.33 ft, measured at East Newark on September 12, 1960, and is equivalent to a flood with a 20-year recurrence interval. During the record flood of October 1903, the Passaic River crested between 9 and 10 ft in the vicinity of Harrison.

2.2.4 Shoreline Features

Both shorelines of the Pilot Study Survey Area are almost completely developed, consisting of commercial and industrial properties. Figure 2-2 shows the northern shoreline just west of the NJTP Bridge. On the northern shoreline is gravel riprap and wooden or stone bulkheads bordering the train yard to the north of the Site. The southern shoreline also contains wooden bulkheads, bordering several chemical facilities (both active and inactive) to the south of the Pilot Study Survey Area. The southern shore also contains an abandoned marina at Blanchard Street between the abandoned Commercial Solvents site and the Benjamin Moore facility. Photographs of the southern shoreline features from the NJTP Bridge to the Diamond Alkali Superfund site are presented in Figure 2-3.

2.2.5 Ecological Resources

The expansion of industry and population in the Newark area has resulted in a severe reduction in the availability of natural habitats for indigenous and migratory biota (Squires and Barclay 1990). Much of the city of Newark occupies land once dominated by salt marsh, which was filled with more than 21 million tons of material, including industrial and municipal wastes, dredged material, and railroad cinders (Zdepski 1992). The shoreline just upstream of the NJTP Bridge was once primarily marshlands (ERM 1992). Between 1873 and 1890, this area was extensively filled with 8 to 12 feet of mixed fill material from coal gasification facilities, eliminating the marsh habitat and introducing a wide variety of chemicals to the environment (ERM 1992). By the early

1900s, the majority of salt marshes were filled with solid waste, and pesticide application was routine in an effort to eliminate mosquito breeding areas (Zdepski 1992; Rod et al. 1989). A decline in bird diversity in the area is attributed to the destruction of marshlands and other natural habitats as a result of encroachment of human development and industrial activities on nesting and breeding grounds (Burger et al. 1993).

Populations of fish and shellfish in the Site and surrounding area have been substantially reduced by over-harvesting, loss of habitat, and pollution (Mytelka et al. 1981; Esser 1982; Franz 1982). A significant commercial fishery has not operated in Newark Bay or the Passaic River, including the Study Area, since the early 1900s (McCormick and Quinn 1975). As early as the Civil War, sales of oysters and shad were affected by reports that the organisms were tainted with coal oil and "off flavors" (Earll 1887; Squires 1981). The Commission of Fisheries of New Jersey reported in 1885 that waterborne pollution was resulting in declining fish populations in the Passaic River (Esser 1982). After the turn of the century, conditions apparently deteriorated rapidly until 1926, when a survey conducted in the area by the US War Department found “fish life destroyed” (Hurley 1992).

Based on the results of monitoring and research undertaken since the mid-1970s, the State of New Jersey has taken a number of steps, in the form of consumption advisories, closures, and sales bans, to limit the exposure of the fish-eating public to toxic contaminants in the Lower Passaic River. The initial measures prohibited the sale, and advised against the consumption, of several species of fish and eel based on the presence of PCB contamination in the seafood. The discovery of widespread dioxin contamination in the Newark Bay Complex led the State of New Jersey to issue a number of Administrative Orders in 1983 and 1984 that prohibited the sale or consumption of all fish, shellfish, and crustaceans from portions of the Passaic River, including the Lower Passaic River. These fish advisories and prohibitions are still in effect (NJDEP and NJDHHS, 2004). Recent studies of the Lower Passaic River report the presence of some fish and benthos known to be highly tolerant of reduced dissolved oxygen conditions, implying the presence of a stressed aquatic system (Festa and Toth 1976; Santoro et al. 1980; Princeton Aqua Science 1982). Depressed levels of dissolved oxygen have been known to be a chronic problem in Newark Bay and its tributaries since the early 1900s (McCormick et al. 1983). Investigations conducted prior to 1940 by the Interstate Sanitation Commission (ISC) indicated substantially decreased levels of dissolved oxygen (DO) throughout the region during the early part of the century (ISC 1939). A survey of benthic organisms conducted in the Site in 1981 indicated that the benthic macroinvertebrate community was limited to those species capable of surviving extremely poor water quality conditions (Princeton Aqua Science 1982).

Available studies of sediment and water quality indicate that pollution control measures and the reduction or control of other environmental stressors have produced a gradual improvement in the ecosystem over the past two decades. Description of the ecological resources in Passaic River by NOAA (Zich 1978, USFWS 1980, Papson et al. 1981, RPI 1985) indicates that species such as blueback herring, alewives, American shad, striped bass, bay anchovy, mummichog, striped killifish, and white perch spawn within the Passaic River. Alewife, shad and herring typically migrate upriver in the spring to spawn in less saline waters. Spawning in the Passaic occurs above the mouth of the Second

River as well as in the Third and Saddle Rivers but not in the Second River. Migratory fish spawning habitat on the Passaic River is limited to below Dundee Dam because of the absence of fish passage facilities. Brackish water and marine species use the lower saline portions of the Passaic for adult and nursery habitat. Their distribution depends on the salt wedge. Resident euryhaline species include white perch, mummichog, and striped killifish, which spawn and develop within the estuary and are distributed throughout the system. Blue crabs use the lower brackish portion of the estuary as a nursery and adult habitat. The American eel uses the Passaic River and its tributaries for adult habitat. Recent surveys by TSI in 1999 through 2001 (TSI 2002, Passaic River and Newark Bay Estuary Data Presentation, May 29, 2002; PRSA Data Presentations Sept 26, 2002 CD) during the Ecological Sampling Plan two seasons field effort recorded the collection of twenty-four species of fish and crabs from the PRSA. These included estuarine, freshwater and marine species. Seven taxa of benthic invertebrates were also identified from the same stations. Approximately 30 bird species were also reported during the survey.

2.2.6 Wetlands and Floodplains

Almost all of the wetlands in the Lower Passaic River have been eliminated, with more than 7,500 acres developed since 1940 (USACE 1987).

2.2.7 Archaeological, Historic, and Cultural Resources

Within the Site, there are no known archaeological or historical resources that would impede the dredging pilot program.

2.2.8 Demographics and Land Use

The Lower Passaic has a long history of industrial activity. By the turn of the 20th century, Newark was the largest industrial-based city in the United States, with well-established industries such as petroleum refining, shipping, tanneries, creosote wood preservers, metal recyclers, and manufacturing of materials such as rubber, rope, textiles, paints and dyes, pharmaceutical, raw chemicals, leather, and paper products (Meyers 1945; Cunningham 1954; Cunningham 1966a; Brydon 1974; Halle 1984; MacRae's 1986; Galishoff 1988). Land use along the lower Passaic River, extending south of the Dundee Dam and including the Pilot Study Survey Area, is dominated by high-density commercial and industrial/commercial development.

2.2.9 Current Commercial Use

In 1998, the State petitioned the Coast Guard to allow for longer notice times to open five drawbridges upstream of the Study Area since there had been few requests to open them in previous years. After a comment period, the Coast Guard agreed to the petitions. The USACE waterborne commerce survey of 2001 shows 2.2 million short tons moving along the river's lower reach, down from over 5 million tons in 1991. It is likely that most of this activity is below the NJTP Bridge.

2.3 SITE HISTORY

During the past two centuries, the Site has been subject to multiple influences and changes due to natural hydrological, topographical, climatological and ecological conditions. However, of greater significance were changes due to rapidly expanding urban and industrial development in the region. Available information indicates that historical pollutant loadings throughout the 1900s have had a substantial impact on the ecological conditions of the Site, as well as the Newark Bay estuary (McCormick and Quinn 1975; Earll 1887; Mytelka et al. 1981; Esser 1982; Squires 1981; and Hurley 1992). Degradation of water quality in the lower Passaic River, including the Site, first became apparent during the Civil War (Brydon 1974; Cunningham 1966b). In 1873, coal tar residues suspended in the river water were noted (Brydon 1974). The deteriorating water quality of the lower Passaic River during this period forced many residents to dig their own wells; by 1885 however, a survey showed that seventy-five percent of groundwater wells also were polluted (Cunningham 1966b). Between 1884 and 1890, over 1,000 of Newark's more than 1,500 wells had been closed due to contamination (Galishoff 1988). In 1887, an inspector for the Passaic River declared that legal action would be required to mitigate pollution of the river from industrial waste practices (Brydon 1974).

The growing population of Newark during the first half of the twentieth century resulted in the generation of increasing volumes of human wastes, resulting in a characterization of the lower Passaic River as an open sewer (Suszkowski et al. 1990). Efforts to improve water quality and to reduce the spread of disease in the Passaic River led to the construction of a trunk sewer line system in 1924 (Brydon 1974). However, despite the development of sewage treatment plants, many industrial facilities located along the Passaic River were not connected to the Passaic Valley Sewerage Commission trunk line until the late 1950s (Brydon 1974).

During the 1980s and early 1990s, several investigations were conducted to evaluate the concentrations of various potential contaminants in sediments within the Site boundaries. These studies include investigations conducted as part of the remedial investigation work at the Diamond Alkali Superfund Site, investigations conducted on behalf of OCC in the early 1990s, and investigations conducted by various governmental agencies, including NOAA, USFWS, and USEPA. These investigations indicated that sediments of the Passaic River Study Area contain elevated concentrations of numerous hazardous substances including, but not limited to, cadmium, copper, lead, mercury, nickel, zinc, bis (2-ethylhexyl) phthalate, polynuclear aromatic hydrocarbons, polychlorinated biphenyls (PCBs), 4,4'-dichlorodiphenyltrichloroethane (4,4'-DDT), diesel range organics (Total Extractable Petroleum Hydrocarbons), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, and chlorinated herbicides and phenols.

The potential contaminants of concern in site sediments are lead, mercury, 2,3,7,8-TCDD, PCBs, PAHS, and DDTs. The concentration ranges and average concentrations of these contaminants, as found in representative sediment samples, are provided in Table 2-2 using historical data and Table 2-3 using the data from the June 2004 sediment coring program. Also included is the total organic carbon content (TOC) of the samples. The distribution of contaminants in the upper four feet of sediment is shown in Figures 2-4a to 2-4g.

2.4 RECENT RELATED INVESTIGATIONS

In order to establish baseline conditions and evaluate applicable technologies, several data collection and background activities have been completed. These activities include both general and site specific studies.

2.4.1 General Studies

2.4.1.1 Dredging Technology Review

TAMS/ET and MPI conducted an assessment of various dredging technologies that are potentially applicable to remediating contaminated sediments within the Lower Passaic River (TAMS/ET and MPI, June 2004b). This assessment concluded that for the pilot study, mechanical dredging systems have the following advantages over hydraulic dredging systems:

- Minimize the capital investment in infrastructure and land for dewatering and treatment systems;
- Reduce sediment transport and handling requirements related to delivering dredged material to sediment decontamination facilities that are beyond reasonable pumping distances from the Pilot Study Dredging Area;
- Enable better control in the context of a targeted, shallow dredging operation;
- Are more effective at dredging areas with debris; and,
- Are likely to be considered for large-scale river remediation.

2.4.2 Site Specific Studies

2.4.2.1 Geophysical Surveys

A subcontractor, Aqua Survey Incorporated (ASI) conducted geophysical surveys within the Pilot Study Survey Area of the Harrison Reach of the Passaic River. The geophysical surveys included:

- Hydrographic survey
- Side Scan Sonar survey
- Magnetometer survey
- Sub-bottom profiler survey

The detailed results of these surveys are included in Appendices B1 and B2 of the Final DSER (TAMS/ET and MPI, 2005).

A hydrographic survey was performed on a 1000-ft long stretch of the river, from bank to bank, using 25-ft wide lanes. Drawings generated from the survey show features in the vicinity of the site on the river bottom.

The sediment surface cross sections and bathymetry plots within the Pilot Study Survey Area are presented in Section 3 of the DSER (TAMS/ET and MPI, 2005b). The March 2004 hydrographic survey conducted by ASI and November 2004 hydrographic survey conducted by USACE shows that although the Pilot Study Survey Area is generally a net depositional environment, both deposition and erosion has taken place since the March/April 1995 hydrographic surveys were conducted by TSI (especially in the deepest portion of the channel; see DSER Figures 3-2 through 3-12). Lesser amounts of sediment have deposited closer to the shoreline. The deepest portion of the channel is closer to the northern bank of the river. From this location the sediment surface slopes more gently towards the southern shoreline.

A side scan sonar survey was conducted on the same 1000-ft stretch of river as the hydrographic survey. The side scan sonar survey was performed by running lines parallel to the shoreline on a 50-ft spacing. A mosaic of the riverbed in the study area was created. As part of the side scan sonar survey, it was planned to collect 30 surface sediment samples for correlation of the side scan results with the actual subsurface conditions. However, only 12 samples were actually collected; these were characterized in the field by an experienced senior field geologist based on the side scan images and the need to verify the sediment types associated with signal types. Due to similarities in the sediment type from these 12 samples, it was not necessary to collect more samples for ground-truth purposes.

The side scan sonar survey identified three areas and seven targets within the Pilot Study Survey Area. These are shown on Figure 2-5 and in Appendix B1 of the DSER (TAMS/ET and MPI, 2005b).

Area 1 spans the entire length of the surveyed area and indicated debris including tires, rocks, poles, and other objects projecting approximately 20 ft into the river from the north side of the survey. Area 2 also spans the entire length of the surveyed area and was identified as parallel lines in the sediment extending between 100 and 200 ft from the wall along the north side of the survey. These lines are probably shallow ridges caused by barges touching the bottom or dragging ropes or chains while transiting the area. Area 3 lies in the southwest portion of the survey area and consists of scattered debris over an approximately 30-ft wide area extending 500 ft east of the western edge of the survey area about 90 ft from the southern shoreline.

Target 1 appears to be a 15-ft tree projecting three feet into the water column. Targets 2 and 3 are approximately 26 and 37-ft long pilings laying on the surface. Target 4 is an approximately 1420 square foot (sf) area of probable differential bottom composition that is probably organic debris. Target 5 is a propeller mark extending approximately 78 ft to the southwest. Target 6 is an approximately 250 sf area of probable differential bottom composition that is probably organic debris. Target 7 is a propeller mark extending approximately 36 ft to the southeast.

Subsequent to the completion of the hydrographic and side scan sonar surveys, a magnetometer survey and a sub-bottom profiler survey were also performed by ASI. These surveys were conducted to detect buried ferrous and non-ferrous objects not detected in the side scan sonar survey, and also aided in the interpretation of the side scan sonar results. These surveys provided information on debris (e.g., the relative size and position of buried objects) as well as archaeological data (potentially significant historic submerged cultural resources) for compliance with the National Historic Preservation Act and the Abandoned Shipwreck Act.

The magnetometer survey revealed 12 distinct magnetic anomalies as well as significant levels of background geologic interference (see Figure 2-5). Of those 12 targets identified in the magnetometer survey, only two could be correlated with the reflections in the sub-bottom profiles. In addition, two potential targets, not detected in the magnetometer survey, were imaged by the chirp system. In addition, the sub-bottom survey was able to provide some description of the sediment in the survey area. In shallow water, the sediment was very soft at the sediment-water interface. On the slopes, the sediment was mainly composed of gassy silt and clay that was rich in organic matter. In the channel, the sediment was composed of well-consolidated silt and clay but the sediment still contained gas bubbles. None of the targets located were found to have signatures indicative of historically sensitive cultural resources. These surveys were not able to determine whether the targets identified would pose a hazard to the dredging pilot study. These surveys and targets are described further in Appendix B2 of the Final DSER (TAMS/ET and MPI, 2005).

ASI recommended further investigation of the sediments in the Pilot Study Survey Area using a gradiometer to minimize the effects of geological interference encountered by the magnetometer survey. As authorized by NJDOT-OMR, during the week of May 2, 2005, ASI conducted a gradiometer survey in the Pilot Study Survey Area. Preliminary results from this gradiometer survey did not identify any targets that would potentially interfere with the proposed pilot study dredging activities.

2.4.2.2 Core Collection and Analysis

The sediment coring and sampling program was conducted in July 2004. Cores with adequate recovery were collected from all 15 grid locations (see Figure 2-6) as designated in the Project Plans (TAMS/ET and MPI, June 2004a). Cores were transferred intact to the R/V Robert E. Hayes processing facility, where cores were sliced into 1-ft sections (0-1, 1-2, 2-3, and 3-4 ft intervals); weighed (for bulk density determinations); homogenized, subsampled, and shipped to the designated laboratories (USEPA-CLP, USEPA Region 2 DESA, STL-VT and STL-TN).

As specified in the plans, 45 discrete samples (plus QC samples) were generated, one from each of the three 1-ft intervals (between 0-3 ft) for each of the 15 grid locations; one additional sample from the 3-4 ft interval was also collected at each grid location. The 3-4 ft interval samples were shipped to the STL-VT laboratory but were ‘archived’ – stored frozen at the laboratory pending further instructions regarding compositing and analysis of these archive samples. In late October 2004, the project team decided to have the archived samples analyzed; and at that point STL prepared and shipped the archive samples to the laboratories performing the analyses. Due to the more limited sample volume available for the archived samples, the archive samples were submitted for either chemical analyses or geotechnical analyses, but not both. Every other sample (starting with A134, then A334, B234, and so on) was selected for chemical analysis (for a total of eight archive samples), and the seven remaining archive samples (starting with A234, then B134, B334) were submitted for geotechnical analyses.

In addition to the discrete samples summarized above, several composites were generated for different purposes. One bulk drum sample (designated as T-17) was obtained by USEPA personnel for use in treatability studies by potential sediment decontamination technology vendors; this sample was collected through material obtained by surface grabs (roughly the top six inches of sediment) using a petite ponar dredge sampler. Other vertical and horizontal composites among the discrete one foot cores were generated for PCB Aroclors, PCB congeners, and PCDD/PCDFs. In general, the sampling program was successful in obtaining sufficient material to perform all the planned analyses.

The sediment cores were analyzed for VOCs, SVOCs, pesticides, PCBs, herbicides, dioxins, metals, total organic carbon (TOC), and geotechnical parameters. A full discussion of the data obtained from the sediment coring program is presented in the DSER (TAMS/ET and MPI, May 2005). The data are summarized below and also in Table 2-3.

<u>Volatile organic compounds.</u> VOC data were only generated for the samples from the 0-3 ft intervals (the archived cores were not analyzed for VOCs). VOC concentrations detected were low (not detected, or less than 12 μg/kg). VOCs were detected in only 12 of the 48 discrete samples (including duplicates). Chlorobenzene was the most frequently detected VOC, reported in eight samples at a maximum concentration of 12 μg/kg. VOC data were validated by USEPA.

<u>Semivolatile organic compounds</u>. The discrete samples from the 0-3 ft interval were analyzed by the USEPA Region 2 DESA laboratory for the CLP target compound list SVOC analytes. Eight archive cores from the 3-4 ft interval were analyzed for 24 PAH compounds (not the CLP SVOC TCL list) by the DESA laboratory in Edison, NJ. SVOC compounds other than phthalates and the 17 target PAHs were generally not detected. The SVOC data typically show that the lowest total PAH concentrations are lowest in the near-surface (0-1 ft interval) samples (with PAHs detected in only four of the 15 discrete samples from this interval), with the highest concentrations and the highest frequency of detection (14 of 15 samples) in the 2-3 ft interval. While PAH compounds were detected in all eight of the 3-4 ft interval cores, concentrations reported were generally lower than those in the 2-3 ft core sections analyzed earlier by DESA. SVOC data were validated by USEPA. The Total PAH concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-7.

<u>Pesticides.</u> Pesticide data were generated for the 0-3 ft interval cores by the CLP laboratory (Mitkem), and eight archive 3-4 ft interval cores were analyzed for pesticides by the USEPA DESA laboratory. 4,4'-DDT and related compounds (4,4'-DDD and 4,4'-DDE) were detected in all the samples analyzed by both the CLP laboratory and DESA. A trend of increasing concentration with depth is less obvious in the samples from 0-3 ft analyzed by Mitkem. DDD, DDE, and DDT were each detected in at least 80 percent of

the valid sample results. Total DDT (sum of valid detections of DDD, DDE, and DDT) ranged from 50 µg/kg to 1100 µg/kg; in some cases the total may be biased low due to rejection of one (or in one sample, two) of the three analytes. A different pattern was evident in the DESA pesticide results. DDD and DDE were each detected in all eight analyses, but DDT was detected in none of the eight 3-4 ft cores. The total DDT concentrations in the 3-4 ft archived core samples, calculated from the DESA data (representing the sum of detections of DDD and DDE, as DDT was not detected), were fairly consistent, ranging from 30 to 48 µg/kg, and in all cases lower than the total DDT result calculated from the Mitkem data. Pesticide data were validated by USEPA. The Total DDT concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-8.

PCBs (Aroclors). PCB data were generated for the 0-3 ft interval cores by the CLP laboratory (Mitkem), and eight archive 3-4 ft interval cores were analyzed for PCBs by the USEPA DESA laboratory. In addition, 15 'row' composites for each depth interval from 0-3 ft were generated (e.g., A01C is a composite of A1-01, A2-01, and A3-01) and analyzed by STL. STL also analyzed five row composites from the 3-4 ft interval (e.g., A34C is a composite of A1-34, A2-34, and A3-34), to correspond with samples also analyzed for PCB congeners. The CLP and DESA data were validated but the STL data have not yet been validated.

PCB results varied by laboratory. PCBs were detected in 30 of the 48 samples analyzed by Mitkem (45 discrete environmental samples plus three field duplicates); in samples in which PCBs were detected, the total PCB concentration ranged from 230 µg/kg to 3800 µg/kg. Aroclor 1254 was the PCB most often reported (in 28 samples), with less frequent detection of Aroclor 1242 (10 samples) and 1260 (one sample). In the 0-3 ft interval row composites analyzed by STL, total PCB concentrations were higher (ranging from 1220 µg/kg to 7400 µg/kg); and Aroclors 1248 and 1254 were reported as present in all of these samples. No other Aroclors were reported present by STL. In the eight archive 3-4 ft samples analyzed by DESA, Aroclor 1248 was the only Aroclor reported, at concentrations ranging from 380 to 780 µg/kg. STL data for five row composites from the same depth interval (although not from identical material analyzed by DESA) indicated PCB concentrations higher than those reported by DESA, typically by a factor of greater than 10, ranging from 8400 to 12,200 µg/kg. Two Aroclors were reported in each of the five 3-4 ft row composites analyzed by STL: Aroclor 1248 in all five samples, and Aroclor 1254 in four, with Aroclor 1260 reported in the other sample. The Total PCB (Aroclor) concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-9.

PCB congeners. STL analyzed 20 row composites for PCB congeners (five rows from each of the four depth intervals from 0-4 ft); for comparability, each of these row composites was also analyzed for PCBs as Aroclors. The vendor composite, T-17, was also analyzed for PCB congeners. Overall the comparability of the total PCB values from the two methods was very good, and no significant bias was noted. Overall, the total PCB congener concentration average was greater than the sum of Aroclors value by about 7 percent, and the median total congener concentration was greater than the sum of Aroclor median by less than 3 percent. PCB congener data have not yet been validated. The Total

PCB (congener) concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-10.

Herbicides. STL performed the herbicide analysis on the 45 discrete cores from the 0-3 ft intervals and on eight archived core samples from the 3-4 ft interval. Only 2,4-D and 2,4,5-T were target analytes in this analysis. Herbicides were detected infrequently. 2,4-D was detected in four samples (plus in one duplicate), at concentrations ranging from 260 to 750 μg/kg, and 2,4,5-T in three samples at concentrations ranging from 40 to 67 μg/kg. No herbicides were detected in any of the 3-4 ft interval samples, nor in the 0-1 ft interval samples. The herbicide data have not yet been validated.

PCDD/PCDFs. STL conducted PCDD/PCDFs analysis on the same 20 samples, plus one field duplicate and the vendor composite, as were analyzed for PCB congeners. As these data have not yet been validated, the toxicity equivalence (TEQ) has not been calculated or presented, and these data should be considered preliminary. Total TCDD and 2,3,7,8-TCDD data were tabulated; both were detected in all samples analyzed. These data do show a general trend of increasing concentration with depth, although there are exceptions in individual cores. The PCDD/PCDF data have not yet been validated. The Total TCDD concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-11.

Metals. Analysis for the 23 target analyte list metals was conducted on all 45 of the discrete samples from 0-3 ft and eight archive (3-4) ft samples by the USEPA DESA laboratory. DESA data are subject to internal review prior to release; as such, and as indicated in the cover letter accompanying the data, these data are considered EPA-validated and fully usable as reported. Mercury was detected in every sample analyzed, at concentrations ranging from 1.4 to 12 mg/kg. Lead was also detected in every sample analyzed, at concentrations ranging from 210 to 1100 mg/kg. For both mercury and lead, there is a general trend of increasing concentration with depth. The mercury and lead concentrations from the June 2004 sediment coring program within the Pilot Study Dredging Area are shown in Figure 2-12 and 2-13 respectively.

Total organic carbon. TOC analysis was performed on all 45 of the discrete samples from 0-3 ft and eight archive (3-4) ft samples by the USEPA DESA laboratory. As such, these data are considered EPA-validated and fully usable as reported. TOC values ranged from 46,000 mg/kg (4.6 percent) to 81,000 mg/kg (8.1 percent). There was no discernible trend of TOC concentration with depth.

Geotechnical data. Geotechnical analyses included percent solids, moisture content, Atterberg limits (liquid limit, plastic limit, and plasticity index), specific gravity, and grain size, performed in the laboratory; and bulk density analysis, performed in the field. Geotechnical analyses was conducted on 44 of the 45 discrete samples from the 0-3 ft interval (there was insufficient recovery/volume for sample E2-01); and grain size analysis was performed on the seven archive 3-4 ft interval samples

Percent solids data and moisture content (ASTM D2216) data are in good agreement, after accounting for the different data reporting conventions of the two methods. These data show the expected trend of increased solids content with depth. The average solids content is 36.6 percent in the 0-1 ft interval, 43 percent in the 0-2 ft interval, and 48 percent in the 2-3 ft interval. Solids results reported by different laboratories on the samples from the same interval are in good agreement, generally agreeing to within ± 4 percent.

Atterberg limits results were reported for liquid limit, plastic limit, and plasticity index. Liquid limit values ranged from 50 to 116, with an average LL of 71.2 and a median of 66. Plastic limits ranged from 34 to 56 with an average of 44.2 and a median of 43. Plasticity index results ranged from 11 to 63, with an average of 27.3 and median of 24 for the 43 discrete samples for which data were reported.

Specific gravity analyses were performed by ASTM D854. Specific gravity values (density of dry solids) ranged from 2.06 to 2.56, with an average of 2.35 and a median of 2.34.

Grain size data are shown on Figure 2-14. Silt is the predominant grain size fraction, typically representing 70 to 80 percent of the sample; it is the dominant fraction in all but one of the samples analyzed. The sand fraction was highly variable, ranging from 5 percent to a maximum of 50 percent. The clay fraction was generally low, with a maximum value of less than 10 percent.

As mentioned in the summary above, analytical data generated by non-EPA laboratories has not yet been formally validated. Data validation subcontractors for the Lower Passaic River project are currently being procured by MPI. When data validation subcontractors are in place, the partner agencies will make a determination as to the prioritization of data from the sediment coring program to be validated. The unvalidated data should be considered preliminary until formal data validation or other appropriate data quality review is completed.

3.0 WORK PLAN RATIONALE

3.1 OVERALL PROJECT OBJECTIVES

The overall objective of the Feasibility Study is to develop a comprehensive watershed-based plan for the remediation and restoration of the Lower Passaic River. The Environmental Dredging and Sediment Decontamination Technology Pilot Study is being conducted in order to facilitate the detailed evaluation of a full-scale dredging remedial alternative within the Lower Passaic River through the collection of site-specific data. Important data for this evaluation include dredging productivity, sediment resuspension, and the effectiveness of sediment decontamination.

Dredging productivity data, which will be collected daily during the pilot study through the dredging contractor's report, is necessary for assisting in the estimation of the full-scale project schedule. Productivity data determines the rate at which a given dredge can remove a given sediment type from a given dredge area prism. Sediment resuspension, which will be measured continuously via a number of sampling and monitoring techniques during the pilot study is required for evaluating surface water quality. The effectiveness of sediment decontamination processes in separating or destroying the various contaminants including dioxins, PCBs, PAHs, metals, pesticides, and herbicides from the dredged sediment to meet applicable criteria for the appropriate beneficial use end product (e.g., cement, light weight aggregate, manufactured soil, glass, etc.) will also be evaluated by chemical analysis of the feed and product streams. This evaluation is necessary for determining feasible and cost-effective options for the final disposition of the dredged sediment. The table below summarizes the objectives of the pilot demonstration, and the metrics to be used to evaluate the results.

Pilot Demonstration Objectives

Objective	Metrics	Method of Determination
Evaluate the feasibility of dredging Lower Passaic River sediments without containment and without causing significant impact to the environment	• Resuspension production rate	• Near field monitoring
	• Resuspension release rate	• Near field monitoring
	• Resuspension export rate	• Monitoring at 300 meters
	• Mass balance	• Hydrodynamic modeling
Evaluate dredging equipment performance	• Dredging production rates	• Contractor's daily log
	• Turbidity levels	• Monitoring program

Objective	Metrics	Method of Determination
	• Operational controls	• Contractor dependent
Evaluate sediment decontamination technologies	• Determine percent removal of contaminants for each technology	• Chemical analyses of feed and product streams
	• Determine ability of technology to meet end use criteria for beneficial use product	• Chemical and geotechnical analysis of end product
	• Economic viability of technology	• Market survey

Note: The near-field based on the hydrology of the Pilot Study Survey Area is within 300 meters of the dredge. The resuspension production rate is the rate that dredging-related disturbances suspend sediments in the water column. The resuspension release rate is the rate of sediment transport in the immediate vicinity of the dredge. The resuspension export rate is the rate of transport beyond 300 meters.

3.2 WORK PLAN APPROACH

A detailed Description of Work (Section 4.0) has been developed and will be strictly adhered to during the implementation. This work includes the following:

- A focused three dimensional hydrodynamic model (ET, 2005) for the Environmental Dredging Pilot Study using Computational Fluid Dynamics modeling software Flow3D has been developed to support the placement and positioning of water column monitoring devices/equipment, estimate the mass flux of sediment leaving the pilot study area, and evaluate the impact of dredging without the presence of any engineering controls. A sensitivity analyses on model results was performed.
- The results of the hydrodynamic modeling have been used to identify suitable monitoring locations. Resuspended sediments will be monitored during dredging using a conductivity-temperature-depth (CTD) probe, Laser In-Situ Scattering and Transmissometry (LISST) probe, and optical back scatter (OBS) turbidity probe and by collecting total suspended solids (TSS) samples for laboratory analysis. The water quality will be monitored using the Trace Organic Platform Sampler (TOPS) apparatus. Monitoring will be conducted using fixed moorings and sampling boats. The sediment load will be evaluated by comparing TSS concentrations downstream to background TSS concentrations measured upstream.
- A design to support environmental dredging of contaminated sediment has been developed. As aspects of the design, plans, specifications, and NJDOT bid documents (NJDOT-OMR, TAMS/ET and MPI, 2005) have been prepared, which

delineate the area to be dredged, and specify required components of dredging equipment, and operational controls. The pilot dredging has been designed and will be implemented to mimic larger scale normal operations to the extent possible. Dredged sediments will be transported by barges/scows to the sediment decontamination facility. A sliding scale measurement and payment scheme has been developed, and will be enforced by conducting pre- and post-dredging hydrographic surveys. Productivity data from contractor's daily reports will be collected.

- Interpret and evaluate the data and prepare a Summary Report that documents the work.

4.0 DETAILED DESCRIPTION OF WORK

4.1 HYDRODYNAMIC MODELING

4.1.1 Rationale/Plan

For the Environmental Dredging Pilot Study, a limited, and focused, three dimensional hydrodynamic model was developed (ET, 2005) using Computational Fluid Dynamics (CFD) modeling software Flow3D (http://www.flow3d.com/software/index.htm) in order to satisfy three objectives:

- Support the placement and positioning of water column monitoring devices/equipment;
- Estimate the mass flux of sediment leaving the pilot study area; and,
- Evaluate the impact of dredging without the presence of any engineering controls.

4.1.2 Development of Model

Development of the hydrodynamic model requires understanding and describing the physical conditions present at the site that can influence the resuspension of sediments as a result of dredging activities. These include the meandering geometry, the tides, the dynamic salt wedge, the freshwater discharge, and sediment from the watershed transported by the river. Available hydrodynamic data, and other pertinent information, were obtained from several sources including USACE-NY District, Rutgers University, USGS, ASI, TSI, Mike Palermo Consulting, and University of Utah.

The following list describes some of the data that was evaluated:

- Freshwater discharge data from the USGS Passaic River at Little Falls, NJ Station (No. 01389500) as per Rutgers University;
- Dispersion data collected from dye tests performed by Rutgers University (September 29 to September 30, 2004 and October 4 to October 5, 2004);
- Bathymetric data from hydrographic surveys performed by USACE New York District (November 2004) and ASI (March 2004);
- Water surface elevation data recorded at Rutgers University moorings: Mooring #1 (located at the mouth of the Passaic River), Mooring #2 (located at Harrison Reach) and Mooring #5 (located 5 miles upstream of the mouth);
- Current data from Acoustic Doppler Current Profiler (ADCP) and Acoustic Doppler Profiler (ADP) recorded at Rutgers University moorings;
- Total suspended solids (TSS) data recorded at Rutgers University moorings;
- Salinity and temperature data recorded at Rutgers University moorings; and,
- Sediment characteristics from the July 2004 sediment coring and sampling event.

After the review of the existing data and the governing natural processes at the site, two cases were selected for evaluation using the model in order to achieve the project objectives. These cases are:

Case 1 – High Energy: Aimed at achieving the second and third study objectives (i.e., estimate the mass flux of sediment leaving the pilot study area, and evaluate the impact of dredging without the presence of any engineering controls). This case represents an elevated sediment transport capacity where the salt wedge is kept downstream of the Harrison Reach near Mooring No. 1. This was during a period of high river discharge.

Case 2 – Low Energy: Aimed at achieving the first study objective (i.e., support the placement and positioning of the water column monitoring devices/equipment). This case represents an elevated sediment settling condition where the salt wedge is located within the Harrison Reach. This was observed to occur during a period of low to average river discharge and neap (i.e., low tidal range) conditions.

These cases were selected from a matrix of nine combinations of two major components that dominate the hydrodynamics at the project site: tidal energy and freshwater discharge (see Table 4-1). Upon defining the modeling cases, the hydrodynamic sediment transport model for the project area was developed to predict the dredge-induced sediment transport under the conditions represented by the defined cases.

Flow3D, a widely used state-of-the-art commercially available, robust Computational Fluid Dynamics (CFD) modeling software, was used for (1) its ability to model sediment particles with variable diameter/density in free surface, three dimensional, transient, turbulent, stratified flow conditions and (2) its unique free surface algorithm called Volume of Fluid (VOF). Handling of free surface in Flow3D via VOF is considered superior to commercially available comparable CFD packages (Olsen, June 1999). The model solves Navier-Stokes equations in three-dimensional space and time using a structured non-uniform finite difference grid and Fractional Areas/Volumes (FAVOR™) algorithm for geometric definition. The model covered an area starting from the mouth of the Passaic River (corresponding to Rutgers University Mooring #1) and extending about 5 miles upstream (Mooring #5), which covered the entire study area. The location of the model boundaries was chosen based on modeling objectives and data availability. Flow3D's non-uniform meshing algorithm was used in order to optimize the mesh and thus avoid larger than necessary run time. The average grid cell size in the Harrison Reach was 70 ft (east to west) by 70 ft (south to north) by 2.5 ft (vertical).

The flow across both boundaries of the model was specified as a time series due to its dynamic nature. The flow was calculated as a function of cross-sectional flow area and velocity. Density was specified by interpolating between the top and bottom gages of Mooring #1 at the southern model boundary and keeping it constant at the northern boundary (per Mooring #5 data). While the density was kept uniform during well-mixed conditions of Case 1, two different densities of 1.94 and 1.96 slugs/ft^3 were specified for stratified conditions of Case 2.

The Rutgers University ADCP measurements taken at the Mooring #2 were used for verification purposes. Model sensitivity analysis was also performed to verify that the model output was not significantly sensitive to turbulence, free surface, grid density and initial conditions. The DREDGE model (Hayes and Je, 2000) was used to calculate the source strength and to provide estimates of the sediment that would be released from pilot dredging. Each sediment class (i.e., sand, silt and clay) was modeled as a group with an average median particle diameter (D_{50}). This rate was then used as a source term in the Flow3D model which was used to simulate transport and settling of sediment. The dredging work was assumed to occur for five days. The increase in sediment load was assumed to occur only during the 12-hour-per-day working period.

The sediment in Passaic River will be carried upstream and downstream due to the hydrodynamic characteristics of the site, as Rutgers University mooring data indicates that during flood stage of the mean tidal range (even with high freshwater discharge) the Passaic River flows upstream at the Pilot Study Dredging Area. This indicates the hydrodynamics of the area are dominated by the tidal energy and, to a lesser extent, by freshwater discharge. Wind and waves could also affect the sediment transport. However, (1) it is assumed for the purposes of this pilot study, that dredging will not take place during high wind/wave conditions since no engineering controls will be in place, and (2) in order for the wind to transfer significant energy to the water, significant fetch area is needed. However, the modeling area is limited in fetch area by length due to the sinuosity of the Passaic River. Therefore, only the effects of the tidal signal and the freshwater discharge were considered as the hydrodynamic transport forcing mechanisms for the Flow3D model.

It is known that Stokes settling is the primary mechanism to initiate settling of coarse sediment (i.e., sand), and aggregation is needed for the settling of fine particles (i.e., silt and clay). In the aggregation process, flocculation becomes the primary settling mechanism for sediment sizes below 0.005 mm (McDuff, 2002). It is promoted by the ions that are found in saltwater. However, salinity is not the only parameter that drives flocculation. Wartel and Francken (1999) showed that floc sizes could increase moving from the saline to fresh water portion of a tidal river and concluded that other processes are as important as salinity, which indicates that flocculation is a site-specific phenomenon.

As a conservative approach from sediment transport perspective (modeling objectives #2 and #3), effects of flocculation were not included and only the Stokes settling algorithm was used in the Flow3D model. By not including flocculation, the mass flux leaving the system was conservatively estimated high. Inclusion of flocculation would cause increased settling velocities of the silts and clays, thus increasing settling rate and decreasing the mass flux leaving the system.

4.1.3 Model Observations

The results of the hydrodynamic and sediment transport modeling have been used to make the following observations:

<u>Monitoring Locations</u>

Model predicted TSS concentrations (i.e. the increase of TSS above background) within the plume range from approximately 2 to 18 mg/L, (typically being around 7 mg/L), and 6 to 54 mg/L (typically being around 21 mg/L) for the average project release (i.e. typical productivity of 3-minute dredge cycle) and maximum short-term release (i.e. increased productivity of 1-minute dredge cycle). Measured TSS background (personal communication with Tim Wilson of USGS), occurring naturally, is 10 to 25 mg/L during average low flow conditions and 100 mg/L during the Estuarine Turbidity Maxima (ETM).

The model predictions indicate that the plume follows the path of deeper water conveyance (i.e., along the navigational channel closer to the northern bank). The plume is well defined during ebb tide, however, the plume is mixed after the flow reversal during flood tide. Figures 4-1 through 4-5 show plan view snapshots of the sediment plume over a 24 hour period. Cross sectional views of the plume during ebb (well defined) and flood (mixed) are shown in Figure 4-6. The plume progression characteristics are similar to those observed during the dye studies (September and October 2004) performed by Rutgers University.

Both transect fixed moorings and shipboard monitoring are recommended. Four fixed transect locations including two (2) at 200-300 feet and two (2) at 1,200-1,500 feet on either side of the pilot study dredging grid are needed to capture the plume and its settling characteristics. While the distance of 200-300 feet corresponds to the minimum distance to safely operate monitoring equipment (per discussions with the multi-agency technical project team), the distance of 1,200-1,500 feet corresponds to the maximum distance where the coarse particles (i.e., sand) are expected to settle leaving only fines (i.e., silt and clay) to monitor. It is also recommended that moorings be placed in the deeper part of the channel (i.e., closer to the northern bank), where the plume appears to concentrate (Figure 4-6). Based on discussions with the dredging contractor (Jay Cashman, Inc.) the moorings closest to the Pilot Study Dredging Area will be positioned at a distance of 400 feet on either side to allow movement and turning of the dredge, guide barge, and scows.

<u>Sediment Flux</u>

Because sediment flux is correlated to freshwater discharge, August and September are not only the months with the lowest freshwater discharge but also those with the lowest sediment flux. Figure 4-7 shows the monthly variation of the freshwater discharge vs. sediment flux into Newark Bay.

Given that 5,000 cubic yards will be dredged and assuming an estimated one percent sediment release rate, an estimated 55 tons of sediment will be released during the Environmental Dredging Pilot Study. Sand is 16 percent of the 55 tons by weight, and it settles within approximately 500 ft of release. Therefore, an estimated 46 tons of silt and clay would leave the study area assuming no flocculation. Figures 4-8 and 4-9 show that during Case 1 and Case 2 conditions, fines (i.e., silt and clay) leave the system within approximately 0.5 and 1 day, respectively.

The estimated 46 tons of sediment released during pilot study dredging corresponds to 0.2 percent of the natural annual sediment flux. Figures 4-10 and 4-11 show estimated sediment releases from the Pilot Study dredging compared to the average daily and monthly natural loading of the Passaic River, respectively. The figures also show that, because the Pilot Study was scheduled to take place during a month with low sediment flux, the combination of natural and dredge-induced sediment flux is lower than the yearly averaged values. The average natural sediment flux values are based upon 40 years of record (provided by Tim Wilson of USGS personal communication). By not including losses from flocculation, the estimate of mass flux leaving the system is conservative (i.e., high). Inclusion of flocculation in the estimate would cause increased settling velocities of the silts and clays, thus increasing settling rate and decreasing the mass flux leaving the system.

4.2 RESUSPENSION MONITORING

4.2.1 Rationale/Plan

One of the goals of the dredging pilot study is to attempt to measure the amount of sediment that is resuspended and subsequent transport that might occur from the Pilot Study Survey Area as a result of dredging operations in the Passaic River estuary. As described in the previous section, hydrodynamic modeling provided an estimate of how much sediment might be released as a result of dredging and how the sand, silt and clay is expected to be transported in the water column. The goal of resuspension monitoring is to develop data for characterizing resuspension releases and transport. The modeling was performed to determine the best locations for monitoring equipment, to estimate the mass flux, and to evaluate the impact of dredging without controls. But the modeling is considered conservative in that the effects of flocculation were not considered. Therefore, the field data from resuspension monitoring is expected to provide a representative estimate of resuspension behavior.

Dredging sediments in rivers and marinas is analogous to excavating soil at land-based construction sites. Moreover, just as construction generates dust particles that are then transported through the air by wind, dredging generates suspended solids that are transported through the water column by water currents. Contaminants associated with suspended solids (resuspended sediments), can impact the water column in a manner that is similar to the way that contaminants associated with dust particles can impact air quality.

Resuspension impacts water quality by two basic means: by the direct addition of contaminated solids to the water column and by the partitioning of contaminants from the contaminated solids to the dissolved phase. While the former mechanism is straightforward and can be assessed by the measurement of suspended solids in the water column, the latter mechanism is more complex and often of equal or greater importance in estimating the total mass of contamination released.

Using the method of DiToro and others (1991) or Karickhoff (1981) the dissolved phase and suspended matter-borne phase of a contaminant at equilibrium can be estimated as:

$$F = \frac{1}{1 + K_d m}$$

where

F = fraction of the contaminant mass in the dissolved phase (unitless)

$K_d = K_{oc} f_{oc}$ = distribution coefficient (L/kg)

m = total suspended solid concentration (kg/L)

K_{oc} = organic carbon partition coefficient (L/kg)

f_{oc} = organic carbon fraction associated with the solids (unitless).

Hence, for a given contaminant, the fraction in the dissolved phase is related to the concentration of total suspended solids (TSS) in the water column, which is a function of particle size and particle distribution. Sands and other coarse material will settle out of the water column fairly quickly and close to the dredging operation; thus, contributing minimally to the TSS value and the dissolved phase concentration. Conversely, silts and clays will remain in the water column as suspended solids and are easily resuspended during dredging. As a result, silts and clays constitute the majority of dredging-related suspended solids. Equally important, these small-size solids remain in the water column long enough to allow substantive desorption of the contaminant from the solid to the dissolved phase, often achieving near-equilibrium conditions.

These considerations highlight the need to understand the amount of resuspension occurring at the dredge head as well as the amount of resuspended sediment that may escape the dredging zone. Regardless of the ultimate distribution of contamination in the water column, it is the resuspended sediment that supplies the means for the release of contaminants from the dredging operation. For these reasons, the dredging pilot program includes an intensive study of the resuspension process, involving extensive suspended solids monitoring around the dredging operation.

The plume of resuspended sediments released from the dredging operation defines the region of the water column most immediately impacted by the dredging. This area will be defined for this study as the downstream region less than 300 meters and is called the "near-field area." A near-field plume requires continuous monitoring to determine the load of TSS relative to background TSS load. "Load," which represents a mass of suspended solids or contaminant transported per time, is estimated from the following equation:

$$L = A \times m \times v \times 1000$$

For suspended solids, the variables are defined as:

L = load of suspended solids (kg/s)

m = total suspended solid concentration (kg/L)

A = cross-sectional area over which the suspended solids concentration applies (i.e., the river width or the width of the plume, as appropriate, in units of m^2)

v = water velocity (m/s)

1000 = conversion factor (L/m^3).

Load for sediment contaminants can be calculated in a similar manner. As part of this study, loads will be calculated both in the near-field area and in the area upstream of the dredging activities (background load). The contaminant load associated with dredging activities is then the net difference between the near-field load and the background load. Impacts to water quality can then be estimated from the dredge-related contaminant load.

4.2.2 Description of Monitoring and Sampling Approach

To monitor TSS load and water quality, both fixed moorings and shipboard monitoring will be utilized in the near-field area (both upriver and downriver of the dredging operation) to monitor water column stratification and stability; particle concentration and size distribution; and both filtered and unfiltered contaminant concentrations.

The monitoring and sampling will be conducted using six fixed moorings and four boats as shown on Figures 4-12 and 4-13. Four moorings will be located along the centerline of the plume (two on either side of the dredging operation). The remaining two moorings will be located in the deepest portion of the channel (closer to the northern bank – one on either side of the dredging operation). Depending on the tides, the near-field plume of resuspended sediments will exist upriver or downriver. During ebb tide, the plume will stretch downriver, and the outgoing water currents will transport the released sediment downriver (Figure 4-12) towards Newark Bay. When the tide changes to a flood tide, the plume will stretch upriver and the incoming water currents from Newark Bay will transport the released sediment upriver (Figure 4-13). In between these two tidal extremes, or slack tide, the plume will exist as a turbid mass around the dredging operation. Due to the presence of the salt wedge, (i.e., the occurrence of water column stratification due to salinity*)*, the leading edge of the near-field plume will occur at an angle as the overlying water moves at a different velocity than the underlying water. Based on field observations and hydrodynamic modeling, flow in the water column is expected to be unidirectional, somewhat simplifying the monitoring program layout. A three-dimensional view of the moorings and associated instruments is shown on Figure 4-14.

A typical mooring is illustrated on Figure 4-15. It consists of float at the water surface and an anchor and a tripod frame suspended on a chain. The anchor and frame rest on the sediment surface. Approximately one meter below the water surface, a Conductivity-Temperature-Depth (CTD) probe, an Optical Back Scatter (OBS) sensor, and a Laser In-Situ Scattering and Transmissometry (LISST) probe are mounted on the chain. On the bottom frame (approximately one meter above the sediment surface), a CTD probe, an OBS sensor, and an Acoustic Doppler Current Profiler (ADCP) are mounted. Since the LISST is a relatively expensive instrument it will only be mounted on the two moorings that are located along the centerline of the plume, closest to the dredging operation. These instruments will collect data (conductivity, temperature, pressure (depth), suspended solids, turbidity, and current velocities) for 24 hours a day for at least eight days (i.e., prior to, during, and after the five-day pilot dredging event).

Four boats will be utilized for the shipboard surveys and sampling. Two boats (see T-boats on Figures 4-12 and 4-13), each equipped with a GPS, a depth profiler, a Trace Organics Platform Sampler (TOPS), and two ISCO automatic samplers will be positioned along the outer edges of the study area that is being monitored (approximately 300 meters on either side of the dredging operation). These boats will move perpendicular to the flow from bank to bank and sample the water column. A third boat (see M-boat on Figures 4-12 and 4-13) will be equipped with a CTD probe, an OBS sensor, and an ADCP, will sweep across the near-field plume in a zig-zag pattern crossing the plume approximately seven times. Each sweep of the M-boat the near-field plume is expected to take one hour, with several sweeps conducted during a single study period. It is expected that near-field monitoring will be conducted over eight tidal cycles during the five-day dredging program; however, field conditions may require modifications to this field sampling plan. The fourth boat (see L-boat on Figures 4-12 and 4-13) will be equipped with a CTD probe, a LISST probe, and an ADCP, will run along the centerline of the plume parallel to the flow. To a limited extent, this L-boat will also move in a zig-zag pattern to identify the edges of the plume.

Details of the sampling performed by the shipboard surveys are provided in Appendix B of the attached QAPP.

To the extent feasible, analytical work for this project will be arranged through the USEPA Contract Laboratory Program (CLP); or through other USEPA-coordinated laboratories (e.g., the DESA laboratory in Edison, NJ). Commercial laboratories (contracted by USGS or TAMS/ET under NJDOT-OMR contract) may be utilized as needed to perform specialized analyses beyond the scope or capacity of either DESA or CLP laboratories. These analyses may include EPA 1600-series methods (trace metals; dioxins/furans; PCB congeners). The USGS laboratory facility will assist in the processing (i.e., filtering) of samples for organic carbon (POC and DOC) and Br/Cl analyses.

The specific analyses that the analytical laboratories will perform are identified in Section B4 of the attached QAPP. In general, it is anticipated that the analytical laboratories utilized will include the following:

- USEPA Region 2 DESA Laboratory. Metals analyses (CLP SOW ILM05.3, ICP-MS; including aluminum; iron analysis by optical emission spectroscopy [OES]); total organic carbon on particulate matter (POC; DESA SOP C-88) and filtered water (DOC; DESA SOP C-83); chloride/bromide on water samples (USEPA Method 300.0); and total suspended solids (DESA SOP C-33; based on USEPA Method 160.2)
- Commercial laboratory (STL, North Canton). Total (whole water) and dissolved low-level mercury analyses USEPA Method 1631E
- CLP – High resolution organic analyses on GFF filter samples and XAD resin samples. Dioxins/Furans (CLP non-RAS method DLM02.0); PCB congeners (USEPA non-RAS method CBC01.0); and pesticides (CLP SOW SOM 01.1 or OLM04.3).

4.2.3 Schedule/Sequence of Sampling

A conceptual schedule showing the types and quantity of environmental samples collected during each day of the program is shown in Appendix B of the QAPP and summarized below. A practice/dry run day (in which all the boats will be in the water, but no samples will be collected) has been tentatively scheduled for Wednesday, November 30, 2005 (the practice day is not included in the day-by-day summary below). The sampling for chemical analysis (conducted from both of the TOPS boats for all days except the post-dredge day, during which only one TOPS boat will be used) will be conducted during 3-hour events (typically; some will be shorter) which consist of transects conducted for the three-hour period immediately prior to either high tide or low tide. Based on the tide charts and the daylight hours in Newark the week of December 5 (sunrise at about 7:05 am and sunset at about 4:30 pm), the following schedule for the collection of samples for chemical analysis from the TOPS boat has been developed. (Note that for all days of dredging, all sampling boats will be in the water and collecting instrument readings and TSS samples at 7:00 am, one-half to one hour prior to the start of dredging.)

- Pre-dredge day – Thursday 12/1/05; low tide at 2:36 pm; the 3-hour event consists of seven transects from 11:30 am to 2:30 pm.
- Monday 12/5/05 – High tide at 10:46 am; if dredger starts at 8 am, then the first transect also starts at 8 (for this event, only six individual transects will be collected, covering 2 ½ hours, rather than 3). A second sample will be collected Monday prior to low tide at 5:48 pm. For safety reasons (associated with operating boats on the river in the dark), the last transect will be at 5:00 pm; so this pre-low-tide event will also consists of six individual transects (3:30 through 5:00), covering a 2 ½ hour period.
- Tuesday 12/6/05 – High tide at 11:49 am; one transect 8:30 – 11:30 am. Tide cycles and daylight do not allow a pre-low-tide event on this day.
- Wednesday 12/7/05 – High tide 12:50 pm; transect 9:30 am – 12:30 pm. Tide cycles and daylight do not allow a pre-low-tide event on this day.
- Thursday 12/8/05 – High tide 1:49 pm; transect 10:30 am – 1:30 pm. Tide cycles and daylight do not allow a pre-low-tide event on this day.
- Friday 12/9/05 (anticipated final dredge day) – There is a low tide at 9:21 am; a partial low-tide event will be conducted on this day, with four transects (7:30, 8:00, 8:30, and 9:00) in this event. (On this day, the dredger will start at 7:30, a half-hour earlier than the normal start time of 8:00 am.) High tide is at 2:49 pm; the high tide transect will be from 11:30 am to 2:30 pm.
- Post-dredge day (Monday 12/12/05). The TOPS boat (for this day only, a single sampling boat will be used) will conduct a 3-hour transect from 9:00 am through noon, ending just prior to low tide at 12:10 pm). The single transect will be conducted at the downstream location of the two TOPS transects used during the dredging operations (closer to the NJTP Bridge).

Day 1 – The dredging contractor has not yet begun any operations. Monitoring will occur on this day to establish 'background' (pre-dredge) conditions. Moorings (and associated field instruments) will be deployed on or prior to this day. One TOPS sampling event (two T-boats) will be conducted to establish 'background' conditions. The TOPS boat will make one traverse back and forth across the river (perpendicular to river flow) every 30 minutes during each three-hour sampling event, so that a total of seven traverses will be made for each event. It is estimated that a traverse will take about 10 or 12 minutes (about five or six minutes each direction). A single sample for each event (integrated [composited] over the six or seven traverses) will be collected and analyzed for dissolved and total metals; pesticides; PCB congeners; and PCDDs/PDCFs. Discrete samples from each leg of each traverse (each leg being one-half the round trip back and forth across the river; each leg will represent either the 1-m below surface depth interval, or the approximately 1- to 1.5-m above the sediment interface depth interval) will also be collected for TOC/POC/DOC analysis (at the same frequency as those for TSS) and continuous composite samples (composited over the 5- or 6-minute estimated duration of each of the two legs comprising a single TOPS traverse, with traverses conducted at 30-minute intervals; so 12 or 14 discrete samples for TSS analysis are generated for each three-hour sampling event).

Day 2 – First day of sediment dredging (assumed to be Monday, December 5). This will likely be the startup/shakedown day for the dredging contractor. Based on the tide cycle and available daylight, two TOPS events will occur on this day. The first will be a pre-high tide event, consisting of six transects (beginning at 8:00 with the last one at 10:30) prior to high tide at 10:46 am. A pre-low tide TOPS event will also be conducted (terminating slightly early due to darkness; this event will consist of six transects from 3:30 pm through 5:00 pm (low tide is at 5:48 pm). Samples collected on the first day of dredging will be analyzed for total and dissolved metals; pesticides, PCB congeners and PCDDs/PDCFs. A set of 12 discrete samples (one from each leg of each traverse) will be collected from each of the two TOPS boats for TSS, POC/DOC, and Br/Cl analysis.

Days 3, 4, and 5 – Second, third, and fourth days of dredging (assumed to be Tuesday, Wednesday, and Thursday). A single three-hour sampling event will be conducted on each of these days; each one prior to high tide (11:49 am, 12:50 pm, and 1:49 pm). One set of samples will be collected from each TOPS boat for all parameters.

Day 6 – Fifth (and final) day of dredging (assumed to be Friday, December 9). Two TOPS sample events will be conducted on this day. In order to obtain a second pre-low-tide event sample, the dredging contractor will start at 7:30 on this day, in order that the TOPS sample boats can complete four transects (starting at 7:30) prior to low tide at 9:21 am. The second TOPS event on this day will be a full set of seven transects (from 11:30 through 2:30) covering the 3-hour period prior to high tide at 2:49 pm.

Day 7 – Post-dredging day (Monday 12/12/05). Final field data collection; moorings and instruments retrieved and data downloaded. One last TOPS vessel sampling event (from 9:00 through 12:00, prior to low tide at 12:10 pm), collect samples for TSS, metals, pesticides to verify that the system has returned to pre-dredge conditions.

4.2.4 Field Modification

Based on real-time data collected in the field, the monitoring approach may be modified in the field as necessary to best measure the plume.

4.3 DREDGING DESIGN

4.3.1 Rationale/Plan

The Environmental Dredging Pilot Study will be conducted without any containment barriers in order to monitor the resuspension as described above. In order to be able to distinguish the plume released by the dredging operations from naturally occurring background conditions, the pilot study was planned to be implemented during periods of neap tide and low river discharge. This dredging was scheduled for the last week in October 2005, but has been postponed due to construction delays at the sediment unloading facility and very heavy rainfall in the Hackensack-Passaic watershed resulting in flood conditions in the river. It is now anticipated that this dredging will be performed in early December 2005. This will also help to minimize any potential impacts to the environment, to the extent possible. Approximately 5,000 cubic yards of contaminated sediment will be dredged from the Harrison Reach. In order to meet the objectives of the project, the dredging equipment used will be capable of removing sediment at a rate of 1,000 cubic yards per 12 hour workday. The dredging will be completed in five continuous workdays under normal operating conditions to simulate the effects of a full-scale dredging operation. For short time periods, an effort will be made to study increased productivity operations. The dredging contractor will conduct debris removal during dredging.

4.3.2 Delineation of Area to be Dredged

In order to avoid highly contaminated materials, the dredging will target a shallow excavation (maximum depth of 3.5 ft). The area to be dredged has been divided into cells, the widths of which mimic the topography of the bottom surface. By following the topography of the river bottom in the dredging area, the dredging operation will minimize overall cut depths and constrain the dredging depth to the portion of the sediment characterized by sediment cores. In order to estimate the total volume of material to be removed, a side slope of 3:1 is assumed, which has also been shown to be a theoretically stable slope. Sloughing may occur at the edges of the excavation, and removal of sloughed material will be addressed by the dredging contractor. Figure 4-16 shows an aerial view of the pilot study area. Figures 4-17 through 4-19 show the details of the dredge prism. Figure 4-20 shows the positioning of the moorings in relation to the dredging area.

4.3.3 Dredging Equipment

Dredging will be conducted using equipment designed specifically for removal of contaminated sediments so that releases of sediments to the water column are controlled and minimized. Mechanical dredging has been specified in the NJDOT bid specifications because water treatment facilities to support hydraulic dredging do not exist near the Pilot Study Survey Area. In addition, the selected dredging equipment will be capable of removing the targeted sediment at near in-situ densities, thereby reducing the volume of excess water being entrained and transported.

The dredging equipment will incorporate the following systems and design features, or equivalent:

- A state-of-the-art environmental bucket that is capable of making a flat horizontal cut.
- Features to maintain complete enclosure of sediments when the bucket is being raised through the water column.
- Features that reduce, to the maximum extent practicable, generation of suspended sediments during bucket lowering, closing and raising in the water column.

- A system to detect bucket closure.
- RTK DGPS positioning controls such as WINOPS™ or HYPACK™ or equivalent that will enable accurate positioning of the dredge bucket to tolerances of:
    - ±2 inches vertical
    - ±3 inches horizontal.

4.3.4 Operation

The dredge will be operated:

- In compliance with the Federal Consistency Determination/Water Quality Certificate permit requirements provided by NJDEP in October 2005 (e.g., lift speed, cycle time constraints, etc.);
- In a manner consistent with the manufacturer's instruction for the equipment being used; and
- By an experienced operator.

4.3.5 Productivity Data

Productivity data will be collected from the contractor's daily report, which contains information regarding the size, quantity, and description of material dredged.

4.3.6 Dredge Material Handling

Dredged sediment will be discharged into a barge that will be hauled to a designated decontamination facility. At the decontamination facility site the barge(s) will be off-loaded into a floating storage ore barge. A sufficient number of barges will be made available so as to maintain a continuity of dredging operations. Barges will be compatible with available draft and other horizontal and vertical clearance limitations found in the Passaic River, Newark Bay, and along the haul route to the designated offloading site.

4.3.7 Pre- and Post-Dredging Hydrographic Surveying

Prior to the start of dredging, a multi-beam hydrographic survey will be performed by the dredging contractor's surveyor to confirm that the bathymetric conditions used during design have not changed. Upon completion of the dredging work, another multi-beam survey will be performed by the dredging contractor's surveyor to confirm that the targeted dredging elevations have been achieved. This work will be performed as described in the Project Plans for Geophysical Surveys and Sediment Coring (TAMS/ET and MPI, June 2004a). In addition, interim surveys may be conducted by the dredging contractor.

4.3.8 Measurement and Payment

A payment scheme, based on professional judgment, was developed to test the dredge operation in a typical production mode. The payment scheme will encourage the contractor to minimize redredging and backfilling. The applicable levels of completion and their corresponding payments are:

- Full payment will be made if at least 90 percent of dredged area is within ±0.5 ft of the targeted dredging elevations shown on the Plans (see Figures 4-17 through 4-19).
- A reduced payment of 90 percent of the price bid will be made if at least 80 percent of dredged area is within ±0.5 ft of targeted dredging elevations shown on the Plans.
- Payment will not be made if less than 80 percent of the area indicated on the Plans is within ± 0.5 ft of targeted dredging elevations shown on the Plans.

The dredging program has been designed to avoid exposing heavily contaminated sediments to the water column, thereby mitigating the risk of resuspension and transport of contaminants of concern. Areas dredged to an elevation of one foot or greater below the targeted dredging elevations have greater potential to expose more contaminated materials, and will require backfilling to immobilize contaminants. If necessary, backfilling will be accomplished using certified clean material of appropriate grain size.

4.4 SEDIMENT DECONTAMINATION

This section provides an overview of the decontamination pilot study work that will be performed by others. Separate detailed Work Plans (BioGenesis, 2005) have been prepared by the sediment decontamination technology vendors.

The objective of the sediment decontamination technology demonstration project is to show that Passaic River sediments, contaminated with dioxins, PCBs, polycyclic aromatic hydrocarbons (PAHs), metals, pesticides, herbicides, and other contaminants can be treated to meet applicable criteria for the appropriate beneficial use end product (e.g., cement, light weight aggregate, manufactured soil, glass, etc.). The decontamination project will collect data to perform a contaminant mass balance and determine the economic viability of the treatment process for commercial scale applications.

Two separate decontamination technologies, sediment washing and thermal treatment, will be evaluated for the pilot study. These are:

- Biogenesis (Sediment washing)
- Endesco/GTI (Ecomelt®)

Final selection of the decontamination vendors is pending negotiation and procurement of the vendors by NJDOT-OMR.

5.0 REPORTING

A Summary Report will be generated to present the findings of the pilot study. The report will include:

- Summary of work performed including deviations from or modifications to the approved project plans.
- Description of problems encountered and resolved
- Dredging productivity data and summaries
- Results and interpretation of monitoring program data
- Evaluation of the effectiveness of decontamination processes and assessment of the economic viability of decontamination for a full scale dredging program.
- Implications for full-scale dredging and decontamination program

6.0 PROJECT SCHEDULE

The proposed project schedule for the Pilot Study is summarized in Table 6-1.

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Tables

Table 2-1
Bridge Clearances and Notice Requirements

Bridge	Location	Type	Horizontal	Vertical Clearance (ft) (high water)	Notice Required
Garden State Parkway (Driscoll Bridge)	Raritan	Fixed	199	135	N/A
Rt 9 Edison Bridge	Raritan	Fixed	250	135	N/A
Victory Bridge	Raritan	Swing		Under Construction	
Conrail	Raritan	Swing	125	8 ft	on signal
Outer Bridge Crossing	Arthurkill	Cantilever	675	143	N/A
Goethals Bridge	Arthurkill	Cantilever	672	135	N/A
Railroad Bridge to Bayway Barge Piers	Arthurkill	Lift	500	31 Down/ 135 Up	on signal
NJ Turnpike Extension	Newark Bay	Fixed	550	135	N/A
Conrail	Newark Bay	Lift	300	35 Down/135 Up	on signal
Central Railroad of NJ	Passaic	Swing	100	25	Removed
Lincoln Hwy Bridge (Routes 1&9)	Passaic	Lift	300	40 Down/135 Up	4 hours
Pulaski Skyway	Passaic	Fixed	520	135	N/A
Point-No-Point Conrail (freight bridge)	Passaic	Swing	103	16	4 hours
NJ Turnpike	Passaic	Fixed	319	100	N/A
Jackson St Bridge	Passaic	Swing	75	15	4 hours
Northeast Corridor (Amtrak)	Passaic	Lift	200	24 Down/138 Up	4 hours

Notes: There are also a number of overhead power cables ranging from 135 to 170 ft vertical clearance.
Information obtained from naviagtional charts 21st edition and 33 CFR 117

Table 2-2
Concentration Ranges and Averages for the Contaminants of Concern and Total Organic Carbon
Historical Data

Depth Interval	0 to ≤3 ft				3 to ≤5 ft				> 5 ft			
Parameter	Det / n	Min	Max	Average	Det / n	Min	Max	Average	Det / n	Min	Max	Average
Organics (data in ug/kg)												
2,3,7,8-TCDD	269 / 281	0.00026	932	5.4	100 / 116	0.00019	5,300	68	94 / 115	0.0003	240	11
PCBs - Sum of Coplanar Congeners	253 / 275	0.03	1,970	196	91 / 117	0.04	1,960	350	102 / 115	0.0091	1,240	226
Total PCBs - Aroclors	216 / 268	54	14,200	1,893	68 / 111	177	47,700	4,596	42 / 110	368	11,300	3,736
Total PAHs (note 1)	291 / 311	640	7,750,000	71,080	92 / 117	520	719,000	56,979	100 / 118	220	1,170,000	99,445
Total DDT	231 / 271	4.13	30,800	598	84 / 112	5.78	18,600,000	337,162	87 / 115	7.0	223,000	4,069
Metals and TOC (data in mg/kg)												
Lead	274 / 274	1.7	17,900	435	114 / 114	1.00	1,230	45,158	99 / 99	3.10	2,490	596
Mercury	249 / 275	0.060	28.5	4.73	92 / 113	0.010	28.1	6.97	86 / 113	0.11	29.6	8.72
Total Organic Carbon (mg/kg)	269 / 271	238	409,000	73,054	117 / 117	324	563,370	76,727	117 / 118	691	271,890	76,608

Data in ug/kg for organics. Data in mg/kg for lead, mercury, and TOC.
Data from Harrison Reach of Passaic River, 1991 - 2000. All data from depths greater than 0.5 ft are from 1991 to 1995.
Depth interval measured from top of sediment/water interface.
Depth interval assigned based on midpoint depth of sample (e.g., sample interval reported as 2.6 to 4.0 ft assigned a depth of 3.3 ft, and in the 3 to ≤5 ft category).
"Det" is number of detections; "n" is total number of data points (includes duplicates and validated and unvalidated data).
For lead, mercury, 2,3,7,8-TCDD, and TOC: Non-detected values assigned one-half of sample reporting limit of zero in averages..
Reporting limits not available for PCBs, PAHs, and DDT; non-detected results assigned a value of zero in averages.
Minimum value is the lowest detected value. Most data sets also included one or more non-detect results.

Notes:
1. The 0 to ≤ 3 ft data set for PAHs includes 39 samples from 0-0.5 ft analyzed by SIM; all other PAH data by conventional SVOC methods.

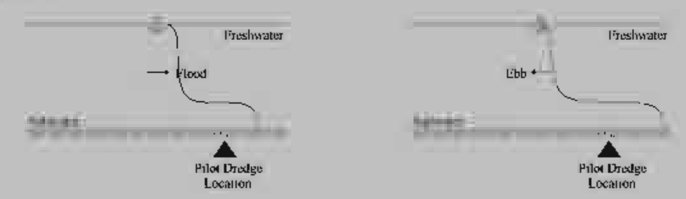
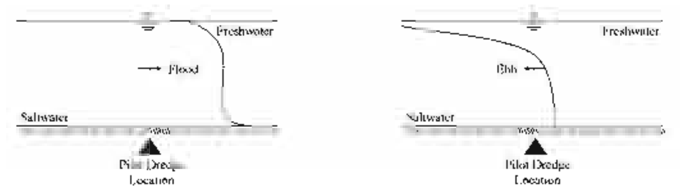
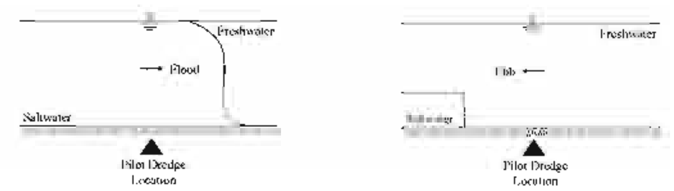
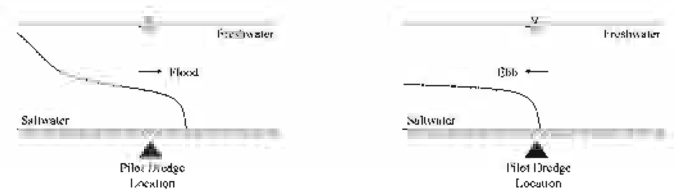
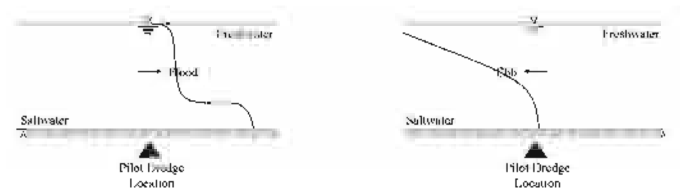
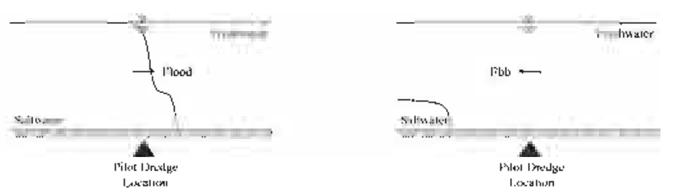
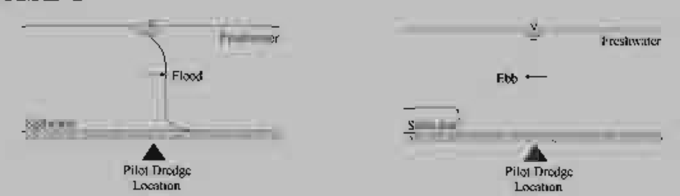
Table 2-3
Concentration Ranges and Averages for the Contaminants of Concern and Total Organic Carbon
Data from Sediment Coring Program, June 2004

Parameter	0 to 1 ft interval				1 to 2 ft interval				2 to 3 ft interval				0 to 3 ft interval composite (Note 3)			
	Det / n	Min	Max	Average	Det / n	Min	Max	Average	Det / n	Min	Max	Average	Det / n	Min	Max	Average
Organics (data in ug/kg)																
2,3,7,8-TCDD	5 / 5	0.29	0.63	0.46	5 / 5	0.29	0.72	0.53	5 / 5	0.37	1.90	1.27	15 / 15	0.29	1.90	0.75
PCBs - Sum of Coplanar Congeners	5 / 5	366	531	428	5 / 5	967	1,098	1,031	5 / 5	1,702	2,472	2,139	15 / 15	366	2,472	1,199.33
Total PCBs - Aroclors (STL)	5 / 5	1,100	1,920	1,656	5 / 5	2,330	3,800	3,346	5 / 5	5,100	7,400	6,600	15 / 15	1,100	7,400	3,867.33
Total PCBs - Aroclors (CLP/DESA)	6 / 15	ND	470	136	10 / 15	ND	2,800	543	9 / 15	ND	5,100	1,193	25 / 45	ND	5,100	624.00
Total PAHs (Note 1)	3 / 15	ND	35,820	6,848	8 / 15	ND	40,210	13,500	14 / 15	ND	66,500	29,910	25 / 45	ND	66,500	16,752.67
Total DDT (4,4' only)	15 / 15	59	1,100	195	15 / 15	46	246	105	15 / 15	53	379	165	45 / 45	46	1,100	155.00
Metals and Total Organic Carbon																
Lead (mg/kg)	15 / 15	210	330	281	15 / 15	320	560	451	15 / 15	450	1,100	647	45 / 45	210	1,100	459.67
Mercury (mg/kg)	15 / 15	1.7	3.5	2.3	15 / 15	2.6	5.5	4.2	15 / 15	2.8	12	5.1	45 / 45	1.7	12.0	3.87
Total Organic Carbon (mg/kg)	15 / 15	49,000	70,000	56,500	15 / 15	46,000	63,000	53,700	15 / 15	45,000	81,000	59,300	45 / 45	45,000	81,000	56,500

Parameter	3 to 4 ft interval			
	Det / n	Min	Max	Average
Organics (data in ug/kg)				
2,3,7,8-TCDD	5 / 5	1.4	2.5	1.9
PCBs - Sum of Coplanar Congeners	5 / 5	3,054	3,530	3,365
Total PCBs - Aroclors (STL)	5 / 5	8,400	12,200	9,600
Total PCBs - Aroclors (CLP/DESA)	8 / 8	400	780	550
Total PAHs (Note 1)	8 / 8	6,299	10,660	7,993
Total DDT (4,4' only)	8 / 8	30	48	37
Metals and Total Organic Carbon				
Lead (mg/kg)	8 / 8	540	850	631
Mercury (mg/kg)	8 / 8	5.4	7.8	6.8
Total Organic Carbon (mg/kg)	8 / 8	46,000	68,000	53,500

Data from samples collected June, 2004. See Data Evaluation Summary Report (TAMS/MPI, May 2005) for full description of samples and data.
Depth interval measured from top of sediment/water interface.
"Det" is number of detections; "n" is total number of data points (includes duplicates and validated and unvalidated data).
ND in "Minimum value" indicates analyte was not detected in one or more samples in this group.
Note 1: PAH sums are for the 17 'standard' PAH compounds. 3-4 ft cores also analyzed for 7 additional PAH compounds (see DESR, Table 4-3C); which added 1046 to 1647 ug/kg to the total.
Note 2: 3-4 interval cores were analyzed by commercial laboratory (5 samples by STL) and DESA (8 samples).
Note 3: Data for "0 to 3 ft composite" is derived mathematically from the data for individual 1-ft sections.
Aroclor analysis on the 15 samples from each 1-ft interval in 0-3 ft range were analyzed by a CLP laboratory (Mitkem).
For averaging purposes, 0 was used for ND results.

Table 4-1. Salt Wedge Characteristics

Tidal Range / Discharge	**Neap** < 4.9 ft (1.5 m)	**Mean** ≈ 4.9 ft (1.5 m) (Mean Range[(1)])	**Spring** > 5.6 ft (1.7 m) (Diurnal Range[(1)])
Average to Low < 1060 ft^3/s (30 m^3/s) [(2)]	**CASE 2**  *Flood:* **Highly stratified**[(4)]. Mostly vertical front diffused at the bottom. Reaches <1 km upstream of the site. Stratified at the site. *Ebb:* **Highly stratified**[(4)]. Diffused shape. The site remains stratified with no freshwater escaping to Newark Bay. *Occurred on 9/6 – 9/7 2004*[(*)]	 *Flood:* **Well-mixed**[(4)]. Vertical shape. Passes the site (>1 km). *Ebb:* **Partially mixed**[(4)]. The site remains mostly in saltwater with some freshwater escaping to Newark Bay on top. *Occurred on 9/3 – 9/4 2004*[(*)]	 *Flood:* **Well-mixed**[(4)]. Vertical shape. Passes the site (>1 km). *Ebb:* **Well-mixed**[(4)]. Gets pushed back to Newark Bay. *Occurred on 8/28 – 9/2 2004*[(*)]
Average to High > 1060 ft^3/s (30 m^3/s) [(2)] < 2825 ft^3/s (80 m^3/s) [(3)]	 *Flood:* **Partially mixed**[(4)]. Diffused shape. Freshwater remains on top extending to Newark Bay. *Ebb:* **Highly stratified**[(4)]. Freshwater flows to Newark Bay. The front extends up to the site. *Occurred on 9/9 – 9/10 2004*[(*)]	 *Flood:* **Highly stratified**[(4)]. Mostly vertical shape diffused at the bottom. Passes the site (<1 km). *Ebb:* **Partially mixed**[(4)]. Mostly vertical shape diffused at the top. The site remains mostly in saltwater with some freshwater escaping to Newark Bay on top. *Occurred on 8/22 – 8/23 2004*[(*)]	 *Flood:* **Well-mixed**[(4)]. Vertical shape. Passes the site (>1 km). *Ebb:* **Well-mixed**[(4)]. Gets pushed back to Newark Bay. *Occurred on 12/14 – 12/15 2004*[(*)(5)]
High > 2825 ft^3/s (80 m^3/s) [(3)]	 *Flood:* **Partially mixed**[(4)]. Diffused shape. Freshwater remains on top extending to Newark Bay. *Ebb:* **Highly stratified**[(4)]. Freshwater flows to Newark Bay. The front extends up to the site. *Occurred on 12/4 – 12/5 2004*[(*)(5)]	 *Flood:* **Well-mixed**[(4)]. Mostly vertical shape slightly diffused at the bottom. Moves up to the site. *Ebb:* **Well-mixed**[(4)]. Gets pushed back to Newark Bay. *Occurred on 9/19 – 9/20 2004*[(*)]	**CASE 1**  *Flood:* **Well-mixed**[(4)]. Vertical shape. Passes the site (<1 km). *Ebb:* **Well-mixed**[(4)]. Gets pushed back to Newark Bay. *Occurred on 9/30 – 10/1 2004*[(*)(+)(-)(5)]

[(1)] Data obtained from NOAA Bergen Point West Reach, NY Tide Station (No. 8519483).
[(2)] Average Daily Mean Flow. Data obtained by averaging daily mean flow values of every day in 107 years of record found in USGS PASSAIC RIVER AT LITTLE FALLS NJ Station (No. 01389500).
[(3)] 90% of the daily mean flows in record are less than this value. Data obtained by statistically analyzing 107 years of record found in USGS PASSAIC RIVER AT LITTLE FALLS NJ Station (No. 01389500).
[(4)] Per USACE, Engineering and Design - Tidal Hydraulics, Figure 2-2 (Reference 8).
[(5)] This time period was not included in the animated profile of salinity that was created by Rutgers University and presented on January 5, 2005. However, data was available in ASCII format through Rutgers University website.

[(*)] Measurements of conductivity, temperature and depth (CTD) available. [(+)] Dye test data available. [(-)] Shipboard survey data available.

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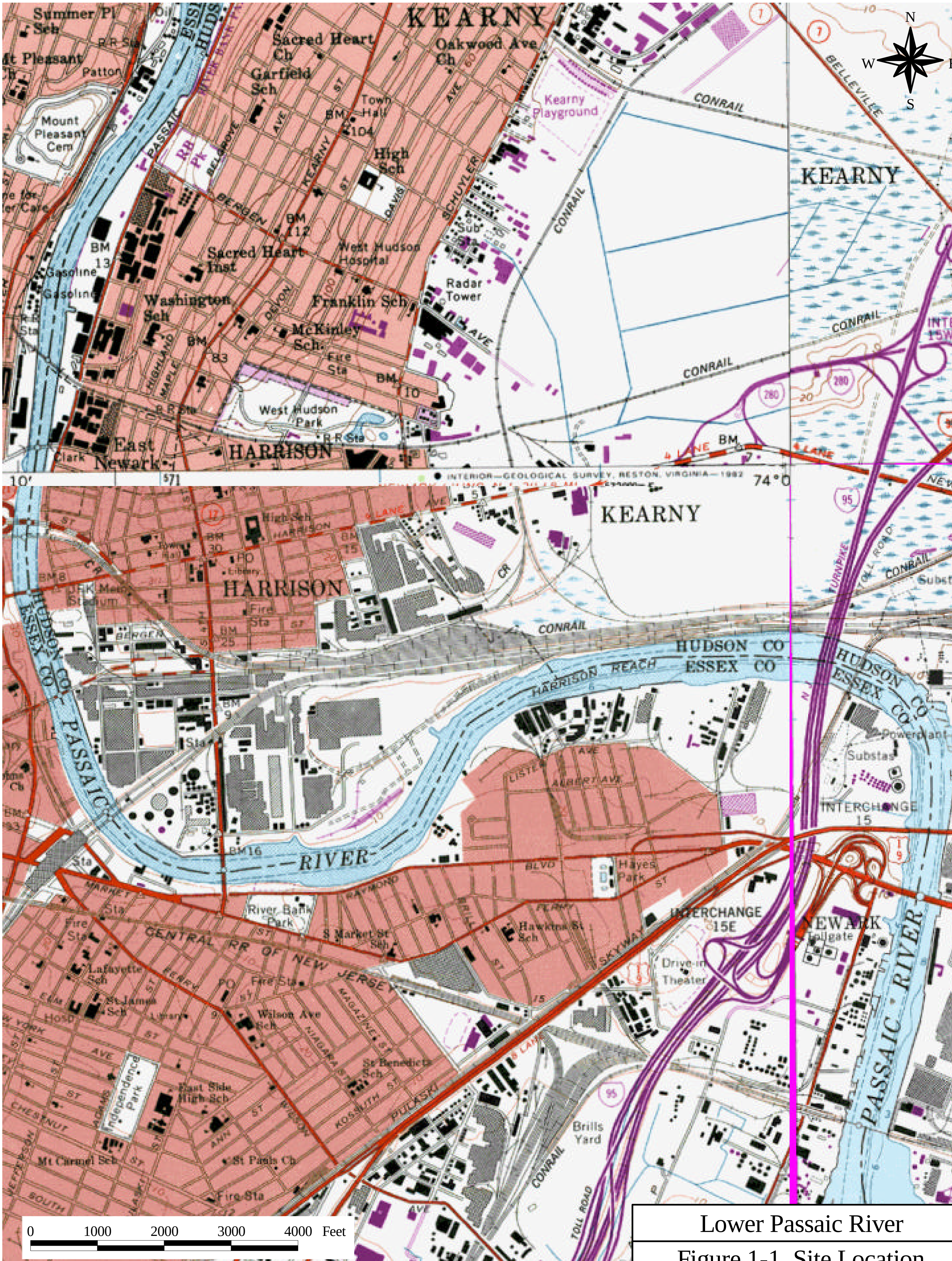
Table 6-1
Project Schedule for Environmental Dredging Pilot Study

Activity	Date
Submit Draft Project Plans	June 17, 2005
Receive Comments from Agencies	July - August, 2005
Submit Final Project Plans	November 22, 2005
Receive Dredging Contractor Bids	September, 2005
Award Dredging Contract	September 30, 2005
Initiate Pilot Study (field work)	November 30 – December 12, 2005
Submit Draft Study report	Spring 2006

Figures



Lower Passaic River

Figure 1-1. Site Location

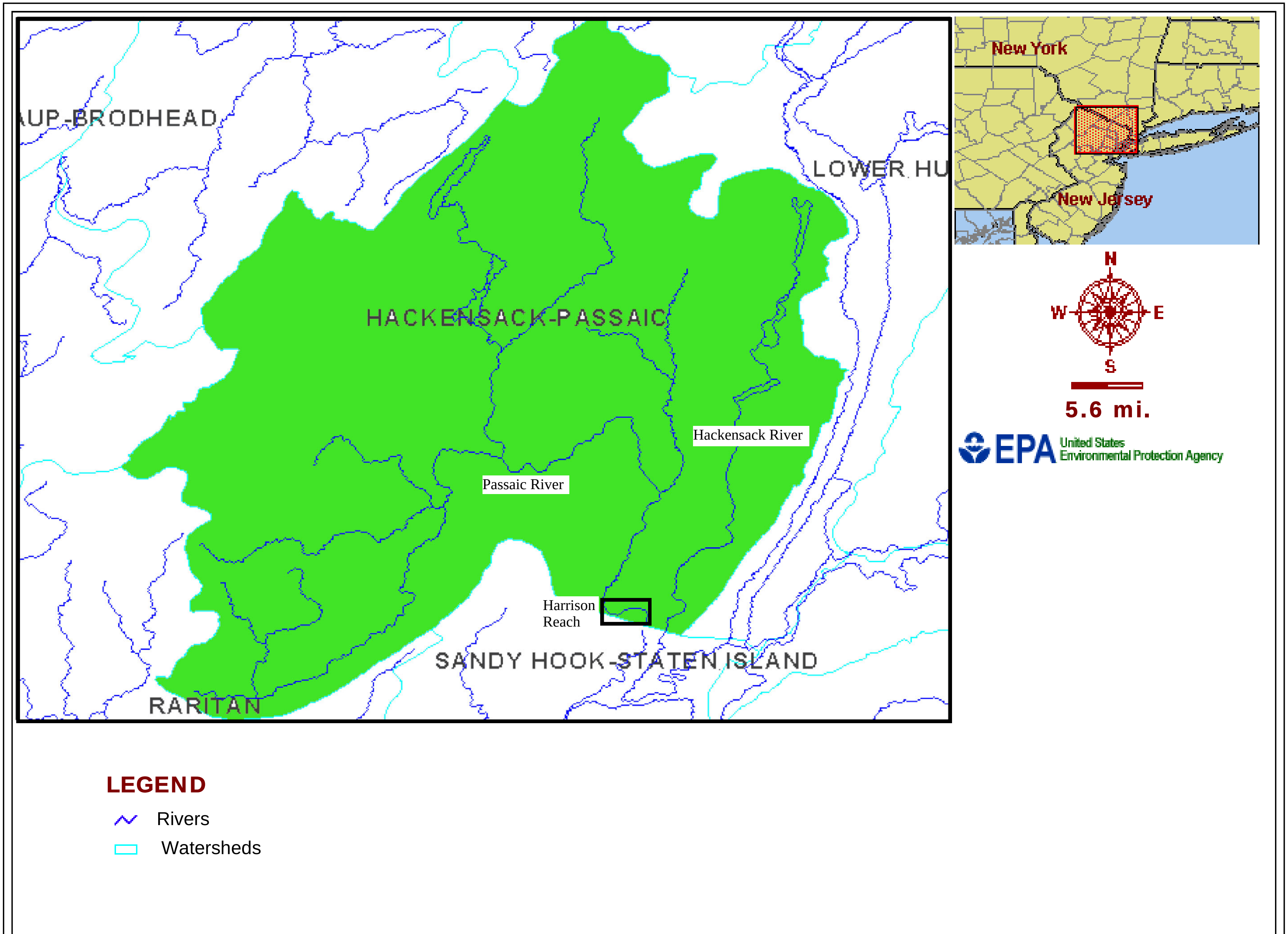
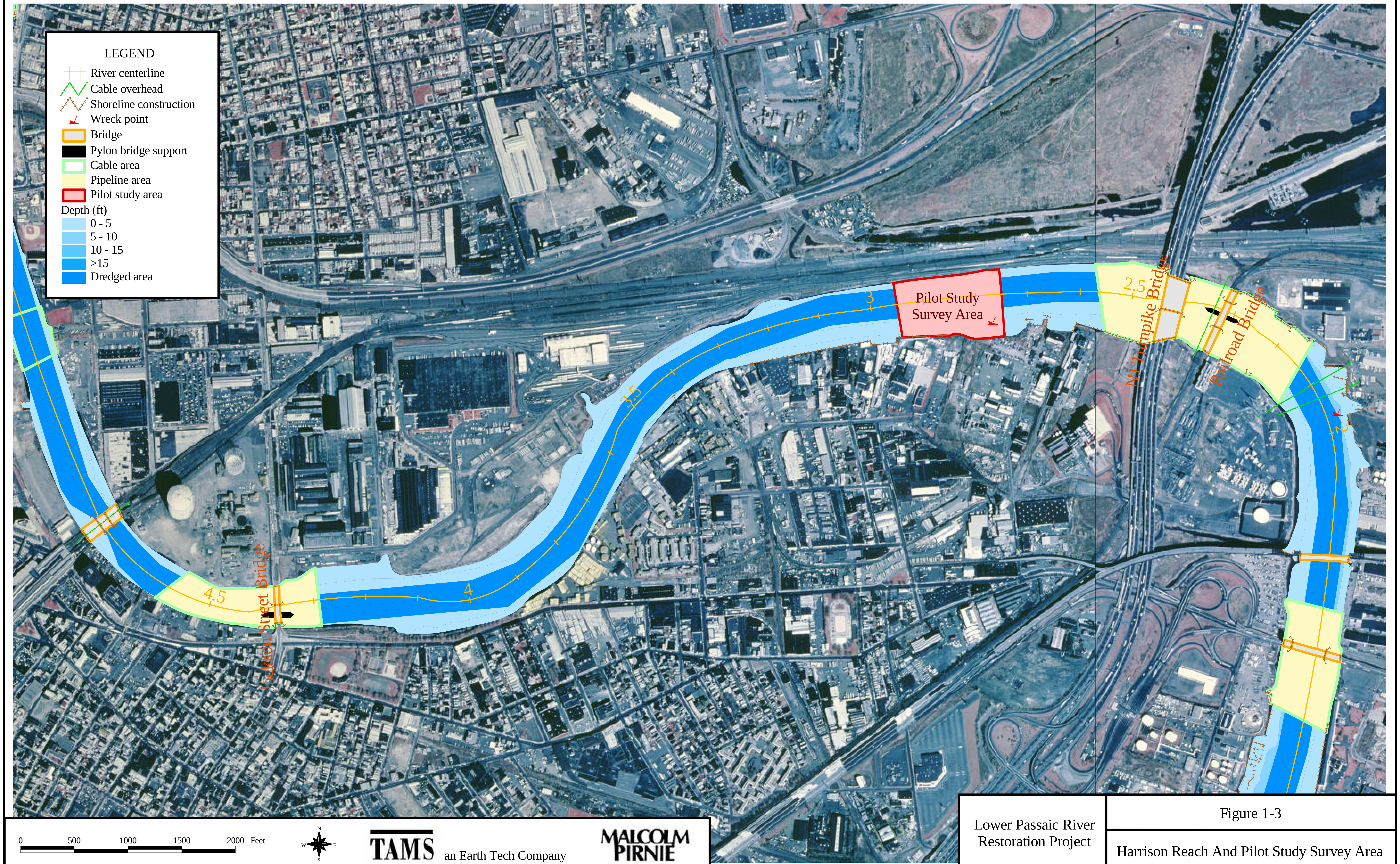


Figure 1-2
Hackensack - Passaic Watershed

Reference: USEPA Envriomapper at http://www.epa.gov/enviro/html/em/index.html



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Lower Passaic River Restoration Project

Figure 1-3

Harrison Reach And Pilot Study Survey Area

Figure 1-4
Organization Chart

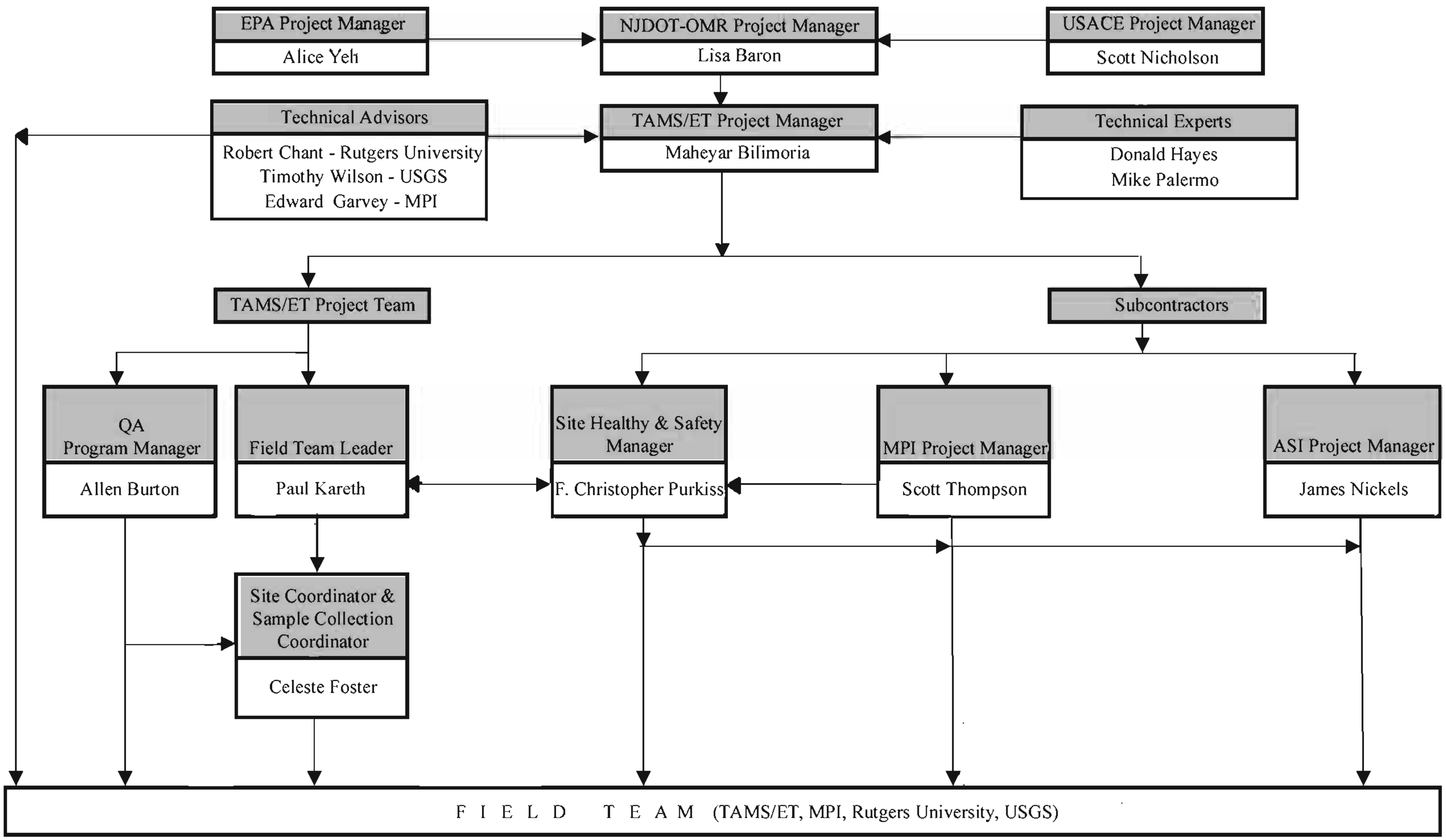


Figure 2-1
Photographs of the Bridges

Jackson Street Bridge

Jackson Street Bridge

Figure 2-1
Photographs of the Bridges

New Jersey Turnpike and Point-No-Point Conrail Bridges

Figure 2-2
Photographs of the Northern Shoreline Features

Northern Shoreline

Northern Shoreline

Figure 2-3
Photographs of the Southern Shoreline Features

Southern Shoreline and New Jersey Turnpike Bridge

Southern Shoreline

Figure 2-3
Photographs of the Southern Shoreline Features

Southern Shoreline and Blanchard Street Dock

Southern Shoreline

Figure 2-3
Photographs of the Southern Shoreline Features

Southern Shoreline

Southern Shoreline

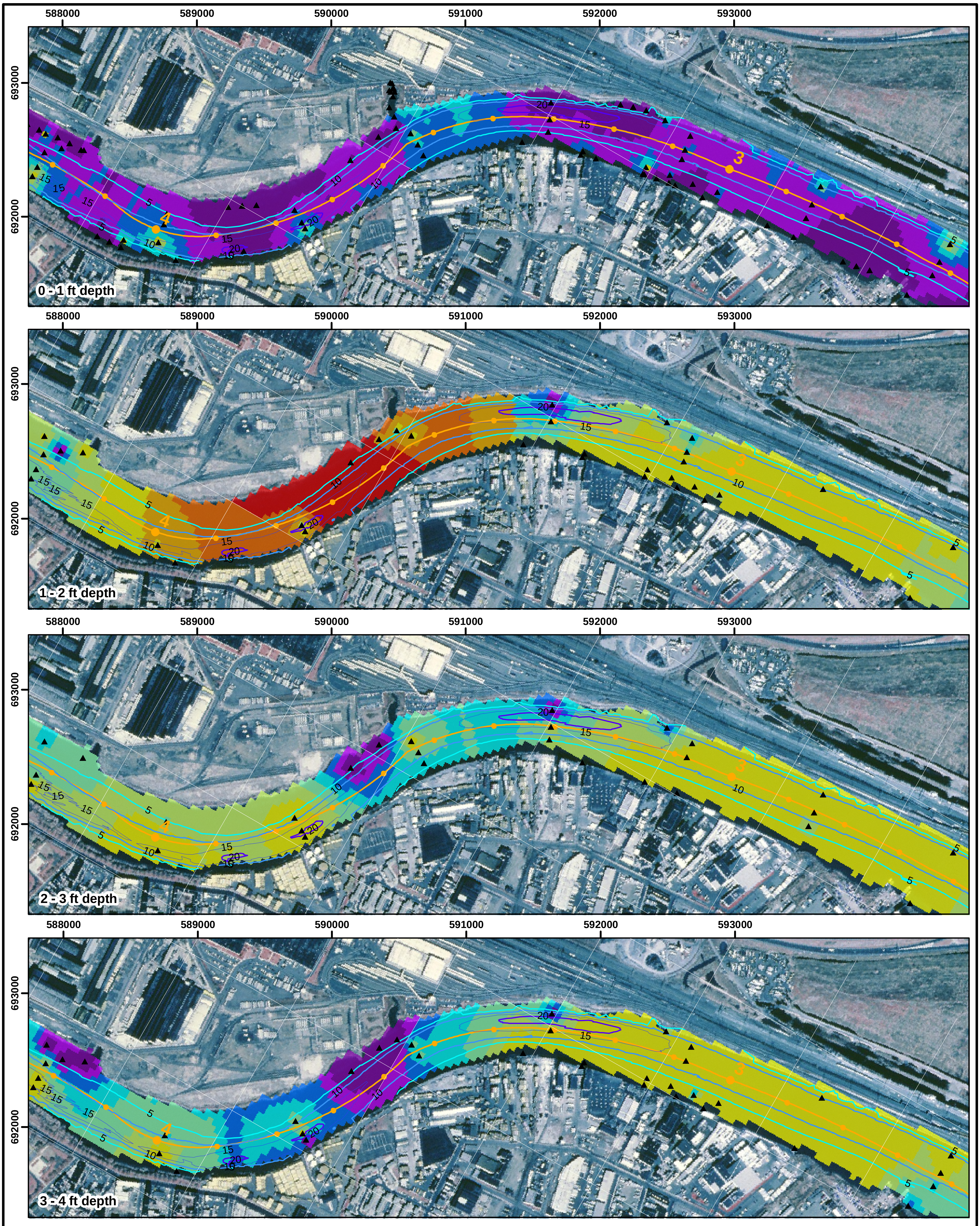
Figure 2-3
Photographs of the Southern Shoreline Features

Southern Shoreline

Southern Shoreline

Figure 2-3
Photographs of the Southern Shoreline Features

Southern Shoreline and Diamond Alkali Superfund Site



N

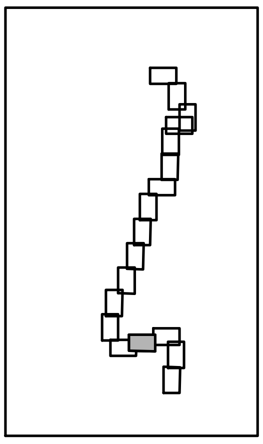
0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

Legend

- ▲ Lead Sample Locations
- Passaic River Centerline
  - 1-Mile segment
  - 1/10-Mile segment
- Bathymetry (ft below MLW)
  - 5
  - 10
  - 15
  - 20
  - 25
  - 30

Lead (ug/Kg)
- 0 - 250,000
- 250,001 - 300,000
- 300,001 - 350,000
- 350,001 - 400,000
- 400,001 - 450,000
- 450,001 - 500,000
- 500,001 - 1,000,000
- 1,000,001 - 1,500,000
- 1,500,001 - 2,000,000
- 2,000,001 - 14,000,000



Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

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Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_Lead_SampleLocations_depth.mxd)
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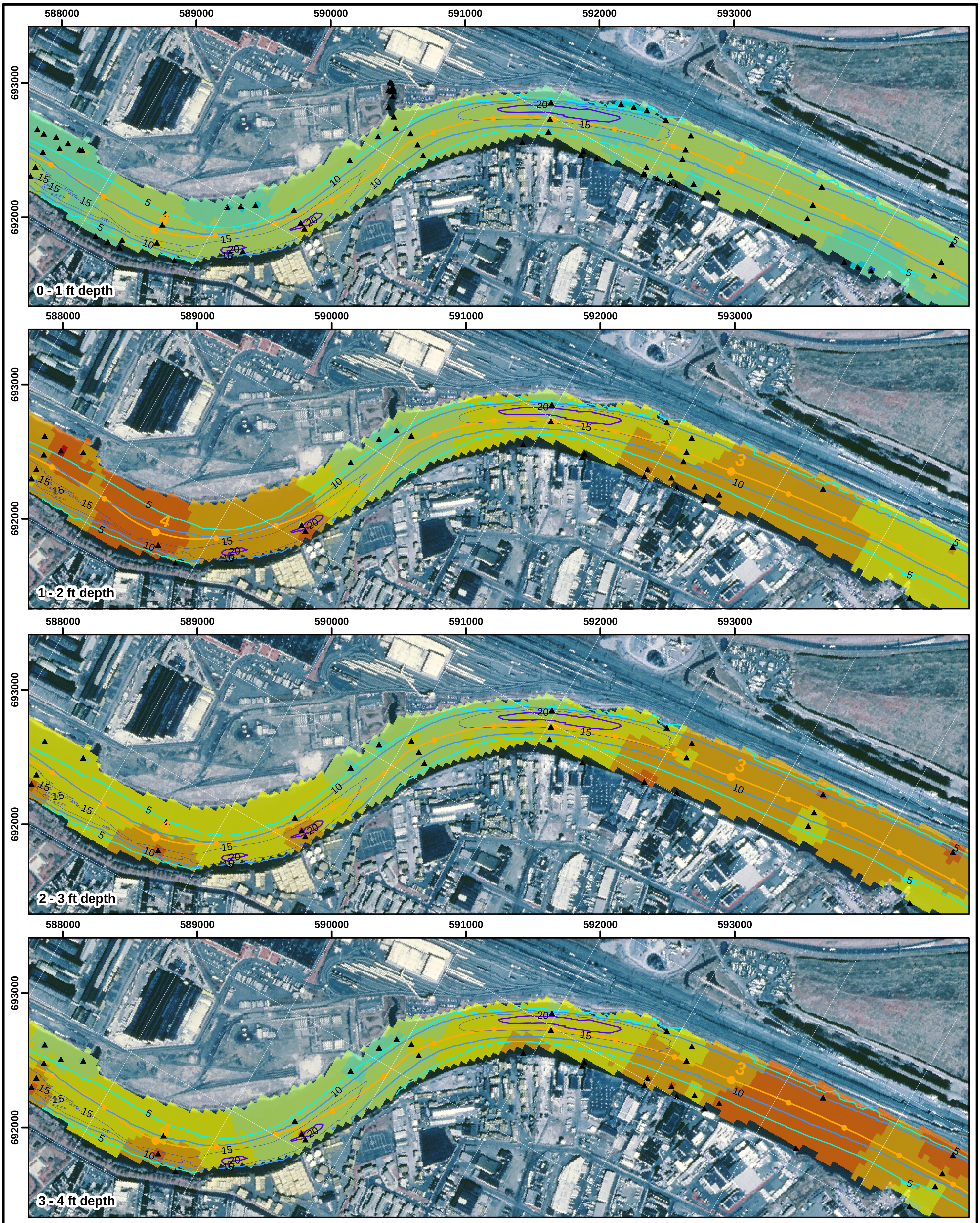
FIGURE 2-4a
MILE 2.7 - 4.1: HARRISON REACH LEAD SEDIMENT DATA 0-4'



N

0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

Legend

- ▲ Mercury Sample Locations
- Passaic River Centerline
  - 1-Mile segment
  - 1/10-Mile segment
- Bathymetry (ft below MLW)
  - 5
  - 10
  - 15
  - 20
  - 25
  - 30

Mercury (ug/Kg)
- 0 - 10
- 11 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 7,500
- 7,501 - 10,000
- 10,001 - 17,500
- 17,501 - 25,000

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Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_Mercury_SampleLocations_depth.mxd)
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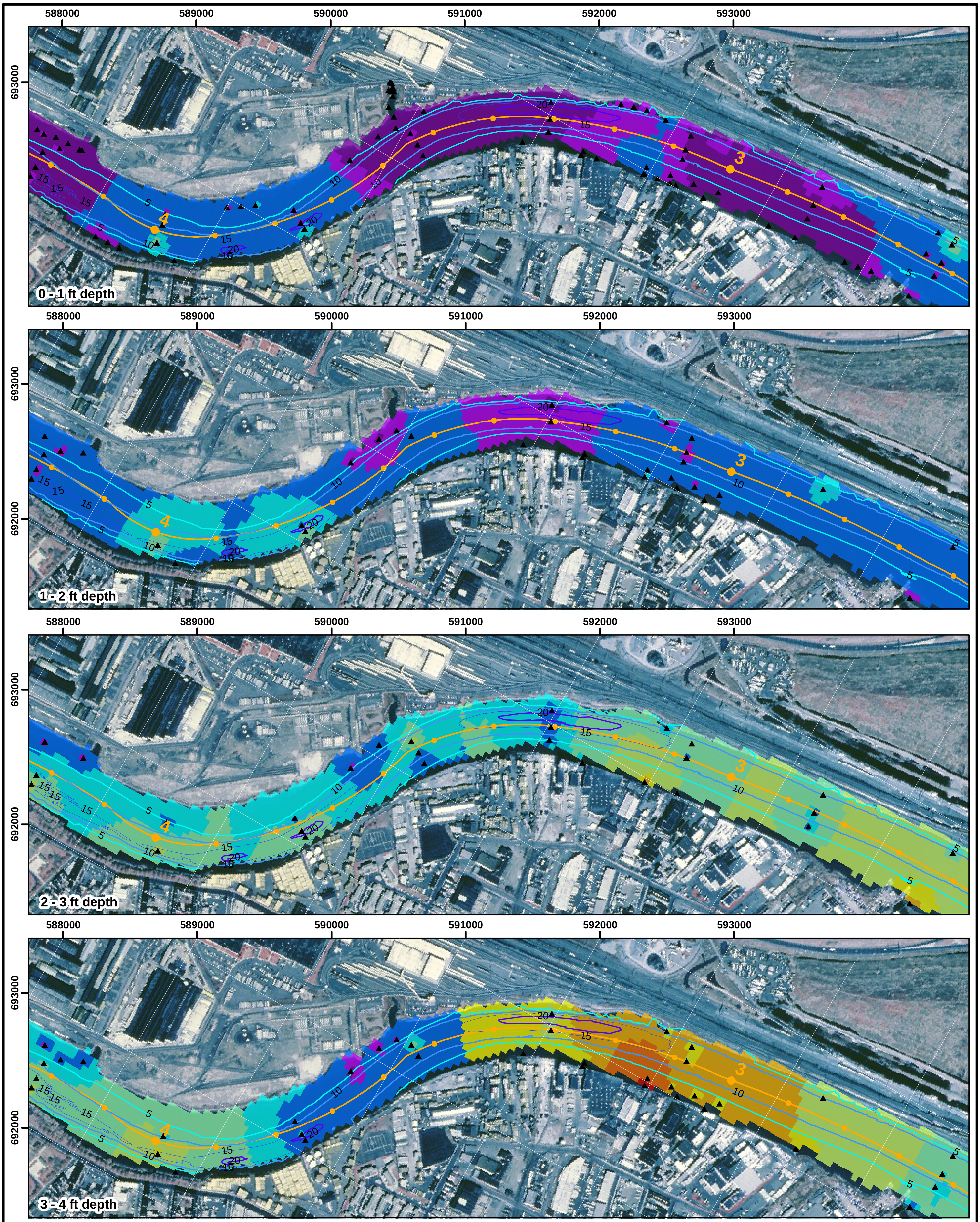
FIGURE 2-4b
MILE 2.7 - 4.1: HARRISON REACH
MERCURY SEDIMENT DATA 0-4'



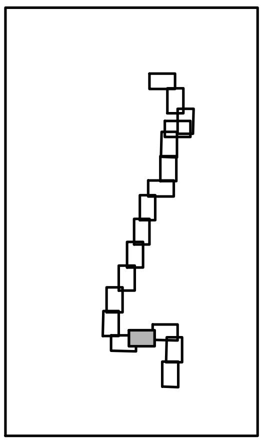
N

0 400 800 1,600 Feet

1 inch equals 800 feet

Legend

▲ Dioxin Sample Locations	Dioxin (ug/Kg)
Passaic River Centerline	0.0 - 0.5
1-Mile segment	0.6 - 1
1/10-Mile segment	1.1 - 3
Bathymetry (ft below MLW)	3.1 - 5
5	5.1 - 10
10	10.1 - 30
15	30.1 - 50
20	50.1 - 100
25	100.1 - 300
30	300.1 - 600



Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

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Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_Dioxin_SampleLocations_depth.mxd)
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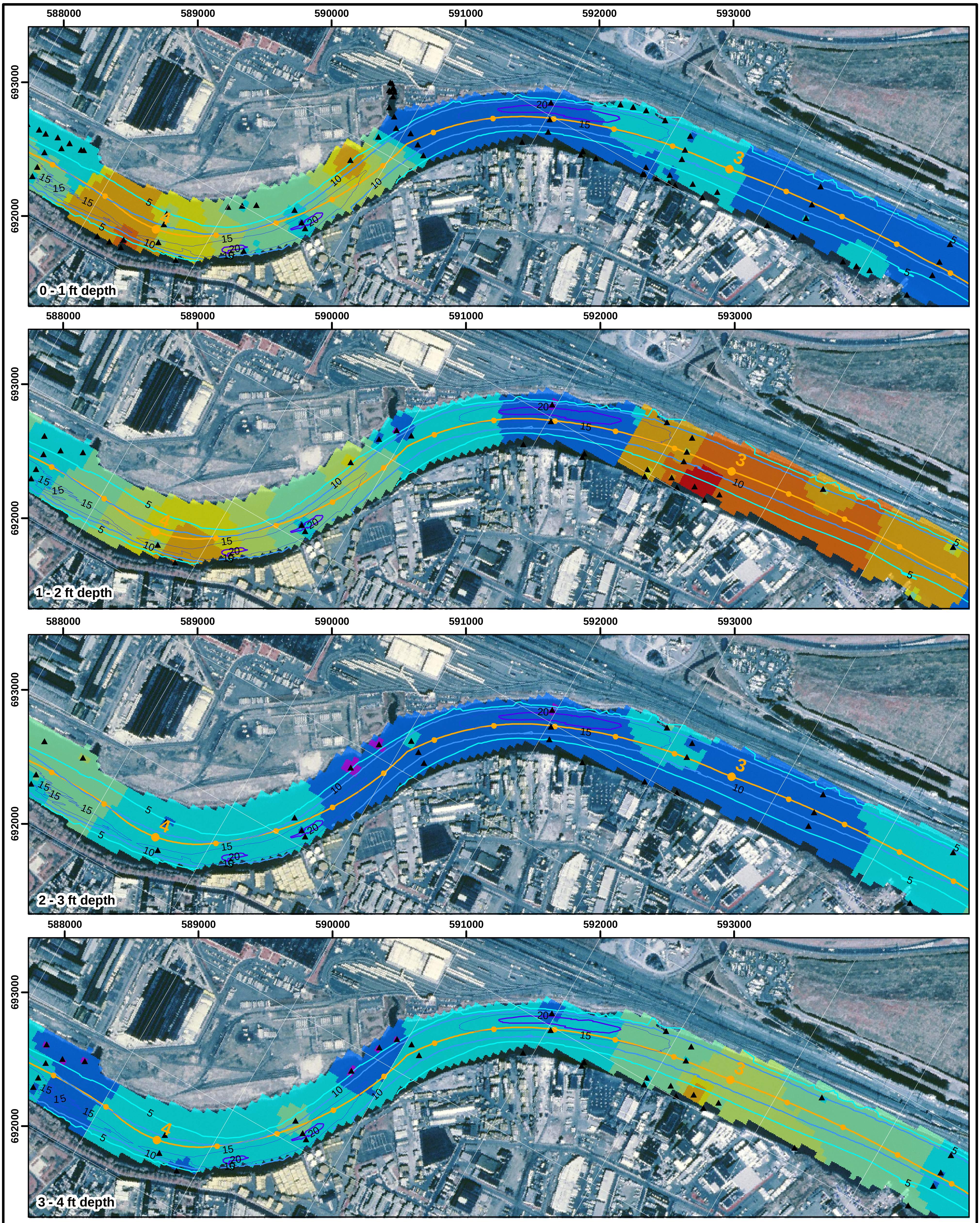
FIGURE 2-4c
MILE 2.7 - 4.1: HARRISON REACH
2,3,7,8-TCDD SEDIMENT DATA 0-4'



0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

Legend

- ▲ Total PAH Sample Locations
- Passaic River Centerline
  - 1-Mile segment
  - 1/10-Mile segment
- Bathymetry (ft below MLW)
  - 5
  - 10
  - 15
  - 20
  - 25
  - 30

Total PAH (ug/Kg)

- 0 - 1,000
- 1,001 - 10,000
- 10,001 - 25,000
- 25,001 - 50,000
- 50,001 - 100,000
- 100,001 - 150,000
- 150,001 - 200,000
- 200,001 - 500,000
- 500,001 - 1,000,000
- 1,000,001 - 3,735,000

Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

US Army Corps of Engineers

MALCOLM PIRNIE

TAMS

Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_TotalPAH_SampleLocations_depth.mxd)
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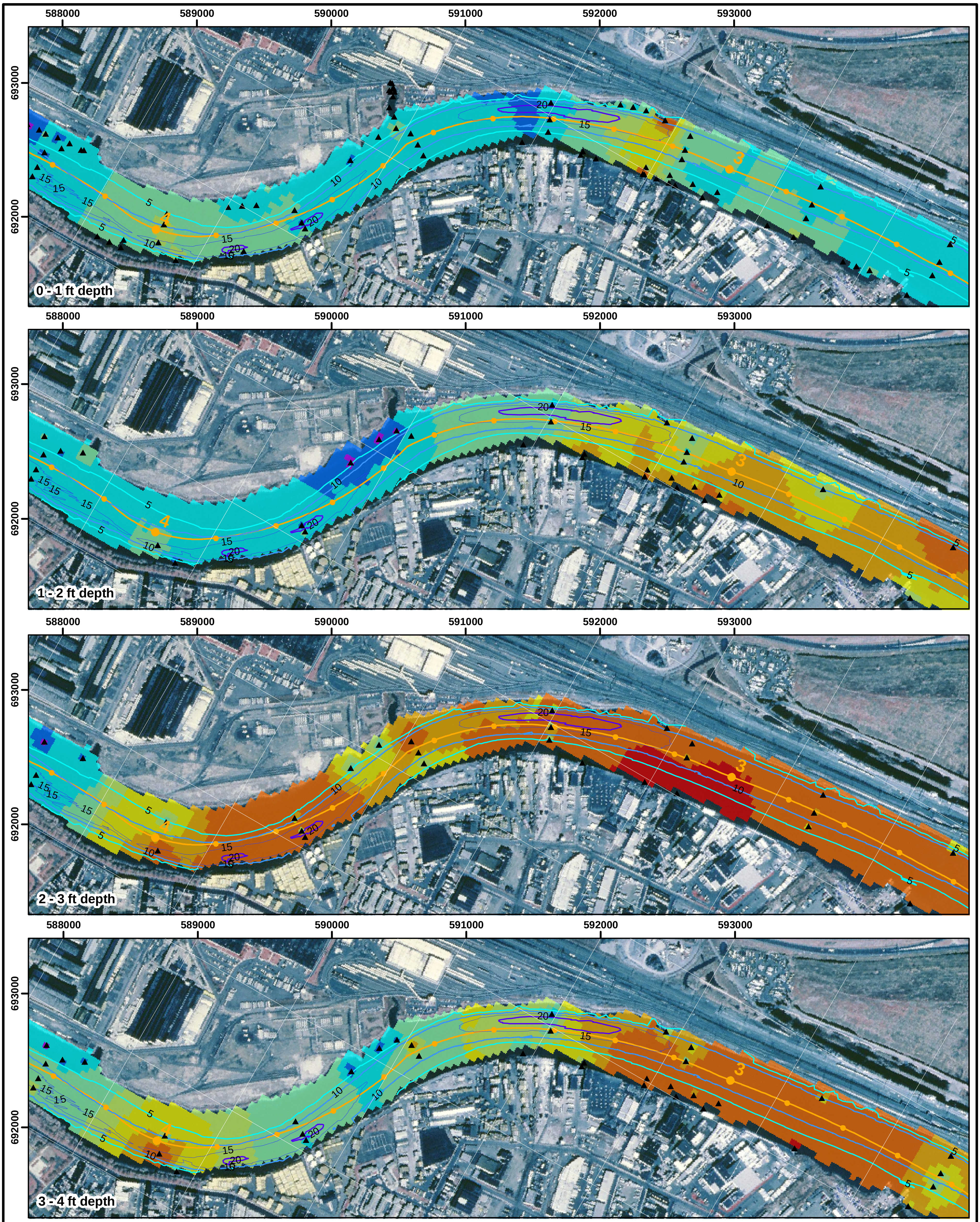
FIGURE 2-4d
MILE 2.7 - 4.1: HARRISON REACH
TOTAL PAHs SEDIMENT DATA 0-4'



N

0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

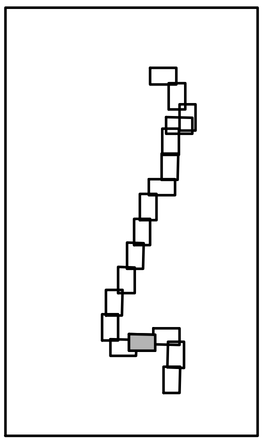
Legend

▲ Total DDT Sample Locations

Passaic River Centerline
- 1-Mile segment
- 1/10-Mile segment

Bathymetry (ft below MLW)
- 5
- 10
- 15
- 20
- 25
- 30

Total DDT (ug/Kg)
- 0 - 10
- 11 - 50
- 51 - 100
- 101 - 200
- 201 - 400
- 401 - 600
- 601 - 800
- 801 - 1,000
- 1,001 - 5,000
- 5,001 - 16,500



Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

US Army Corps of Engineers

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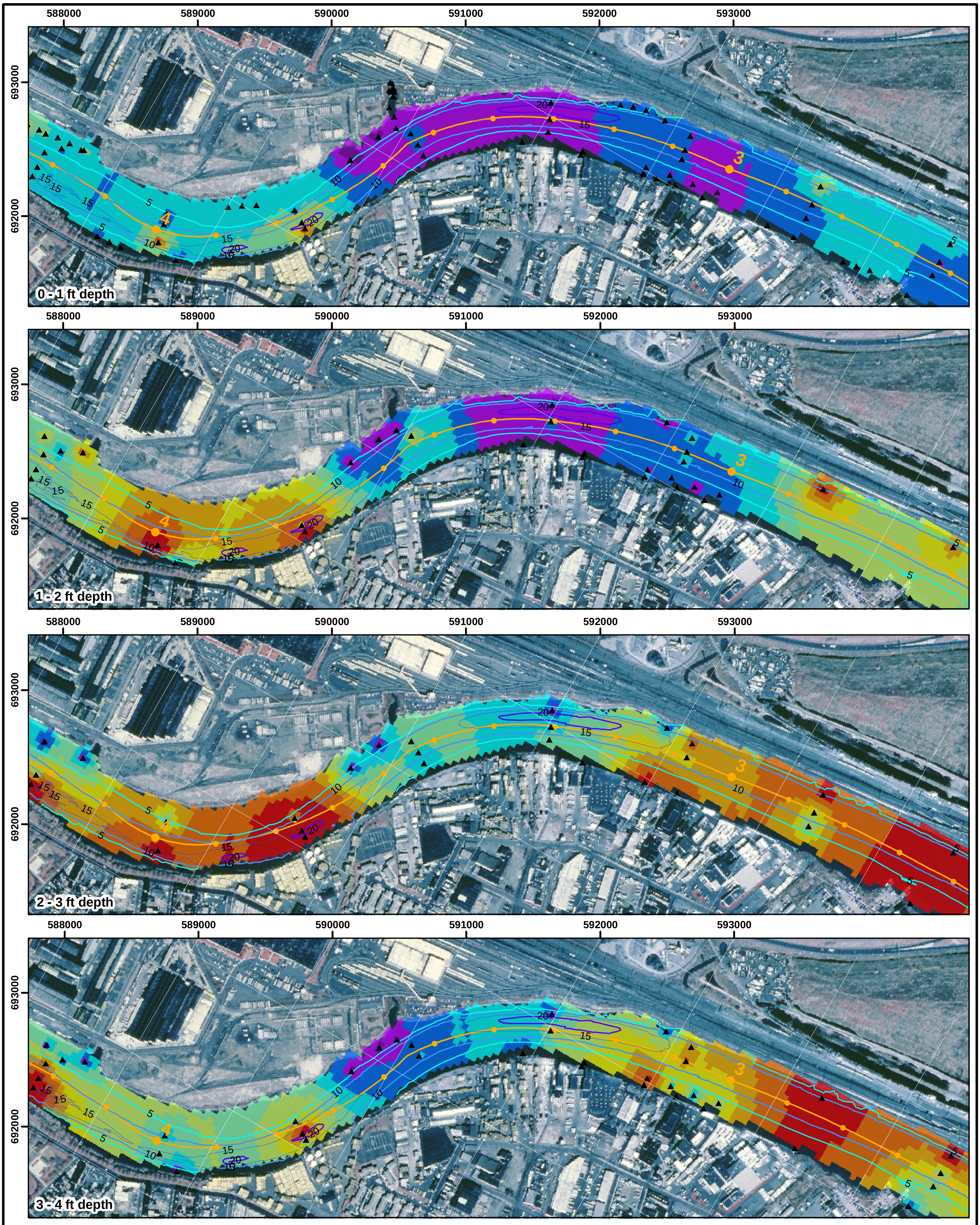
TAMS
AN EARTH TECH COMPANY

Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\ MapDocuments\HarrisonReach_TotalDDT_SampleLocations_depth.mxd) 11/12/2003 -- 11:15:02 AM

FIGURE 2-4e
MILE 2.7 - 4.1: HARRISON REACH
TOTAL DDT SEDIMENT DATA 0-4'



N

0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

Legend

▲ Total PCB (Congener) Sample Locations

Passaic River Centerline

1-Mile segment

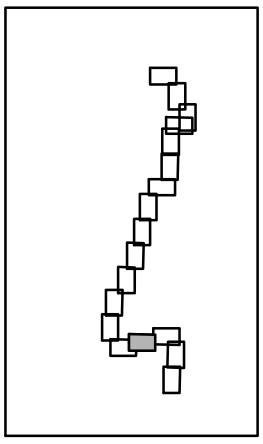
1/10-Mile segment

Bathymetry (ft below MLW)

- 5
- 10
- 15
- 20
- 25
- 30

Total PCB (ug/Kg)

- 0 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300
- 301 - 350
- 351 - 400
- 401 - 500
- 501 - 3,500



Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

US Army Corps of Engineers

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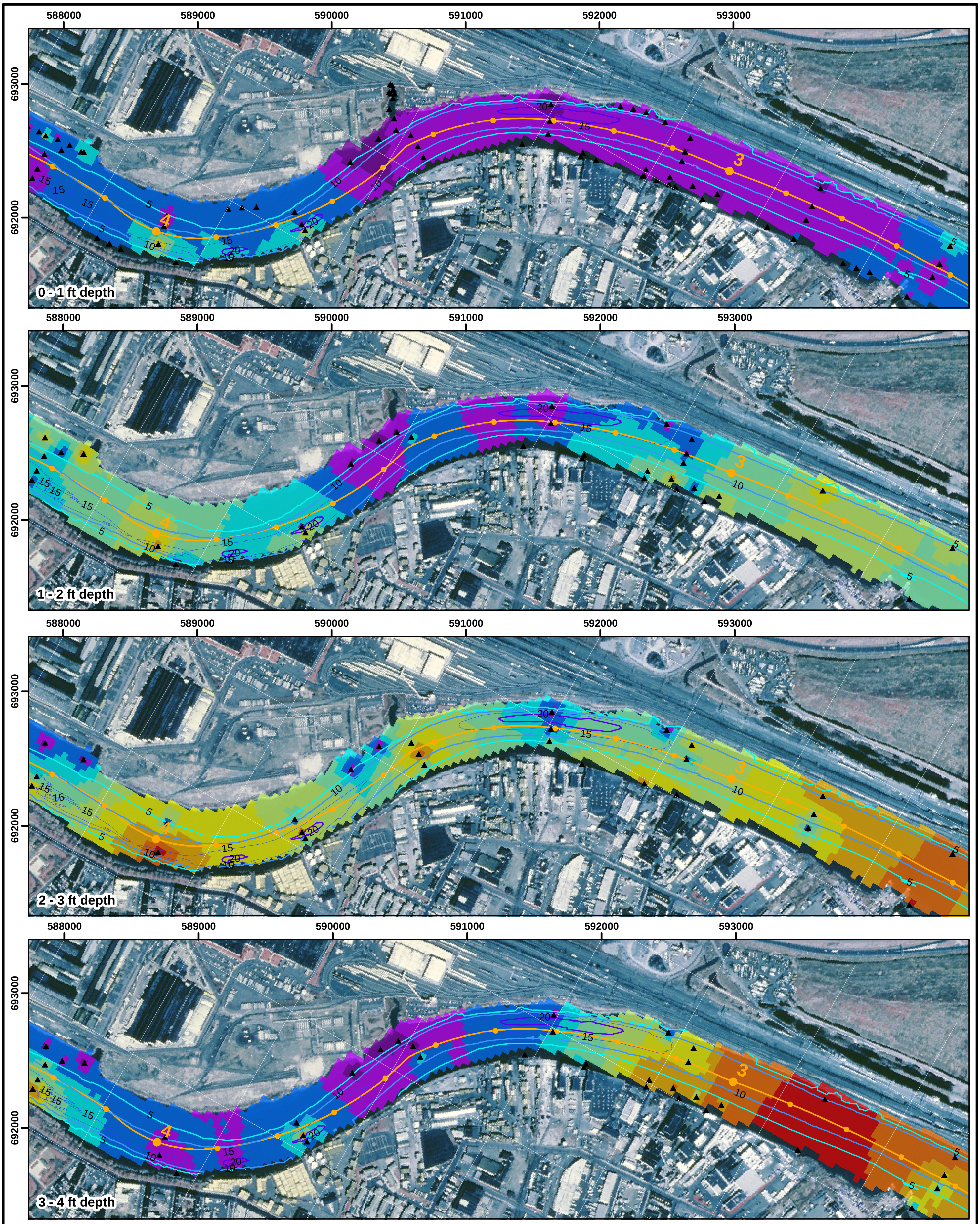
TAMS

Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_TotalPCB_SampleLocations_depth.mxd)
11/12/2003 -- 12:10:07 PM

FIGURE 2-4f
MILE 2.7 - 4.1: HARRISON REACH
TOTAL PCB (Coplanar Congeners) SEDIMENT DATA 0-4'



0 400 800 1,600 2,400 Feet

1 inch equals 800 feet

Legend

▲ Total PCB (Aroclors) Sample Locations

Passaic River Centerline

1-Mile segment

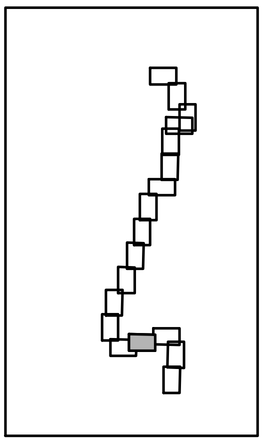
1/10-Mile segment

Bathymetry (ft below MLW)

5
10
15
20
25
30

Total PCB (ug/Kg)

0 - 500
501 - 1,000
1,001 - 1,500
1,501 - 2,000
2,001 - 2,500
2,501 - 3,000
3,001 - 4,000
4,001 - 6,000
6,001 - 10,000
10,001 - 36,000



Notes:
1. Sediment data from Terra Solutions, Inc. database Version 4.
2. Digital orthophotography acquired from the NJDEP.
3. Bathymetry - Contours based on 2002 survey by NY District Corps of Engineers.
4. Samples interpolated with inverse distance weighting.
5. Map Projection: New Jersey State Plane Feet NAD83.

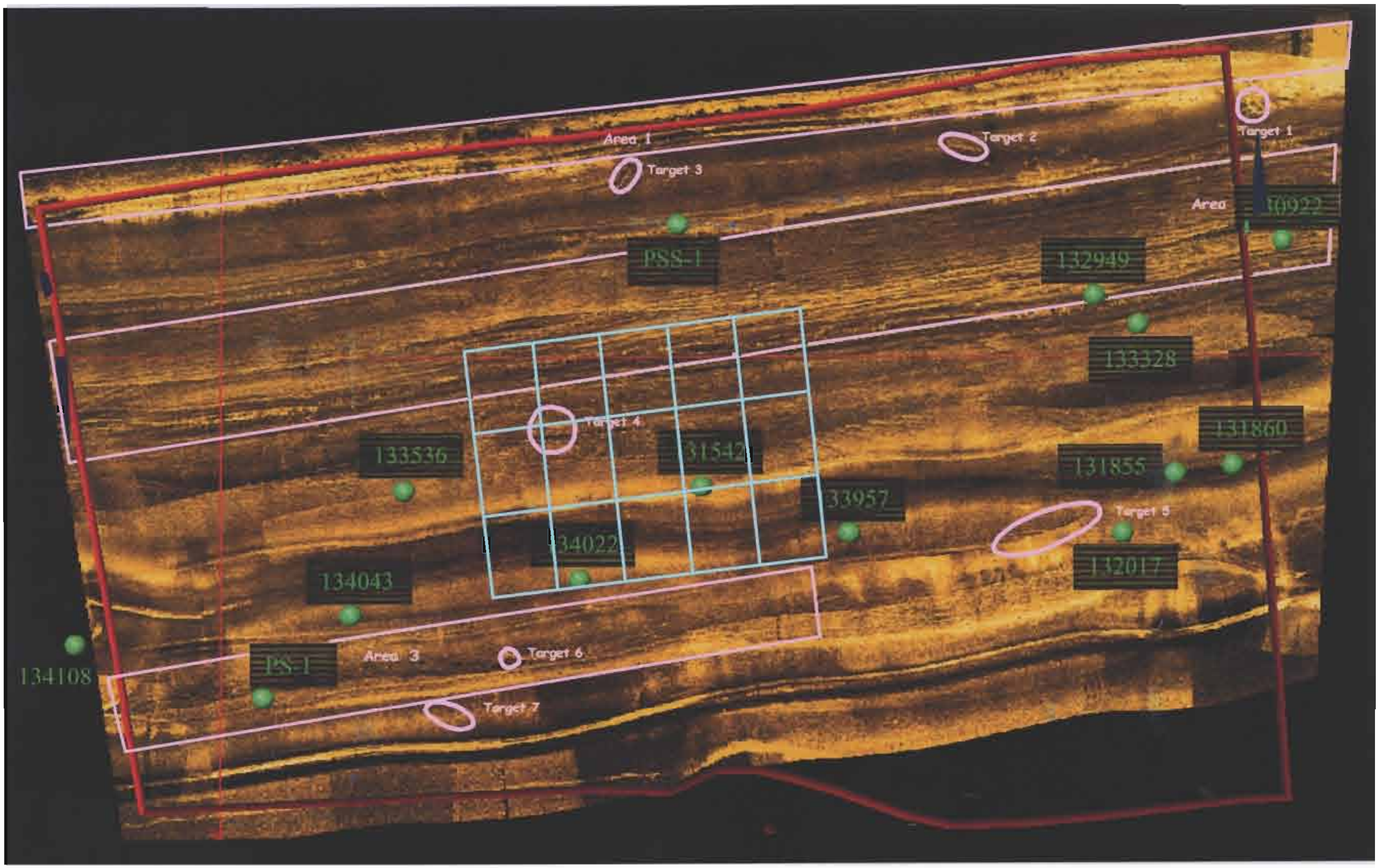
US Army Corps of Engineers

MALCOLM PIRNIE

TAMS AN EARTH TECH COMPANY

Map Document: (S:\Projects\0285924\Maps_3473003_TAMS\MapDocuments\HarrisonReach_TotalPCB_SampleLocations_depth.mxd)
11/12/2003 -- 12:10:07 PM

FIGURE 2-4g
MILE 2.7 - 4.1: HARRISON REACH
TOTAL PCB (Aroclors) SEDIMENT DATA 0-4'



LEGEND

- Magnetic anomalies and sub-bottom targets
- Side scan sonar targets and areas
- Sediment coring grid

N

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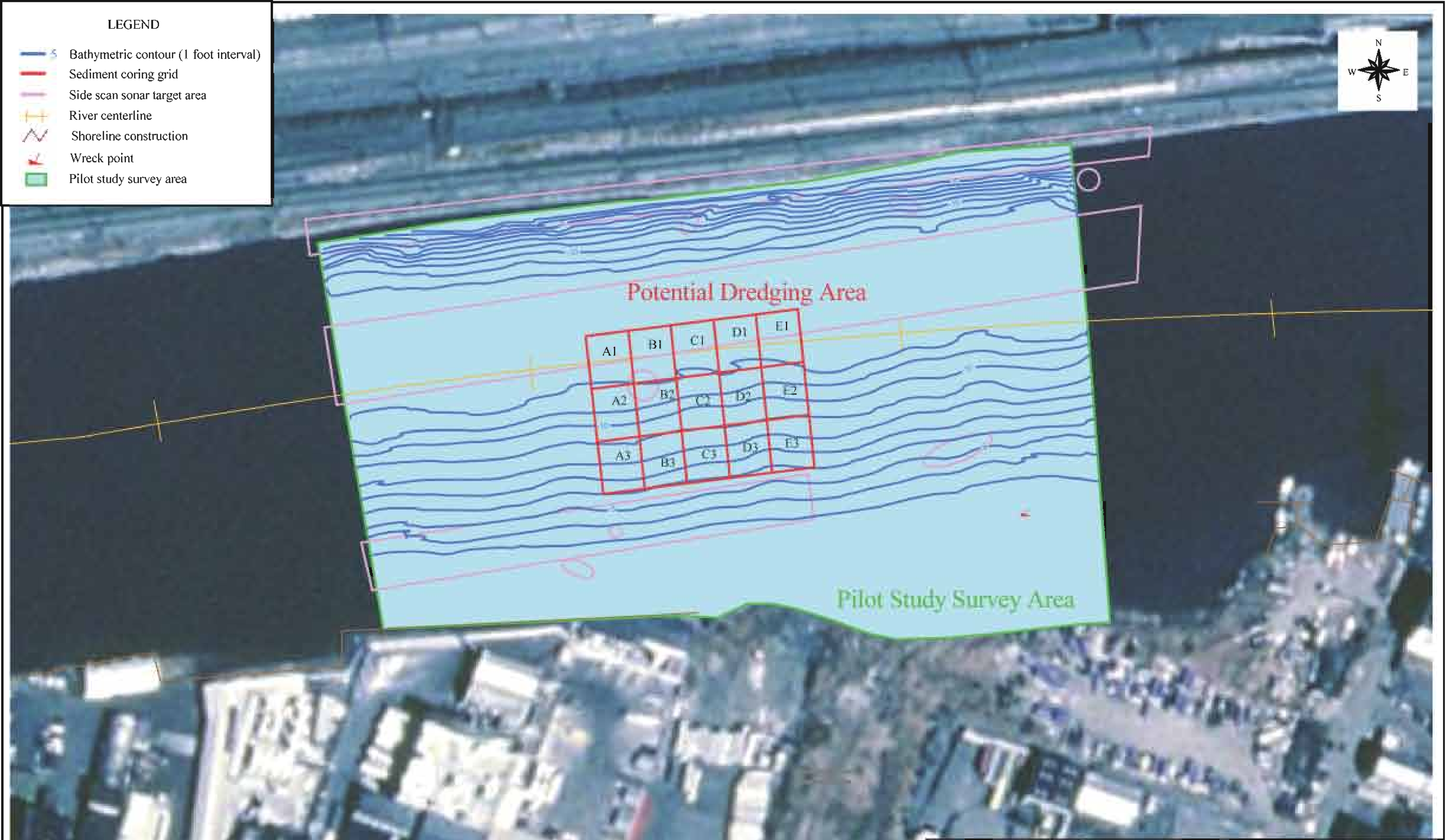
Lower Passaic River Restoration Project	Figure 2-5
	Magnetic Anomalies and Sub-bottom Profiler Targets Overlaid on Side Scan Sonar Targets and Mosaic



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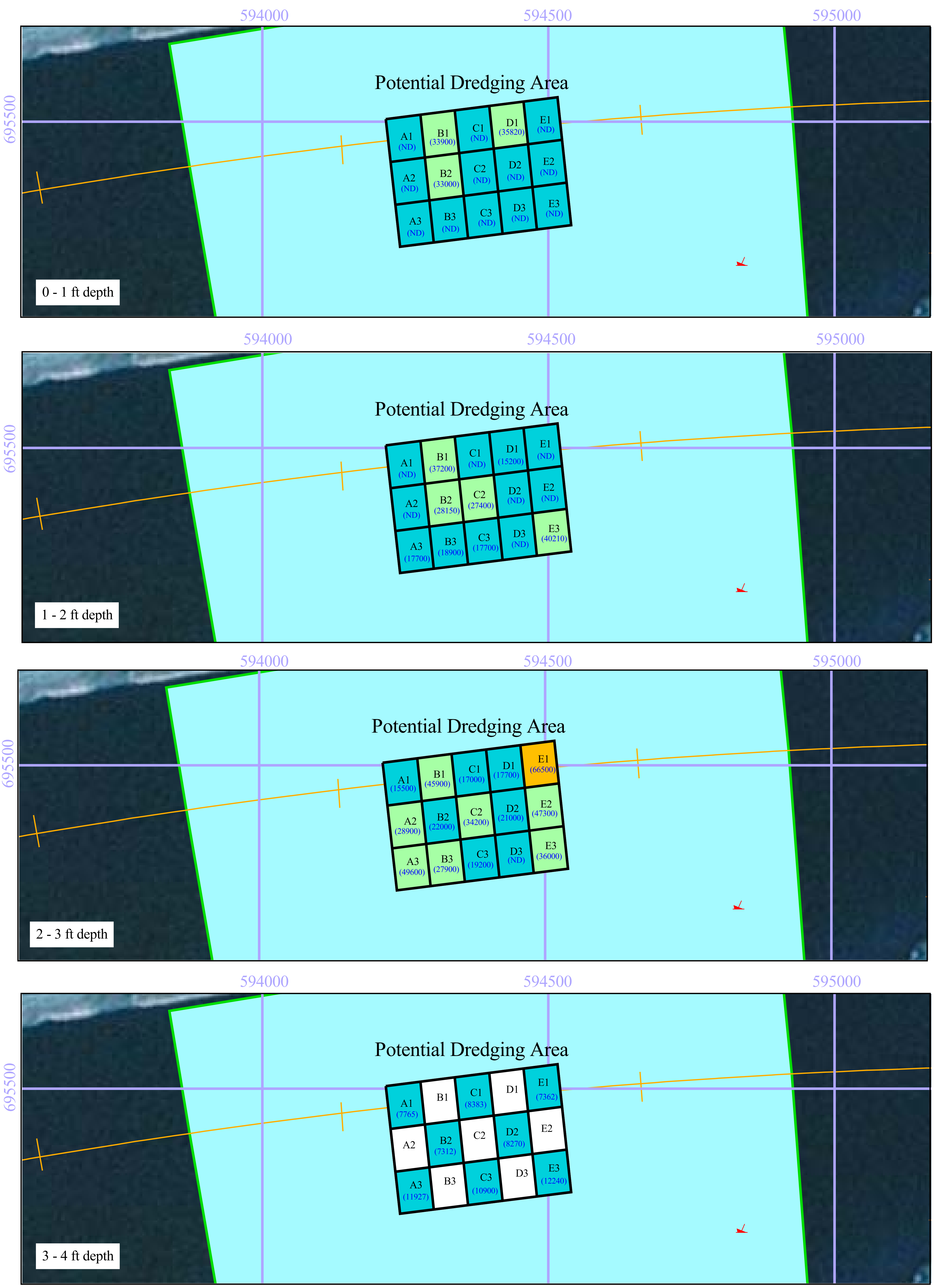
Lower Passaic River Restoration Project

Figure 2-6

Potential Dredging Area and Sediment Coring Grid



LEGEND

Total PAH concentration (ug/kg)

- < 25000
- 25000 - 49999
- 50000 - 74900
- ≥ 75000
- Sample Not Analyzed

- C1 — Sediment coring grid
- (22000) — Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area

Note: See Table 4-3

N W E S

0 50 100 150 200 250 300 Feet

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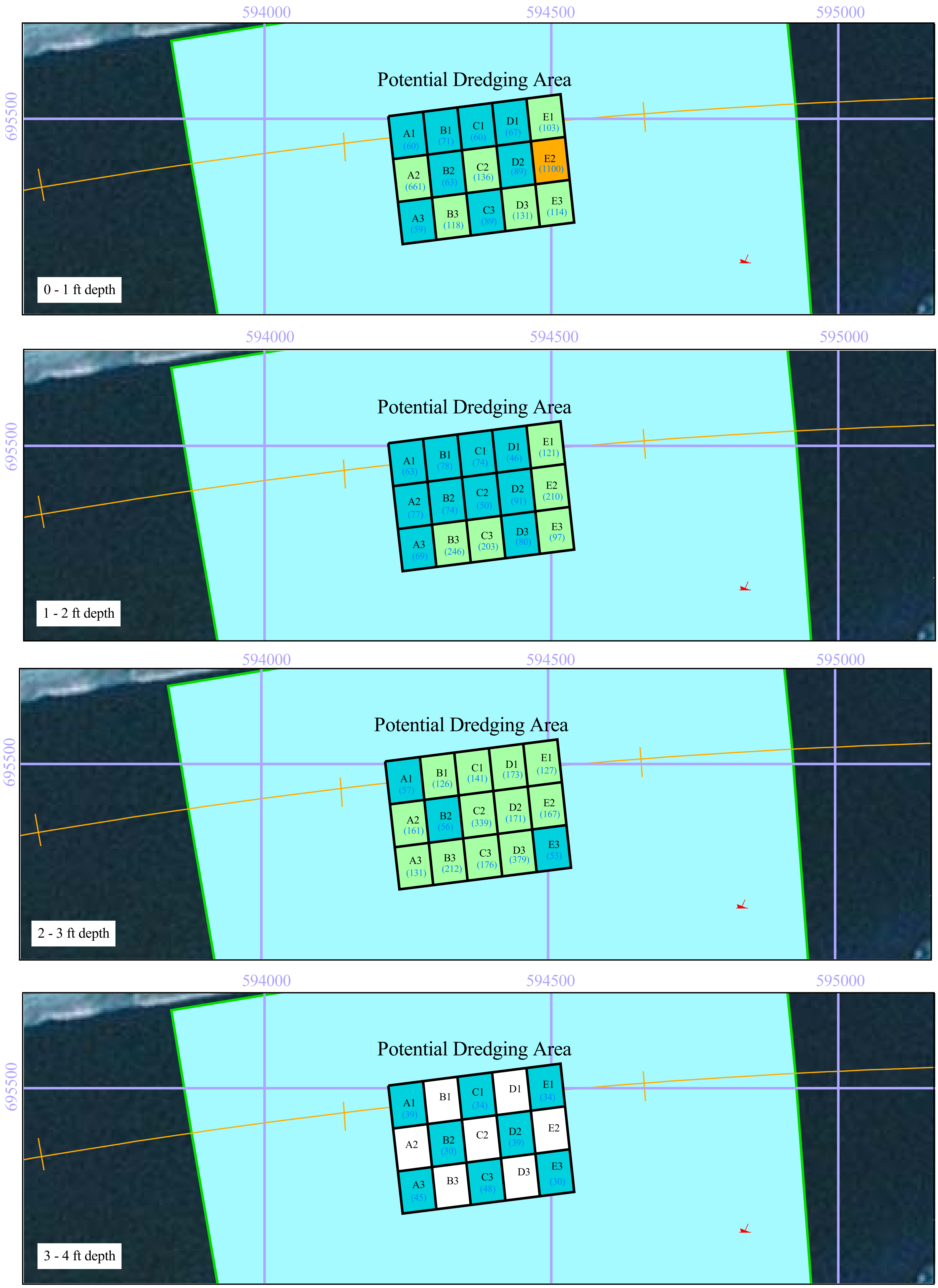
Lower Passaic River Restoration Project	Figure 2-7
	Total PAH Concentrations within Potential Dredging Area



LEGEND

Total DDT concentration (ug/kg)
- < 100
- 100 - 999
- 1000 - 9999
- ≥ 10000
- Sample Not Analyzed

- C1 Sediment coring grid
- (2596) Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area

Notes: See Table 4-4
Total DDT is the sum of valid detections of 4,4'DDD, 4,4'-DDE, and 4,4'-DDT.

N W E S

0 50 100 150 200 250 300 Feet

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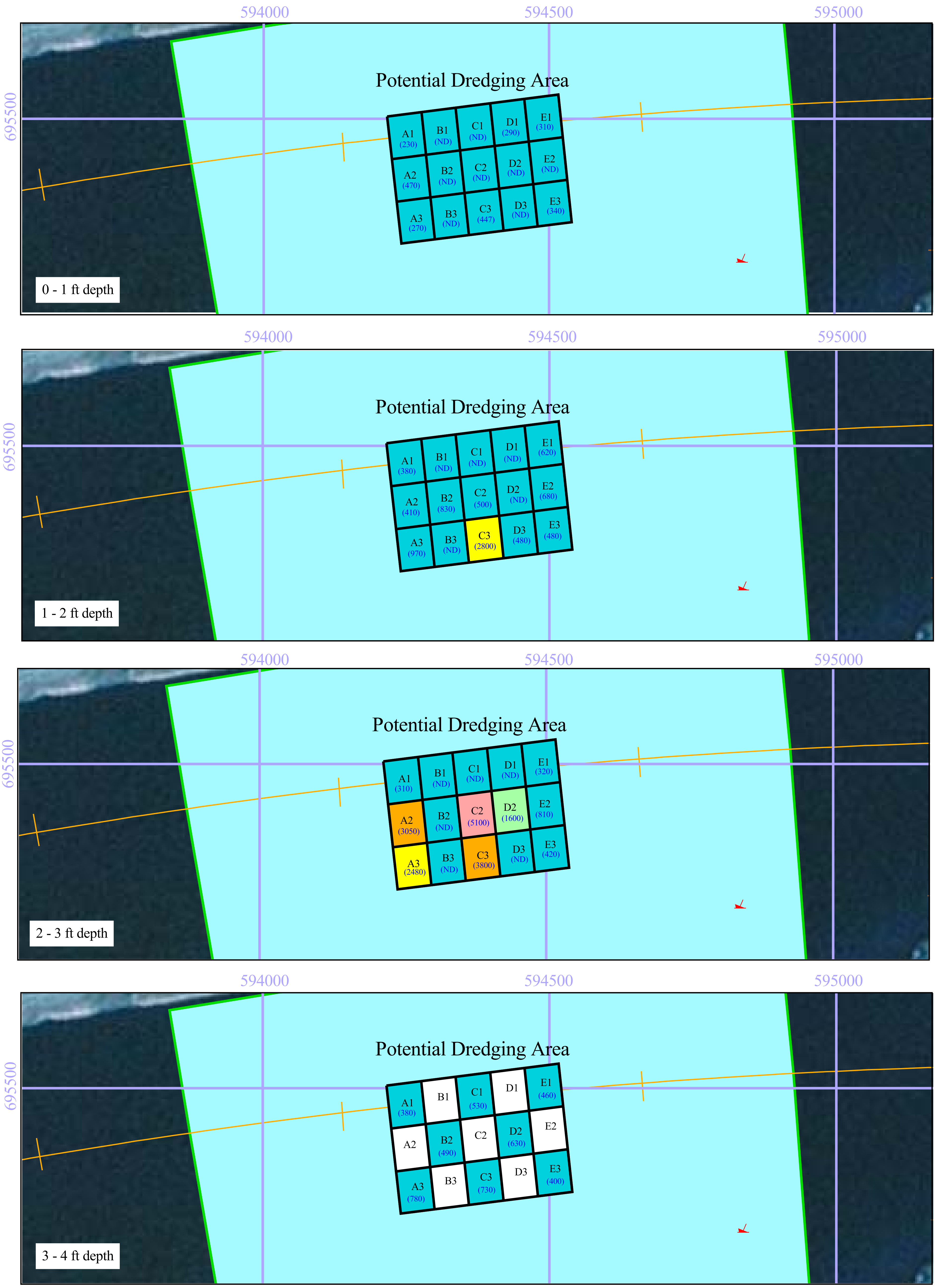
Lower Passaic River Restoration Project

Figure 2-8

Total DDT Concentrations within Potential Dredging Area



LEGEND

Total PCB (Aroclors) concentration (ug/kg)

- < 1000
- 1000 - 1999.9
- 2000 - 2999.9
- 3000 - 3999.9
- ≥ 4000
- Sample Not Analyzed

- C1 Sediment coring grid
- (312) Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area

Note: See Table 4-5

N W E S

0 50 100 150 200 250 300 Feet

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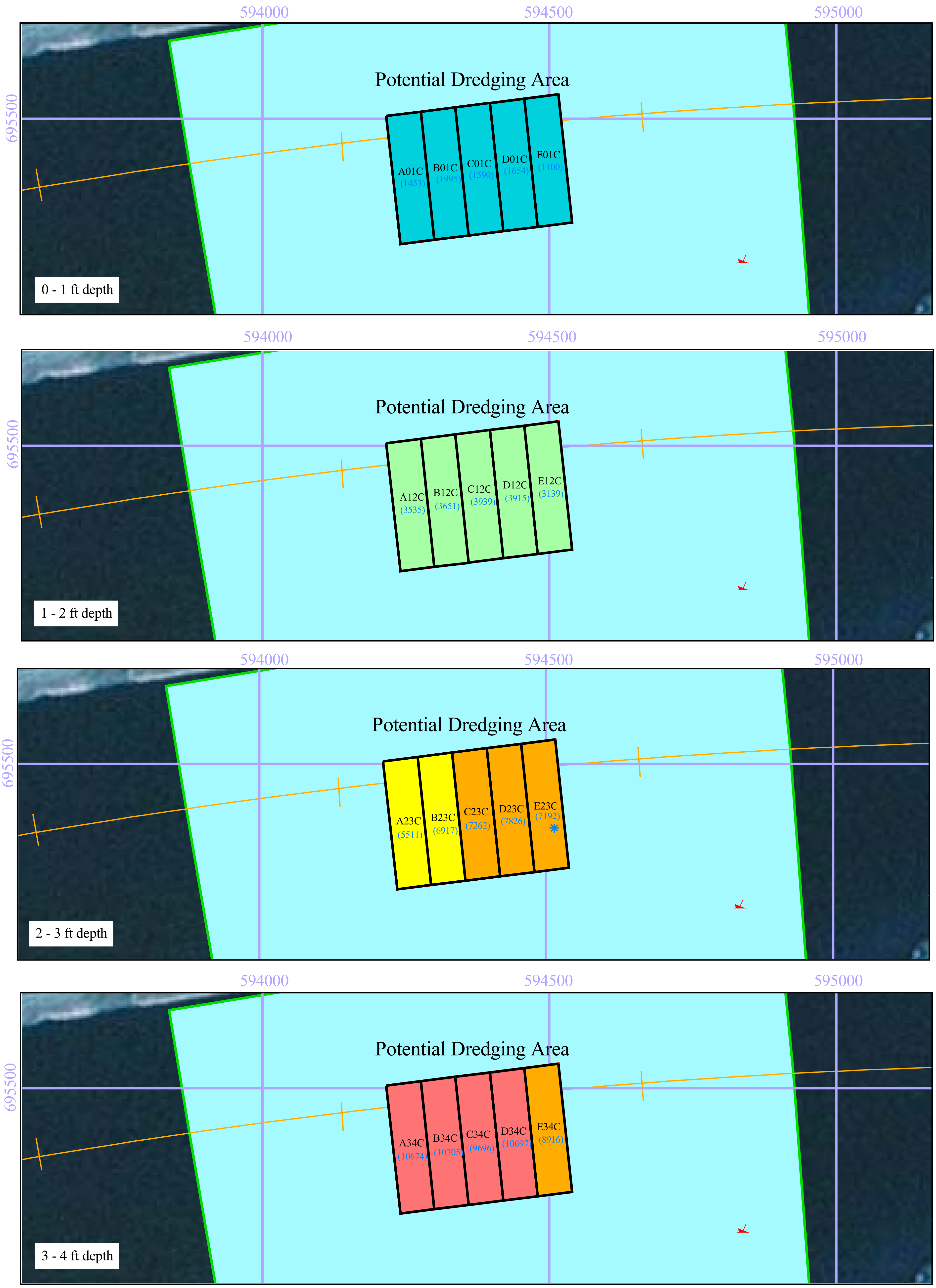
Lower Passaic River Restoration Project

Figure 2-9

Total PCB (Aroclors) Concentrations within Potential Dredging Area



LEGEND

Total PCB Congener concentration (ug/kg)

- < 3000
- 3000 - 4999.9
- 5000 - 6999.9
- 7000 - 8999.9
- ≥ 9000

Note: See Table 4-6

- C1 Sediment coring grid
- (2596) Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area
- ✳ Average of duplicate pair.

N W E S

0 50 100 150 200 250 300 Feet

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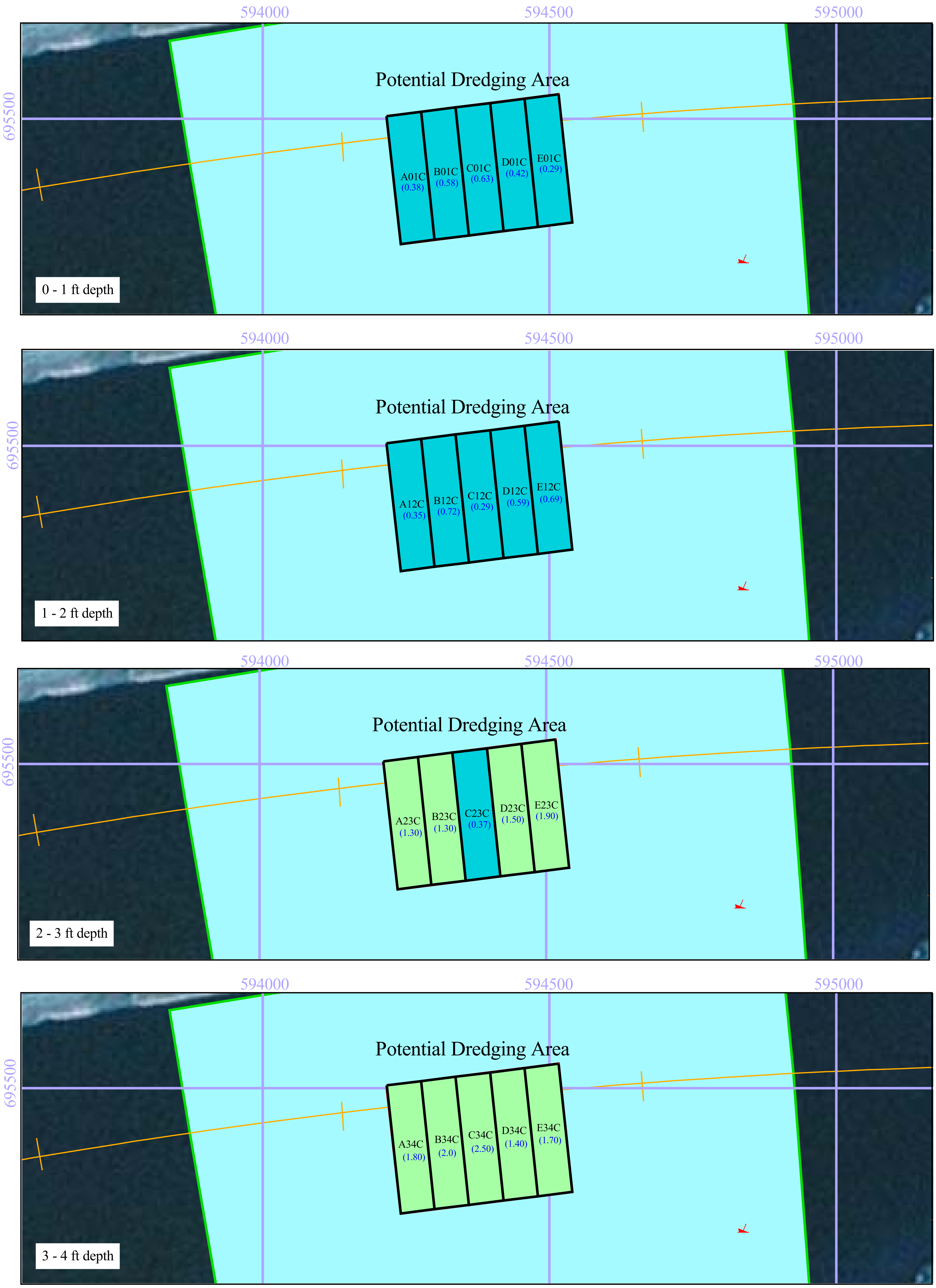
Lower Passaic River Restoration Project

Figure 2-10

Total PCB (Congeners) Concentrations within Potential Dredging Area



LEGEND

TCDD concentration (ng/kg)
- < 1
- 1 - 10
- 10 - 100
- ≥ 100

- C1 Sediment coring grid
- (1.3) Actual concentration value
- Coordinate grid
- Channel centerline
- Wreck point
- Pilot study area

Note: See Table 4-8

N W E S

0 50 100 150 200 250 300 Feet

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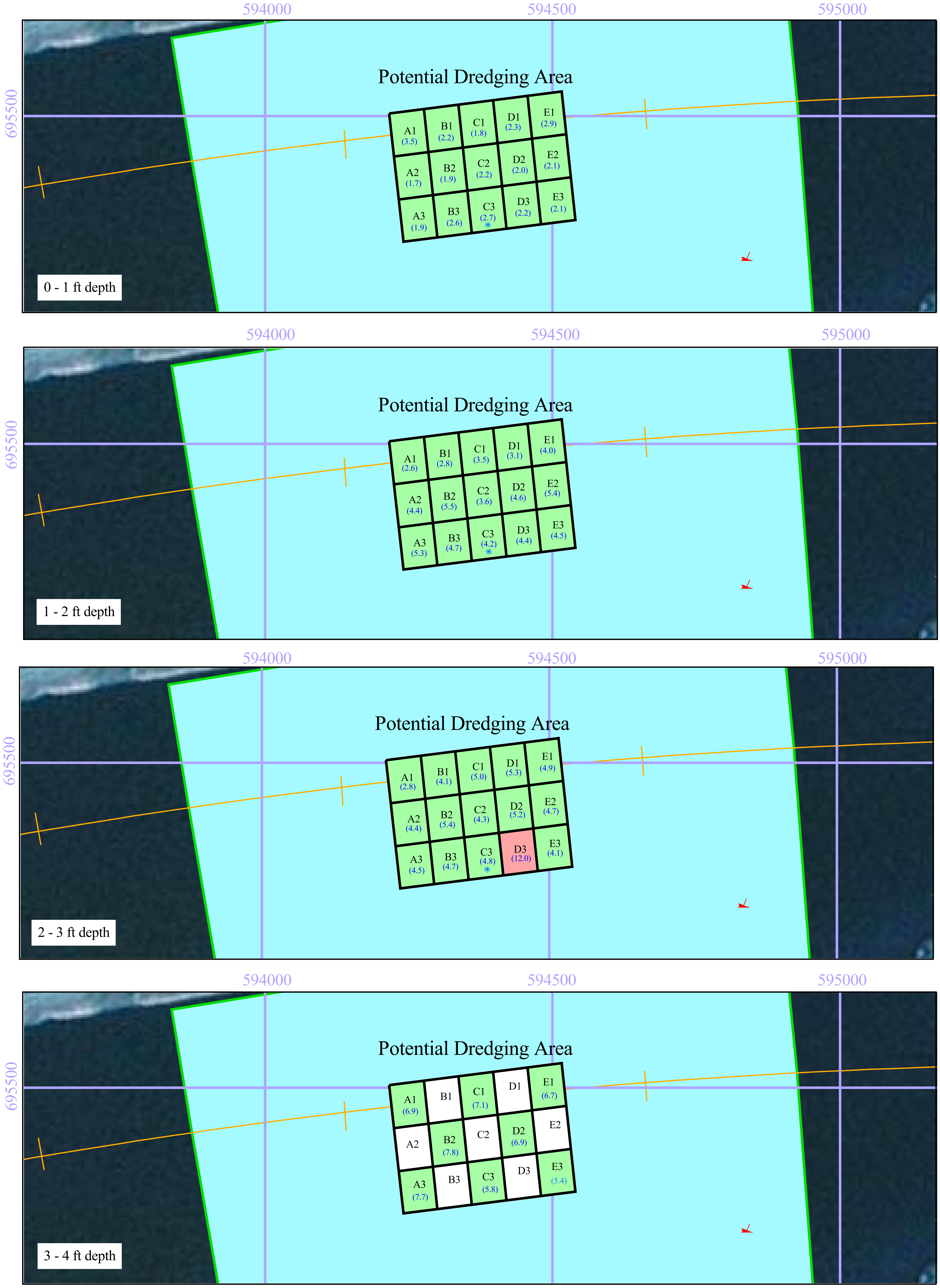
MALCOLM PIRNIE

Lower Passaic River Restoration Project

Figure 2-11

Total TCDD Concentrations within Potential Dredging Area



LEGEND

Mercury concentration (mg/kg)
- < 1
- 1 - 9.9
- ≥ 10
- Sample Not Analyzed

- C1 Sediment coring grid
- (2.8) Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area
- * Average of duplicate pair

Note: See Table 4-9

N E S W

0 50 100 150 200 250 300 Feet

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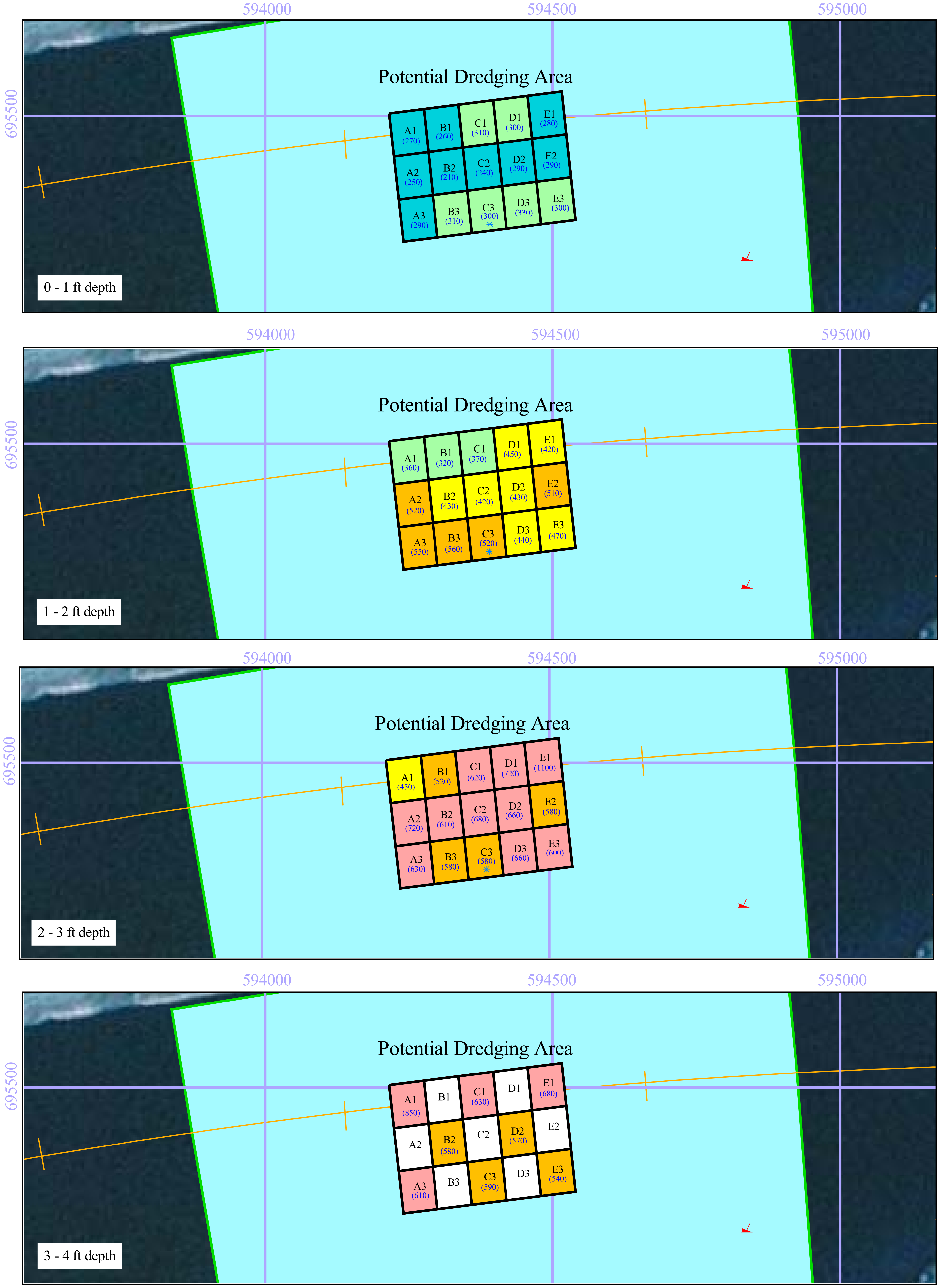
Lower Passaic River Restoration Project	Figure 2-12
	Mercury Concentrations within Potential Dredging Area



LEGEND

Lead concentration (mg/kg)
- < 300
- 300 - 399
- 400 - 499
- 500 - 599
- ≥ 600
- Sample Not Analyzed

- C1 Sediment coring grid
- (450) Actual concentration value
- Coordinate grid
- Centerline
- Wreck point
- Pilot study area

Note: See Table 4-9

* Average of duplicate pair

N E S W

0 50 100 150 200 250 300 Feet

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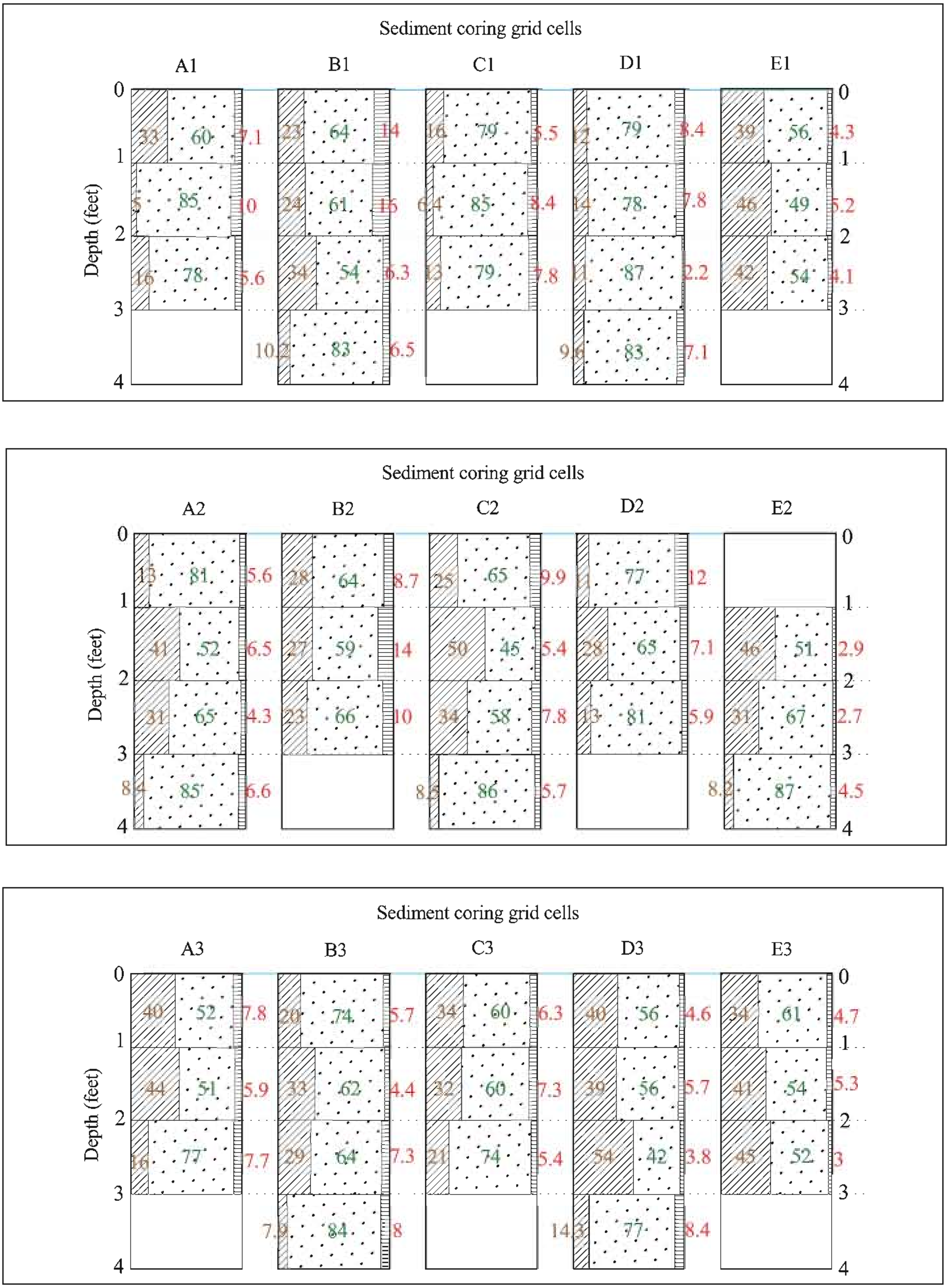
Lower Passaic River Restoration Project

Figure 2-13

Lead Concentrations within Potential Dredging Area



Note: B1-23 also included 5.5% Granule, >2mm. This fraction was not significant (i.e., ≤0.2%) in all other samples.

LEGEND

Sediment type and percentage

- 16 Sand
- 77 Silt
- 7.7 Clay

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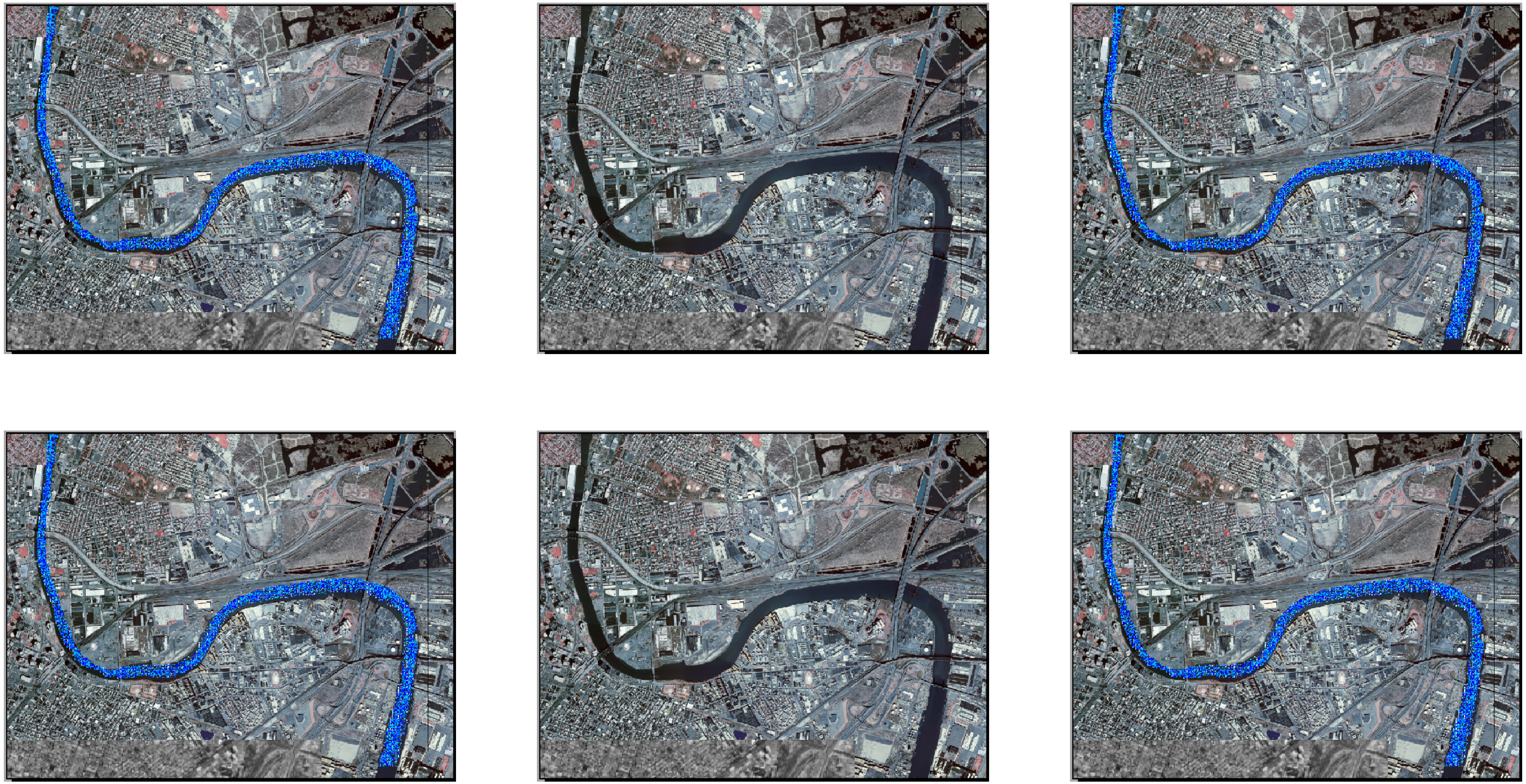
Lower Passaic River Restoration Project	Figure 2-14
	Cross-section of Sediment Coring Grid Cells Showing Sediment Type

NATURAL BACKGROUND | DREDGE INDUCED | NATURAL BACKGROUND AND DREDGE INDUCED

CASE 1

CASE 2



NOTES:

1) Natural background represents low TSS concentration of 10 mg/L.

TIME = 0 HRS

SEDIMENT TYPES

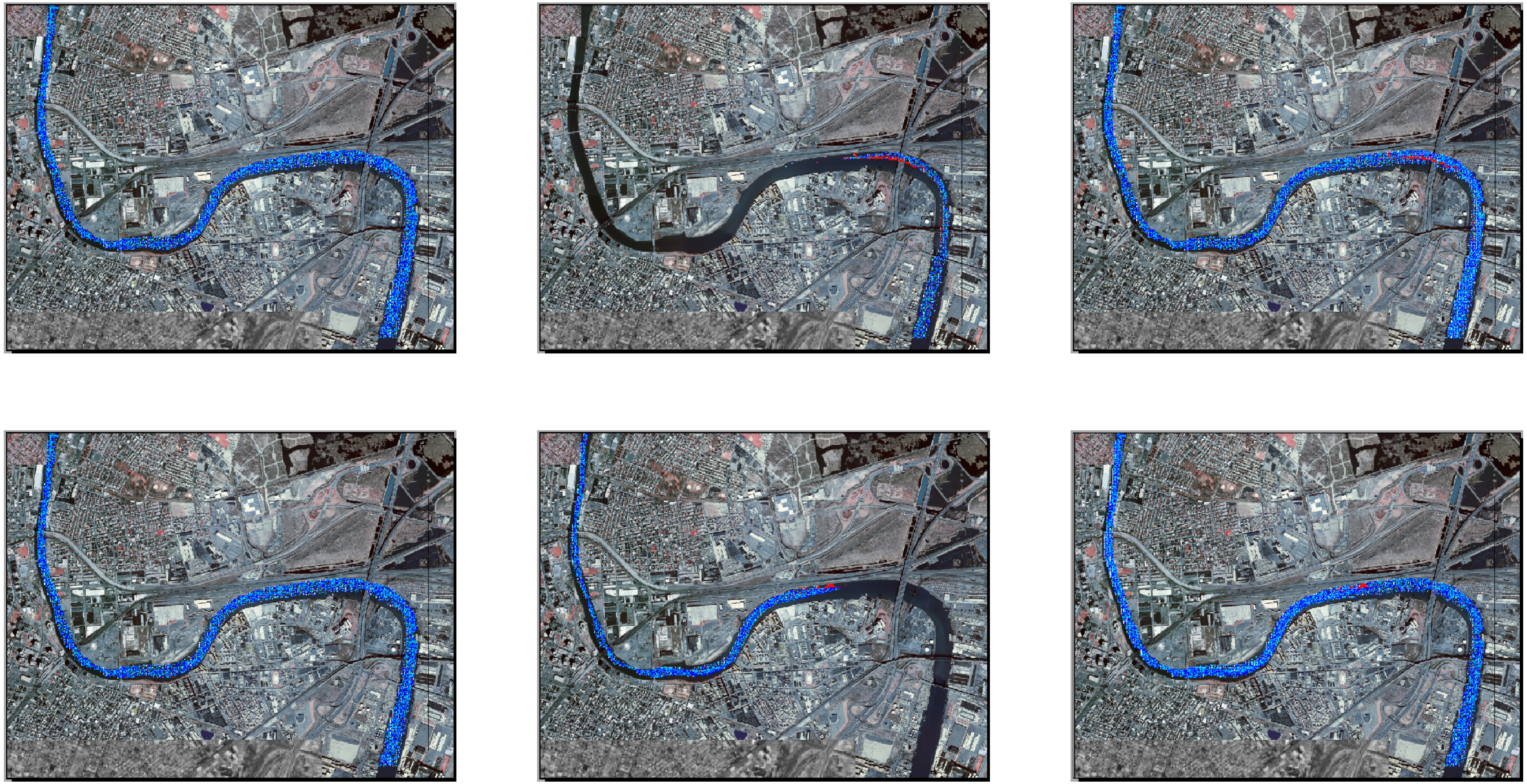
SAND SILT CLAY

Figure 4-1 – Particle Test Cases 1 and 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

NATURAL BACKGROUND | DREDGE INDUCED | NATURAL BACKGROUND AND DREDGE INDUCED

CASE 1

CASE 2



NOTES:

1) Natural background represents low TSS concentration of 10 mg/L.

TIME = 6 HRS

SEDIMENT TYPES

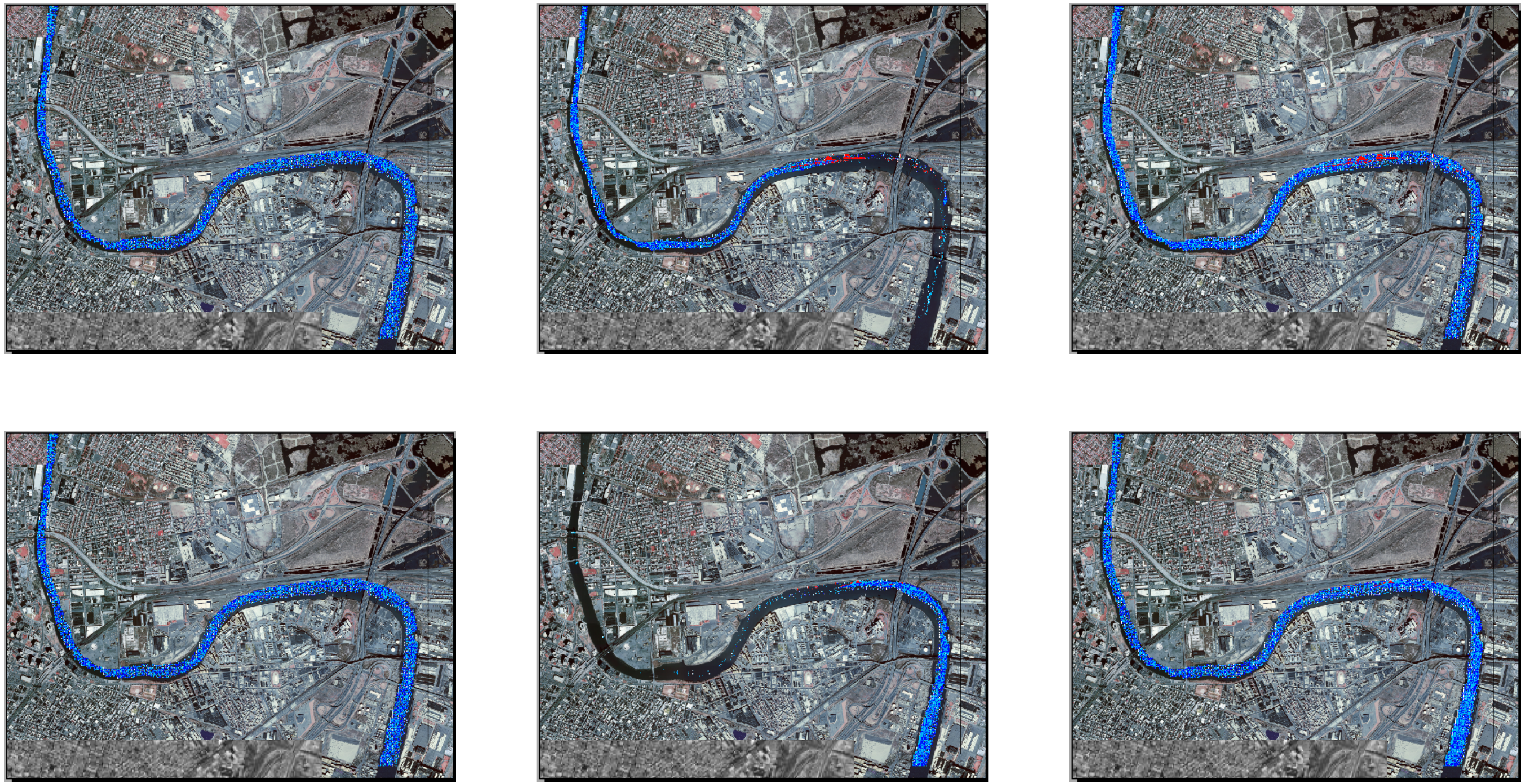
SAND SILT CLAY

Figure 4-2 – Particle Test Cases 1 and 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

NATURAL BACKGROUND | DREDGE INDUCED | NATURAL BACKGROUND AND DREDGE INDUCED

CASE 1

CASE 2



NOTES:

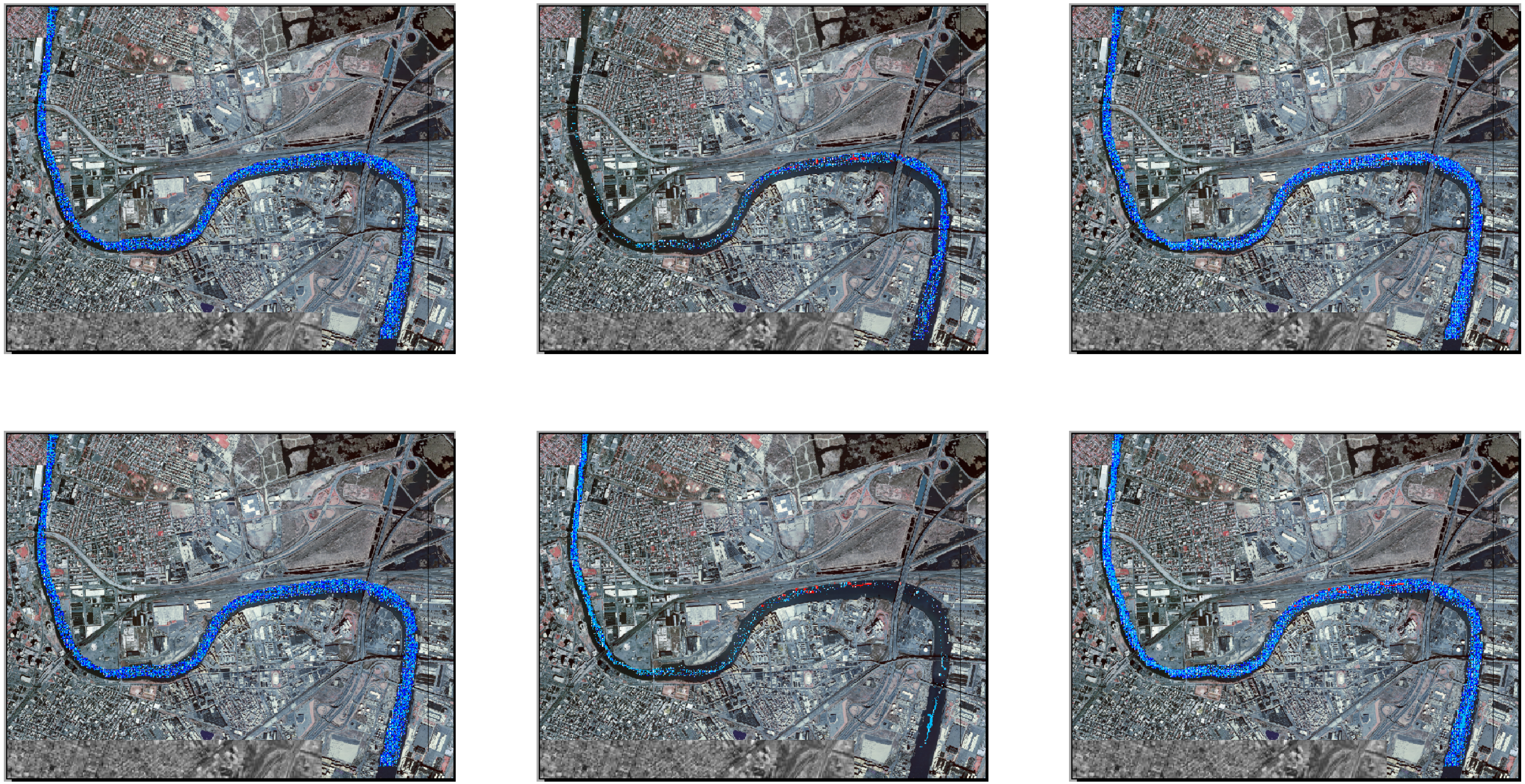
1) Natural background represents low TSS concentration of 10 mg/L.

TIME = 12 HRS

SEDIMENT TYPES

SAND SILT CLAY

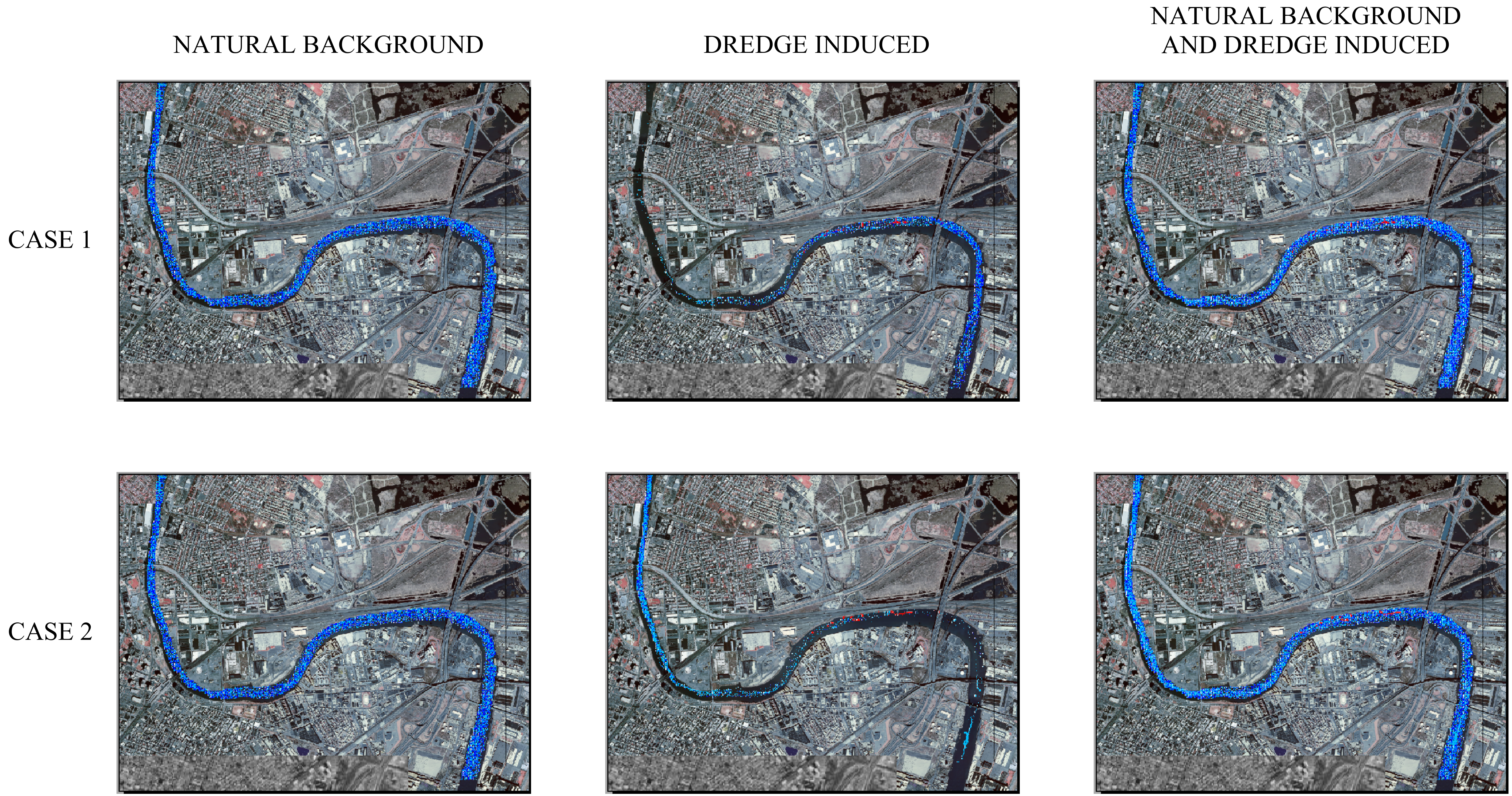
Figure 4-3 – Particle Test Cases 1 and 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling



NOTES:

1) Natural background represents low TSS concentration of 10 mg/L.

Figure 4-4 – Particle Test Cases 1 and 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling



NOTES:

1) Natural background represents low TSS concentration of 10 mg/L.

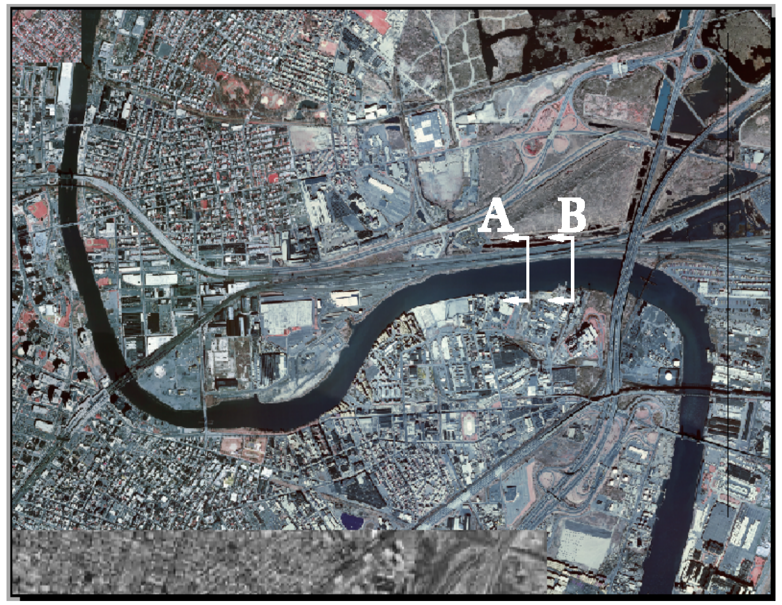
TIME = 24 HRS

SEDIMENT TYPES

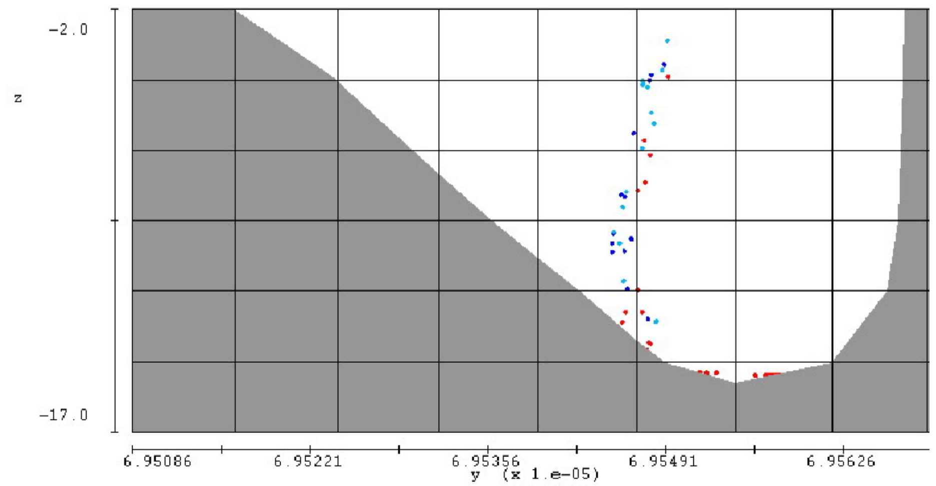
SAND SILT CLAY

Figure 4-5 – Particle Test Cases 1 and 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

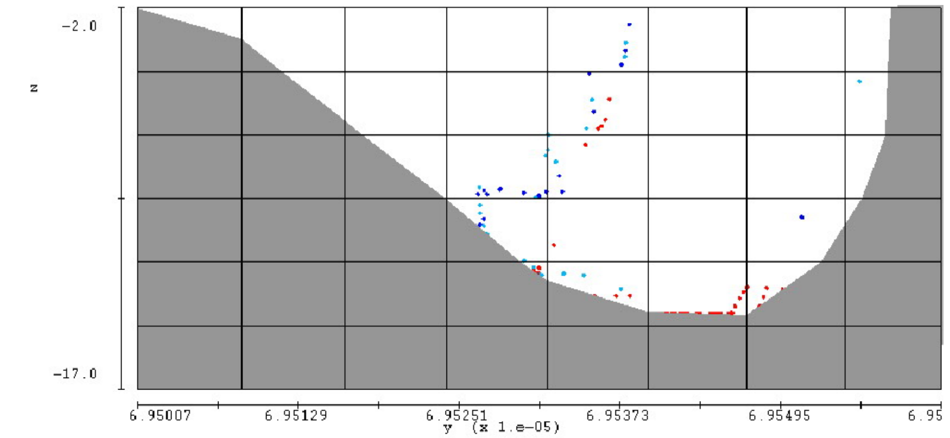
CROSS SECTION LOCATIONS



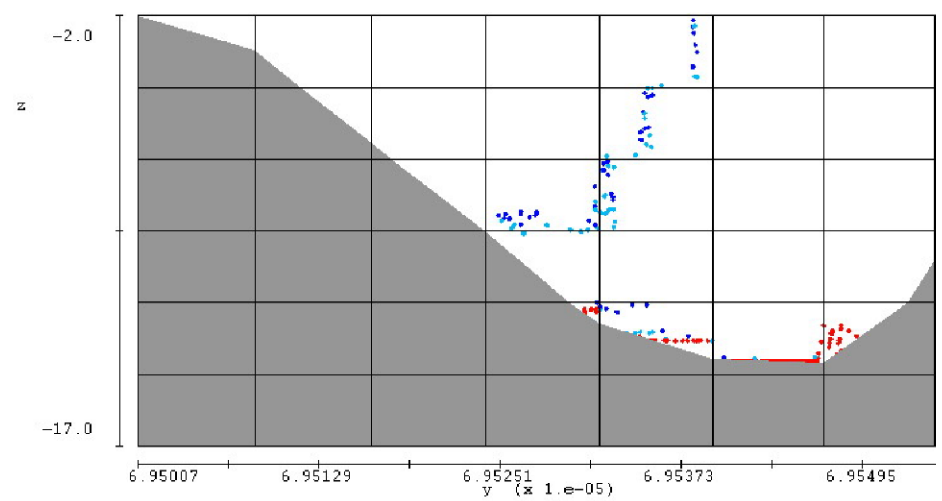
LOCATION A: 500' UPSTREAM OF MOORING 2
LOCATION B: 500' DOWNSTREAM OF MOORING 2



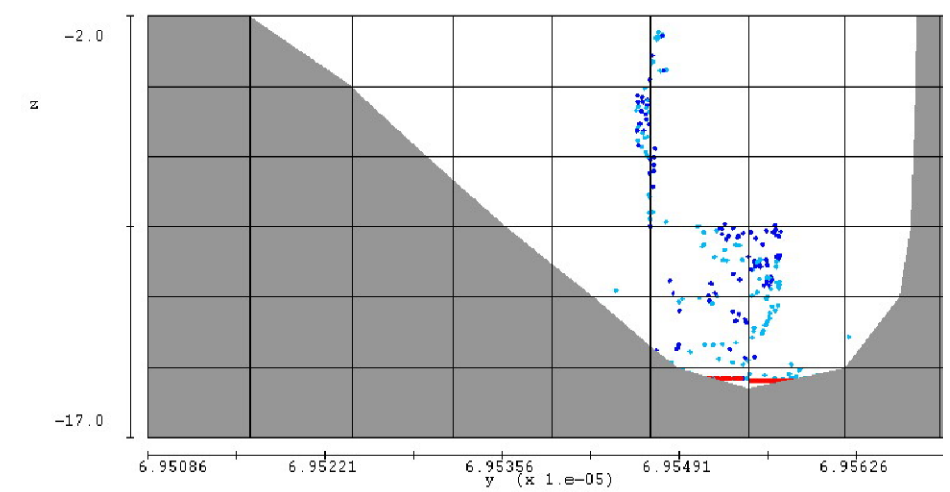
CASE 1: 6 HRS AT LOCATION B



CASE 1: 12 HRS AT LOCATION A



CASE 2: 6 HRS AT LOCATION A



CASE 2: 12 HRS AT LOCATION B

<u>NOTES:</u>

1) Natural background represents low TSS concentration of 10 mg/L.

<u>SEDIMENT TYPES</u>

SAND SILT CLAY

Figure 4-6 — Particle Cross Sections
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

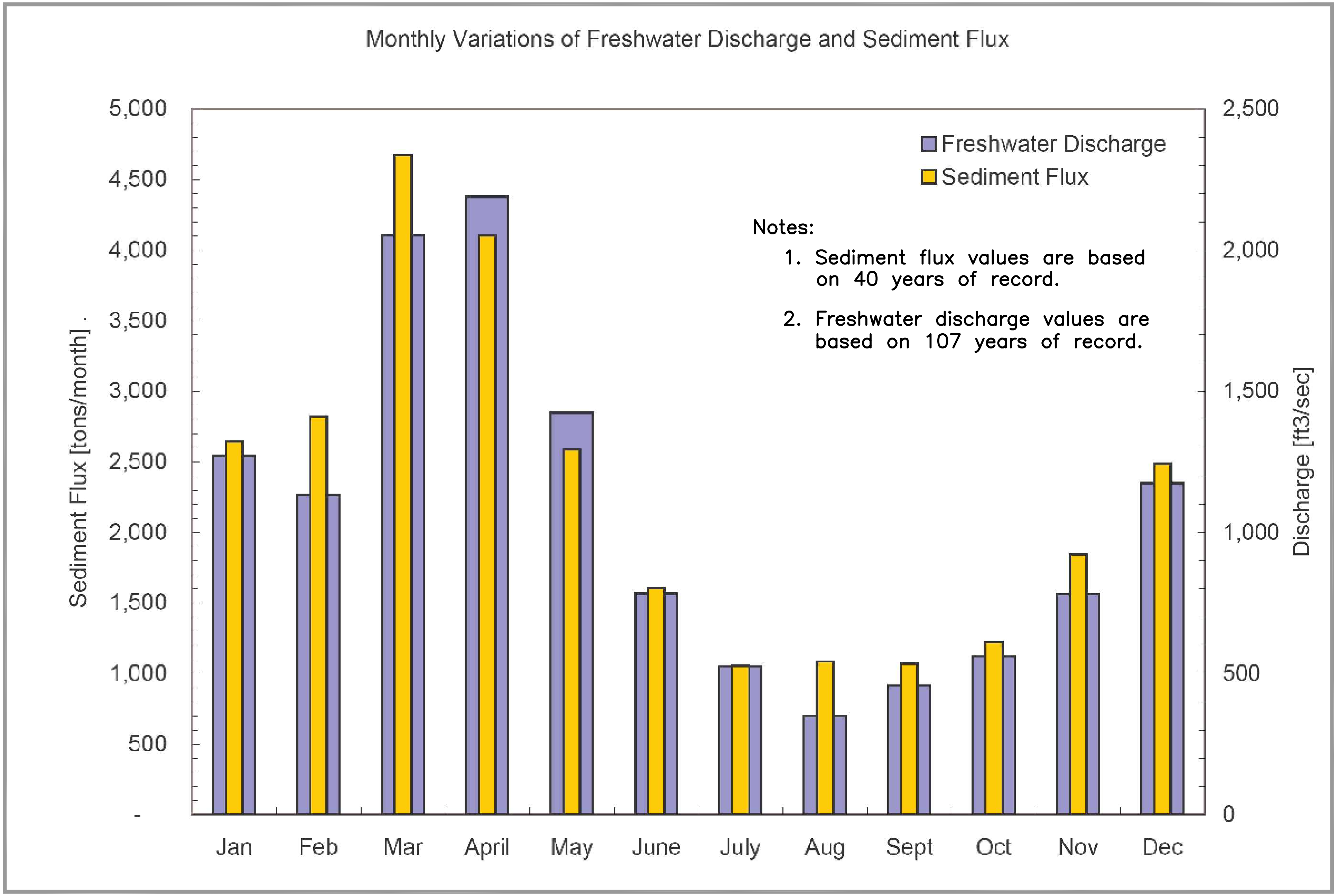


Figure 4-7 — Monthly Variations of Freshwater Discharge and Sediment Flux
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

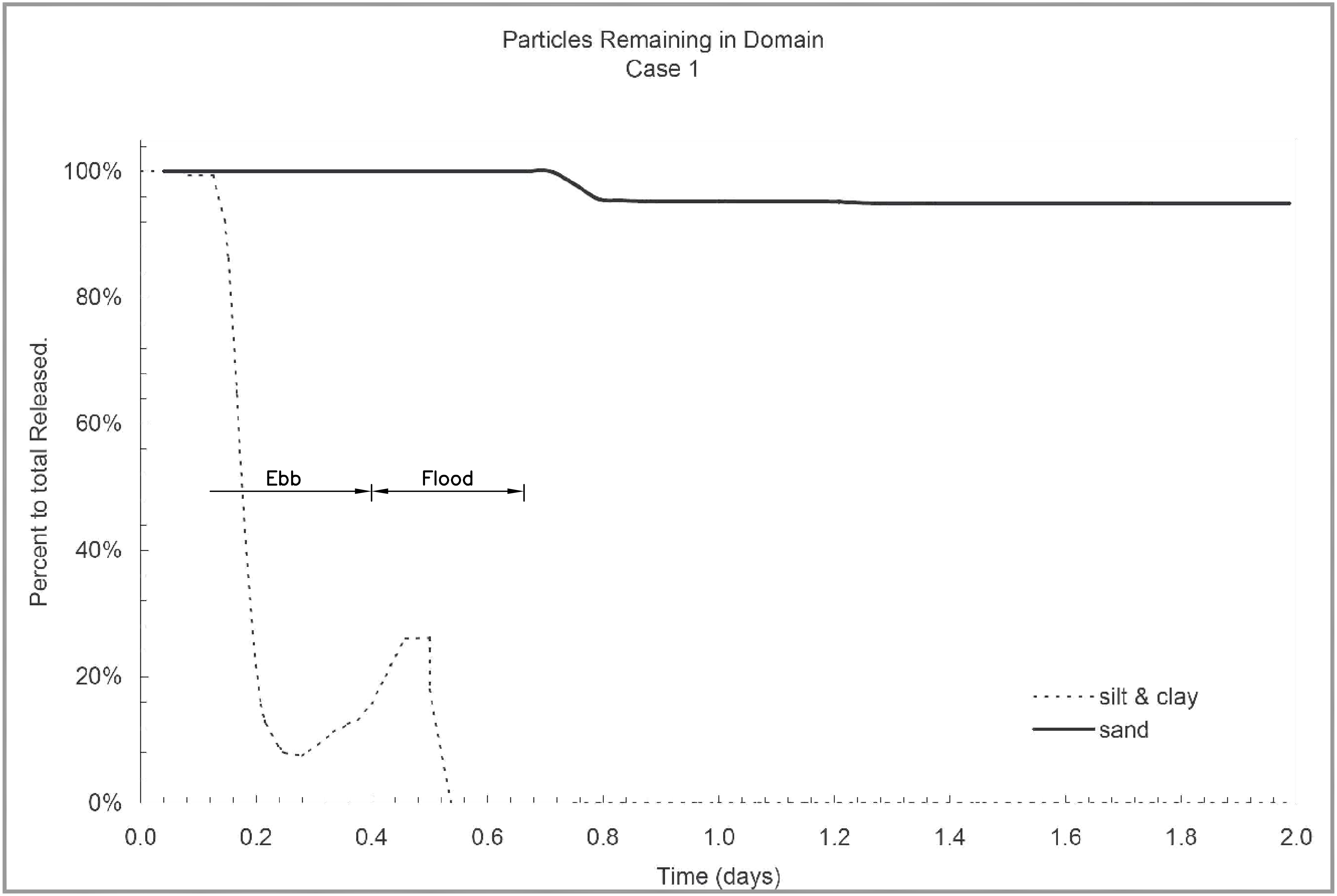


Figure 4-8 — Particles Remaining — Case 1
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

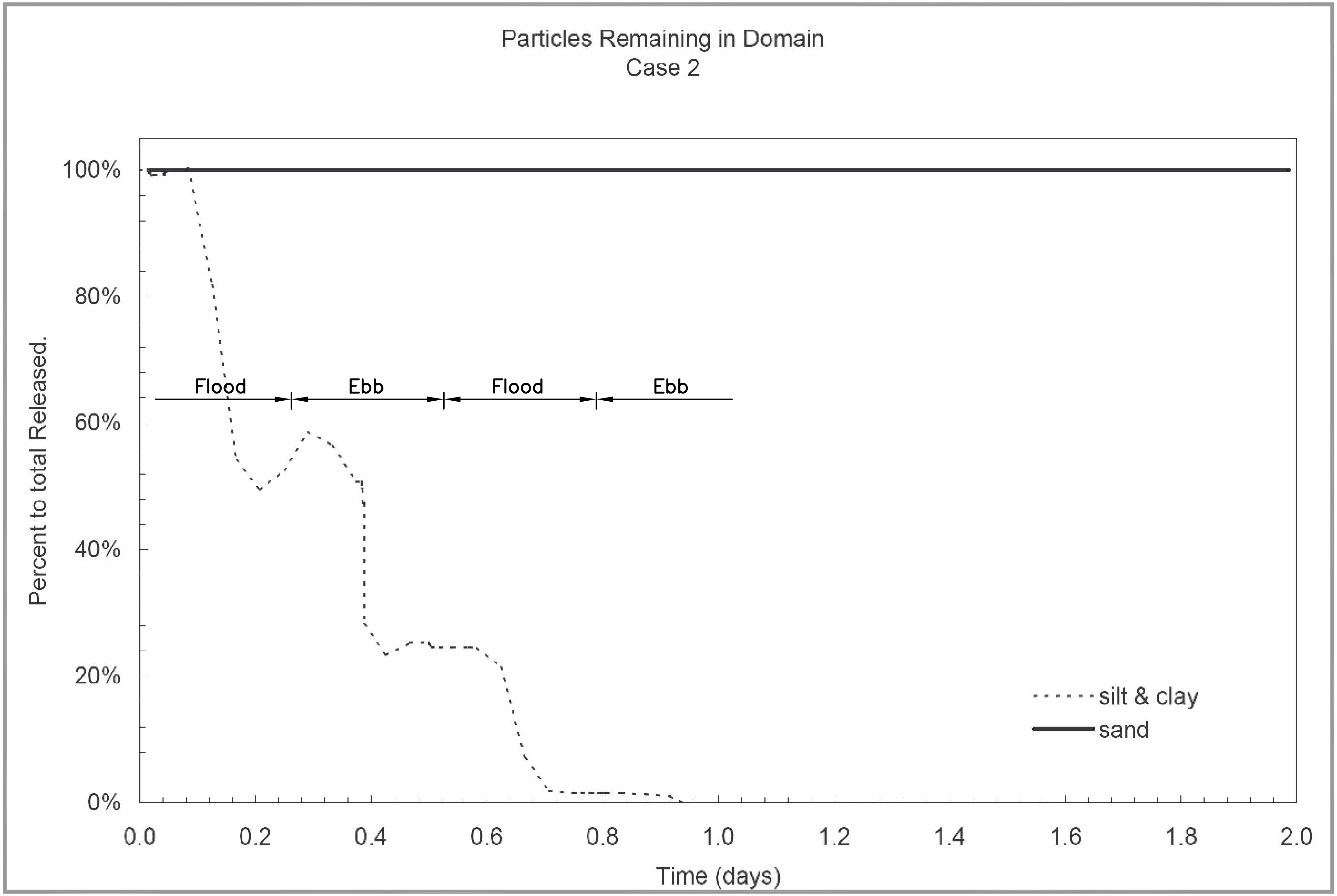


Figure 4-9 — Particles Remaining — Case 2
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

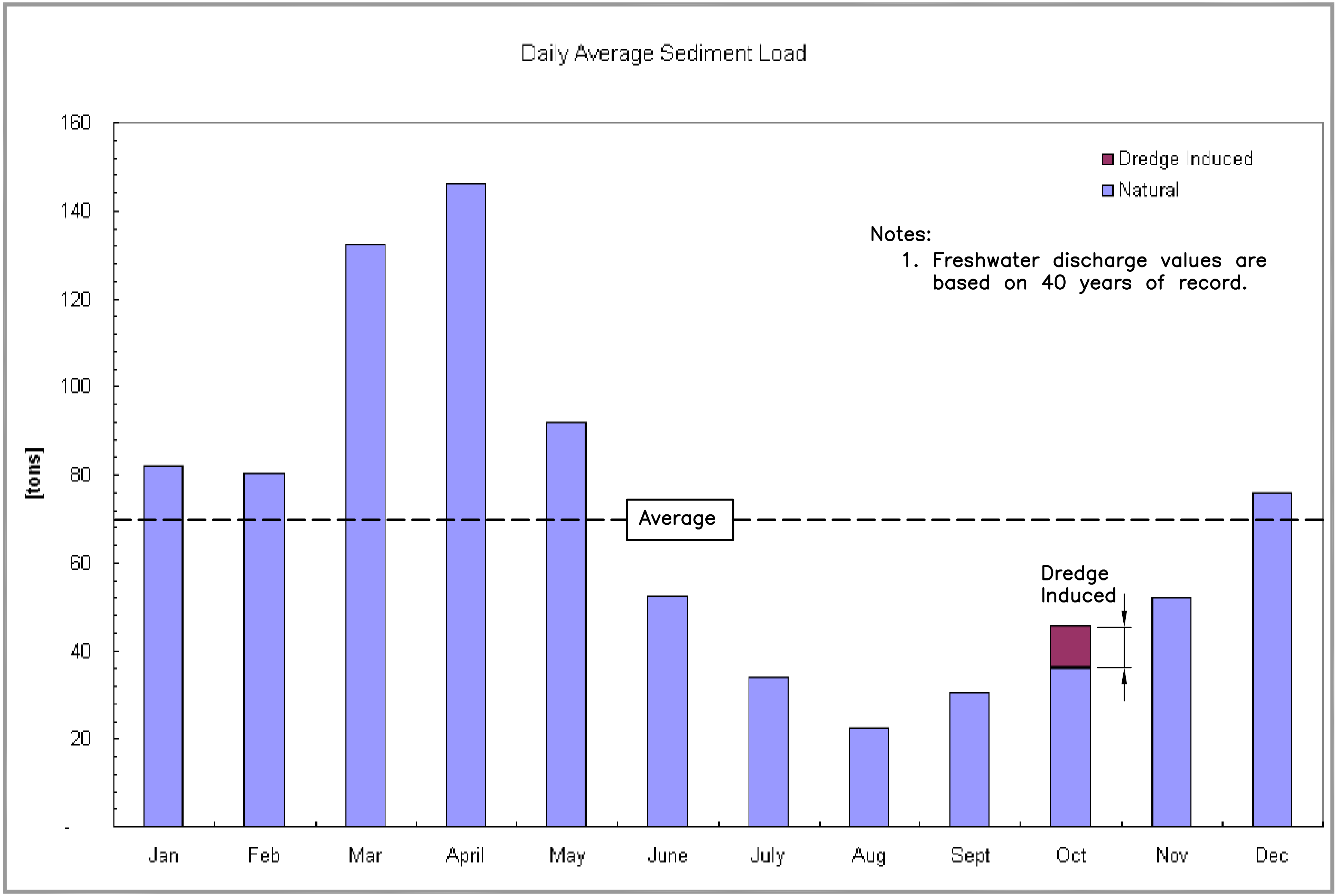


Figure 4-10 — Daily Sediment Flux
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

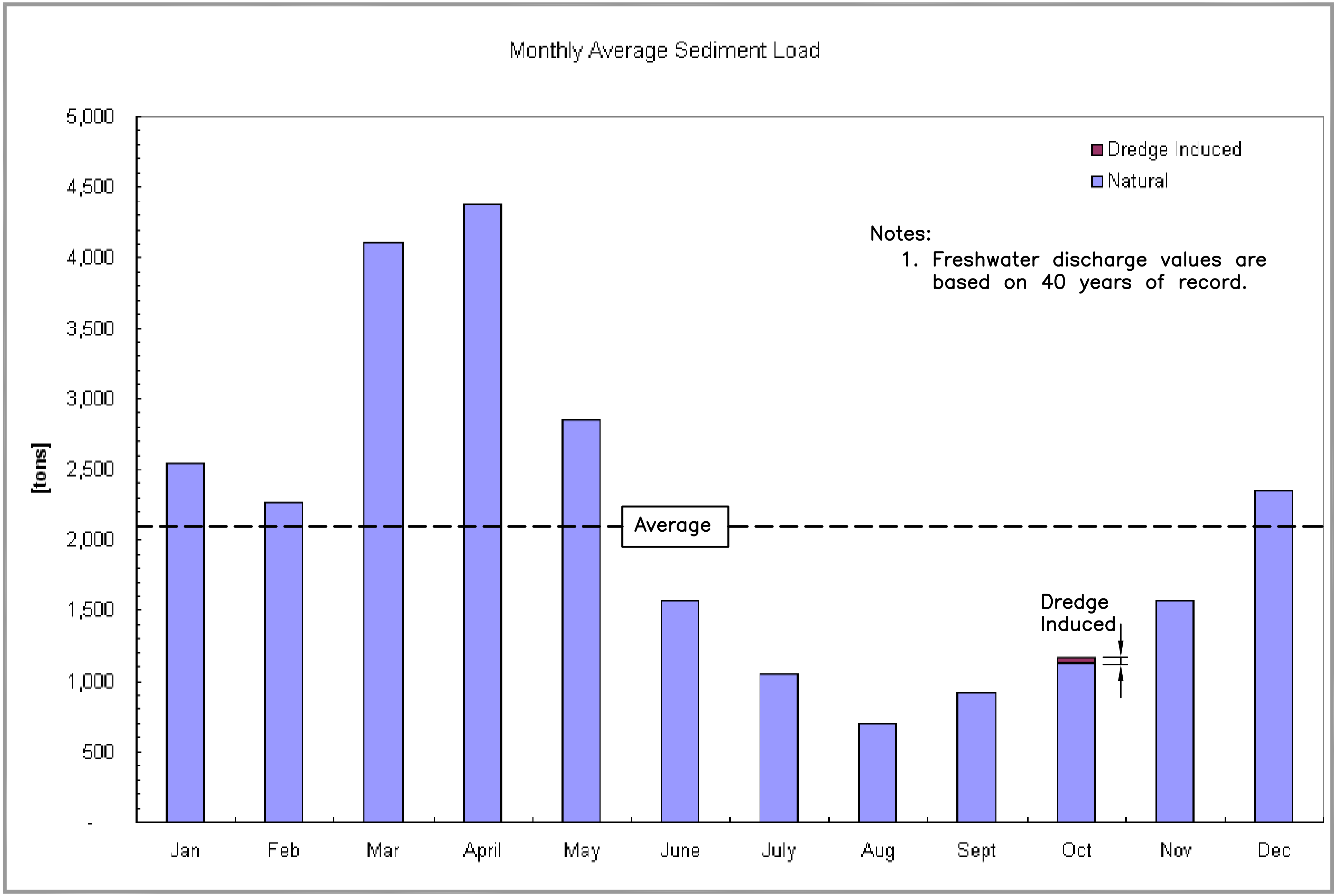


Figure 4-11 — Monthly Sediment Flux
Passaic River Environmental Dredging Pilot Study
Hydrodynamic Modeling

Figure 4-12: Monitoring Mooring Arrangement with Monitoring Boat Track (Plan View) Ebb Tide

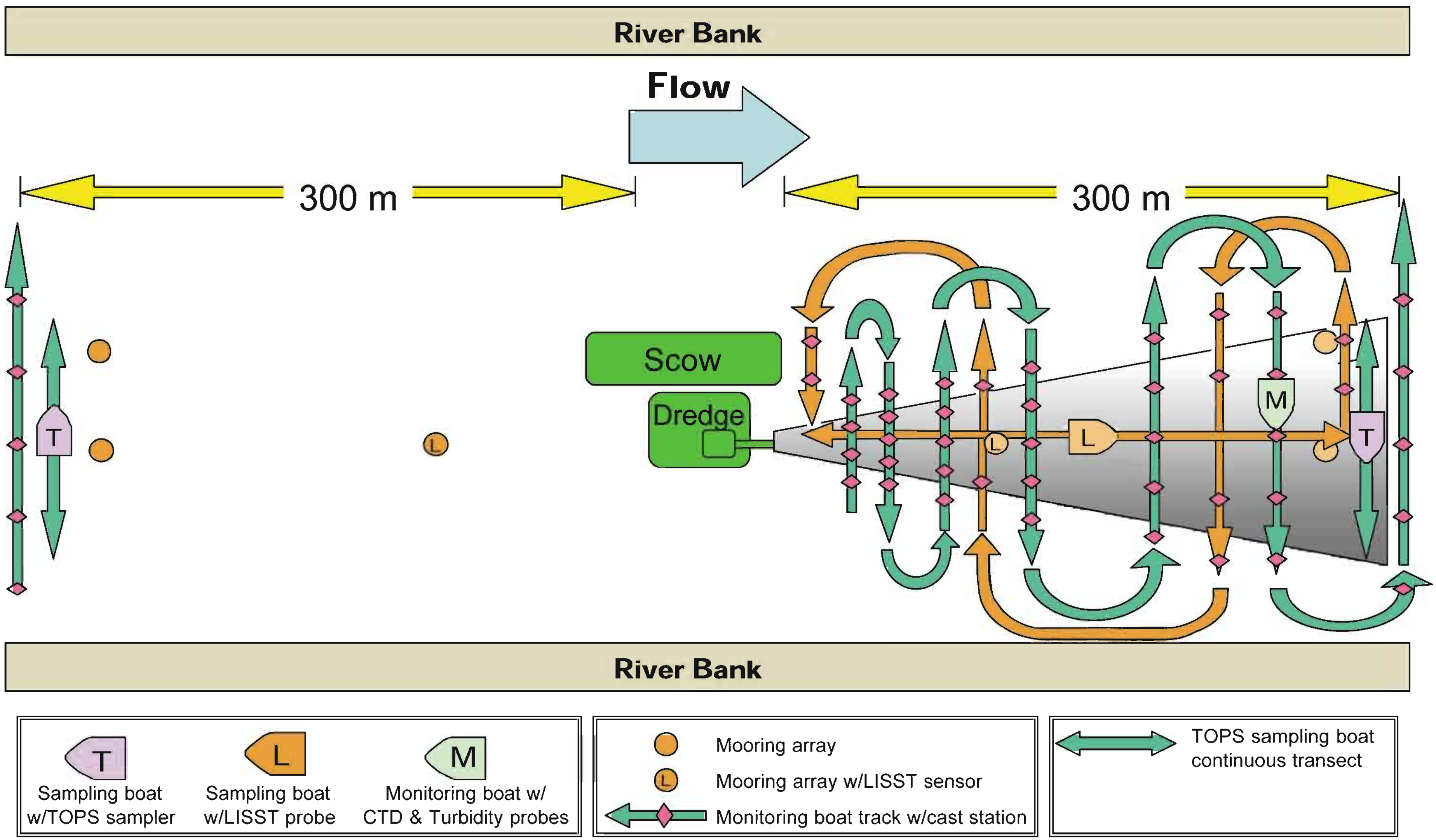


Figure 4-13: Monitoring Mooring Arrangement with Monitoring Boat Track (Plan View) Flood Tide

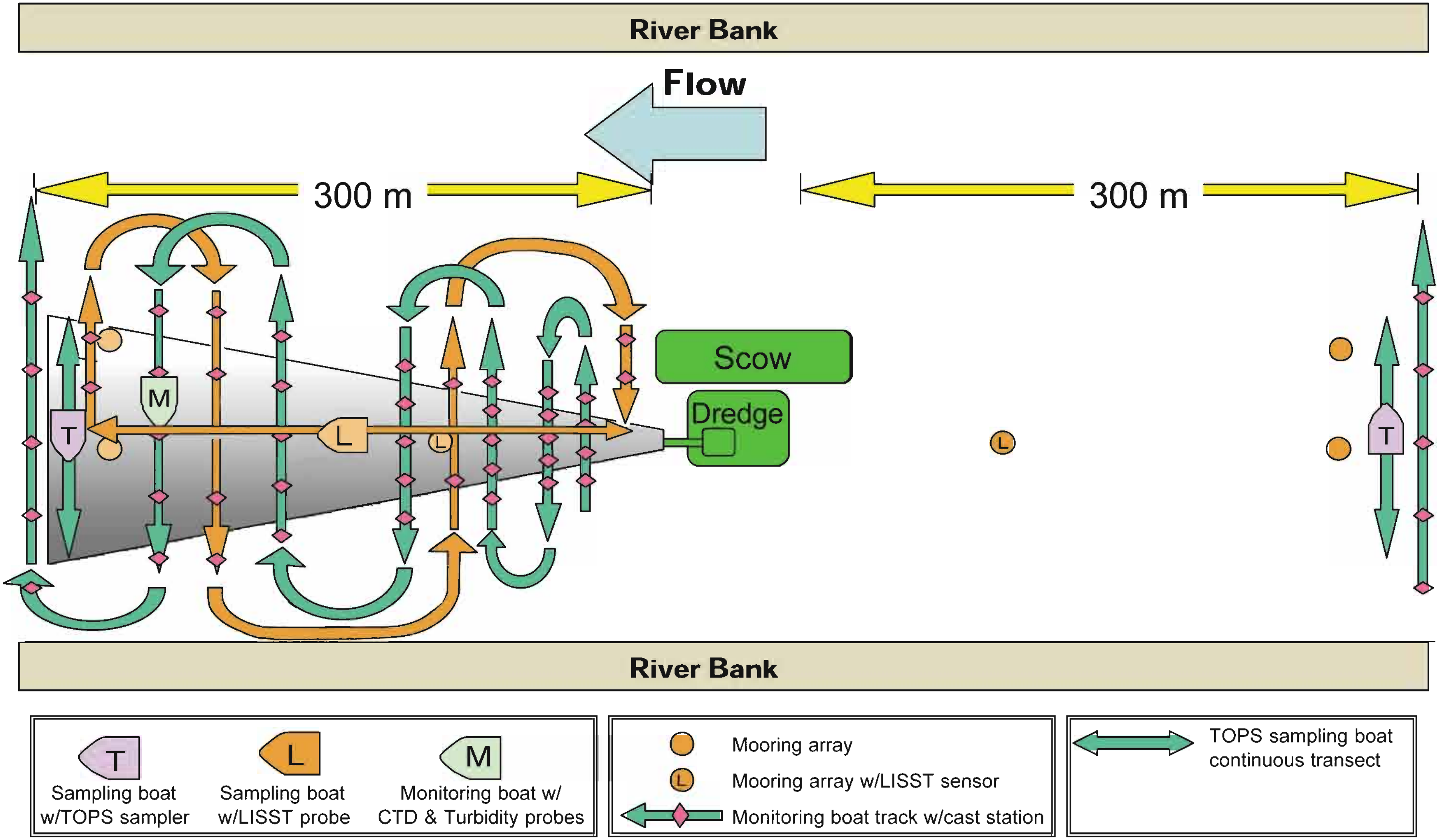


Figure 4-14: Monitoring Mooring Arrangement (3D View)

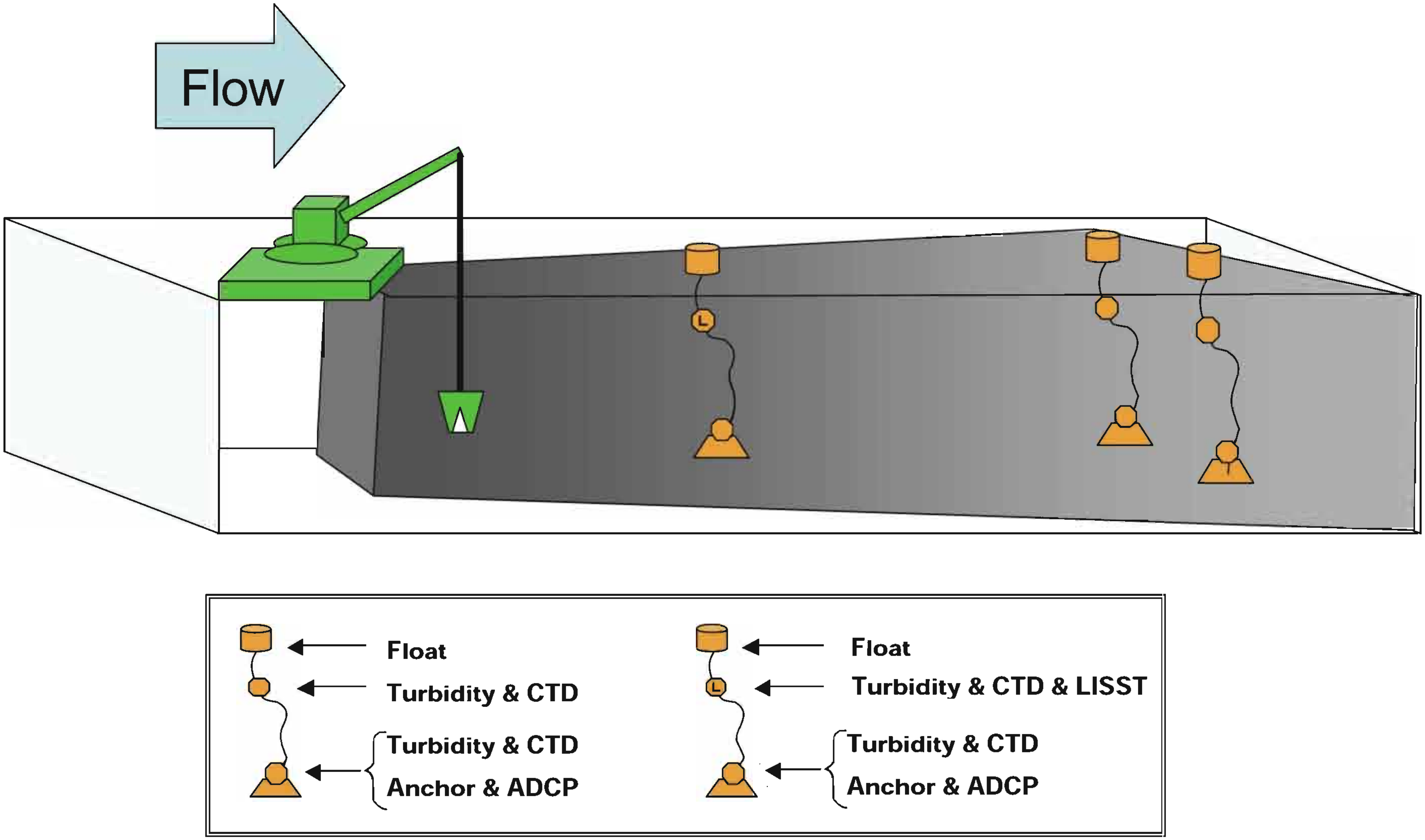


Figure 4-15: Typical Mooring Setup

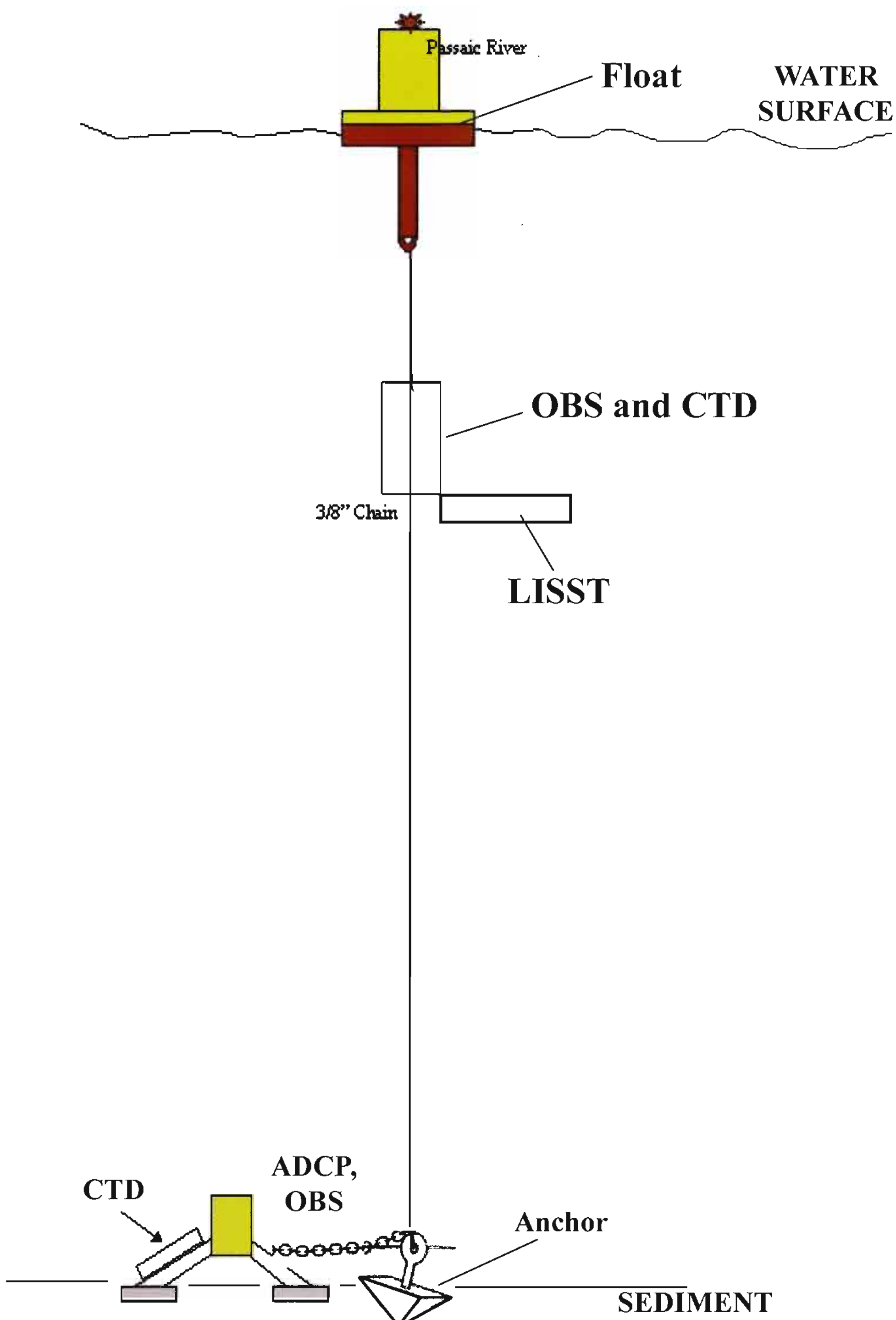


FIGURE 4-16
EXISTING CONDITIONS
SITE PLAN

JUNE 2005

MALCOLM PIRNIE | TAMS

REVISIONS

NO.	BY	DATE	REMARKS

DES JBM/SET
DWN JLF
CHD NRB/JJB/RMP

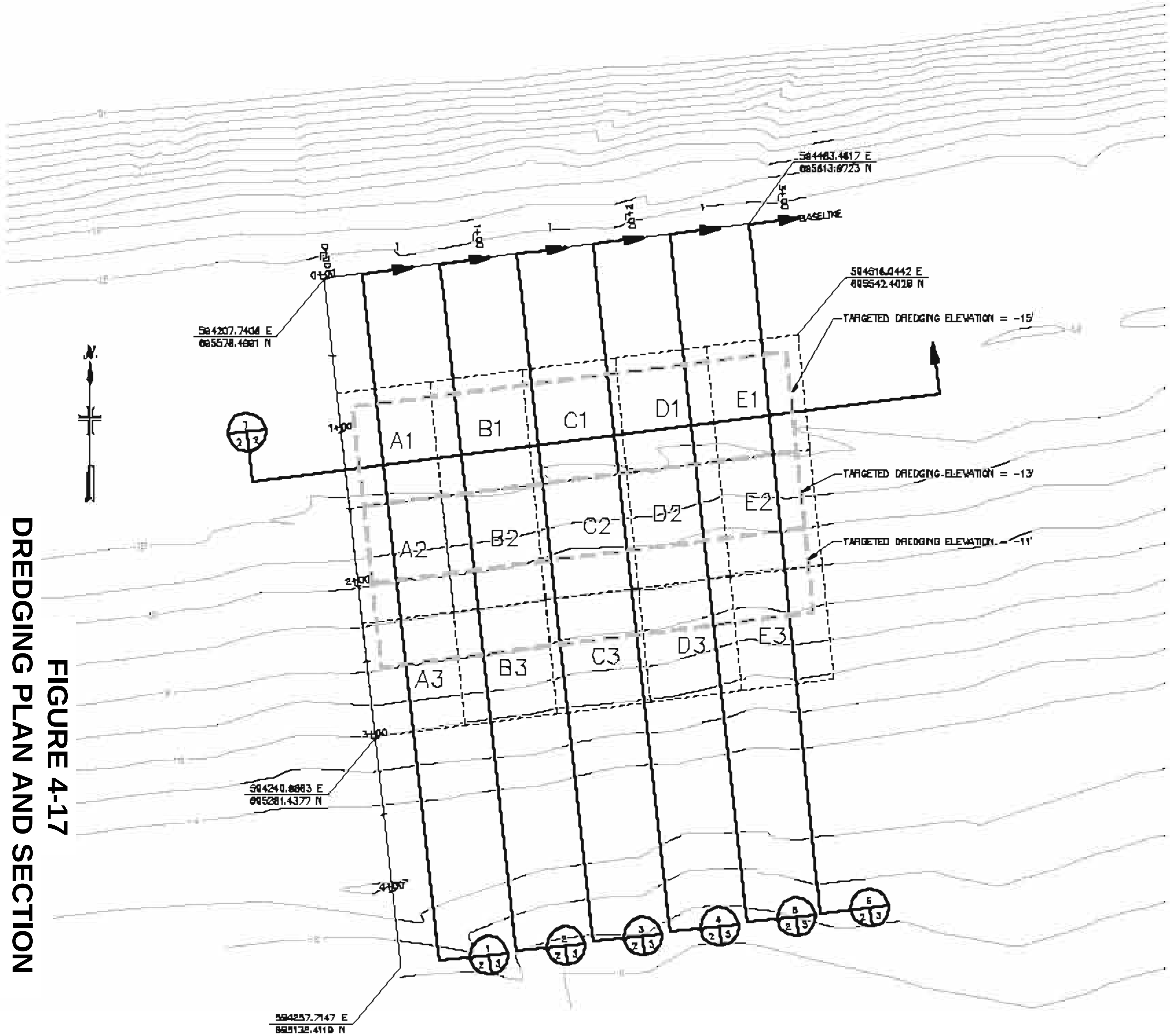
NEW JERSEY DEPARTMENT OF TRANSPORATION
OFFICE OF MARITIME RESOURCES
LOWER PASSAIC RIVER DREDGING PILOT STUDY
CONSTRUCTION CONTRACT NO. XXXXXXXX

FIGURE 4-16
EXISTING CONDITIONS
SITE PLAN

DATE JUNE 2005
SHEET 1 OF 3
CAD REF. NO. 3473003

FIGURE 4-17
DREDGING PLAN AND SECTION

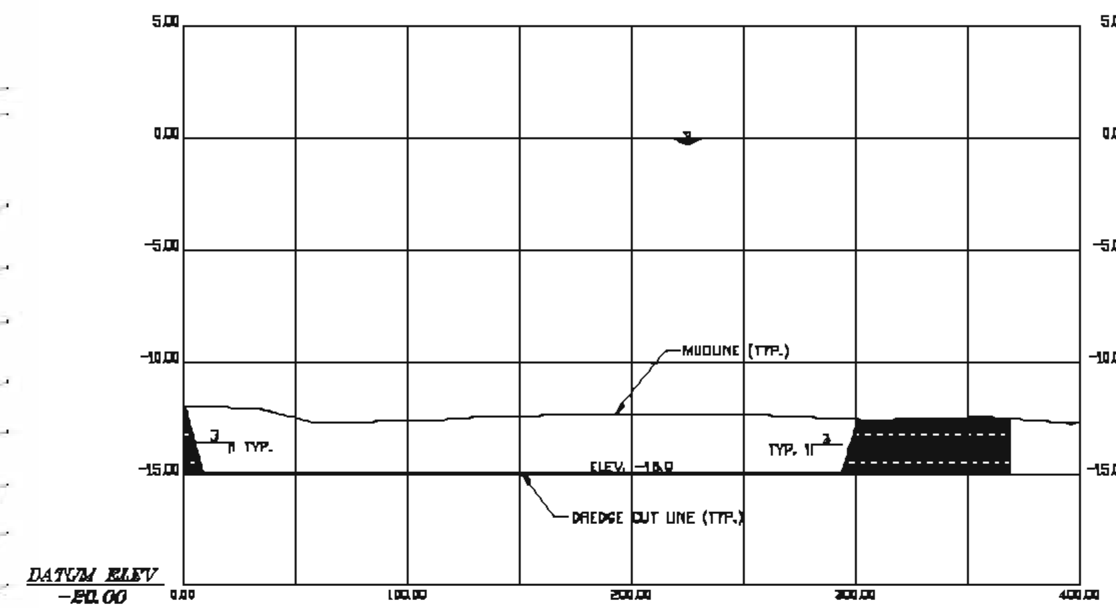
June 2005



DREDGING PLAN

20 0 20 40

SCALE: 1" = 40'



SECTION 7/2 2

HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 4'

LEGEND

EXIST. CONTOUR

EXIST. SEDIMENT CORING GRID CELL A2

LIMITS OF TARGET SEDIMENT

UNDISTURBED SEDIMENTS (TYP.)

NOTES:

1. CONTRACTOR'S OPERATIONS SHALL BE CONDUCTED SO AS NOT TO AFFECT NAVIGATION. CONTRACTOR SHALL MAINTAIN SAFE CLEARANCE FOR VESSELS USING THE WATERWAY TO PASS THE CONTRACTOR'S OPERATION AND WORK.

2. CONTRACTOR SHALL TAKE ALL MEASURES NECESSARY TO PROTECT ANY UTILITIES THAT MAY BE AFFECTED BY WORK.

MALCOLM PIRNIE | TAMS

REVISIONS

NO.	BY	DATE	REMARKS

DSG JBM/SET
DWN JLF
CKD NRB/JAS/RNF

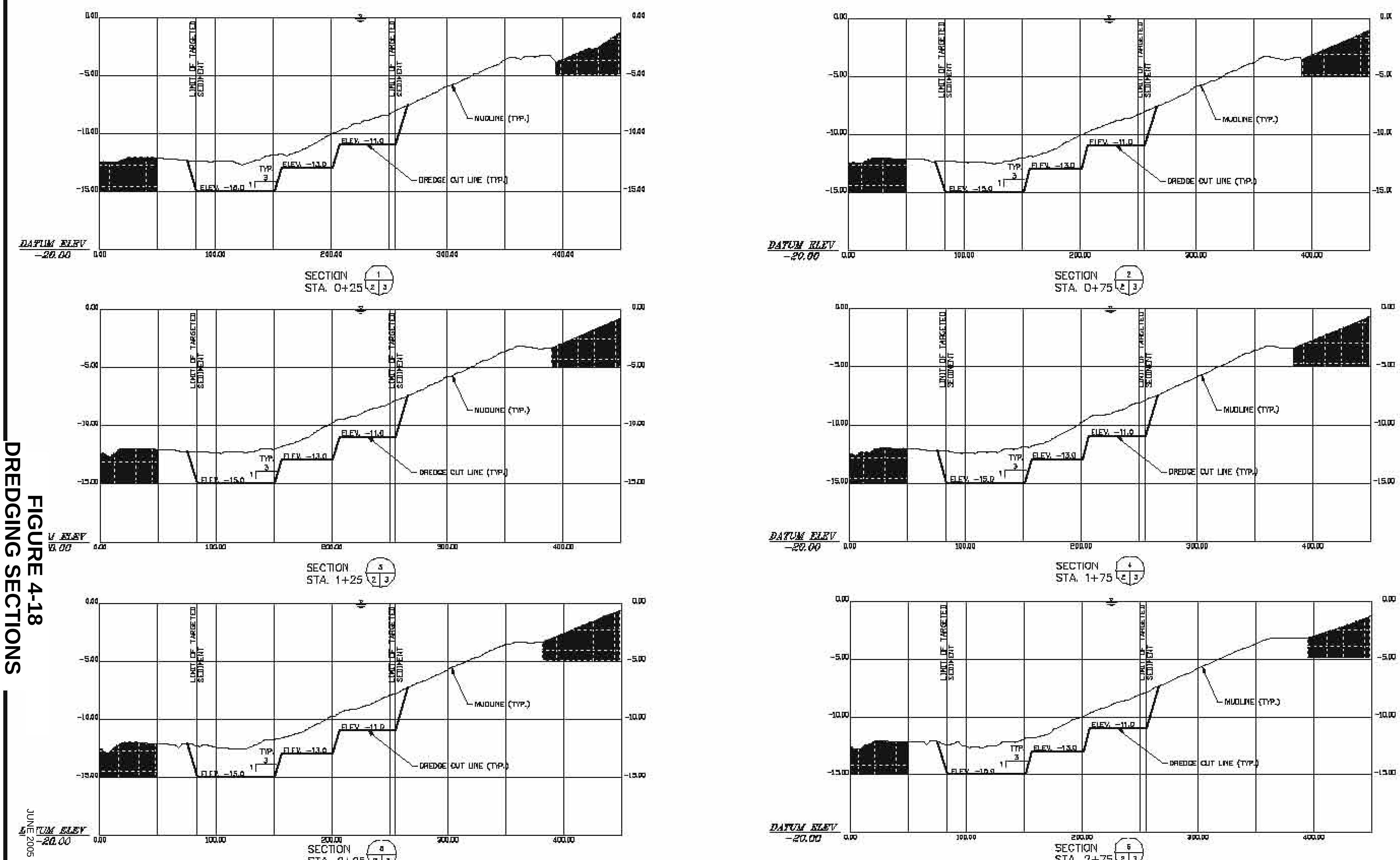
NEW JERSEY DEPARTMENT OF TRANSPORATION
OFFICE OF MARITIME RESOURCES
LOWER PASSAIC RIVER DREDGING PILOT STUDY
CONSTRUCTION CONTRACT NO. XXXXXXXX

FIGURE 4-17
DREDGING PLAN AND SECTION
HORIZONTAL SCALE: 1" = 40' VERTICAL SCALE: 1" = 4'

DATE June 2005
SHEET 2 OF 3
CAD REF. NO. 3473003

FIGURE 4-18
DREDGING SECTIONS

JUNE 2005



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DES JBM/SET
DRN JLF
CKD MRB/JJS/RMF

NEW JERSEY DEPARTMENT OF TRANSPORATION
OFFICE OF MARITIME RESOURCES
LOWER PASSAIC RIVER DREDGING PILOT STUDY
CONSTRUCTION CONTRACT NO. XXXXXXXX

FIGURE 4-18
DREDGING SECTIONS

HORIZONTAL SCALE: 1" = 40' VERTICAL SCALE: 1" = 4'

DATE JUNE 2005
SHEET 3 OF 3
CAD REF. NO. 3473003

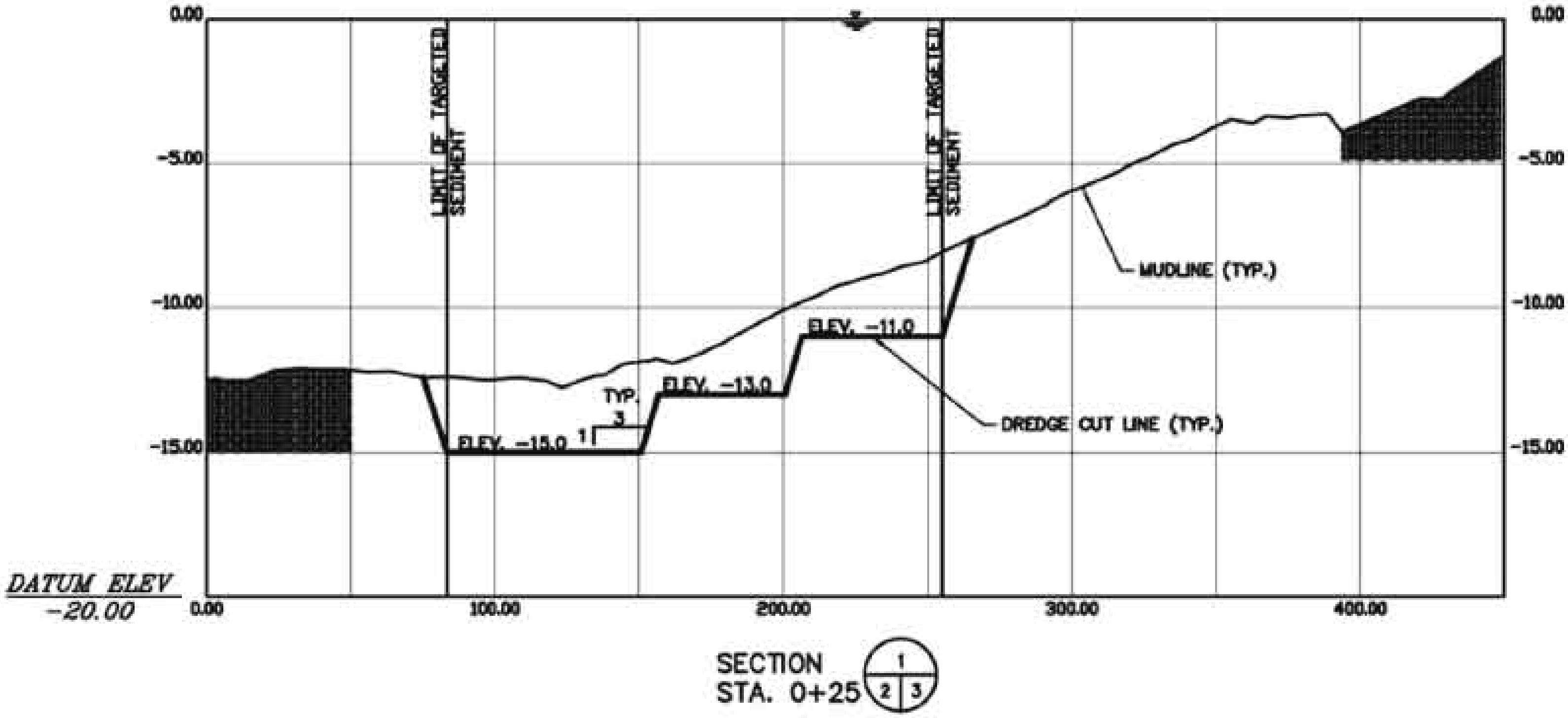

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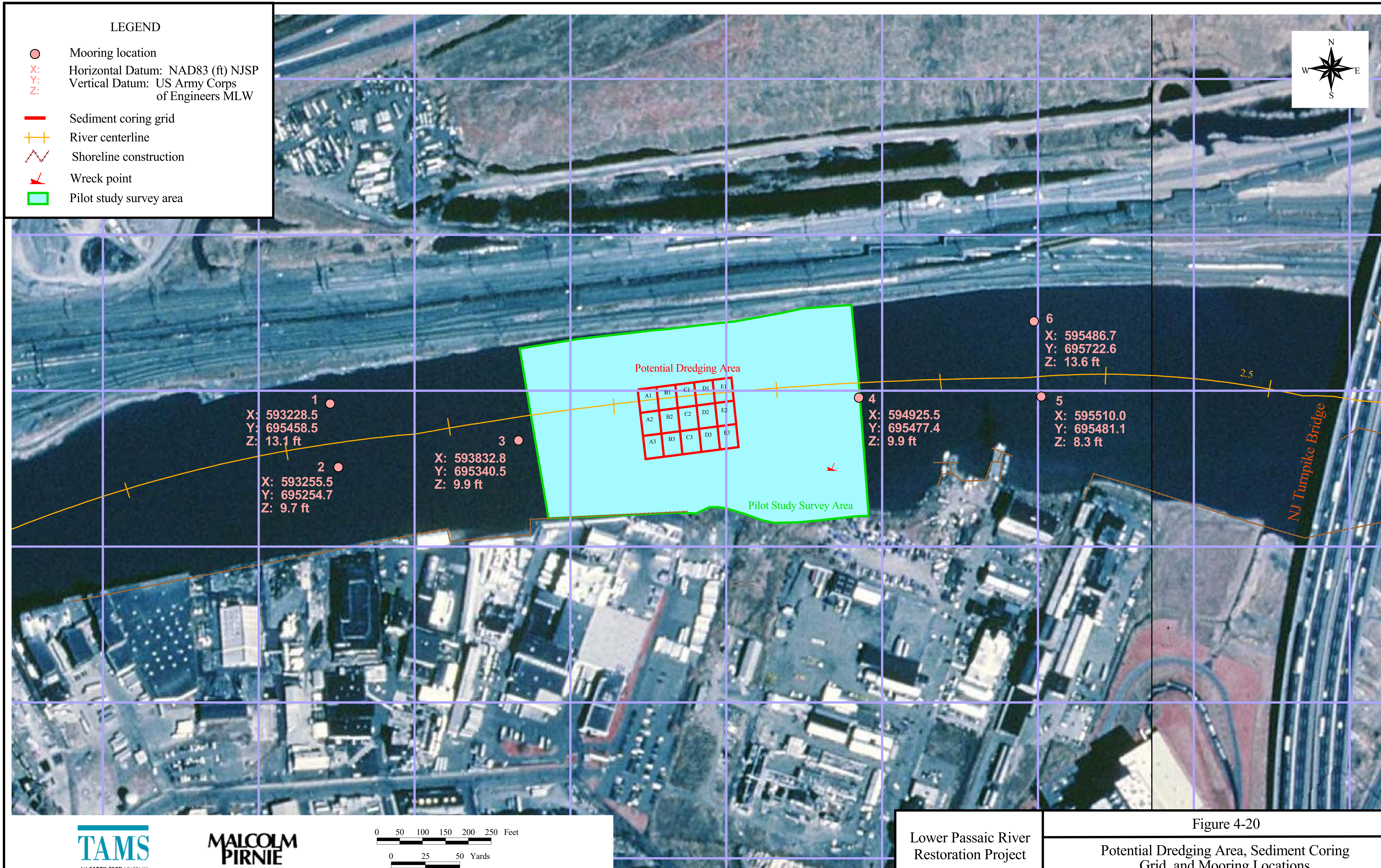
FIGURE 4-19
DREDGING SECTIONS

HORIZONTAL SCALE: 1" = 40' VERTICAL SCALE: 1" = 4'

DATE: JUNE 2005
SHEET 3 OF 3
CAD REF. NO. 3473003



Lower Passaic River Restoration Project

Figure 4-20

Potential Dredging Area, Sediment Coring Grid, and Mooring Locations