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Water Quality Mitigation Banking

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Submitted by

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16. Abstract

Current practice in New Jersey for mitigating stormwater impacts caused by transportation infrastructure projects is established by NJDEP Stormwater Regulations (N.J.A.C. 7:8). These rules outline specific processes to offset impacts to water quality, groundwater recharge and peak rate of runoff/runoff volume resulting from the addition of impervious surfaces. The rules are written to address impacts of individual projects without specific provisions for addressing cumulative programmatic impacts of multiple projects through "mitigation banking". The requirement to design and build separate, "on site" mitigation features for each project results in delayed implementation schedules, inefficient and nominally effective results and excessive maintenance demand. Over two decades ago, with reference to wetland resources, the need to achieve greater efficiency and environmental and economic benefits of scale led to the creation of wetland banking, which serves as a useful model for establishing a Stormwater Banking Program in the State of New Jersey. This report describes outcomes of a comprehensive study on the feasibility of water quality banking in the State of New Jersey. Groundwater recharge can be included within the banking system; however peak flow control banking is less likely feasible due to the potential for increased flooding of private properties. A detailed survey of future New Jersey Department of Transportation (NJDOT) projects was carried out to assess mitigation needs and to identify a pilot watershed for water quality mitigation banking. The Hackensack River HUC-11 watershed was selected for this purpose. Due to its highly developed context, "on site" project mitigation will likely cause significant hardship and delay future projects. By identifying a feasible "off site" location for water quality treatment, it was shown that an initial bank can be established to meet future needs within the watershed. A framework for tracking mitigation credits using a web-based computer program was also developed for successfully implementing water quality mitigation banking. The approach will provide future opportunities for adding credits to the bank by removing unnecessary impervious surfaces on projects and "over-treatment" at available "on site" BMPs.

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INTRODUCTION

Current practice in New Jersey for mitigating stormwater impacts caused by transportation infrastructure projects is established by NJDEP Stormwater Regulations (N.J.A.C. 7:8). These rules outline specific processes by which an applicant must evaluate and propose mitigation to offset impacts to water quality, groundwater recharge and peak rate of runoff or the volume of runoff resulting from the addition of impervious surfaces. The rules are written to address impacts of individual projects without specific provisions for addressing cumulative programmatic impacts of multiple projects through "mitigation banking". The requirement to design and build, "on site" mitigation features for each project often causes delayed implementation schedules, inefficient and nominally effective results and excessive maintenance demand.

Dozens of projects per year, many of which barely exceed the regulatory thresholds for compliance, must undergo analysis, design, regulatory review and permitting to achieve compliance with Stormwater Regulations. Many issues faced by this regulatory program are similar to those associated with the early implementation of wetland regulatory programs. The wetland mitigation paradigm began with project specific mitigation, resulting in many small created wetland areas which did not provide the anticipated environmental benefits. The need to achieve greater efficiency and environmental and economic benefits of scale led to the creation of wetland banking, which has now been in place for over two decades. It serves as a useful model for establishing an efficient Stormwater Banking Program.

The term "banking" used for this project means the implementation of water quality control best management practices (BMP) using a system of debits and credits which result in a net balance or enhancement of environmental benefit. Credits are accrued by providing water quality improvement at the project site, at an offsite banking location or through removal of unnecessary impervious surface within a designated watershed. Debits result from the addition of impervious surface resulting from transportation projects.

It is often difficult to find appropriate vacant property and unconstrained physical space adjacent to individual projects to mitigate impacts. This problem is especially acute for widening projects and those in urbanized areas where land development, utilities and other infrastructure severely restricts the feasible construction of water quality treatment. In such areas, as an alternative, reliance is often placed on installing underground manufactured treatment devices, which have specific maintenance requirements. Location of on-site treatment is often not compatible with existing landscapes or land use contexts. Finally, the proliferation of many small water quality mitigation sites results in questionable environmental benefits, substantial project development and regulatory review cost and increased demands for maintenance.

The general model for accounting for water quality impacts and water quality enhancements (credits) is not a new one and has been in use for both water and air media by the regulatory community. For example, according to a 2004 study by the Environmental Protection Agency (EPA), water quality trading (WQT) can be a cost-effective, environmentally sound local solution for improving water quality. Generally, WQT involves a party facing relatively high pollutant reduction costs compensating another party to achieve less costly pollutant reduction with the same or greater water quality benefit. Essentially, the EPA framework proposes water quality trading as a commercial commodity that can be traded between all stakeholders and parties, including commercial entities, government agencies and other interested stakeholders. WQT can be a useful tool for water quality enhancement in the right circumstances, and some dischargers welcome the flexibility it provides. The framework discussed in EPA (2004) is much broader than the water quality banking framework needed for the New Jersey Department of Transportation (NJDOT).

It should be noted that EPA has supported the implementation of WQT for several years, including the preparation of the “Draft Framework for Watershed-Based Trading” issued in 1996 and through financial support provided to a number of watershed-based trading efforts including those on the Tar-Pamlico River in North Carolina, in Long Island Sound and the Chesapeake Bay, and in the Lower Boise and Snake Rivers in Idaho.

EPA’s approach for allowing “off-site” mitigation to offset “on-site” impacts within the same watershed sets the stage for establishing a water quality banking approach for the New Jersey Department of Transportation (NJDOT).

Another method which manages environmental impacts through a system of credits and debits is articulated within the Federal Clean Water Act which requires states to identify waters bodies designated as “Water Quality Limited” (needing water quality improvement). Water quality limited waters require the application of Total Maximum Daily Loads (TMDLs) to determine the allowable stress for each stream. A TMDL is the level of pollution or pollutant load below which a water body will meet water quality standards and thereby allow designated usage goals. It recognizes that restoration of stream water quality may require a balancing of pollutant loading from multiple sources in a watershed. Implementation of water quality banking is therefore consistent with the overall water quality management approach embodied by The Act.

The supporting rationale for environmental benefits resulting from storm water quality banking can be supported by the premise that the quality of water streams depends on several contributing factors. Stormwater runoff is just one of them. For non-point sources of pollution, all land surfaces, including pervious and impervious, contribute varying levels of pollution loading. These pollutants, in combination with point sources and atmospheric sources result in variations in water quality within stream segments of subareas within watersheds. The variation, if managed though a debit/ credit process, such as banking, is unlikely to cause adverse effects on the overall stream water quality within a watershed as long as mitigation (banking) at “off-site” locations offsets pollution caused by addition of impervious surfaces at project locations (“on-site”). In fact, greater efficiency of pollutant removal, resulting in enhanced water quality, can be achieved since a central “off-site” mitigation site, generally of larger scale, allows greater location and design flexibility to achieve effective BMPs and reduces the number of sites requiring maintenance, most of which are typically manufactured treatment chambers.

The development and implementation of water quality mitigation banking offers numerous economic, environmental and social benefits. Economic benefits can include:

- Allowing NJDOT to take advantage of economies of scale and treatment efficiencies within a watershed by performing mitigation for several projects at one “off-site” location.
- Reducing the overall cost of achieving water quality objectives on a watershed basis by reducing project development cost, purchase of ROW parcels and the construction and maintenance of numerous, generally small, “on-site” BMPs.
- Providing the means to advance transportation goals efficiently by reducing environmental reviews for permitting, while protecting the environment as well.
- Minimizing hours and cost required for the design of individual “on-site” BMPS by consolidating efforts for designing/ administering a banking solution.
- Streamlining and eliminating NJDEP reviews, saving time and budgets for both NJDEP and NJDOT.

Environmental benefits of water quality banking for NJDOT, NJDEP and New Jersey residents can include:

- Achieving water quality objectives more quickly and effectively, since NJDOT may chose to credit excess mitigation well in advance of construction of several projects within watersheds.
- Encouraging NJDOT to minimize creation of impervious areas, and removal of unneeded pavement during project design.
- Encouraging adoption of innovative technologies in treating nonpoint pollution to solve water quality problems.
- Providing collateral benefits such as improved habitat and ecosystem protection.
- Reducing the proliferation of small mitigation sites, related maintenance demands and environmental risks.
- Opening doors for collaboration with watershed management organizations to identify potential projects which offer water quality improvement for inclusion as credits within the future banking system.

From a social standpoint, water quality banking provides an opportunity to enhance the appearance of roadsides and the State's overall landscape by integrating well designed water quality bank sites into the environment.

The concept also can open doors for interagency cooperation among counties, New Jersey Transit, New Jersey Turnpike and other public entities to participate in the banking process and enhance its overall effectiveness and benefit towards the achievement of sustainable development/ redevelopment of the State. The concept can also provide opportunity for public-private partnerships for addressing water quality issues on a watershed basis.

In consideration of the potential advantages and public benefits of water quality mitigation banking presented above, the objectives of this research project were to:

- Investigate the feasibility of establishing a pilot stormwater bank site for NJDOT projects within a specific watershed, which can be implemented, evaluated and expanded for State-wide application.
- Establish a water quality banking system which reduces the cost and time spent by NJDOT and NJDEP for project by project mitigation and which provides a tool for managing credits and debits for accounting impacts within watersheds

Stormwater Mitigation Banking Approach for NJDOT

A logical, three stage, cost effective approach was used to investigate the feasibility of stormwater mitigation banking. These three stages are:

1. **Investigating Regulatory Feasibility**: NJDEP approval is required to establish and implement a Stormwater Mitigation Bank. The Stormwater regulations or NJDEP policy may present fatal flaws or obstacles to implementation. If these cannot be overcome, the concept would not be feasible. In order to obtain input on the feasibility of water quality mitigation banking, a technical panel which included senior NJDOT, FHWA and NJDEP management and technical staff was established. Two meetings (October 30, 2007 and December 19, 2007) were held to discuss the regulatory feasibility of the banking concept for NJDOT. During these meetings, NJDEP representatives tentatively welcomed the concept of water quality banking. However, because of changes within NJDEP, further involvement by NJDEP in the project was not provided.
2. **Investigating Technical Feasibility**: Significant technical issues needed to be overcome to design a feasible mitigation bank, including the need for banking by NJDOT; the selection of watershed size (watershed management area, HUC11, or HUC14); feasibility of banking water quality, groundwater recharge, peak runoff rates

at the same bank; and the technical basis for establishing credits. A statewide search for mitigation opportunity was determined to be too broad and cost prohibitive and therefore was not undertaken because of time and budget limitations. Instead, the approach focused on narrowing the effort to one watershed to develop a pilot bank site. During regulatory feasibility discussions with NJDEP, the use of HUC11 watershed was considered to be feasible as a water quality banking watershed.

3. **Establishing the Stormwater Bank**: Based on the feasibility study, a pilot bank in Hackensack River watershed was proposed. This watershed includes enough planned projects with impervious impacts to support development of a banking site. Considering the extremely dense development within this watershed, the difficulty and expense of ROW acquisition for individual projects, and other site constraining hardships, the watershed is ideal for exploring the streamlining opportunities offered by a bank concept. Based on a systematic and exhaustive search within the watershed, the research team identified a feasible location for creation of a mitigation banking facility. The site can serve as the first credit installment to the pilot bank. While this credit can be used for projects that are ready for execution, the banking system also provides NJDOT opportunities for generating credits by removing un-necessary pavement and creating extra mitigation at feasible on-site locations.

Literature Review on Water Quality Mitigation Banking

Since the concept of water quality mitigation banking is relatively new and relies on regulatory approval of environmental agencies in different states of the country, very few papers/reports on this issue could be found. However, there are several papers on wetland banking aspects. The most significant resources on water quality banking are reports by EPA: "Water Quality Trading Assessment Handbook" published in 2004 [EPA (2004)] and "National Forum on Synergies Between Water Quality Trading and Wetland Mitigation Banking" published in 2005 [Environmental Law Institute (2005)]. EPA (2004) discusses broad aspects of water quality trading between all interested stakeholders, including commercial entities and government agencies, and presents several case studies and scenarios on water quality trading. However, the handbook mostly addresses trading by considering implementation of TMDL. The Handbook assesses the likely viability of watershed-scale trading conducted in the context of a Total Maximum Daily Load (TMDL) or equivalent framework. TMDLs and similar frameworks function as "pollutant budgets" for waterways, estimating the total pollutant load that a specific watershed or segment can assimilate without exceeding water quality standards. Water quality standards are established by states at levels that protect the designated use(s) of each water body such as recreation, fishery, or source of drinking water. Once established, the TMDL total allowable load is allocated across point sources and nonpoint sources located in the watershed. Once implemented, TMDL is likely to impose more stringent requirements on stormwater quality mitigation standards in New Jersey, considering the fact that a majority of water bodies in New Jersey are impaired.

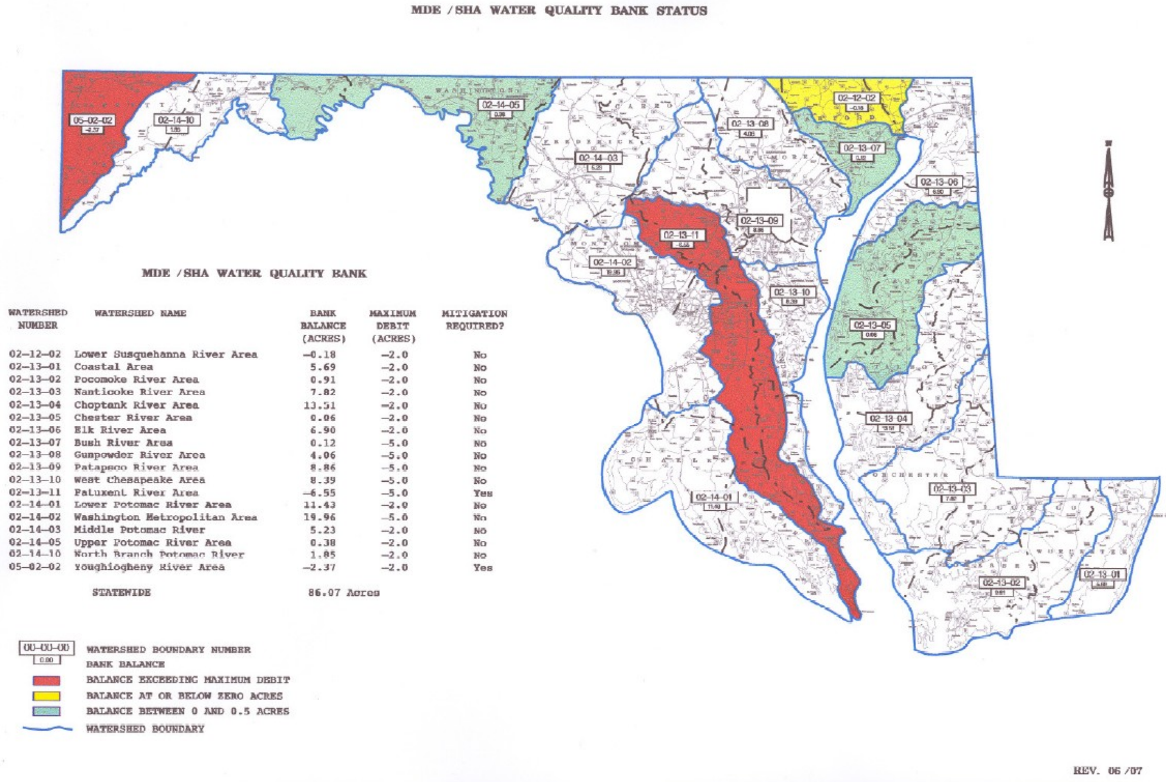
The report by Environmental Law Institute (2005), documents outcomes of discussions at a national forum on "Synergies between Water Quality Trading and Wetland Mitigation Banking", held during July 11-12, 2005 in Washington, DC. The forum was sponsored by the EPA and facilitated interested comparisons between wetland mitigation banking and water quality trading. Essentially, wetland mitigation banking has a number of advantages over traditional permittee-responsible mitigation because of the ability of mitigation banking programs to: (i) Reduce uncertainty over whether the mitigation will be successful in offsetting project impacts; (ii) Greatly expand entrepreneurial opportunities for third-party mitigation credit providers; (iii) Bring together extensive financial resources, planning, and scientific expertise not always available to many permittee-responsible mitigation proposals; (iv) Reduce permit processing times and provide more cost-effective compensatory mitigation opportunities; and (iv) Increase the efficiency of limited agency resources in the review and compliance monitoring of mitigation projects because of consolidation. However, siting a wetland bank is often driven by economic factors, rather than ecological factors. On a regional scale, banks tend to be sited near urban areas where there is a high level of demand. On a local scale, even within service areas or watersheds, banks are usually located in areas where the cost of production is lowest, which may not necessarily meet the ecological priorities of the watershed. Although these observations are for wetland mitigation banking programs, they are equally applicable to water quality mitigation banking approach.

A white paper on "Applying Lessons Learned from Wetlands Mitigation Banking to Water Quality Trading" [Landry et al. (2005)] discusses different models for water quality trading based on lessons learned from wetland banking experience. Since the water quality trading involves much broader issues because of the involvement of commercial as well as government stakeholders, there are very few parallels that could apply to a water quality mitigation banking approach.

Doll et al. (1999) provided examples of stormwater utilities with credits for onsite stormwater management, including credits for peak runoff controls, implementation of water quality BMP, and proper maintenance of onsite stormwater facilities. However, this work focuses mostly on incentives and credits for on-site water quality mitigations.

Water Quality Mitigation Banking Implementations by Other States

Based on the literature survey and further discussions, it has been observed that two states, Maryland and Delaware, have implemented stormwater quality mitigation banking programs and have clearly demonstrated their advantages. The water quality mitigation banking program in Maryland has been in operation since 1992 and resulted in significant savings and achievement of water quality standards. As of August 2007, the state had approximately 86.07 acres credit in their bank (see Figure 1.1). The Maryland water quality mitigation banking program was implemented through a MOU between the Maryland State Highway Administration (SHA) and the Maryland Environment's Sediments and Stormwater Administration (SSA).



WATERSHED NUMBER	WATERSHED NAME	BANK BALANCE (ACRES)	MAXIMUM DEBIT (ACRES)	MITIGATION REQUIRED?
02-12-02	Lower Susquehanna River Area	-0.18	-2.0	No
02-13-01	Coastal Area	5.69	-2.0	No
02-13-02	Pocomoke River Area	0.91	-2.0	No
02-13-03	Nanticoke River Area	7.82	-2.0	No
02-13-04	Choptank River Area	13.51	-2.0	No
02-13-05	Chester River Area	0.06	-2.0	No
02-13-06	Elk River Area	6.90	-2.0	No
02-13-07	Bush River Area	0.12	-5.0	No
02-13-08	Gunpowder River Area	4.06	-5.0	No
02-13-09	Patapsco River Area	8.86	-5.0	No
02-13-10	West Chesapeake Area	8.39	-5.0	No
02-13-11	Patuxent River Area	-6.55	-5.0	Yes
02-14-01	Lower Potomac River Area	11.43	-2.0	No
02-14-02	Washington Metropolitan Area	19.96	-5.0	No
02-14-03	Middle Potomac River	5.23	-2.0	No
02-14-05	Upper Potomac River Area	0.38	-2.0	No
02-14-10	North Branch Potomac River	1.85	-2.0	No
05-02-02	Youghiogheny River Area	-2.37	-2.0	Yes
	STATEWIDE	86.07 Acres		

Figure 1.1 Map Showing Credits Banked in Maryland till August 2007

A copy of the MOU between SHA and SSA is enclosed in Appendix II. Main highlights of the MOU are:

- Deferral of water quality for new pavement areas up to a total of 5 acres per watershed in metropolitan areas and 2 acres in rural areas.
- Credit for treatment of offsite pavement areas (i.e., county roads, parking lots, etc.) that drain into SHA facilities.
- Credit for wetland mitigation sites designed to Maryland Department of Environment (MDE) criteria which receive pavement runoff.
- Ability to extend the use of bank to other state agencies, subject to the approval by the Chief Engineer.
- Establishment of a process to initiate water quality retrofits to clear existing bank debits or create bank credits.
- MDE SSA to make final determination on approval of off-site quality management.
- If a quality management (credit) project is proposed to reduce the pavement deficit in the bank, the proposed roadway to be treated should be similar to that of the project deferred to the bank.
- Infiltration is the most preferred and extended basis is the least preferred means (Note: Current version of the MOU doesn't differentiate between different BMPS).

Quality management in the same area as the impervious area it was designed to treat receives 100% credit.
- Under certain conditions, untreated pavement requiring quality management in one watershed may be deferred to excess quality management in another watershed.
- Credit is allowed for the removal of existing pavement and replacement with pervious areas.

Similar to Maryland, the Delaware water quality banking program provides watershed based water quality mitigation outlined in provisions of a memorandum of agreement (MOA) between DelDOT and Delaware Department of Natural Resources and Environmental Control (DNREC) [McCleary (1999)]. Highlights of this program include the following:

- The banking program is for water quality only. Peak flow rates associated with highway projects must still be controlled on-site.
- The banking of credits and debits is on watershed basis only for DelDOT projects. However, the MOA does allow for the possibility of mitigations outside a watershed.
- Banking is allowed only for projects located in areas that pose difficult site considerations or which otherwise offer little opportunities to implement on-site mitigations.
- DelDOT is delegated by DNREC to administer its own stormwater management program since 1991. This gives DelDOT the ability to design, review and permit its own projects for stormwater management.
- DelDOT is required to implement stormwater management control on every project involving disturbances of 5000 sq ft or more, resulting in large number of stormwater ponds requiring significant financial resources. In one case, the cost of a pond to treat less than 2-acres drainage area exceeded $300,000. In fact, the total cost of all stormwater management practices for the 6-year period (FY1995-FY2000) was estimated at approximately $10.2 million. Banking approach gave DelDOT the ability to manage its program more efficiently and economically.
- Acceptable water quality mitigation includes source controls, removal of existing pavement, reforestation of cut woodlands, replacement of riparian vegetation, retrofitting existing stormwater ponds, removal of illicit connections. Other land improvement techniques can also be considered.
- A simple spreadsheet based approach is used for the accounting of the banking credits and debits.
- The MOA between DelDOT and DNREC can be modified or terminated upon written notification by either party.
- Funding for banking projects is provided through on-site construction (excess mitigation) and percentage of contract costs (around 1%) held in escrow from multiple projects or programs (e.g., DelDOT's pavement management program). Although public-private and public-public partnerships have been considered, they haven't been implemented.
- The MOA doesn't affect the ability of DelDOT to acquire property by invoking rights of eminent domain.

- The MOA is consistent with the requirements of TMDL and NPDES Stormwater permit programs of the Clean Water Act and Coastal non-point pollution control program of Federal Coastal Zone Act Reauthorization Amendments (CZARA).
- The MOA allows for the consideration of wetlands creation among many other alternatives for surface water quality control.

CHAPTER 2
INVENTORY OF FUTURE PROJECTS AND IMPACT TO IMPERVIOUS SURFACES WITHIN WATERSHEDS

In order to identify future impacts (impervious surfaces) within the State's HUC -11 watershed boundaries and to identify one pilot HUC11 watershed area in which the feasibility of water quality mitigation banking could be demonstrated to NJDOT and NJDEP, an inventory of NJDOT Project Planning & Development (DPPD) and Capitol Program Management (CPM) projects was necessary. The research team collected and reviewed an extensive amount of data on NJDOT projects in order to map them on GIS layers and to identify future impervious surface impacts within HUC-11 watershed boundaries throughout the State. Table 2.1 shows various types of data collected and sources of this data.

Table 2.1- Data collected to map NJDOT projects on GIS map

Sources of Data	ARCGIS Shape files	Project Information	Other
NJDOT	DPPD Projects Shape files	CPM Project list (Excel) DPPD Project list Impervious Impact data	DPPD Map (PDF)
RBA Group	New Jersey State, Counties, Watershed Management areas, HUC 11, HUC 14 Boundaries, State Municipalities and NJ Roadways Shape files		
NJDOT Website NJDOT Statewide transportation Improvement program			Straight line diagrams (SLD) (for CPM/DPPD Projects) Routes by County, Projects by County, Projects by Route

Mapping of DPPD and CPM Projects

The shape files for the State of New Jersey were overlaid in ARCMAP in the order of: (i) State, (ii) County, (iii) Roadways, (iv) HUC 11 and (v) DPPD Projects. The DPPD projects were marked as “Red” and “Green” lines for “Concept Development” and “Feasibility Assessment” phases, respectively, on the GIS Map. The list of DPPD projects was copied from the DPPD PDF map obtained from NJDOT. Some of the projects on this list were not mapped in the original shape file. To map these projects, the mileposts were determined from the information obtained from NJDOT (projects by routes/county & SLD). The DPPD projects were labeled by their Universal Project Code (UPC) number with a white borderless background for easy identification. These labels were converted to annotations so that we could easily move them around for more clarity. The counties were also labeled.

The shape file for the CPM projects was not available. Hence, CPM Projects were plotted manually on the GIS map. The milepost information was made available from the CPM project sheet (Excel). The Straight line diagrams for the respective projects were identified and the exact starting and ending mileposts were measured on the map using the roadways shape file. All the feature additions were saved as a new shape file for CPM projects. These CPM projects were marked by “Purple” lines for the “Active projects” and were labeled by their UPC number for easy differentiation between the DPPD and the CPM projects

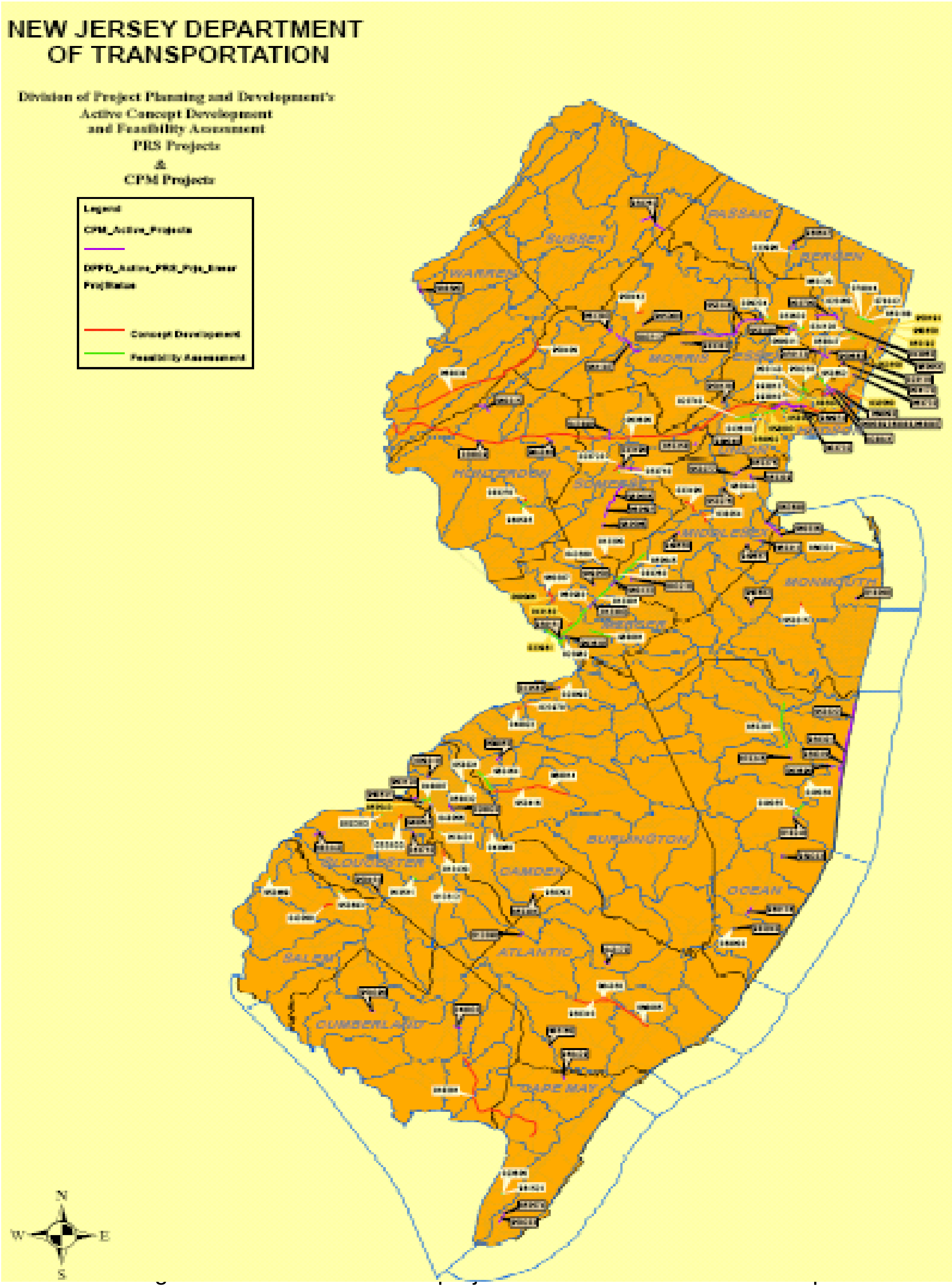
Figure 2.1 is a map which illustrates both DPPD and CPM projects. The same process was repeated to create another similar map without the labels, which is shown in Figure 2.2. The map without labels was necessary because, with all the labels in place, it was difficult to identify the HUC11 watershed with the maximum number of projects. The County shape file was removed since some of the HUC11 boundaries overlapped with the county boundaries. The HUC11 watersheds were marked by their assigned numbers. This allowed easy identification of potential HUC11 watersheds for a pilot study.

Determining Projects by HUC 11 Boundaries

In order to identify a pilot HUC11 watershed for a detailed study of water quality mitigation banking, all the projects lying in a particular HUC11 watershed were individually measured for the project length in miles. Some projects were encapsulated by the HUC11 boundaries while many projects spanned or intersected two or more HUC11 watersheds. These projects were broken down into length segments corresponding to each HUC11 boundary they intersected. All the projects were measured manually and a list was prepared for all the HUC11 watersheds within the State of New Jersey. Table 2.2 shows this list of projects by HUC11 watershed for the entire State. This list contains the number of DPPD and CPM projects in a HUC11 watershed and the project total length in that watershed. Based on the total number of projects and the total length of projects, the following six HUC11 watersheds were chosen as potential candidates: #29 (Hackensack River); #101 (Woodbury/Big Timber/Newton Creeks); #46 (Newark Bay/Kill Van Kull/Upper Newark Bay); #69 (Assunpink Creek); #56 (Millstone River); and #45 Elizabeth River). Table 2.3 contains impervious area information and other relevant information on all of the DPPD & CPM projects in these six HUC11 watersheds.

Impervious Impact Information for the Six Selected HUC 11 Watersheds

The impervious impact area (in acres) for each project was obtained from the Project Managers/ Team Leaders at NJDOT. This part of the task was very time-consuming and required significant level of effort by the research team and the project manager, Dr. Aboobaker. The process took more than 8 months because of difficulty in scheduling research team meetings with NJDOT project managers. The impervious impact area information was compiled for each of the six HUC11 watersheds. Impervious impact data for these projects is shown in Table 2.3. The impact value (in acres) for each HUC11 was also plotted on the GIS map, as shown in Figure 2.3. It can be noted from Table 2.3 & Figure 2.3 that HUC11 watershed # 101 has 116.75 acres of impervious area followed by the HUC11 watershed #29 with 23.26 acres of impervious impact area. The other four watershed areas have significantly lower less impervious impact area.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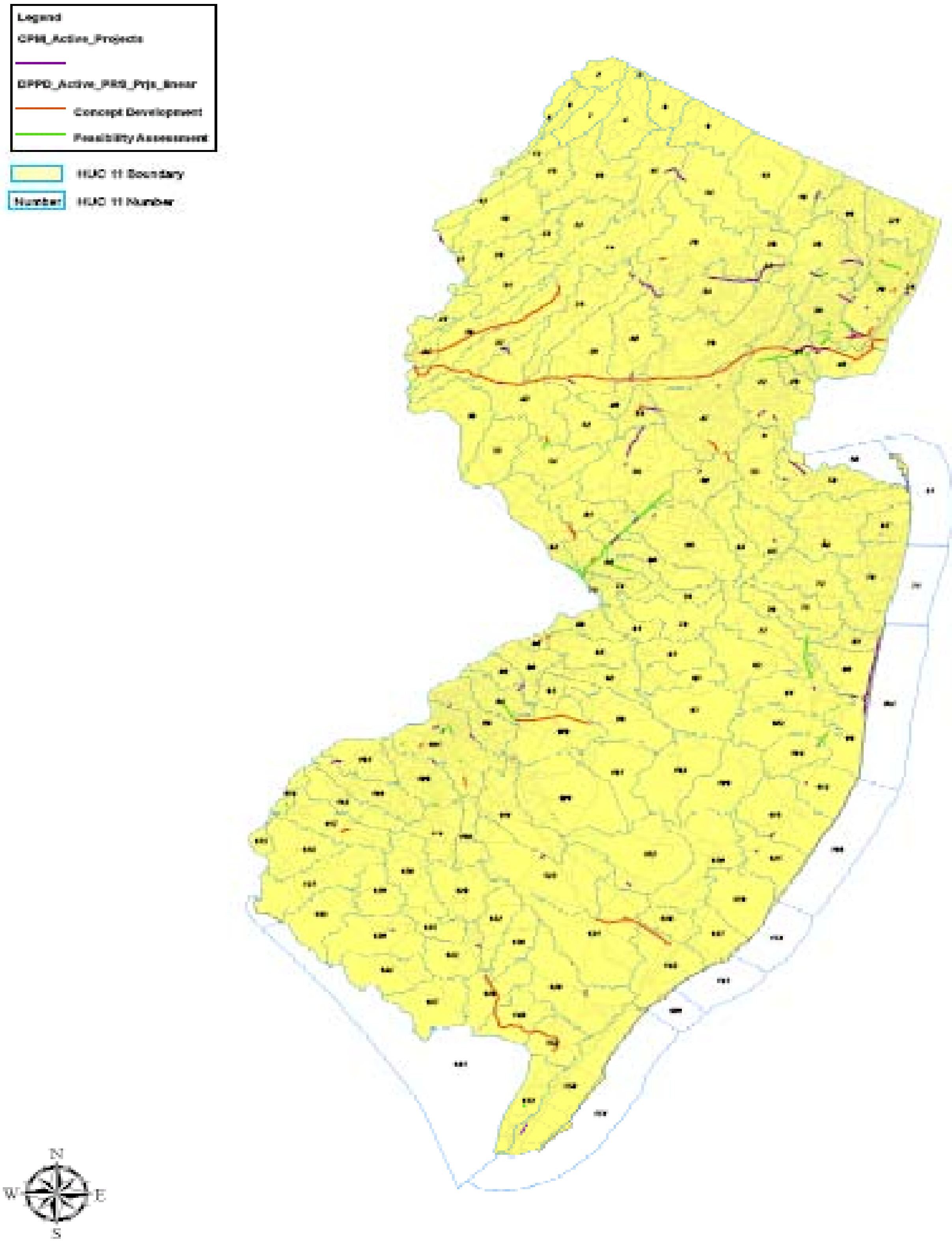


Figure 2.2 DPPD and CPM projects without labels on the GIS map

Table 2.2 - List of projects by HUC11 watersheds for the entire state of New Jersey

HUC11 Number	HUC11	Water Shed NAME	DPPD Projects			CPM Projects			Total Length
			# of	UPC	Length	# of	UPC	Length	(Miles)
11	02020007010	Wallkill River (above road to Martins)				1	950262	2.63	2.63
14	02030103050	Pequannock River				1	950262	1.47	1.47
16	02030103100	Ramapo River				1	960647	0.26	0.26
19	02030103140	Saddle River	2	23990	0.1	2	960647	0.94	1.78
				53120	0.12		003700	0.62	
20	02030103030	Rockaway River	1	950442	0.9	3	950446	1	2.86
							985280	0.08	
							961187	0.88	
24	02040105150	Musconetcong River (above Trout Brook)	2	950409	1				1.45
				068038	0.45				
25	02030101170	Hudson River	1	063600	3.11	2	063730	0.3	4.39
							950651	0.98	
26	02030103120	Passaic River Lower (Saddle to Pompton)	3	009234	0.5	3	003700	2.58	5.49
				068011	1.23		950189	0.63	
				053630	0.25		950446	0.3	
27	02040105060	Stony Brook / Delawanna Creek				1	998500	1.2	1.2
29	02030103180	Hackensack R (below/incl Hirshfeld Bk)	12	078042	2.52	10	970173	0.4	15.64
				023460	0.4		950662	0.39	
				950198	0.05		004170	0.4	
				950194	0.08		068090	2	
				950192	0.06		068089		
				950650	0.2		068088		
				024120	0.5		068087		
				058047	0.62		028041	0.9	
				053550	0.64		063730	0.3	
				033560	3.88		023110		

				950652	1.9				
				078044	0.4				
32	02030103040	Passaic River Upr (Pompton to Pine Bk)				1	950446	4.8	4.8
33	02030105050	Lamington River	1	063600	9.25	3	984040	1.3	12.1
							961283	0.07	
							961187	1.48	
34	02030103020	Whippany River				4	003712	4.1	7.15
							950446	2.6	
							983383	SOI	
							961187	0.45	
35	02030105010	Raritan River SB (above Spruce Run)				1	961283	0.83	0.83
36	02030103150	Passaic River Lower (Nwk Bay to Saddle)	4	950250	0.4	2	970173	1.8	5.15
				003140	1.4		950189	0.87	
				033560	0.52				
				985041	0.16				
37	02040105160	Musconetcong River (below incl Trout Bk)	2	068038	8.35	1	960315	1	12.93
				063600	3.58				
38	02030103010	Passaic River Upr (above Pine Bk br)	1	063600	7.22	1	950129	0.16	7.38
39	02040105140	Pohatcong Creek	2	068038	12.2				17.63
				063600	5.43				
40	02030105060	Raritan River NB (above Lamington)	1	063600	1.77	2	043890	0.8	4.07
							961187	1.5	
42	02030104050	Rahway River / Woodbridge Creek	2	063600	4.32	3	950209	0.8	8.39
				023740	2.11		950275	0.5	
							950277	0.66	
43	02030105020	Raritan River SB (3 Brdgs to Spruce Run)	3	960585	0.71	2	960315	0.89	12.09
				063600	9.06		038039	0.5	
				083270	0.93				
44	02040105120	Lopatcong Creek	1	068038	2.4				2.4

45	02030104020	Elizabeth River	6	058006	0.3	1	003732	2.27	9.7
				058003	0.8				
				058002	0.6				
				043610	0.4				
				023740	1.39				
				063600	3.94				
46	02030104010	Newark Bay / Kill Van Kull / Upr NY Bay	5	993813	0.29	2	003732	2.53	13.71
				993810	1.05		960974	0.5	
				063600	9				
				058006	0.3				
				985041	0.04				
47	02030105120	Raritan R Lower (Lawrence to Millstone)	2	063600	7.28	3	950258	0.49	11.1
				033490	2.18		033190	1.14	
							989040	0.01	
49	02030105070	Raritan River NB (SB to Lamington)	1	063600	2.77	1	043890	0.7	3.47
51	02030105080	Raritan River Lower (Millstone to NB/SB)	2	053710	0.2	1	033190	1.7	3.26
				023720	1.36				
54	02030105030	Neshanic River	1	960585	0.69				0.69
55	02030105160	Raritan R Lower (below Lawrence)	1	063940	NA	1	950657	0.1	0.1
56	02030105110	Millstone River (below/incl Carnegie Lk)	4	043560	0.03	3	960605	2.1	11.4
				013200	0.1		960597	3	
				950645	0.5		960596	0.46	
				083260	5.21				
59	02030104060	Raritan / Sandy Hook Bay tributaries	1	950331	0.1	3	063680	0.2	3.3
							960326	2.7	
							950311	0.3	
60	02030105130	Lawrence Brook	1	038054	1.72	1	960550	0.6	2.32
61	02030105090	Stony Brook	4	960307	1.23	3	013303	0.48	5.46
				083260	2.17		989050	0.2	

				013301	0.54		960123	0.14	
				088006	0.7				
62	02040105210	Alexauken Ck / Moore Ck / Jacobs Ck	3	960307	0.9				2.76
				023961	1.8				
				023962	0.06				
64	02030104070	Navesink River / Lower Shrewsbury River	1	950315	0.8				0.8
65	02030105150	Matchaponix Brook				1	950662	0.5	0.5
66	02030105100	Millstone River (above Carnegie Lake)	1	083260	2.18	2	960123	0.86	3.54
							003210	0.5	
67	02030104080	Shrewsbury River (above Navesink River)				1	018080	0.22	0.22
68	02040105230	Assunpink Creek (above Shipetaukin Ck)	3	083260	2.05	1	013303	1.26	5.01
				063580	0.5				
				013301	1.2				
69	02040105240	Assunpink Creek (below Shipetaukin Ck)	5	023962	0.56	2	950151	0.15	10.1
				960307	0.57		993620	0.12	
				043160	0.75				
				083260	5.22				
				068091	2.73				
73	02040201030	Duck Creek and UDRV to Assunpink Ck	2	023962	0.88				1.59
				083260	0.71				
77	02040301060	Toms River (above Oak Ridge Parkway)	1	950207	4.76				4.76
78	02040301030	Metedeconk River SB	1	950207	1.48				1.48
80	02040201090	Crafts Creek	1	023090	0.1	1	013560	0.1	2.41
83	02040301040	Metedeconk River				1	950322	2.21	
85	02040201100	Assiscunk Creek	1	023970	0.8				0.8
86	02040201110	Burlington/Edgewater Park Delaware tribs	1	048022	0.6				0.6
88	02040202080	Rancocas Creek				1	009050	0.41	0.41
89	02040301050	Kettle Creek / Barnegat Bay North				4	950321	5	8.06
							950319	1.37	

							950322	1.29	
							063690	0.4	
91	02040301080	Toms River (below Oak Ridge Parkway)	1	950207	0.66	1	970245	0.5	1.16
94	02040202100	Pennsauken Creek	2	960464	3.28	1	009050	0.87	4.57
				950416	0.42				
96	02040202110	Cooper River	2	058031	0.1	2	028020	0.9	1.7
				058032	0.1		009010	0.6	
98	02040202050	Rancocas Creek SB (above Bobbys Run)	1	950416	0.06				0.06
99	02040301100	Barnegat Bay Central & Tribs	2	048055	1.31	2	950319	2.63	4.55
				048058	0.06		063690	0.55	
100	02040202060	Rancocas Creek SB SW Branch	2	950416	9.52				9.72
				068014	0.2				
101	02040202120	Woodbury / Big Timber / Newton Creeks	7	950353	0.1	5	028020	0.9	7.73
				053100	0.81		063710	0.28	
				013431	0.2		048005	0.2	
				013430	1.48		993120	1	
				950543	1.3		950541	0.4	
				048006	0.56				
				048007	0.5				
102	02040301090	Cedar Creek	1	048055	0.23				0.23
104	02040301110	Forked River / Oyster Creek	1	048055	0.47	1	018240	0.38	0.85
105	02040202140	Cedar Swamp / Repaupo Ck / Clonmell Ck				1	983440	0.55	0.55
106	02040202130	Mantua Creek	1	013511	0.52	1	063710	0.32	0.84
109	02040301160	Mullica River (above Basto River)	1	950292	0.12	1	950301	0.1	0.32
110	02040202150	Raccoon Creek / Birch Creek				2	983440	0.89	0.94
							950434	0.05	
111	02040302030	Great Egg Harbor R (above HospitalityBr)	1	043060	0.38				0.38
112	02040301120	Waretown Ck / Barnegat Bay South				1	950202	0.4	0.4
113	02040202160	Oldmans Creek	1	950693	0.1				0.1

114	02040206020	Pennsville / Penns Grove tribs	1	950469	0.3				0.3
115	02040301130	Manahawkin/Upper Little Egg Harbor tribs				1	960176	1	1
117	02040206030	Salem R(above 39d40m14s dam)/Salem Canal	1	043080	1.3				1.3
119	02040206120	Still Run / Little Ease Run	1	013512	0.08				0.08
121	02040301140	Lower Little Egg Harbor Bay tribs	1	068000	0.32	1	984040	0.2	0.52
122	02040301170	Mullica River (Turtle Ck to Basto River)				1	043170	0.64	0.64
131	02040302050	Great Egg Harbor R (below Lake Lenape)	3	064050	0.9	1	985160	0.2	7.8
				950343	6.48				
				068095	0.22				
132	02040206180	Menantico Creek				1	048033	0.34	0.34
136	02040206190	Manamuskin River	1	018291	0.92				0.92
139	02040206090	Cohansey River (below Cornwell Run)				1	950390	0.45	0.45
140	02040302070	Tuckahoe River				1	960429	1	1
142	02040206170	Maurice River (Menantico Ck to Union Lk)				1	048033	0.56	0.56
143	02040302060	Patcong Creek/Great Egg Harbor Bay	2	068095	4.68				8.9
				950343	4.22				
146	02040206200	Maurice River (below Menantico Creek)	1	018291	5.52				5.52
148	02040206210	West Creek / East Creek / Riggins Ditch	1	018291	6.98				6.98
150	02040302080	Cape May Bays & Tribs East				2	950574	0.4	1.5
							950203	1.1	
152	02040206220	Dennis Creek	1	018291	5.58				5.58
153	02040206230	Cape May Tribs West	2	023600	0.1				0.2
				961521	0.1				

Table 2.3 - DPPD and CPM projects in top six HUC 11 watersheds with impervious impact information

HUC 11 # 29 (Hackensack R below/incl Hirshfeld Bk)					
UPC	**DPPD Project Details Title**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
078042	Rt 4, Pedestrian Mobility Improvements, Teaneck	00000004	Feasibility Assessment	2.52	< 0.25
023460	Rt 4 Hackensack River Bridge	00000004	Concept Development	0.4	< 0.25
950198	Rt 4 Teaneck Road Bridge	00000004	Concept Development	0.05	0.5
950194	Rt 4 Jones Road Bridge	00000004	Concept Development	0.08	< 0.25
950192	Rt 4 Flat Rock Brook Bridge	00000004	Concept Development	0.06	0
950650	Rt 4 Jones Road Drainage	00000004	Concept Development	0.2	0 (Tom Saylor)
24120	Rt 80 North Street Drainage Improvements	00000080	Feasibility Assessment	0.5	(Tom Saylor) Terminated
058047	Rt 46 Main St to Vicinity of Frederick Place,	00000046	Feasibility Assessment	0.62	< 0.25 To CPM
053550	Rt 93 Rt 1 & 9 to Rt 46	00000093	Concept Development	0.64	0
033560	Rt 1&9 Pulaski Skyway	00000001	Concept Development	3.88	< 0.25
950652	Rt 7 Kearny, Drainage	00000007	Feasibility Assessment	1.9	(Tom Saylor)
078044	Rt 4, Bridge over Palisade Avenue and CSX, Bridge Improvements	00000004	Feasibility Assessment	0.4	Temporary structure
	Grand Avenue Project (Hackensack Meadowland)				0.5 > 1 acre (Looking for projects related to Meadowlands, Buy into it & get credits)
UPC	**CPM Project Details Title & Description**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
970173	Rt 3 at the Passaic River Crossing Route 3 Bridge Replacement over the Passaic River. The project limits are from Main Ave./Route 3 interchange to the Route 3/17 interchange. The project includes the addition of acceleration and deceleration lanes, safety upgrades, noise walls, and inter	00000003	Preliminary Design	0.4	7.5 Acres Christophe Manz (609-530-2511)
950662	Rt 17 Railroad Avenue Drainage Improvements Flooding is caused by an inadequate storm water collection system. The IPA includes upgrades to the existing drainage system. The system would outfall to the existing channel. The channel will discharge via two existing 36`	00000017	Preliminary Design	0.39	No Impact Charles Henry (609-530-2389)

	pipes and a proposed 48` RCP				
004170	Rt 3 Hackensack River (EB and WB) Rehabilitation (2 structur The proposed improvements involve rehabilitation of Route 3 (Eastbound and Westbound) bridges over Hackensack River. Eastbound Bridge Structure Number 0204152 Westbound Bridge Structure Number 0204151	00000003	Preliminary Design	0.4	No Impact Robert Lee (609-530-3813)
068090	Rt 7 Hackensack River Wittpenn Bridge Contract 4 This project (Contract 4 of 4) provides for the final bridge & approach roadway segments of the new vertical lift bridge over the Hackensack R. & the improvements to the interchange at Fish House Rd. New connection ramps to Newark Ave & St. Paul's Ave wil	00000007	Preliminary Design	2	13.01 Acres Bruce Riegel (609-530-4232)
068089	Rt 7 Hackensack River Wittpenn Bridge Contract 3 This project (Contract 3 of 4) will provide for the new vertical lift span over the Hackensack River. The new bridge will be located approximately 200 feet north of the existing bridge.	00000007	Preliminary Design	-	Bruce Riegel (609-530-4232)
068088	Rt 7 Hackensack River Wittpenn Bridge Contract 2 This project (Contract 2 of 4) will provide for the off-line portions of the new bridge over the Hackensack River and the improvements to the interchange of Fish House Road. There will be minimal traffic impacts with the proposed construction as the bridg	00000007	Final Design	-	Bruce Riegel (609-530-4232)
068087	Rt 7 Hackensack River Wittpenn Bridge Contract 1 This project (Contract 1 of 4) will provide for the river piers and fender system for a new vertical lift bridge over the Hackensack River. The new bridge will be located approximately 200 feet north of the existing bridge.	00000007	Final Design	-	Bruce Riegel (609-530-4232)
028041	Portway/Fish House Road/Pennsylvania Ave	09000659	Preliminary Design	0.9	No Information available

	This project proposes two 12-ft lanes and a 12-ft shoulder for eastbound and westbound along Penn-Fish House Road. Sidewalk will be provided along the eastbound side of Central Ave to approximatley 250` east of the intersection.				Edward Darcy (609-530-3631)
063730	Rt 495, Rt 1 & 9/Paterson Plank Road Bridge Rehabilitation of the nine-span viaduct located in North Bergen township, Hudson county. The scope includes the reconstruction of the bridge deck, replacement and/or strengthening of the deteriorated structural steel, structural steel painting and repair	00000495	Final Design	0.3	No Impact Babulal Dhulesia (609-530-2387)
023110	Sixty-Ninth Street Bridge NJ Transit will construct a new bridge to provide a grade separation at Sixty-Ninth Street over the North Bergen Railroad Yard. The project is located on Sixty-Ninth Street between West Side Avenue, and Nolan Avenue which is to the west of US Route 1&9.	-	Preliminary Design	-	No Impact Lawrence Vogel (609-530-5529)
			Total Impact :		**23.26 Acres**
HUC 11 # 101 (Woodbury / Big Timber / Newton Creeks)					
UPC	**DPPD Project Details** **Title**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
950353	Rt 44 Little Mantua Creek Drainage	00000044	Feasibility Assessment	0.1	Terminated
053100	Rt 45 Carpenter St to Red Bank Av Traffic Stu	00000045	Concept Development	0.81	0 (curb to curb)
013431	Rt 42, Gantown Rd Intersection Improvements	00000042	Feasibility Assessment	0.2	0 to 1 Acres
013430	Rt 42 Tuckahoe Road to Vicinity of Atlantic City Expressway,	00000042	Concept Development	1.48	Terminated
950543	Rt 295 & 42/I-76 Direct Connection Camden County	00000295	Feasibility Assessment	1.3	115 Acres (Jody)
048006	Rt 168 I-295 Interim Interchange Improvements	00000168	Feasibility Assessment	0.56	0
048007	Rt 168 Kings Highway Intersection Improvements	00000168	Feasibility Assessment	0.5	0 (Terminated)
UPC	**CPM Project Details** **Title & Description**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**

028020	Rt 30 Warwick Road to Jefferson Avenue This project will address safety and operational deficiencies related to the lack of left-turn accommodations at Route 30 and Evesham Avenue (CR 544). In addition it will improve minor capacity and level of service. Drainage system will be upgraded.	00000030	Preliminary Design	0.9	0.40 Acres (Estimate based on latest discussions) Not yet started Mark Dietrich (609-530-2519)
063710	Rt 46 Hackensack River Bridge MP. 70.20 to 70.80	00000047	Preliminary Design	0.28	No Information Manuel Viteri (609-530-2563)
048005	Rt 168 Benigno Boulevard This fix it first project wil restore the operation of the intersection of Rt. 168 and Benigno Boulevard, at milepost 6.84. Curb radii will be increased, traffic signal will be replaced and the motel driveway will be signalized. Drainage will be replace	00000168	Preliminary Design	0.2	Decrease by 0.09 Acre Edward Pennell (609-530-2521)
993120	Rt 130 Brooklawn Circles Route 130 from vicinity of Haakon Ave to Conrail Bridge. Creek Road from Route 47 to Old Salem Road and Old Salem Road from Creek Road to Route 130. Project eliminates some turn movements from the Circle to Creek Road and from Creek Road to NJ Rt. 47 to	00000130	Preliminary Design	1	0.35 Acres Victor Mottola (609-530-5277)
950541	Rt 295 & 42 Study A (Missing Moves) This project will eliminate the missing moves of Rt. 42 NB to I-295 SB and I-295 NB to Rt. 42 SB. The preferred alternative provides the missing moves through the construction of direct connection ramps between I-295 and Rt. 42. The ramps will be construct.	00000295	Final Design	0.4	No estimate available, needs to be rescoped Thomas Saylor (609-530-2739)
			Total Impact:		**116.75 Acres**
HUC 11 # 46 (Newark Bay / Kill Van Kull / Upr NY Bay)					
UPC	**DPPD Project Details** **Title**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
993813	Rt 21 Mulberry St Long-term Intersection Impr	00000021	Feasibility Assessment	0.29	Terminated

993810	Rt 21 Newark Needs Analysis Murray St to Edison Pl	00000021	Feasibility Assessment	1.05	0
063600	Rt 78, CR 523 to NJ Turnpike, ITS Improvements	00000078	Concept Development	9	Terminated
058006	Rt 22 Hilldale Place/Broad Street	00000022	Feasibility Assessment	0.3	< 0.25
985041	Rt 21 Newark Arena Pedestrian Access Study	00000021	Feasibility Assessment	0.04	0
UPC	**CPM Project Details Title & Description**	**Route**	**Project Status**	**Length(m)**	**Impervious Impact Area (Acres)**
003732	Rt 78 Union/Essex Rehabilitation, Contract B	00000078	Preliminary Design	2.53	No Impact
	Route I-78 Eastbound and Westbound, Reconstruction and safety improvements. milepost 53.7 to 58.5. Also, minor improvements to the existing drainage.				Manubhai Patel (609-530-2837)
960974	Rt 1&9 Haynes Avenue Operational Improvements The project would eliminate substandard geometric features associated with the Route 1&9 and Haynes Ave. interchange, and add an acceleration/deceleration lane along southbound Route 1&9 local to improve traffic safety.	07141822	Final Design	0.5	No Information available Steve Hochman (609-530-5366)
			Total Impact:		**0.25 Acre**
HUC 11 # 69 (Assunpink Creek below Shipetaukin Ck)					
UPC	**DPPD Project Details Title**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
023962	Rt 29 Blvd Cass St to North of Calhoun St	00000029	Feasibility Assessment	0.56	Reduction
960307	Rt 31 Sec 3G	00000031	Concept Development	0.57	1.83 to 3 Acres (Interim Improvements: Increase of 0.11 Acres in Pervious area)
043160	Rt 1 Business Brunswick Circle to Texas Ave	00000001B	Concept Development	0.75	Reduction
083260	Rt 1, New Road Intersection Improvements	00000001	Feasibility Assessment	5.22	< 0.25 (Bob Marshall NJDOT, NJ Turnpike)

068091	Rt 33 Sidewalk Improvements I-295 to George Dye Road	00000033	Feasibility Assessment	2.73	2.5 Acres Mitigation already in place, sewer along the sidewalk,
UPC	**CPM Project Details Title & Description**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
950151	South Broad Street Bridge (Rt 206) over Assunpink Creek The project will construct a new structure (Structure No. 1100002) over the Assunpink Creek. It requires the removal of two existing exterior arches and the preservation of original center arch. The center arch would be widened to the downstream side,	00000206	Preliminary Design	0.15	No Information Available Anup Kumar Gandhi (609-530-2166)
993620	Trenton Amtrak Bridges This project is replacing the existing three orphan bridges over Amtrak electrified rail tracks with new single span bridges, in the City of Trenton, Mercer County. Chestnut Avenue over Amtrak, Structure No. 1149163 East State Street over Amtrak,	11000635	Preliminary Design	0.12	No Impact John Campi (609-530-5689)
			Total Impact:		**5.75 Acres**
HUC 11 # 56 (Millstone River below/incl Carnegie Lk					
UPC	**DPPD Project Details Title**	**Route**	**Project Status**	**Length(m)**	**Impervious Impact Area (Acres)**
043560	Rt 206 Ewing St Safety Improvements	00000206	Concept Development	0.03	0 to 0.5
013200	Rt 206 Cherry Valley Road Intersection Improvements	00000206	Concept Development	0.1	0.25 to 0.5
950645	Rt 1 South Brunswick Drainage Improvements	00000001	Concept Development	0.5	Terminated
083260	Rt 1, New Road Intersection Improvements	00000001	Feasibility Assessment	5.21	Bottleneck
UPC	**CPM Project Details Title & Description**	**Route**	**Project Status**	**Length(m)**	**Impervious Impact Area (Acres)**
960605	Rt 206 Sec 15N	00000206	Final Design	2.1	No Information

	This project will construct an additional lane in each direction of Route 206 between Doctors Way and Brown Avenue				Robert Verner (609-530-2372)
960597	Rt 206 Bypass Sec 14A 15A	00000206	Final Design	3	No Information
	This project will bypass existing Rt 206 on new alignment located east of its present location, between the Old Somerville Rd intersection and the Mountain View Rd intersection in Hillsborough Twp. The bypass will be one travel lane in each direction sou				George Worth (609-530-3800)
960596	Rt 206 (41) Crusers Brook Bridge	00000206	Preliminary Design	0.46	< 0.25
	The existing Route 206 bridge over Crusers Brook will be demolished and replaced with a new structure.				Robert Verner (609-530-2372)
			Total Impact:		**1.25 Acre**
HUC 11 # 45 (Elizabeth River)					
UPC	**DPPD Project Details Title**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
058006	Rt 22 Hilldale Place/Broad Street	00000022	Feasibility Assessment	0.3	< 0.25
058003	Rt 22 Vic of Vaux Hall Rd to West of Bloy St	00000022	Feasibility Assessment	0.8	< 0.25
058002	Rt 22 Garden State Pkwy/Rt 82 Interchange Imp	00000022	Feasibility Assessment	0.6	< 0.25
043610	Rt 22 Chestnut Street Replacement (CR 626)	00000022	Concept Development	0.4	< 0.25
023740	Rt 22 Pedestrian Imp Union/Springfield Twps	00000022	Feasibility Assessment	1.39	0
063600	Rt 78, CR 523 to NJ Turnpike, ITS Improvements	00000078	Concept Development	3.94	0
UPC	**CPM Project Details Title & Description**	**Route**	**Project Status**	**Length (m)**	**Impervious Impact Area (Acres)**
003732	Rt 78 Union/Essex Rehabilitation, Contract B	00000078	Preliminary Design	2.27	No Impact
	Route I-78 Eastbound and Westbound, Reconstruction and safety improvements. milepost 53.7 to 58.5. Also, minor improvements to the existing drainage.				Manu Patel (609-530-2837)
			Total Impact:		**1 Acre**

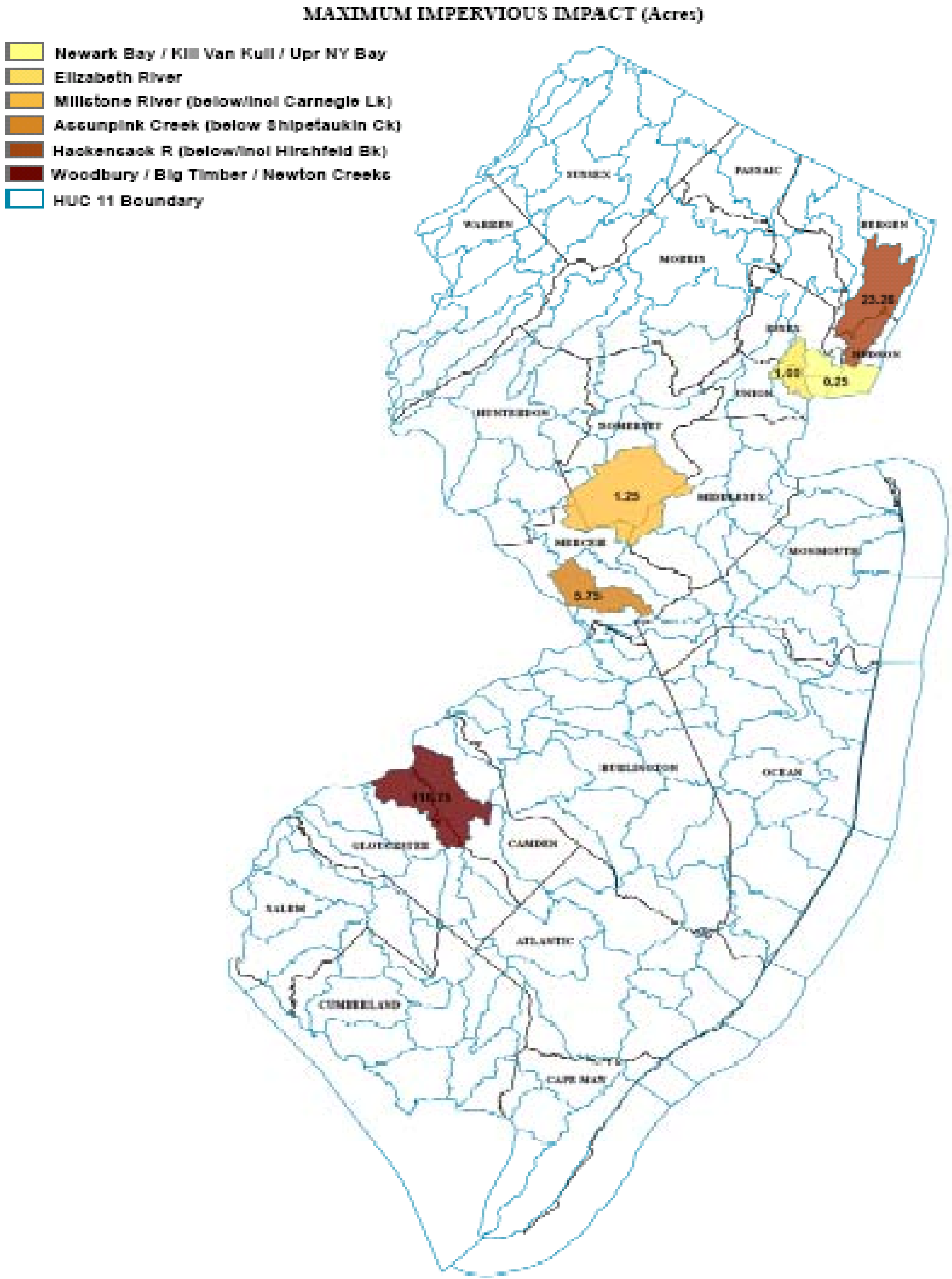


Figure 2.3 GIS map with impact areas in acres for six watersheds

Selection of the Pilot HUC11 Watershed Area

Based on discussions with the Mr. David Ahdout (project customer) and Dr. Nazhat Aboobaker (project manager) at NJDOT on December 11, 2008, the HUC11 watershed number 29 (Hackensack river) was determined to be the most suitable watershed area for the evaluation of mitigation banking. Although HUC11 watershed # 101 has 116.75 acres of impact, a majority of it (approximately 115 acres) is the result of a single project entitled "Rt 295 & 42/I-76 Direct Connection Camden County". On the other hand, there are numerous projects in HUC11 watershed number 29 (Hackensack river). In fact, the impact area for this watershed is likely to be much higher than 23.28 acres because of the "Rt 1&9 Pulaski Skyway" project. As per Mr. Ahdout, the detailed plan for this project is being developed and the impact is likely to be much higher than the estimated 0.25 acres provided by the project manager during the meeting with the research team. Because of these reasons, HUC11 watershed # 29 offers significantly better opportunity of demonstrating water quality mitigation banking concepts to NJDOT and NJDEP. Hence, HUC11 watershed # 29 (Hackensack River) has been selected to be the pilot watershed for further study. Figure 2.4 shows the map of the HUC11 watershed number 29 (Hackensack river) with all DPPD and CPM projects identified.

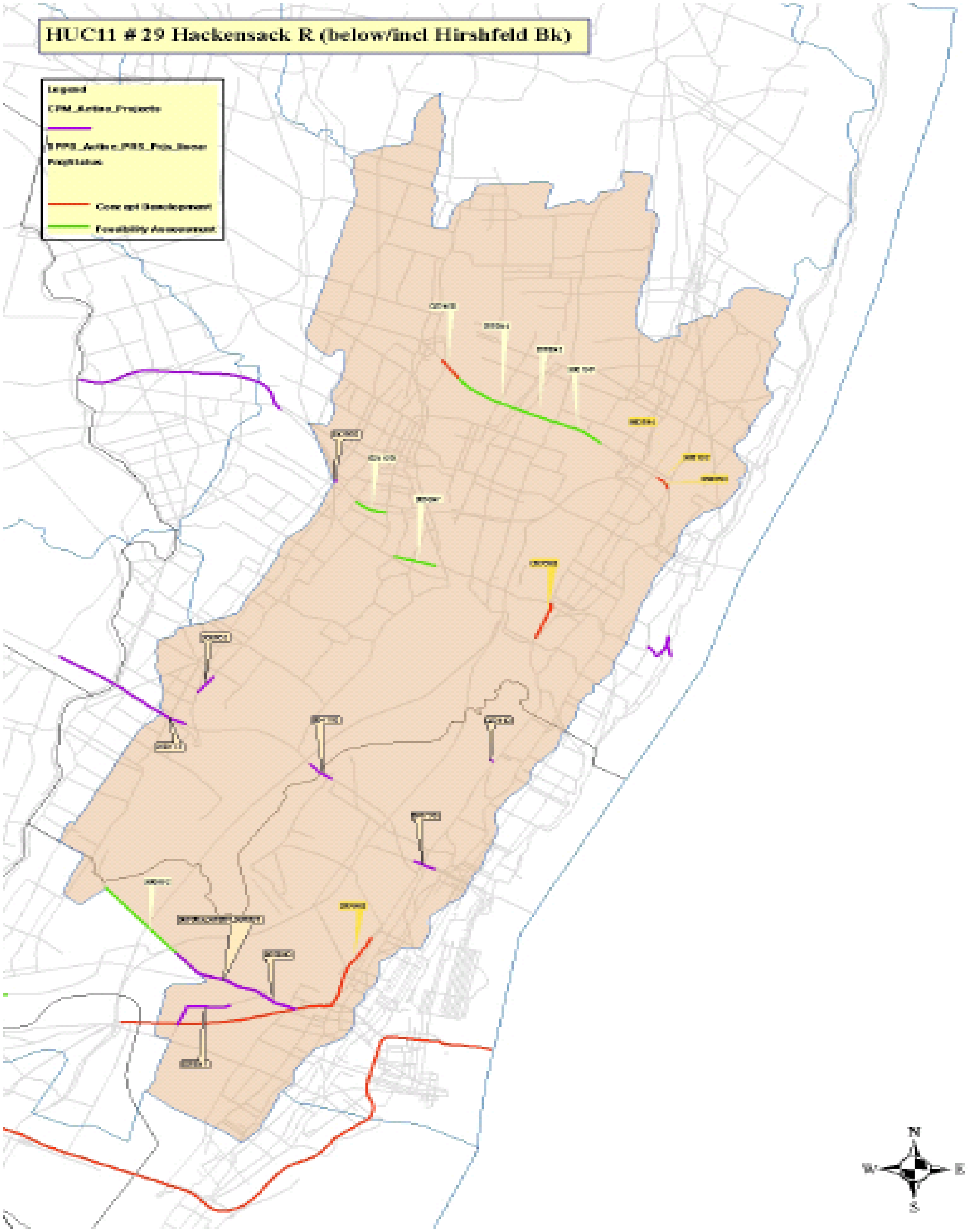


Figure 2.4 GIS map for HUC11 watershed # 29 (Hackensack river) with DPPD & CPM projects

CHAPTER 3
PILOT WATER QUALITY MITIGATION BANK: POTENTIAL MITIGATION / BANKING / RETROFIT SITES, POTENTIAL MITIGATIONS AND SPECIFIC MITIGATION/BANK LOCATION

This chapter presents the efforts performed regarding the selection and design of a retrofit stormwater mitigation site for treatment of existing untreated runoff from NJDOT highways within the Hackensack HUC-11 Watershed. The Hackensack Watershed was selected and recommended by the NJDOT as the most feasible watershed with regard to banking for future project needs. Within this watershed, there is a need to treat runoff from approximately 23 acres of new impervious surface associated with four NJDOT projects currently under feasibility assessment. Considering dense development in this watershed and the lack of right-of-way (ROW), it is likely that “on-site” mitigation will not be feasible or will pose significant hardships to NJDOT. In such conditions, use of water quality mitigation bank credits is an innovative and creative solution that can benefit both NJDOT and NJDEP by optimizing man-power and financial resources to advance projects. It is unlikely that NJDEP will allow NJDOT to debit mitigation bank credits for current needs based on future mitigations. The pilot water quality bank must have initial credits through the creation of “off-site” mitigations before credits can be withdrawn. The creation of such an “off-site” bank involves: investigation of water quality mitigation/banking/retrofit sites along state highways within the selected watershed area; selection of a specific mitigation/bank location for the study based on ROW, environmental constraints, watershed characteristics, and drainage data; the design of the mitigation bank site: and the construction of the mitigation site. A detailed description of the work carried out to create the Pilot Bank for the Hackensack Watershed is presented in this chapter.

Methodology for the Site Selection

Using aerial photography and USGS quadrangle maps, an initial screening sequence was established to locate potential mitigation sites. The goal was to utilize existing right of way, especially associated with interchanges. The screening identified eighteen potential sites, shown on Figure 3.1, which were discussed with NJDOT at the March 27, 2009 quarterly status meeting. Following this effort, a detailed screening of the eighteen sites was done to determine the drainage area to each of the eighteen potential sites. To achieve this, USGS mapping was supplemented with New Jersey Meadowlands Commission mapping, I-Map wetlands mapping and the F.E.M.A. 100 year flood hazard information. Sites with small drainage areas and those that fell within the wetlands boundaries were excluded from further investigation. As a result, the eighteen potential sites were narrowed down to six. The remaining sites were numbered 5, 6, 7, 8, 14 and 16. NJDOT As-Built plans and aerial imagery was evaluated as a second level of screening. Finally, a field visit to the final list of feasible sites was conducted to supplement mapping results and to identify the most promising location. A brief description of these sites is presented in the following.

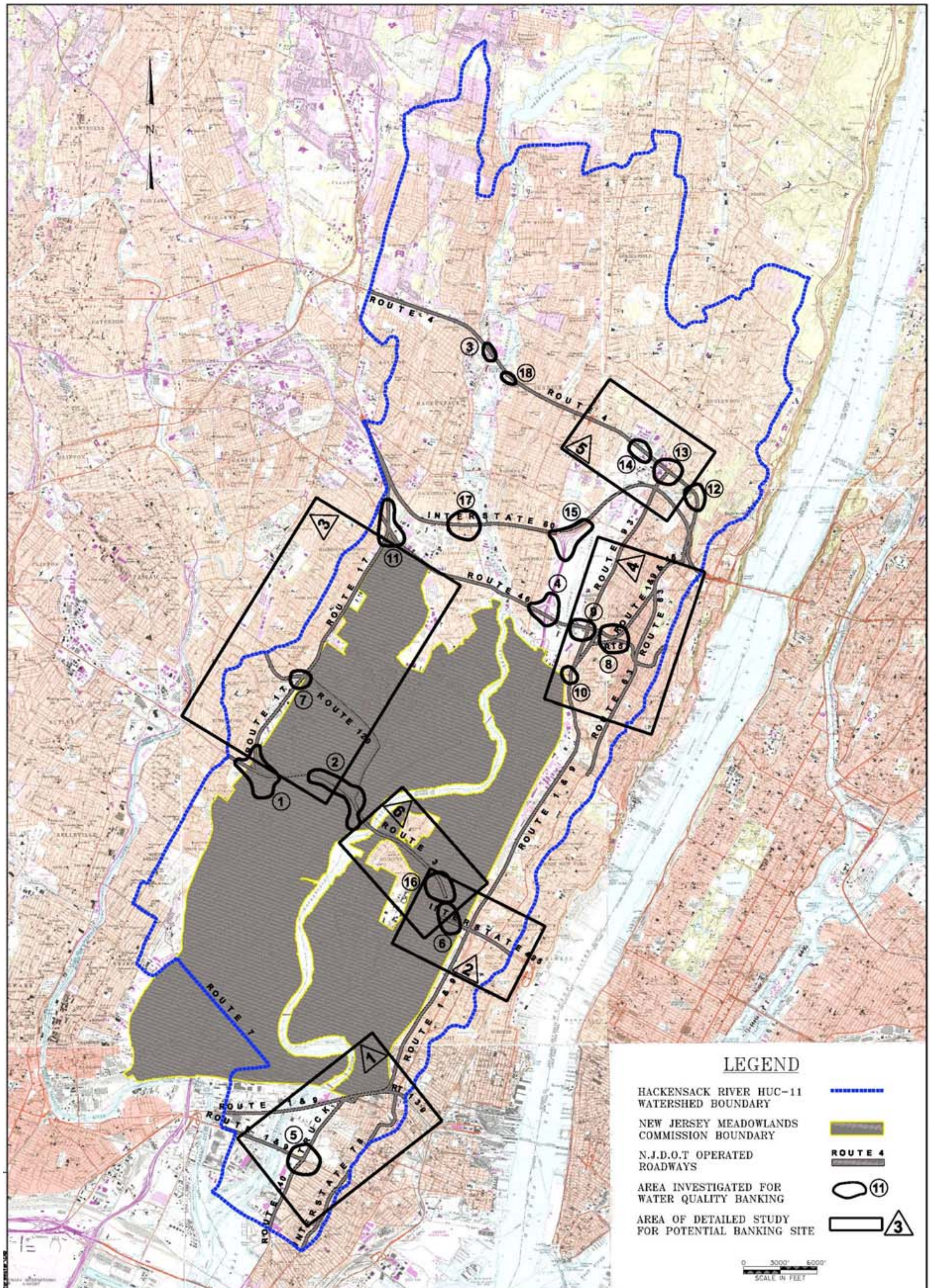


Figure 3.1 Map showing 18 potential sites for the bank

Site 5

Site five is located at the intersection of Route 1&9 Truck and Route 440, City of Jersey City. The initial investigation concluded that runoff generated from 12.2 acres of highway impervious surface could potentially be captured and treated at this site. After examining As-Built plans, it was determined that the banking site could only capture and treat approximately 4 acres. According to the As-Builts, a portion of the pavement is collected and diverted to off-site locations, thereby reducing the runoff captured. In addition, areal imagery revealed that the intersection infield area is smaller than initially assumed. Additional R.O.W. would likely be needed and trees cleared to construct a banking facility at this location. *Therefore, site number five was determined unsuitable for banking.*

Site 6

Site six is located at the intersection of Interstate 495 and Route 3, Township of North Bergen and Town of Secaucus. Initial investigation concluded that runoff generated from 15 acres of state highway surface could potentially be captured and treated at this site. After examining As-Built plans (which were incomplete for the full extent required for evaluation), it was determined that runoff from I-495 flows toward the intersection of I-495 and Rt. 3. Areal imagery shows there is plenty of open space to build a banking facility at this location and *further field investigation is needed to determine whether site number six is suitable for banking.*

Site 7

Site seven is located at the intersection of Route 17 and Route 120, Borough of East Rutherford and Borough of Carlstadt. The initial investigation of the site concluded that runoff generated from 55 acres of state roadway could potentially be captured and treated at this site. After examining As-Built plans, it was determined that the banking site could only capture and treat a small fraction of the 55 acres of drainage area. As-Builts of the site itself were not available. As-Builts of Route 17 near the potential banking site showed that collected stormwater runoff is frequently diverted off-site. The plans also revealed frequent high and low points along the road. As a result, it is estimated that the potential bank site could capture only a few acres of pavement. In addition, R.O.W. would need to be acquired to construct the banking site in the surrounding urbanized area. *Therefore, site number seven was determined to be unsuitable for banking.*

Site 8

Site eight is located at the intersection of Routes 1, 9, 46 and Route 5, Borough of Palisades Park and Borough of Ridgefield. Initial investigation of the site concluded that runoff generated from 25 acres of roadway could potentially be captured and treated at the site. After examining As-Built plans, it was determined that the banking site could capture and treat much less than 25 acres of drainage area since a portion of the pavement runoff is diverted off-site. The plans also revealed frequent high and low points along the various contributing roadways. As a result, it is estimated that the potential banking site could capture only a few acres of pavement. Areal imagery revealed that the potential banking site is fully developed. Therefore, R.O.W. would need to be purchased to construct the banking site in the surrounding urbanized area. *As a result, site number eight was determined to be unsuitable for banking.*

As an alternative to site eight, site nine, located at the intersection of Route 93 and Route 46 in the Borough of Palisades Park and Borough of Ridgefield could potentially capture runoff from approximately 7 acres of roadway surface. However, R.O.W. acquisition may be necessary to construct the banking facility at this site. It appears that site nine is a better potential site than site eight. *Additional investigation would be required to determine the suitability of site nine for banking.*

Site 14

Site fourteen is located at the crossing of Overpeck Creek and Route 4, City of Englewood and Township of Teaneck. Initial investigation determined that runoff generated from 19 acres of roadway could potentially be captured and treated at this site. However, the construction of a banking site could only treat approximately 9.5 acres since the remaining area enters an existing stream. As-Builts obtained for this site do not show the existing drainage network. Areal imagery revealed that the potential banking site is developed. Additional R.O.W. would need to be purchased to construct the banking site in the surrounding area which also lies within floodplain limits. *Therefore, site number fourteen was determined unsuitable for banking.*

Site 16

Site sixteen is located at the intersection of Route 3 and Paterson Plank Road, Town of Secaucus. Initial investigation determined that runoff generated from 21 acres of roadway could potentially be captured and treated at this site. After examining As-Built plans the exact drainage area could not be determined. According to As-Built plans, a portion of pavement runoff is diverted to off-site locations. The plans also revealed frequent high and low points along Route 3. Areal imagery revealed that the potential site looks feasible for the construction of a stormwater banking facility. No R.O.W. would be needed to construct this banking facility. *Therefore, site sixteen was determined potentially suitable for construction of a banking facility.*

Field Evaluation Results

On May 21, 2009, potential banking sites 6, 9 and 16 were visited to determine the best site out of the three. The following was determined:

Site 6

Runoff from I-495 is diverted off site, upstream of the point where the interstate crosses over Paterson Plank Road. The bridged section of the roadway is drained through scupper or joint inlets. The inlet piping was observed to be plastic and to discharge at the ground level. Since most of the runoff that was thought to be captured and treated at the intersection of I-495 and Rt. 3 is diverted off-site, *site six is not suitable for banking.*

Site 9

Using As-Built plans, the configuration of drainage structures were verified. As a result of this, in combination with field observations, it was determined that the site could capture approximately 7.4 acres of roadway runoff. However, there is no open space available for the construction of a bank facility, which would not require right of way acquisition. *Therefore this site is not suitable for banking.*

Site 16

The field conditions generally matched conditions identified in the As-Built plans. Field observations verified that *the interchange infield area is suitable for banking construction.* The impervious area that could be captured by this facility is at least 6.5 acres. Depending on the results of more detailed investigation, the potential paved drainage area could be as much as 7.6 acres. Further evaluation would be needed to identify the location and potential impact on existing communication utilities, including eleven manholes located adjacent to Route 3, on a banking facility at this site.

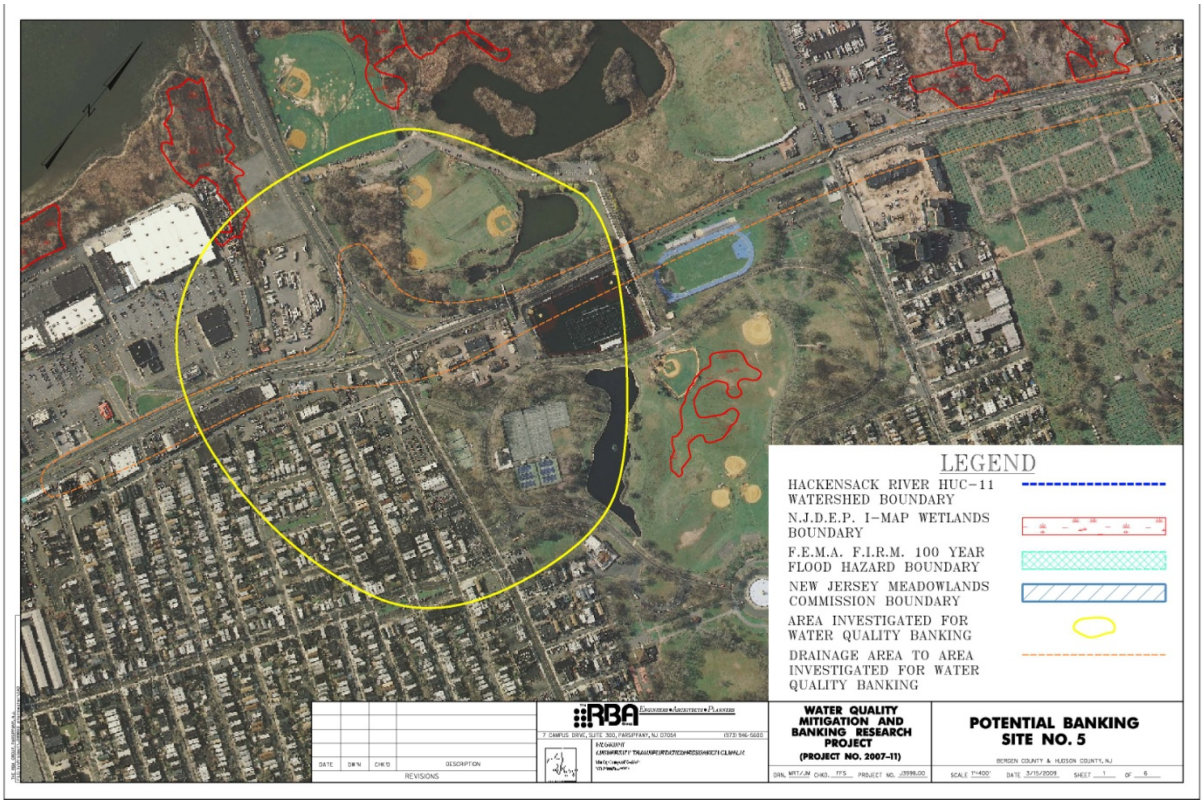


Figure 3.2 Areal Map of the Site 5

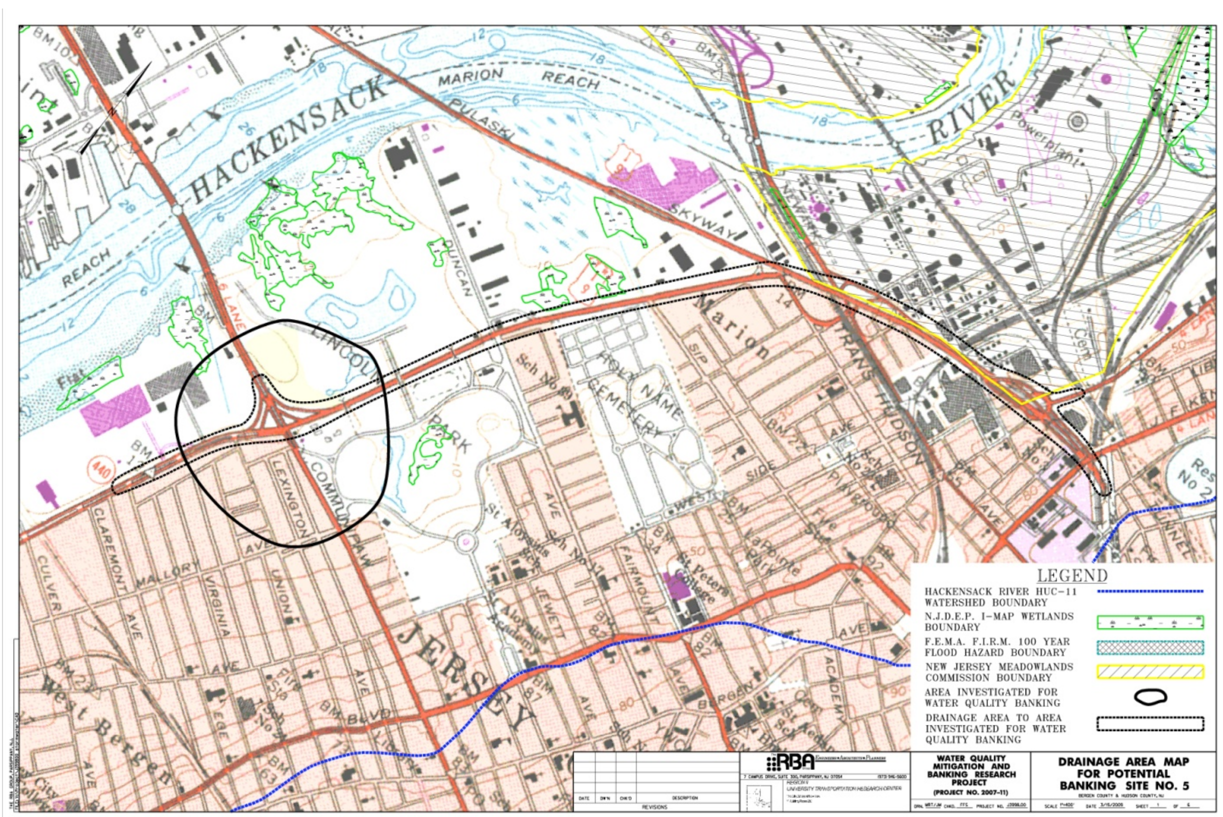


Figure 3.3 USGS Map of the Site 5

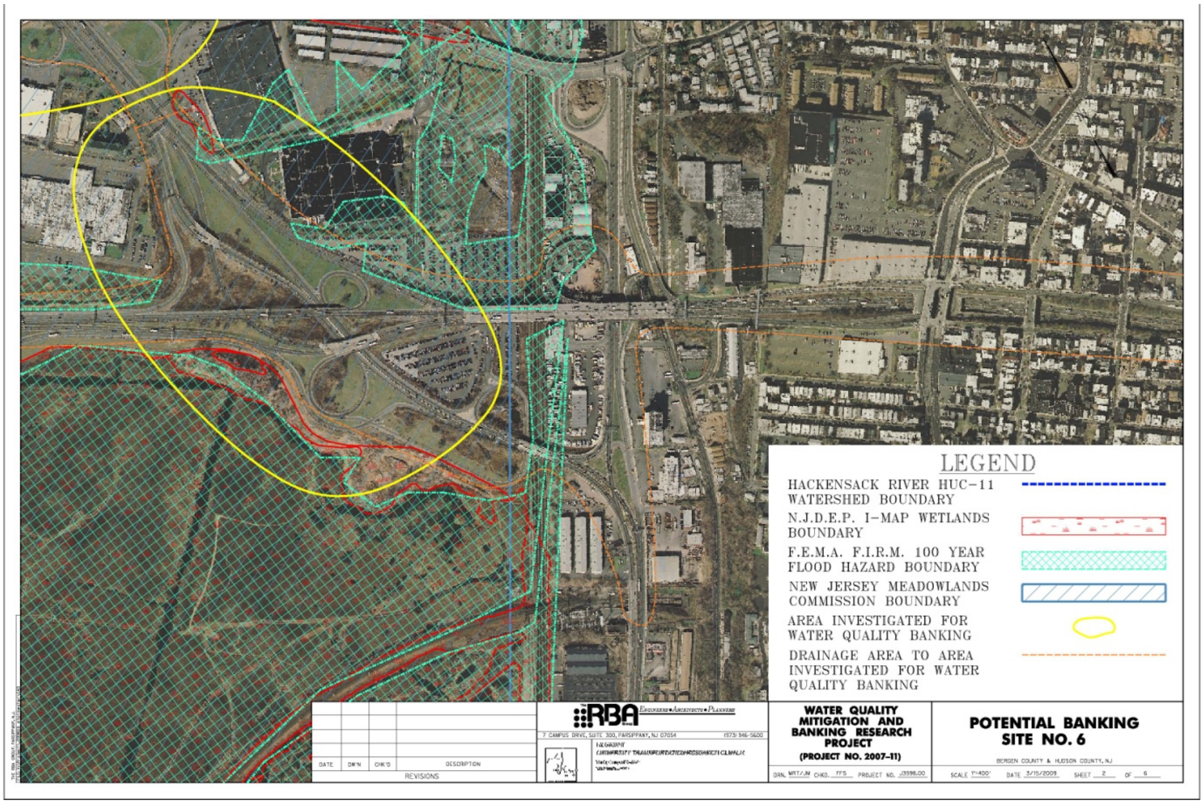


Figure 3.4 Areal Map of the Site 6

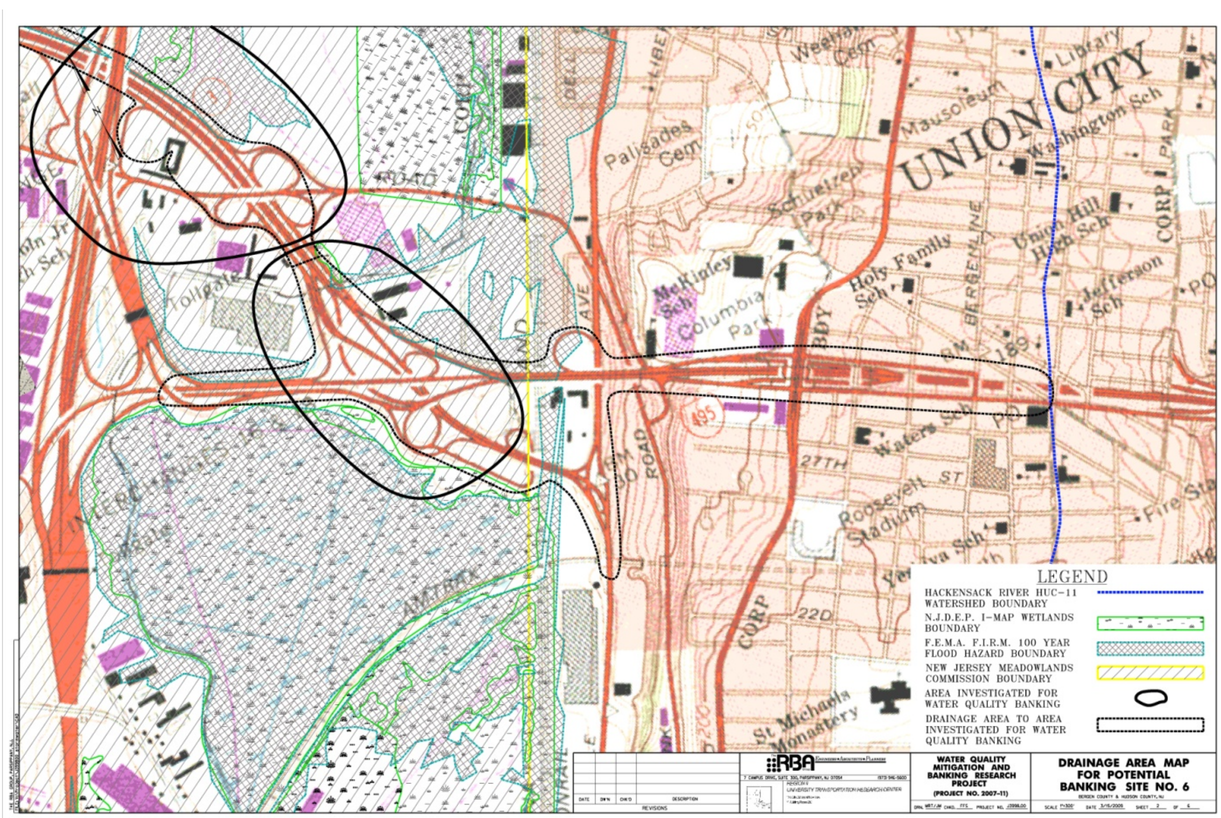


Figure 3.5 USGS Map of the Site 6

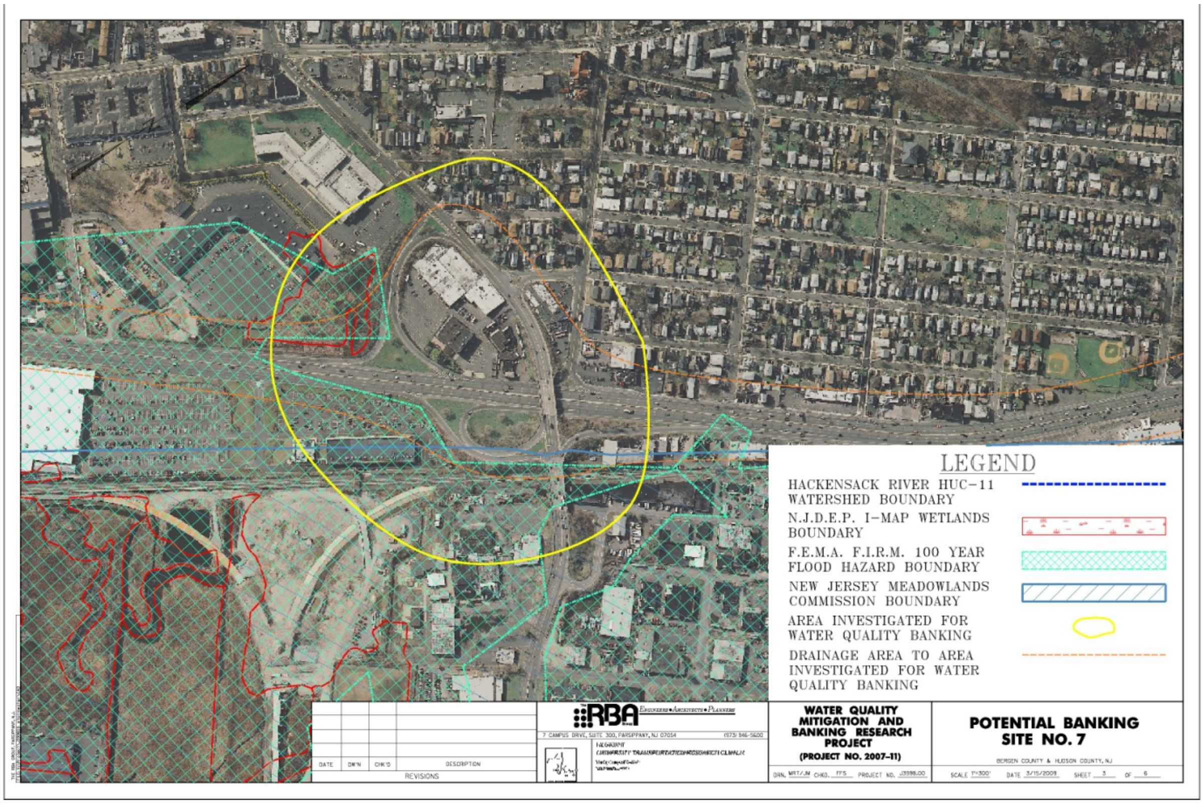


Figure 3.6 Areal Map of the Site 7

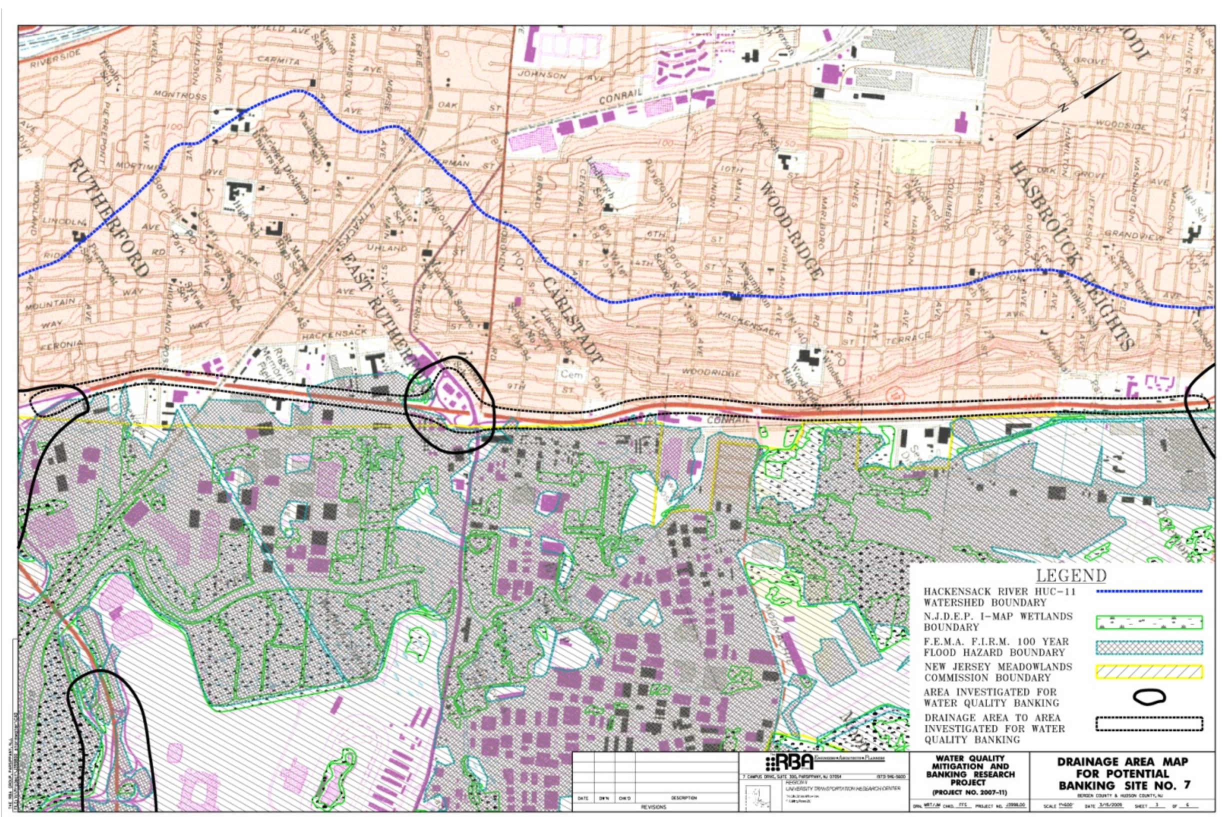


Figure 3.7 USGS Map of the Site 7

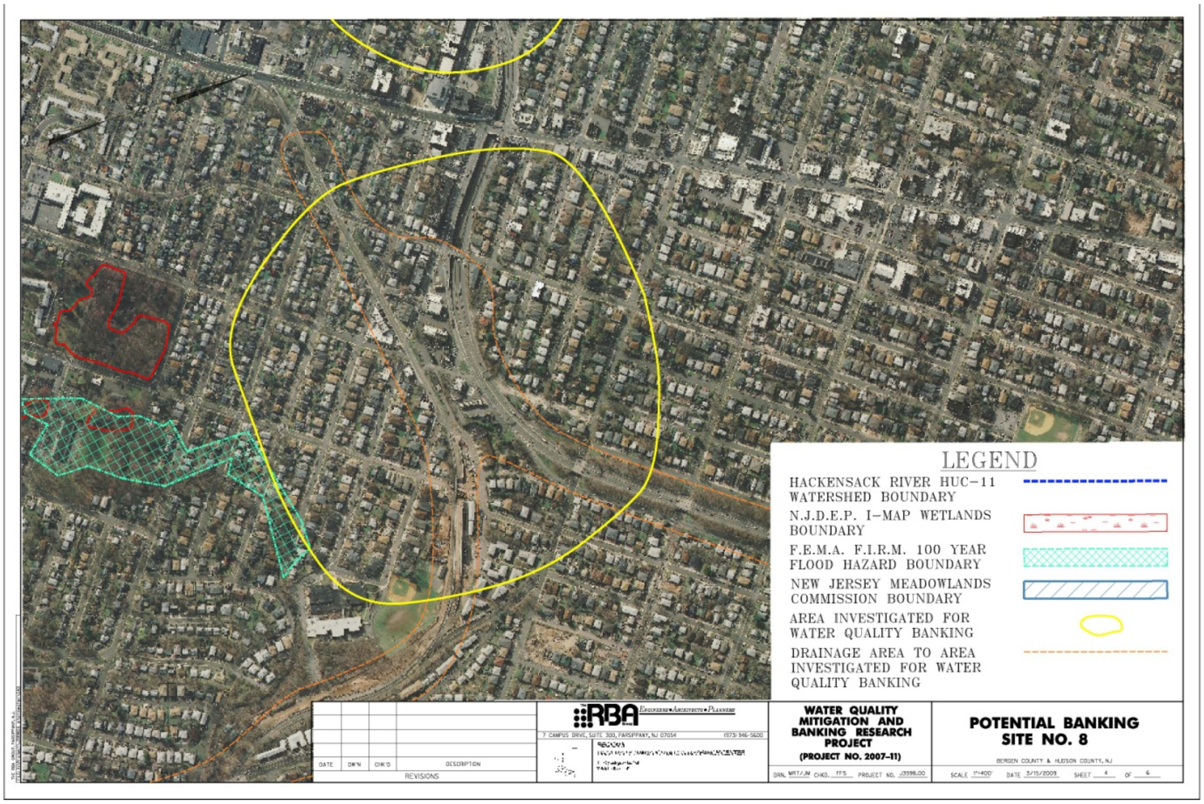


Figure 3.8 Areal Map of the Site 8

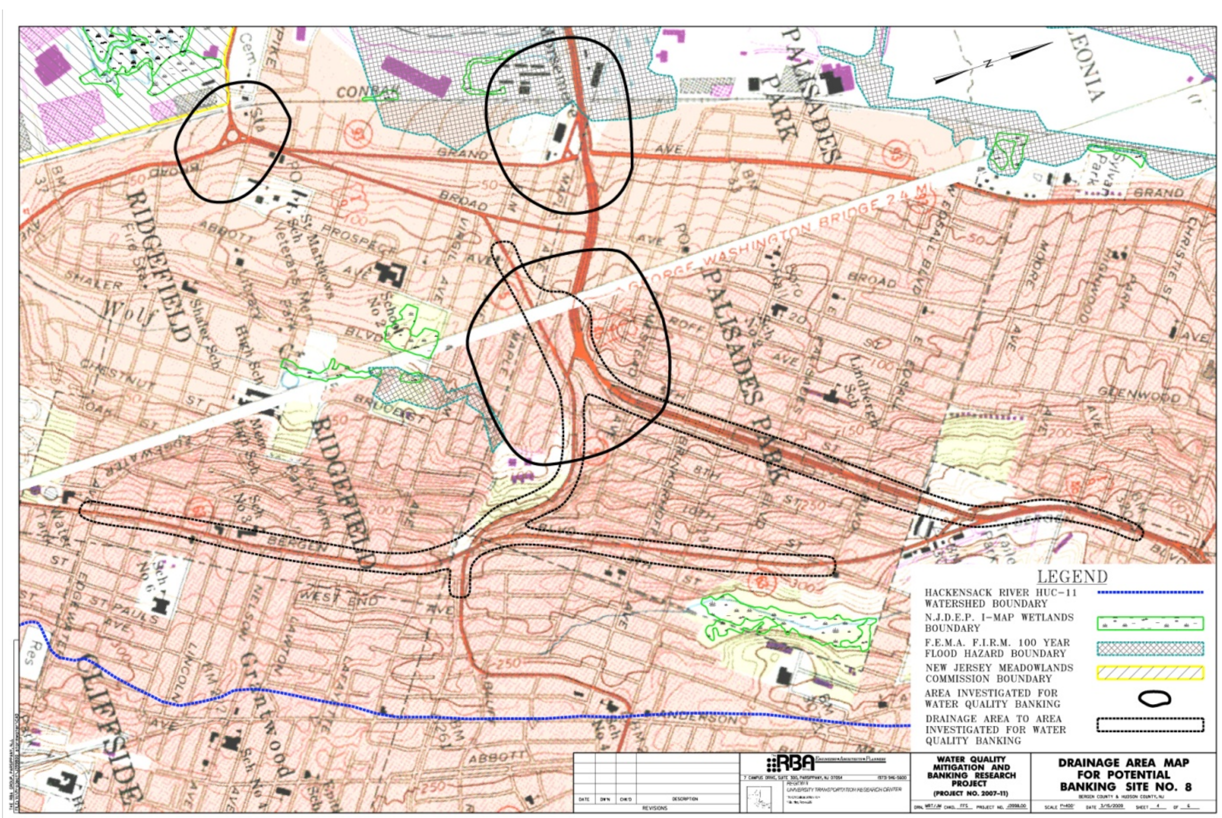


Figure 3.9 USGS Map of the Site 8

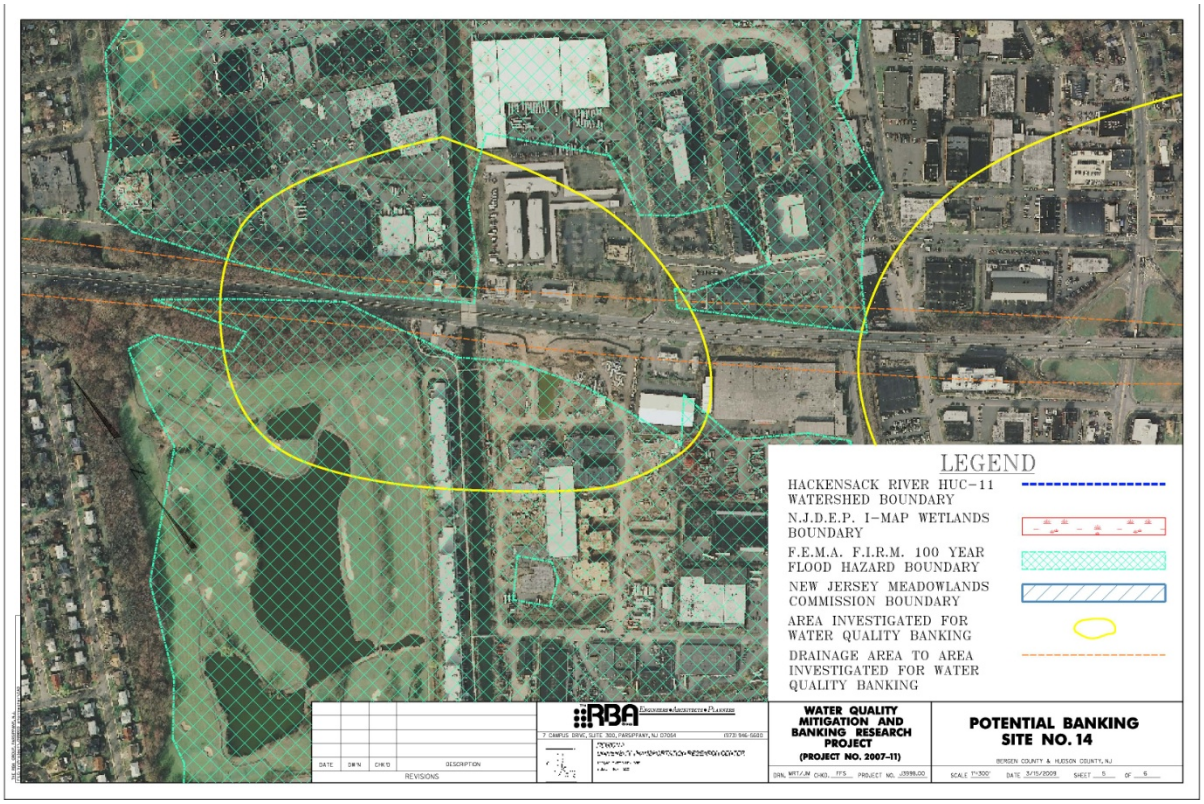


Figure 3.10 Areal Map of the Site 14

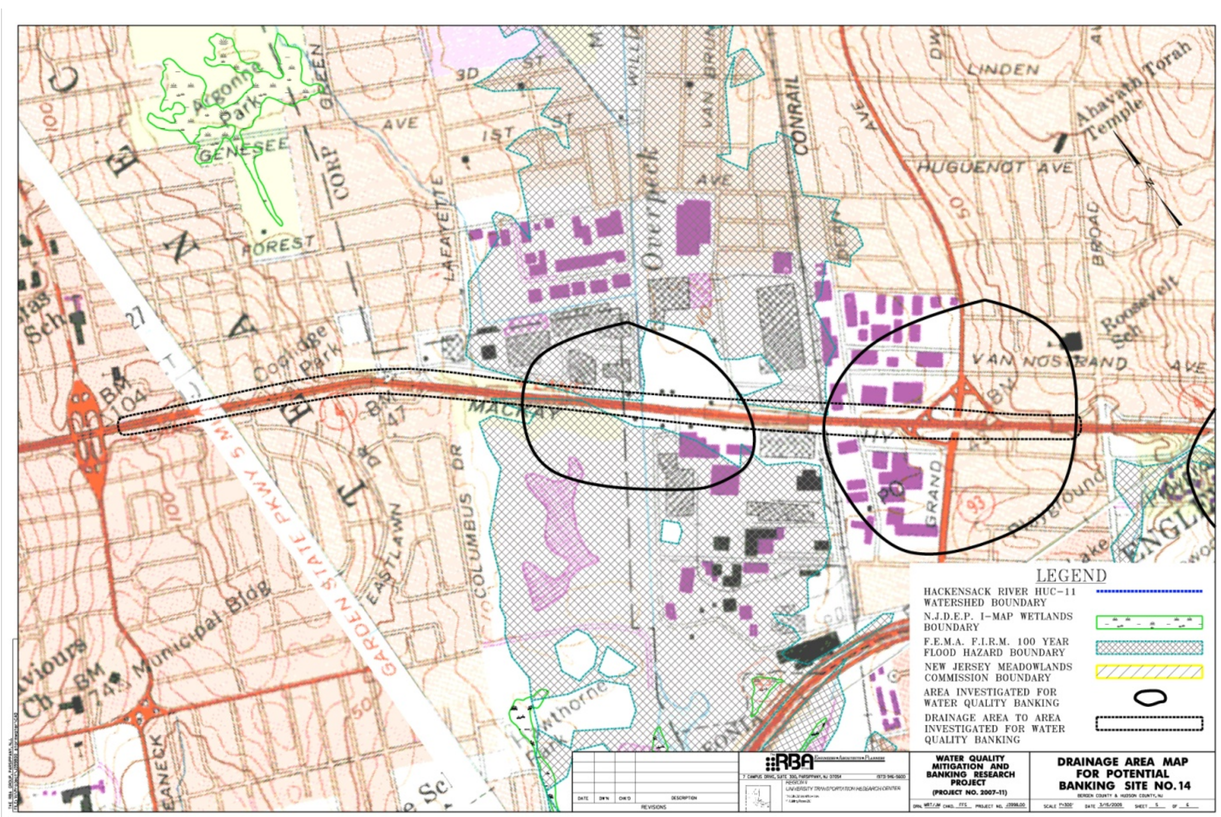


Figure 3.11 USGS Map of the Site 14

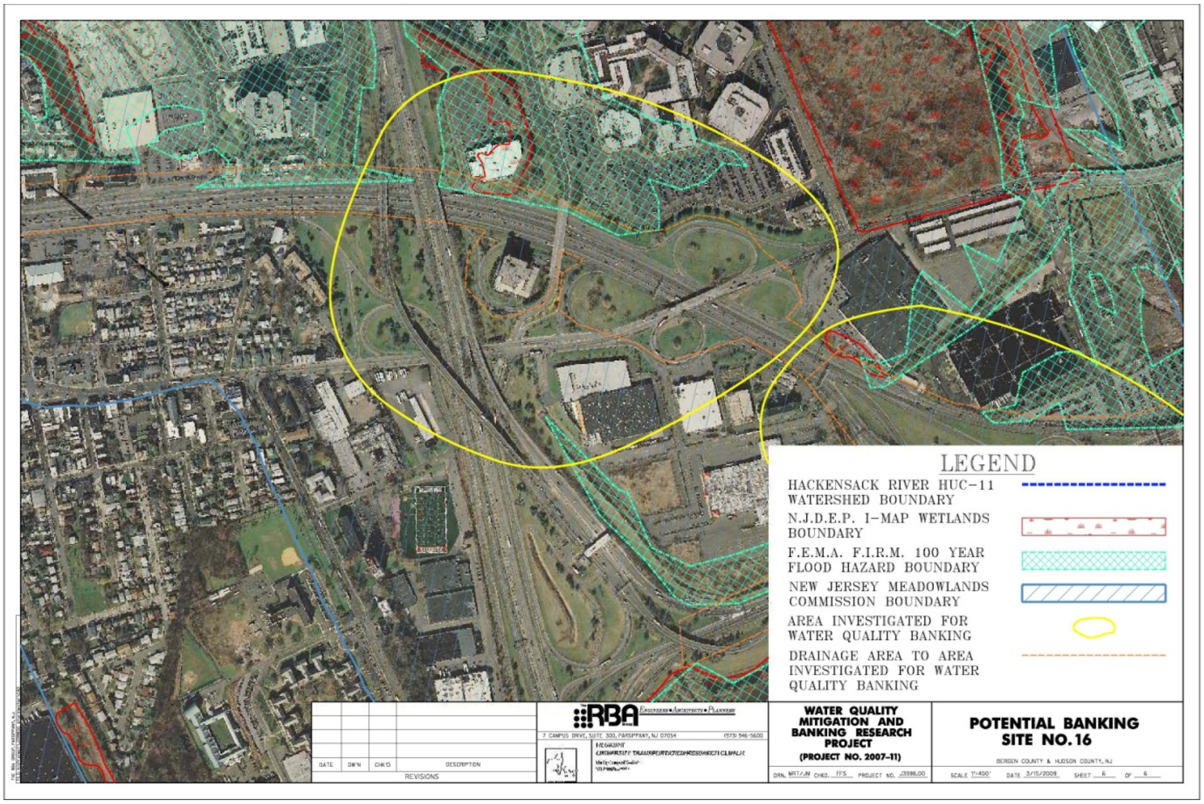


Figure 3.12 Areal Map of the Site 16

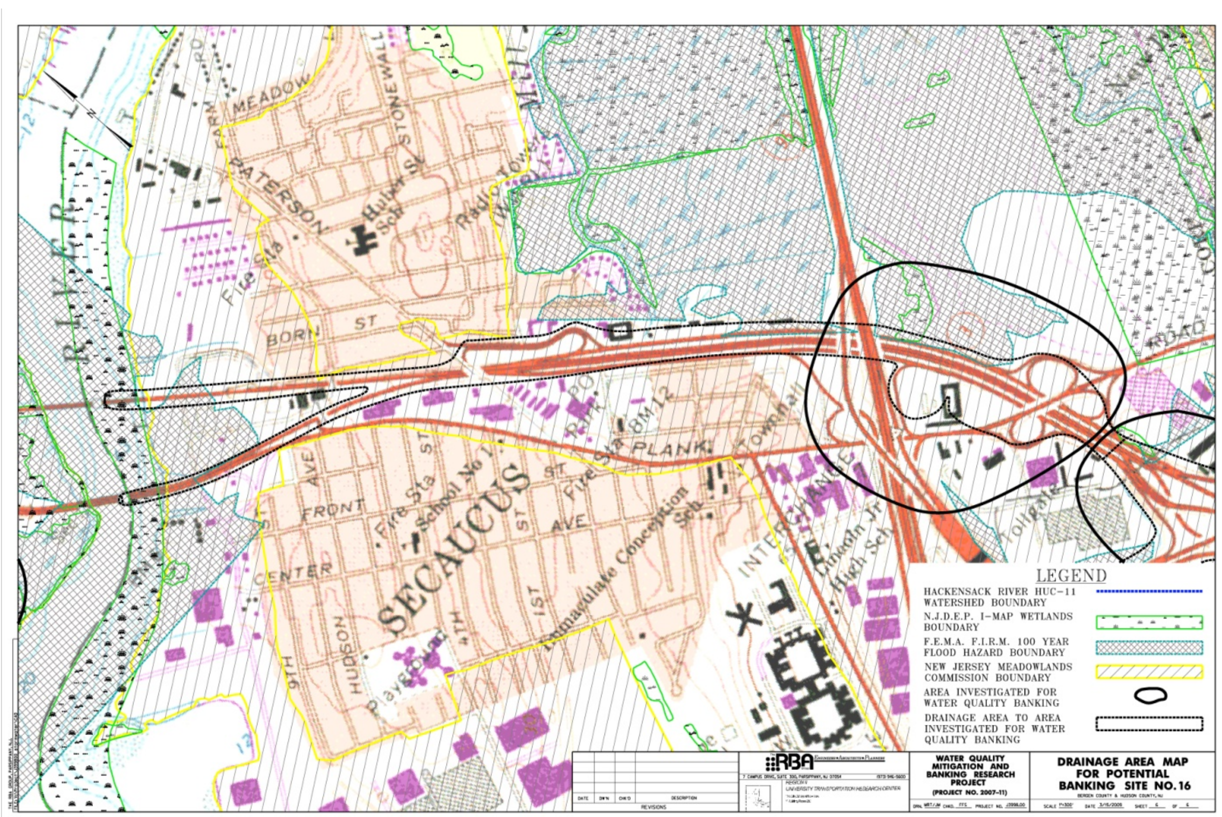


Figure 3.13 USGS Map of the Site 16

Summary and Conclusion on Site Selection

Subject to the results of an evaluation of utility relocation issues, site sixteen was determined to be the most suitable location for construction of a banking facility. A minimum of 6.5 acres of pavement runoff could be treated at this location, constructed entirely within existing R.O.W. within an infield area of the Paterson Plank Road ramp to Route 3. Prior to proceeding with further evaluation for banking at this site, concurrence was requested and received from NJDOT. Figures 3.2 to 3.13 shows the aerial maps and USGS map, respectively, of the potential banking sites evaluated.

Design of Mitigations

Upon selection of the most promising stormwater facility location, the next step involved determining the most appropriate and effective stormwater management BMP to design and retrofit for the site. The goals for the facility included: maximizing potential water quality treatment for the largest impervious area; avoiding utility impacts; utilizing as much of the existing drainage infrastructure as possible to minimize construction cost, and; designing a facility that would comply with the requirements outlined in Chapter 9 of the New Jersey Best Management Practices Manual (NJBMP).

Identification of Site Design Constraints

In order to develop a realistic design concept, detailed information on the existing site and the watershed draining to it was gathered. An initial field evaluation was performed to verify the drainage area and general configuration of the drainage collection and conveyance facilities. Visible utilities and other constraints were noted, and an environmental screening was performed. A utility mark-out was then performed to determine the location of any subsurface utilities traversing the infield areas. This task turned out to be critical, since numerous utilities which were previously unknown where brought to our attention, affecting the final layout and design of the stormwater facility. These utilities included a 36” gas main, 12” water main, and fiber optic conduit bank.

RBA also performed formal soil test pits (one pit in each infield area) to determine soil parameters and restrictive zones. Based on the low elevation of the project site (+/- elevation 5 feet to 7 feet NAVD 1988), we expected the seasonal high water table to be relatively high. The soil logs confirmed that the seasonal high water table was approximately elevation 1.0 feet. Although the soils in the area did not appear to be hydraulically restrictive, the high groundwater table would ultimately be the major controlling factor in selecting a suitable stormwater BMP. Upon completion of the site investigations, a topographic survey of the infield areas was performed, which included ground elevations, physical features, drainage structures and inverts, and marked out utility locations.

Analysis of Available Best Management Practices (BMPs)

With a complete base map and understanding of the constraints, an analysis of compatible stormwater facilities was performed. Following are the design parameters that were taken into account:

- Lowest inlet grate elevation draining to the stormwater facility …….. 5.7 feet
- Elevation of seasonal high groundwater table ……………………….. 1.0 feet
- Total drainage area to infield piping systems ………………………… 15.6 acres
- Total impervious area draining to infields ……………………………. 6.5 acres
- Available surface area for BMP construction ………………………… 1.9 acres
- Existing inverts of infield piping systems ……………………………… -0.5' to 0.79'

Following is a summary of the treatment alternatives investigated, and the factors affecting their appropriateness for this site:

A. <u>Bio-retention System</u> *(SOURCE: New Jersey Stormwater Best Management Practices Manual Chapter 9.1)*

A bio-retention system consists of a soil bed planted with suitable non-invasive (preferably native) vegetation. They are used to remove a wide range of pollutants, such as suspended solids, nutrients, metals, hydrocarbons, and bacteria from stormwater runoff. They can also be used to reduce peak runoff rates and increase stormwater infiltration when designed as a multi-stage, multi-function facility. Bio-retention systems can be used to filter the runoff from both residential and nonresidential developments. The TSS removal rate for bio-retention systems is 80 or 90 percent, depending upon the thickness of the soil planting bed and the type of vegetation grown in the bed. The thickness and character of the bed itself must provide adequate pollutant removal, while the bed's permeability rate must be sufficient to drain the stored runoff within 72 hours. The maximum water depth during the treatment of the stormwater quality design storm runoff volume shall be 12 inches in a flat-bottomed bio-retention system and 18 inches at the deepest end of a sloped-bottom bio-retention system.

The elevation of the Seasonal High Water Table (SHWT) relative to the bottom of a bio-retention system is critical to ensure proper functioning of the system. The SHWT shall be at least 1 foot below the bottom of a bio-retention system's underdrain system. For bio-retention systems without underdrains, the SHWT shall be at least 2 foot below the bottom of the soil planting bed.

Based on site constraints, the minimum elevation of a bio-retention basin for this site would be 4.5' (1.0' + 2.0' + 1.5'), which provides for virtually no storage between the lowest inlet grates and the basin bottom. Therefore, a bio-retention basin is not appropriate for this site.

B. Constructed Stormwater Wetland *(SOURCE: New Jersey Stormwater Best Management Practices Manual Chapter 9.2)*

Constructed stormwater wetlands are used to remove a wide range of stormwater pollutants from land development sites as well as provide wildlife habitat and aesthetic features. Constructed stormwater wetlands can also be used to reduce peak runoff rates when designed as a multi-stage, multi-function facility. The adopted removal rate for constructed stormwater wetlands is 90 percent.

Constructed stormwater wetlands should not be located within natural wetland areas, since they will typically not have the same full range of ecological functions.

Constructed stormwater wetlands typically consist of three zones: pool, marsh, and semi-wet.

Depending upon their relative size and the normal or dry weather depth of standing water, the pool zone may be further characterized as a pond, micropond, or forebay. Ponds generally have standing water depths of 4 to 6 feet and, depending on the type, may comprise the largest portion of a constructed stormwater wetland. Micropond also has a standing water depth of 4 to 6 feet, but is smaller in surface area than a standard pond. Forebays are located at points of concentrated inflow to constructed stormwater wetlands. They typically have normal standing water depths of 2 to 4 feet. The marsh zone may be further characterized as either high or low marsh based again upon the normal standing water depth in each. A low marsh has a standing water depth of 6 to 18 inches. A high marsh has a maximum standing water depth of 6 inches. The semi-wet zone in a constructed stormwater wetland is located above the pool and marsh zones and is inundated only during storm events. Safety ledges must be constructed on the slopes of all constructed stormwater wetlands with a permanent pool of water deeper than 3 feet. The minimum drainage area to a constructed stormwater wetland is 10 acres to 25 acres, depending on the type of wetland.

The only constraint for the stormwater wetland is the drainage area, which can be 10 acres for an extended detention stormwater wetland, or 25 acres for a standard constructed stormwater wetland basin. Therefore, the extended detention stormwater wetland is a feasible alternative, since the contributory area is 16 acres. With this particular facility, the groundwater table will not be a constraint, and this elevation can also serve as the normal (permanent) pool elevation in the various wet components of the facility. During periods of low runoff, the groundwater will help maintain the hydrology in the basin.

C. Extended Detention Basin (*SOURCE: New Jersey Stormwater Best Management Practices Manual Chapter 9.4)*

An extended detention basin is a facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff. The adopted TSS removal rate for extended detention basins is 40 to 60 percent, depending on the duration of detention time provided in the basin. These facilities are used to address both the stormwater runoff quantity and quality impacts of land development. They are designed for complete evacuation of runoff and normally remain dry between storm events. Extended detention basins can be used at residential, commercial, and industrial development sites. To achieve a 60 percent TSS removal rate, a minimum of 10 percent of the runoff volume must remain in the basin 24 hours after the peak basin water surface and maximum runoff storage volume is achieved. The lowest elevation in an extended detention basin, excluding low flow channels, must be at least 1 foot above the seasonal high groundwater table.

Based on the design parameters, the lowest basin bottom elevation would be 2.0' (1.0' + 1'). This only provides for 3.7' of maximum storage, but could conceivably be enough to achieve water quality goals. However, the piping networks in the infields are approximately 2' below this elevation, and cannot be raised without significant infrastructure improvements and likely utility impacts. Therefore, an extended detention basin is not considered viable for this site.

D. Infiltration Basin (*SOURCE: New Jersey Stormwater Best Management Practices Manual Chapter 9.5)*

An infiltration basin is a facility constructed within highly permeable soils that provides temporary storage of stormwater runoff. The adopted TSS removal rate for infiltration basins is 80 percent. Infiltration basins are used to remove pollutants and to infiltrate stormwater back into the ground. These facilities must fully drain this runoff volume within 72 hours, and runoff storage for greater times can render the basin ineffective and may result in anaerobic conditions, odor, and both water quality and mosquito breeding problems. Basin construction should not occur where surrounding slopes are greater than 10 percent. The bottom of the infiltration basin must be at least 2 feet above seasonal high water table or bedrock.

Although site soils consist of permeable material, construction of this type of facility has similar difficulties as the extended detention basin. The low pipe inverts are further compounded by the need to raise the basin floor to elevation 3.0' (1.0' + 2'). Therefore, an infiltration basin is not feasible for this site.

E. Wet Pond *(SOURCE: New Jersey Stormwater Best Management Practices Manual Chapter 9.11)*

A wet pond is a stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff. It has an outlet structure that creates a permanent pool and detains and attenuates runoff inflows and promotes the settlement of pollutants. The adopted TSS removal rate for wet ponds is 50 to 90 percent depending on the permanent pool storage volume in the pond and, where extended detention is also provided, the duration of detention time provided in the pond. Wet ponds should not be located within the limits of natural ponds or wetlands, since they will typically not have the full range of ecological functions as these natural facilities. The permanent pool should be shallow enough to avoid thermal stratification and deep enough to minimize algal blooms and re-suspension of previously deposited materials by subsequent storms and strong winds. A mean depth of three to six feet is normally sufficient to maintain a healthy environment within the permanent pool. The outlet structure or riser should be located in a relative deep area to facilitate withdrawal of cold bottom water to help mitigate any downstream thermal impacts. The minimum permanent pool surface area is 0.25 acres. The length to width ratio of a wet pond should as large as possible to simulate conditions found in plug flow reaction kinetics. The riser structure should be equipped with a bottom drain pipe, sized to drain the permanent pool within 40 hours so that sediments may be removed mechanically when necessary. The minimum drainage area to a wet pond must be 20 acres.

As with the stormwater wetland basin, the high groundwater table and low pipe inverts are not a problem. In addition, there is sufficient surface area to construct an appropriately sized pond. The only design criterion that cannot be met is the minimum drainage area requirement.

Summary of Selected BMP for Pilot Water Quality Banking Site

Although the use of a wet pond could possibly be justified even without the required drainage area, the constructed stormwater wetland basin can be incorporated to meet all NJBMP Manual requirements and also maximizes to the level of treatment that can be attained. Therefore, the extended detention stormwater wetland basin was selected as the facility to advance. The original intent was to construct the basin in one infield area, but due to underground utility constraints, the basin had to be designed to extend into the second infield area. Table 3.1 below presents a summary of the specific NJBMP Manual requirements and how the facility complies with these requirements.

Table 3.1 - Proposed Storm Water Wetland Basin Summary

Storm Event	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Outlet Configuration:
WQ	19.88	0.63	2.13	5" orifice @ Elev. 1.00’
2	31.85	5.84	3.18	2' wide rectangular weir @ Elev. 2.25’
10	54.76	14.52	4.10	Grate Elev. 4.80’
100	100.52	46.58	5.39	

Design Parameters (Per NJBMP Manual):	
Water quality storm volume = 30,090 cf:	
Minimum drainage area = 10 acres:	Provided area = 15.6 acres
Min. pool vol. = 20% x WQ storm volume (6,018 cf):	Provided volume = 7,000 cf
Min. low marsh vol. = 20% x WQ storm vol. (6,018 cf):	Provided volume = 7,000 cf
Min. high marsh vol. = 10% x WQ storm vol. (3,009 cf):	Provided volume = 3,500 cf
Total permanent pool vol. reqd. = 50% x WQ storm (15,045 cf):	Provided volume = 16,000 cf
Reqd. semi-wet zone vol. = 50% x WQ storm (15,045 cf):	Provided volume = 17,500 cf
Basin should retain 10% of peak vol. 24 hours after peak:	Provided retention = 28.4 hrs

Based on our preliminary cost estimate, the proposed facility will cost approximately $417,000 to construct. The majority of the cost (approximately two-thirds) is associated with excavation, with the remaining third associated with minor improvements / modifications to the existing drainage infrastructure and plantings. In addition, the project does not require any right-of-way involvement, NJDEP land use permits, or utility relocations.

In summary this facility represents a cost effective water quality banking site that provides 90% TSS removal for 6.5 acres of impervious coverage. This treatment level is comparable to 100% treatment of 5.85 acres, 80% treatment of 7.3 acres of new pavement, or 11.7 acres of redeveloped area at 50% treatment. Please refer to the following appendices for associated back-up information:

- Appendix III - Preliminary Construction Plans and Sections
- Appendix IV - As-Built Mapping of the Site
- Appendix V - Environmental Screening
- Appendix VI – Drainage Area Map
- Appendix VII – Soil Logs
- Appendix VIII – Hydrologic Calculations
- Appendix IX – Preliminary Construction Cost Estimate
- Appendix X – Photographs of the Project Site and Test Pits

CHAPTER 4
THE BANK: TRACKING MITIGATION CREDITS

Introduction

A successful implementation of water quality mitigation banking program for NJDOT must have the following four components: (i) Initial bank or project in a watershed to provide initial credits for the bank to function (just like making an initial money deposit in a bank to start using it unless either the bank provides a line of credit or credit is accrued by successive deposits), (ii) The bank instrument – the legal agreement between the bank owner (NJDOT) and regulators establishing liability and the terms of bank credit approval (NJDEP) (iii) An interagency team that assists with the review, approval, and oversight of the bank; and (iv) A service area – the geographic area in which the bank can operate and compensate for permitted impacts (possibly HUC-11) watershed area. The main objective of these four components is to meet the following water quality objectives:

- Assuring compliance with the Clean Water Act and NJDEP Stormwater Management Regulations;
- Defining and executing the banking process;
- Ensuring water quality equivalence of banking credits
- Tracking credits
- Managing financial and legal risk related to water quality banking credits and their impacts on water quality within a watershed.
- Providing information to the public and other concerned stakeholders about advantages of water quality banking concepts

A good mitigation tracking mechanism is necessary to minimize delays in project permitting process while providing NJDEP with easy and prompt access to the tracking system for verifications and audit. At the fundamental level, each watershed will be required to have a separate bank account in the tracking system. Mitigations credits will be accrued by excess mitigations or mitigations generating credits approved by NJDEP. Although documenting credits and debits seems like a fairly easy task, the process is complicated by factors such as: the type of impervious area treated (new impervious, redevelopment, or existing impervious); the level of treatment required (80% TSS removal vs. 95% TSS removal for C1 watercourses); the level of treatment attained by each stormwater BMP; and the boundaries of the watersheds in which the credits and debits are generated. To create normalized values for the percentages of TSS removal required and provided, areas of treatment have been converted to acres at 100% TSS removal. The credits and debits shown in the computer program presented herein are based on this unit of measurement. Regarding the boundaries of the watersheds to be used for banking, it was agreed that the HUC-11 watershed would be used for this research project. Ultimately, the watershed size and credit/debit measurement units will depend on the agreement between NJDOT and NJDEP.

Among the states implementing water quality mitigations banking program, Delaware uses a simple spreadsheet based system to track banking credits. On the other hand, Maryland uses a database based tracking program that automatically tracks banking credits for every watershed in the state, stores all project data and approvals from the regulatory agencies and allows for an easy audit of the tracking system. For NJDOT, research team investigated various options for tracking credits and has adopted the approach used by Maryland because of its versatility and flexibility.

Tracking Credit Approach

Figure 4.1 shows the flow chart of proposed approach to generate banking credits. It should be noted that the approval of credits because of specific mitigations depends on the MOU between NJDOT and NJDEP. The flow chart is based on the understanding of the research team of possible mitigations that may generate credits (e.g., excess on-site treatment) in NJDOT projects. It is also possible that NJDEP may allow additional methods of generating credits in the future (e.g., reducing impervious areas), depending on the agreement between two parties.

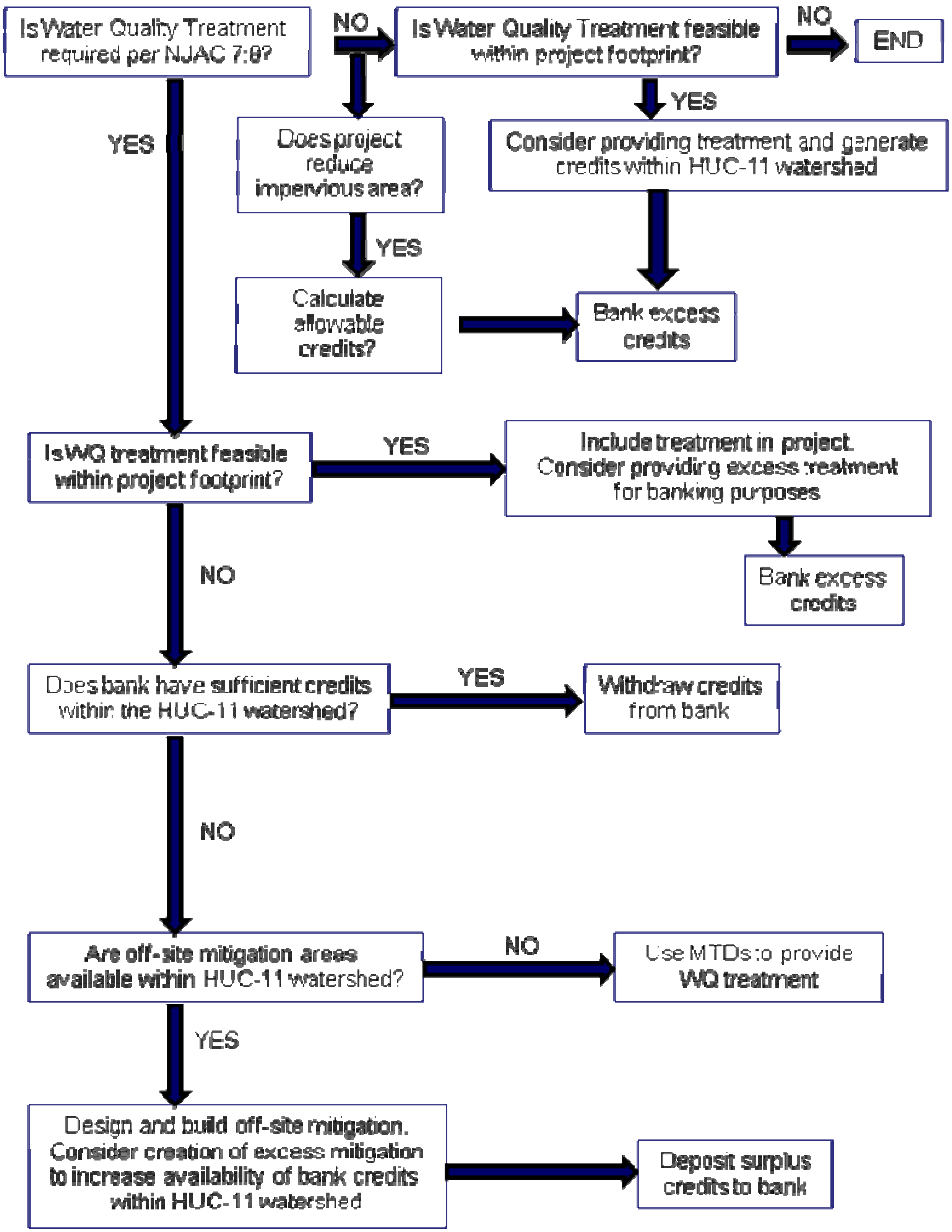


Figure 4.1 Water Quality Mitigation Banking Process Diagram.

It is observed from the flowchart in Figure 4.1 that the tracking mechanism will allow banking of credits when (i) water quality mitigation is not required, however, it is possible to provide mitigations within the project footprint, (ii) project reduces imperious surfaces instead of increasing it, (iii) water quality mitigation is required and is possible to provide extra mitigations within the project footprint and (iv) water quality mitigation is required and an off-site location is available to provide more than required mitigations to generate extra credits. When water quality mitigation is required and mitigation is not possible within project footprints, available credits can be withdrawn from the bank. If sufficient credits are not available in the bank and off-site mitigation locations are also not available, MTDs should be considered as a final option for water quality treatment.

Computer Program for Bank Management

A computer program has been developed based on Microsoft ASP.NET 3.0 to manage and track water quality banking credits for NJDOT. This program has the following capabilities:

- Access through Internet
- Administrator, Manager and Visitor levels of accessibility
- Automatically tracking banking credit based on HUC-11 Watershed boundaries
- Managing all approved documents / approvals by NJDEP on project basis

The computer program is named “New Jersey Stormwater Mitigation Banking System”. The homepage for the New Jersey Storm Water Mitigation Banking System provides the User log-in dialog as shown in the Figure 4.2 below. A registered user can log into the system by using his/her user name and password.

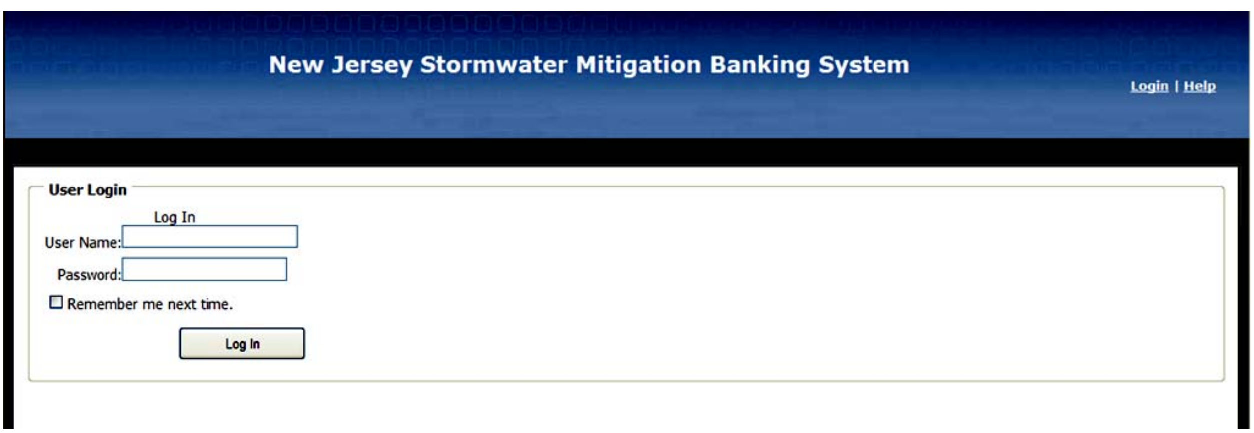


Figure 4.2 Home page for New Jersey Storm Water Mitigation Banking System.

Once logged in, a user can see the default Summary page in Figure 4.3. This page gives the user three options tabs to click on: Bank System, About and Administration. Clicking on Bank System gives three options: Summary, WMA and Watershed, as shown in Figure 4.4.

Bank System Summary

Clicking on "Summary" option shows the summary of banking credits. Water quality banking summary can either be seen by WMA by clicking on WMA button (see Figure 4.5) or by HUC11 watershed by clicking on HUC11 button (see Figure 4.6). For each WMA or HUC11, the page shows the number of pending, approved and reconciled projects, pending credit balance, approved balance, overall balance and minimum balance. Pending projects are ones that are in permitting process. Approved projects are ones that have been approved by the NJDEP. Reconciled projects refer to projects for which water quality credit in the bank has been audited by the NJDEP or its representative. Pending and approved credit balances refer to water quality credits corresponding to pending and approved projects. Overall balance refers to the sum of pending and approved balances. Should the NJDEP allow initial debiting of the bank, the minimum balance will show that amount. By default, this amount is set to zero. The summary view can be sorted in ascending/ descending order based on the WMA name, Pending balance, Approved balance and Overall balance by clicking on the respective heading.

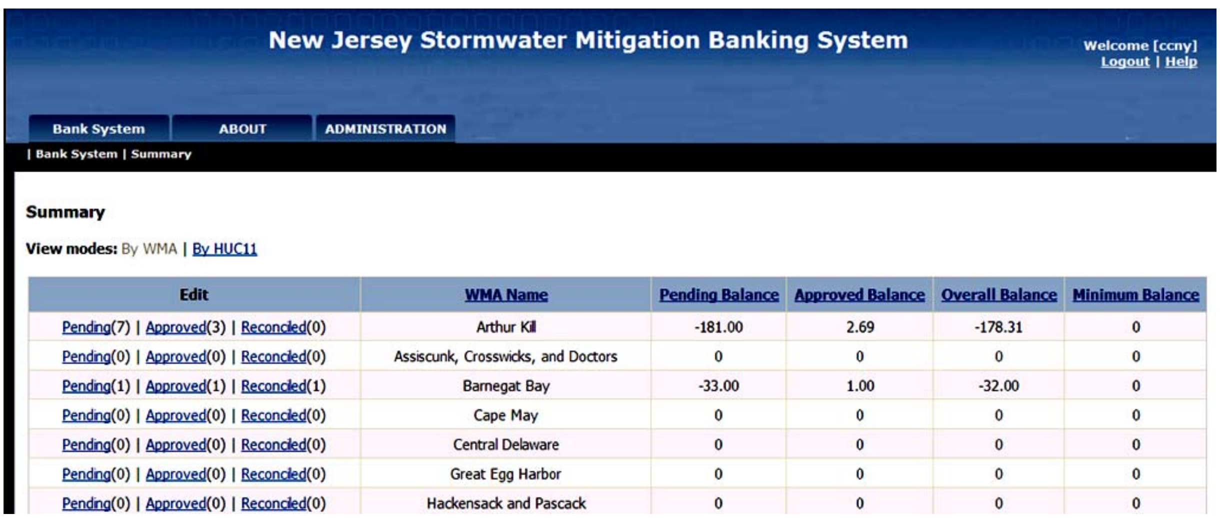


Figure 4.3 Default Summary Page

Figure 4.4 Sub-menu Under "Bank System" Option on Default Summary Page

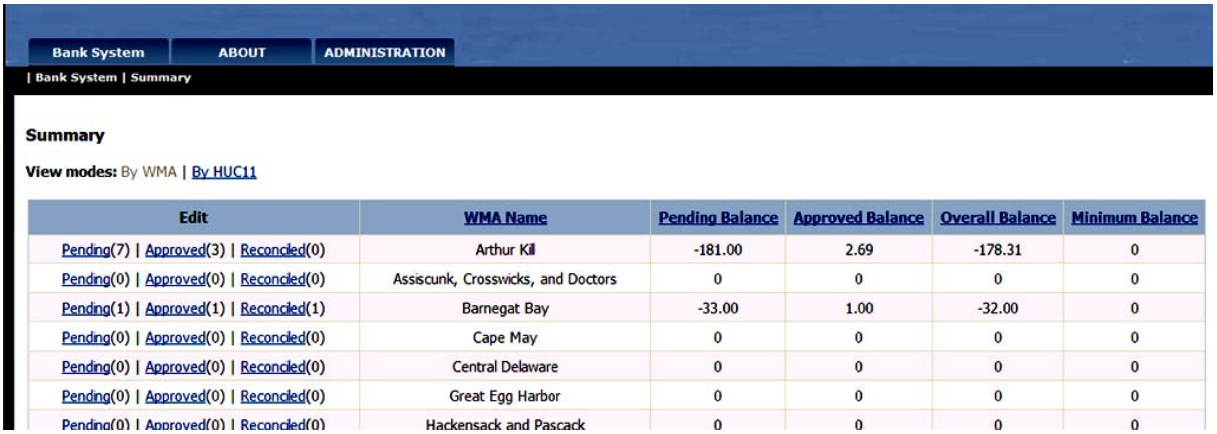


Figure 4.5 Summary Page View Organized by WMA

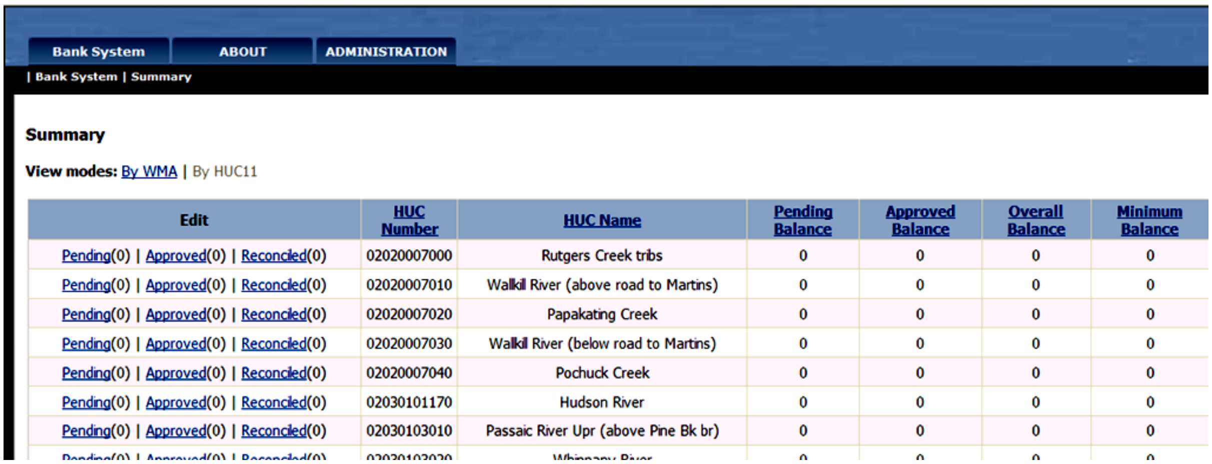
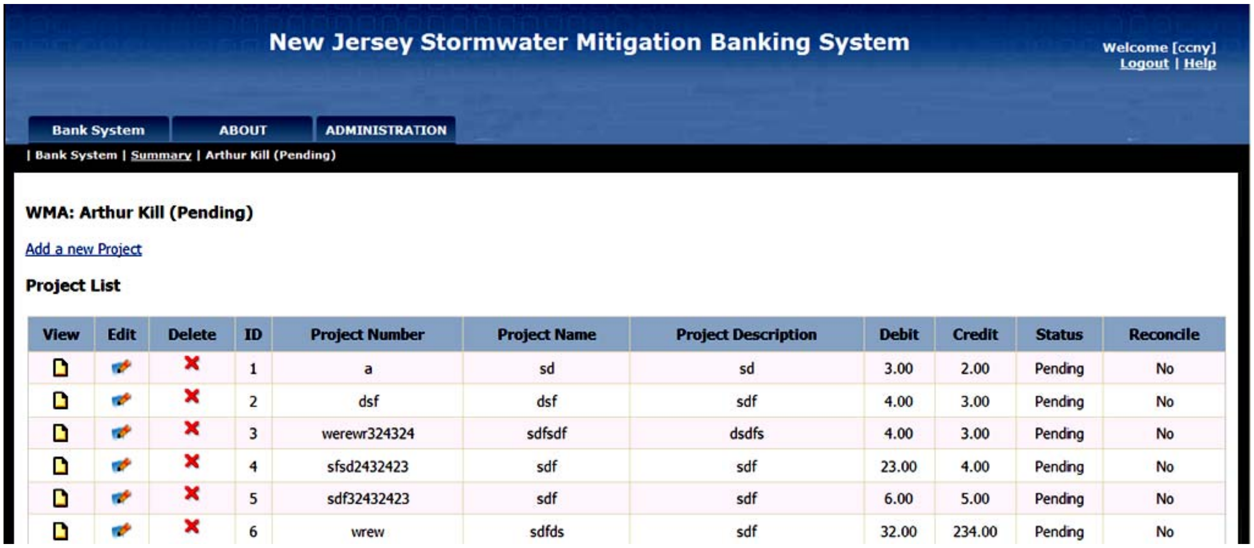


Figure 4.6 Summary Page View Organized by HUC 11

Depending on the project status, you can view/add projects in a WMA or HUC11 by clicking on any of the “Pending”, “Approved” or “Reconciled” tabs, which will take you to the “Project List” for that particular status.

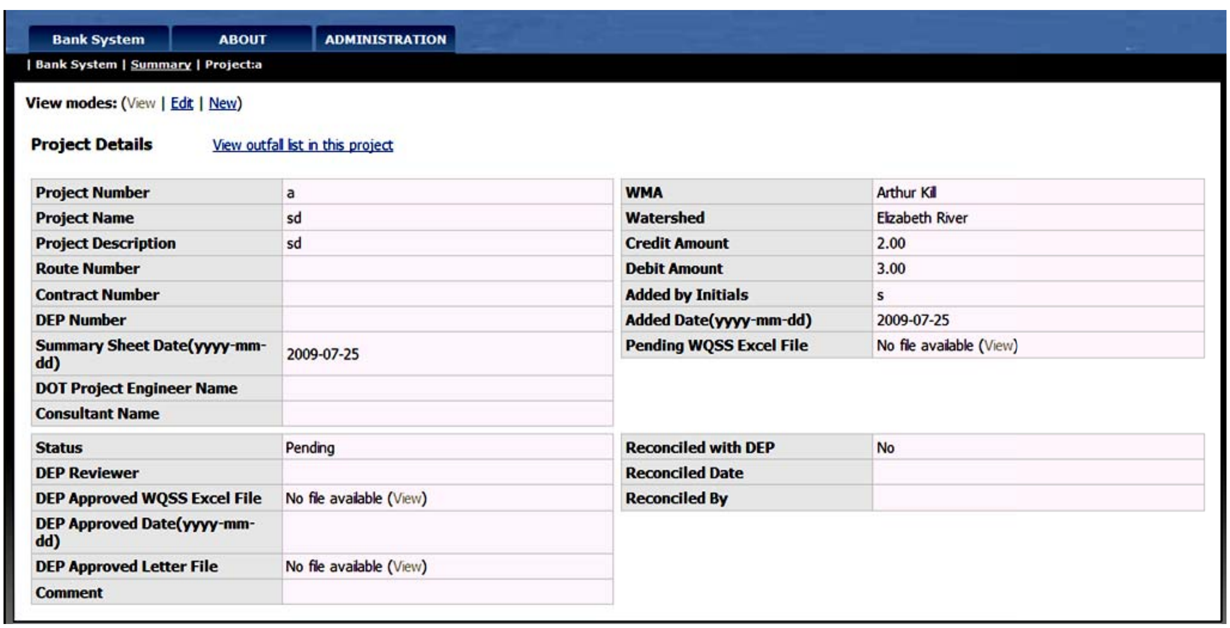
The “Project List” page presents a list of projects in a WMA or HUC11. For example, if the user clicks the link "Pending Projects" in Arthur Kill WMA (first row in Figure 4.3), the new page will show the list of pending projects in this WMA, as shown in Figure 4.7. The project list table shows a summary of project number, project name, project description, debit, credit, status, reconcile status for each project. You can add a new project by clicking the link "Add a new Project". You can also view or edit or delete a specific project in the project list.



View	Edit	Delete	ID	Project Number	Project Name	Project Description	Debit	Credit	Status	Reconcile
			1	a	sd	sd	3.00	2.00	Pending	No
			2	dsf	dsf	sdf	4.00	3.00	Pending	No
			3	werewr324324	sdfsdf	dsdfs	4.00	3.00	Pending	No
			4	sfsd2432423	sdf	sdf	23.00	4.00	Pending	No
			5	sdf32432423	sdf	sdf	6.00	5.00	Pending	No
			6	wrew	sdfds	sdf	32.00	234.00	Pending	No

Figure 4.7 Project List for pending projects in Arthur Kill WMA

Clicking on any icon below the “View” tab in the project list in Figure 4.7 takes the user to the “Project Details” page, as shown in Figure 4.8. On this page, one can also click "Edit" link or "New" link to edit the selected project or add a new project. The "Edit" page is similar to the "New" page and is shown in Figure 4.9. On the "Edit" page, items marked with "*" must be filled in. A list of outfalls in the project can be viewed by clicking on the “View outfall list in this project” link. Clicking on “New” link on the “Project Details” page takes the user to the new project window page shown in Figure 4.10.



Project Number	a	WMA	Arthur Kill
Project Name	sd	Watershed	Elizabeth River
Project Description	sd	Credit Amount	2.00
Route Number		Debit Amount	3.00
Contract Number		Added by Initials	s
DEP Number		Added Date(yyyy-mm-dd)	2009-07-25
Summary Sheet Date(yyyy-mm-dd)	2009-07-25	Pending WQSS Excel File	No file available (View)
DOT Project Engineer Name			
Consultant Name			
Status	Pending	Reconciled with DEP	No
DEP Reviewer		Reconciled Date	
DEP Approved WQSS Excel File	No file available (View)	Reconciled By	
DEP Approved Date(yyyy-mm-dd)			
DEP Approved Letter File	No file available (View)		
Comment			

Figure 4.8 Project Details Page

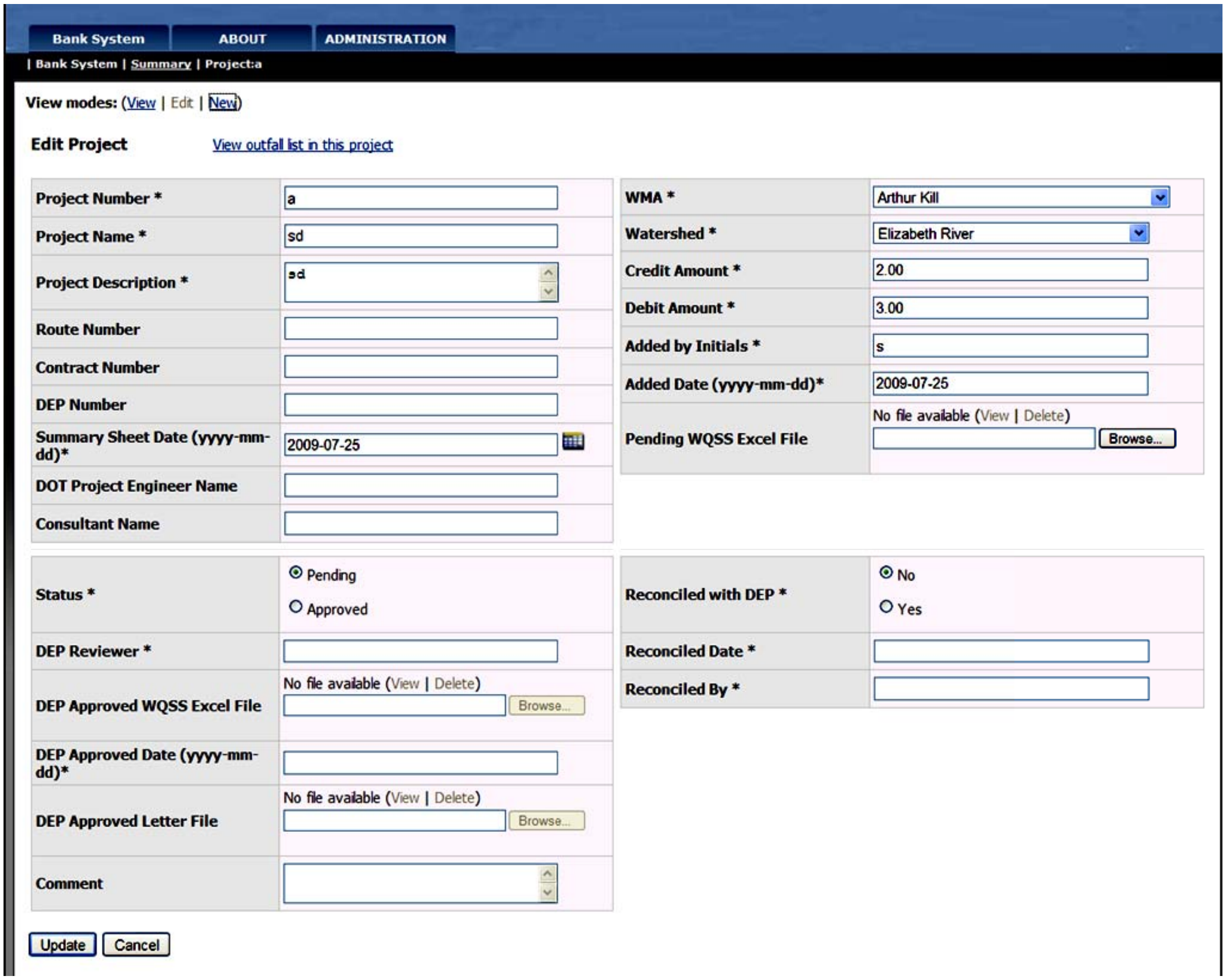


Figure 4.9 Edit Project Page

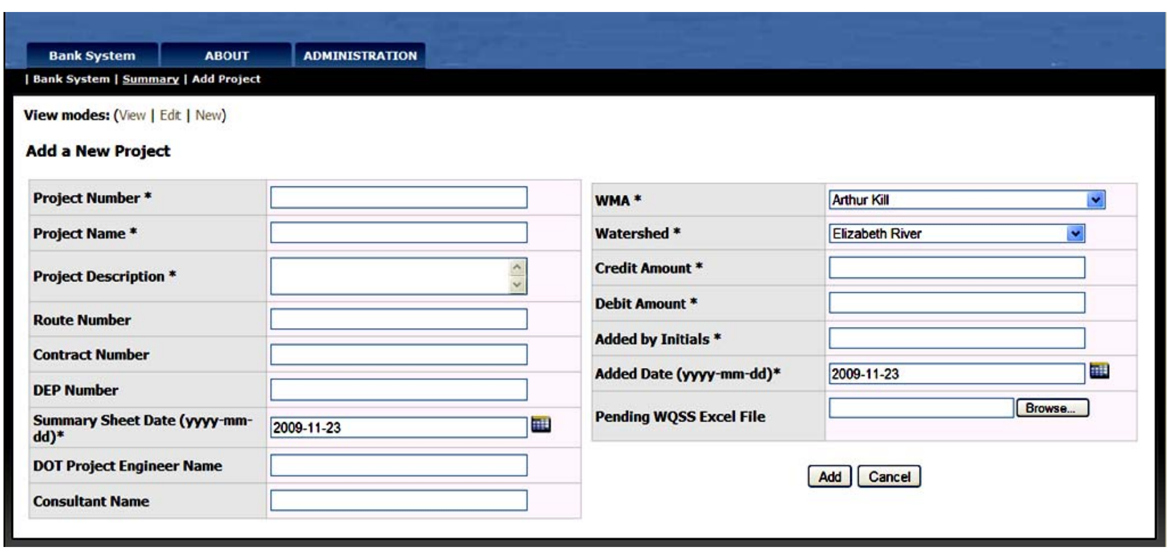
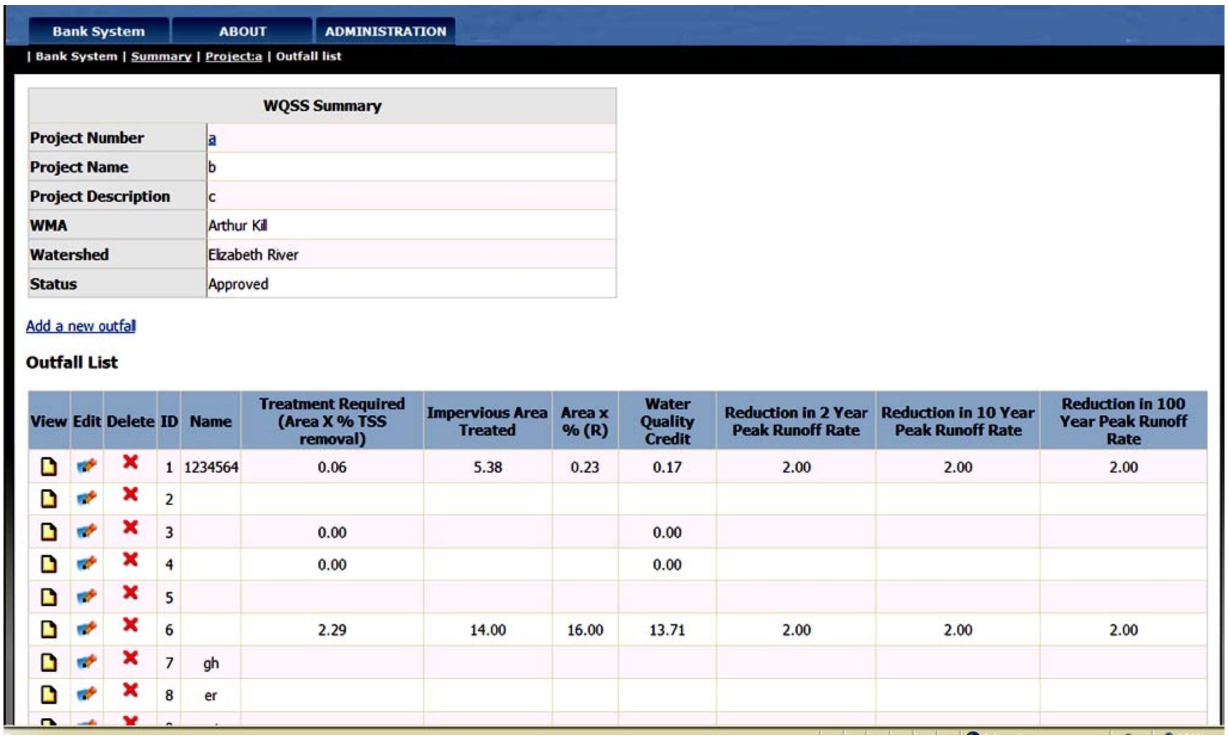


Figure 4.10 New Project webpage

It is observed from Figure 4.9 that the computer program allows NJDOT project managers to store all important data for a project, including detailed project information, project status (approved or pending), approved WQSS file, NJDEP approval date and letter, project debit/credit information and any information about reconciliation of water quality credits by the NJDEP or consultants appointed by NJDEP. This vital information can be retrieved by NJDOT engineers or NJDEP reviewers immediately.

Clicking "View outfall list in this project" in the “View” and “Edit” modes of the Project List/Details directs a user to a page showing all outfalls in the selected project as shown in Figure 4.11.



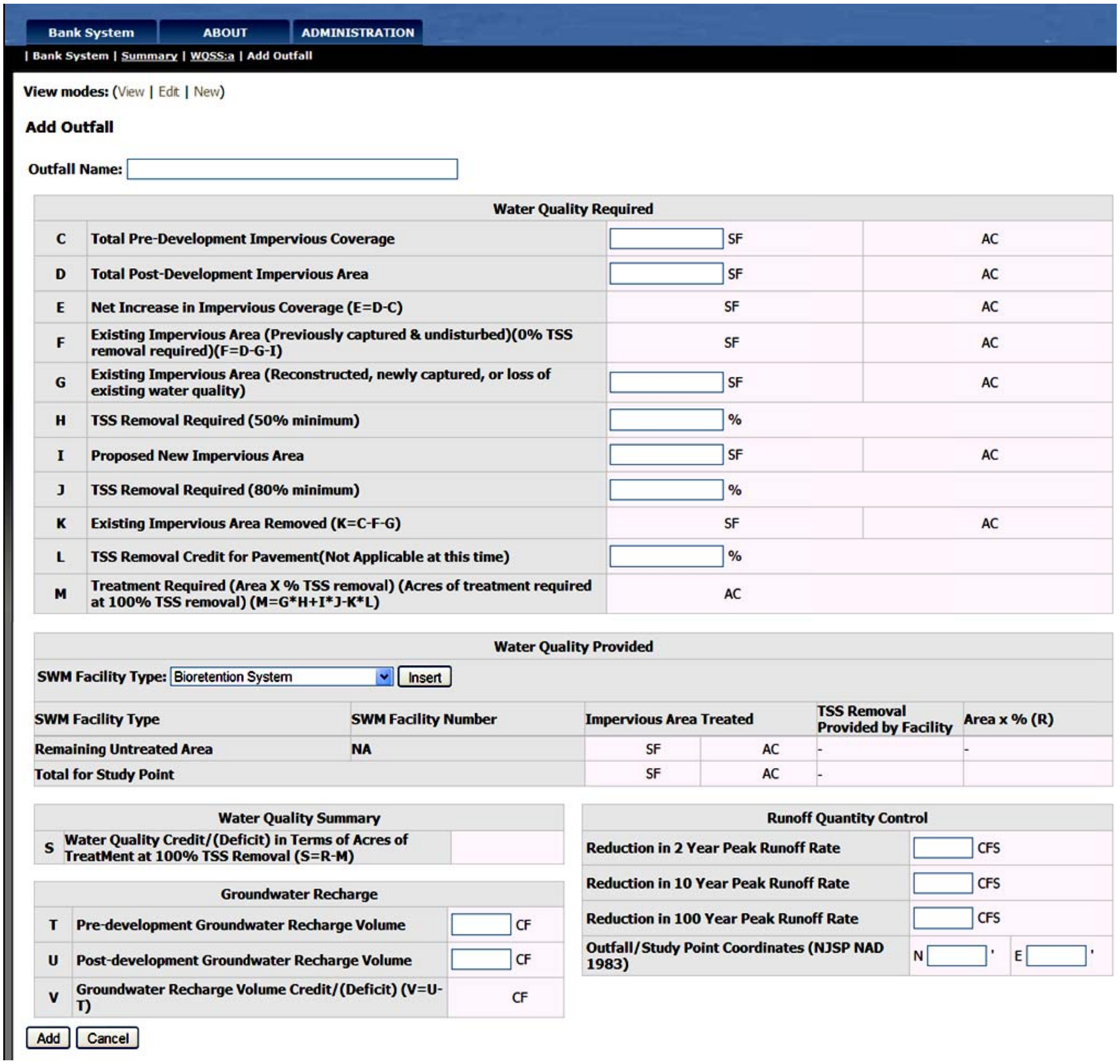
WQSS Summary	
Project Number	a
Project Name	b
Project Description	c
WMA	Arthur Kil
Watershed	Elizabeth River
Status	Approved

View	Edit	Delete	ID	Name	Treatment Required (Area X % TSS removal)	Impervious Area Treated	Area x % (R)	Water Quality Credit	Reduction in 2 Year Peak Runoff Rate	Reduction in 10 Year Peak Runoff Rate	Reduction in 100 Year Peak Runoff Rate
			1	1234564	0.06	5.38	0.23	0.17	2.00	2.00	2.00
			2								
			3		0.00			0.00			
			4		0.00			0.00			
			5								
			6		2.29	14.00	16.00	13.71	2.00	2.00	2.00
			7	gh							
			8	er							

Figure 4.11. Outfall List in a Project

For each outfall in the project, outfall list in Figure 4.11 shows (i) Treatment Required, Impervious Area Treated, Total Mitigation based on %TSS removal by a BMP, Water Quality Credit (Total Mitigation based on %TSS removal by a BMP – Treatment Required), Reduction in 2 Year Peak Runoff Rate, Reduction in 10 Year Peak Runoff Rate and Reduction in 100 Year Peak Runoff Rate. One can view, edit or delete a specific outfall by clicking the corresponding icons.

“Water Quality Credit” for an outfall is based on detailed calculations based on the following logic for the “Add Outfall” window in Figure 4.12. The upper window in Figure 4.12 shows calculations for water quality required.



Bank System | ABOUT | ADMINISTRATION

| Bank System | Summary | WQSS:a | Add Outfall

View modes: (View | Edit | New)

Add Outfall

Outfall Name:

Water Quality Required			
C	Total Pre-Development Impervious Coverage	SF	AC
D	Total Post-Development Impervious Area	SF	AC
E	Net Increase in Impervious Coverage (E=D-C)	SF	AC
F	Existing Impervious Area (Previously captured & undisturbed)(0% TSS removal required)(F=D-G-I)	SF	AC
G	Existing Impervious Area (Reconstructed, newly captured, or loss of existing water quality)	SF	AC
H	TSS Removal Required (50% minimum)	%	
I	Proposed New Impervious Area	SF	AC
J	TSS Removal Required (80% minimum)	%	
K	Existing Impervious Area Removed (K=C-F-G)	SF	AC
L	TSS Removal Credit for Pavement(Not Applicable at this time)	%	
M	Treatment Required (Area X % TSS removal) (Acres of treatment required at 100% TSS removal) (M=G*H+I*J-K*L)	AC	

Water Quality Provided

SWM Facility Type: Bioretention System [Insert]

SWM Facility Type	SWM Facility Number	Impervious Area Treated		TSS Removal Provided by Facility	Area x % (R)
Remaining Untreated Area	NA	SF	AC	-	-
Total for Study Point		SF	AC	-	

Water Quality Summary		
S	Water Quality Credit/(Deficit) in Terms of Acres of TreatMent at 100% TSS Removal (S=R-M)	

Groundwater Recharge		
T	Pre-development Groundwater Recharge Volume	CF
U	Post-development Groundwater Recharge Volume	CF
V	Groundwater Recharge Volume Credit/(Deficit) (V=U-T)	CF

Runoff Quantity Control	
Reduction in 2 Year Peak Runoff Rate	CFS
Reduction in 10 Year Peak Runoff Rate	CFS
Reduction in 100 Year Peak Runoff Rate	CFS
Outfall/Study Point Coordinates (NJSP NAD 1983)	N ' E '

[Add] [Cancel]

Figure 4.12. Add Outfall Page

The lower window of Figure 4.12 shows total water quality provided for a particular BMP, total water quality credit, ground water recharge volume credit and information about the runoff quality control. Figure 4.13 shows detailed calculations of required water quality required, water quality provided and water quality credit generated. Refer to Table 4.1 for a calculation of water quality for a sample project and Table 4.2 for calculations of water quality provided by the pilot mitigation bank.

Table 4.1 - Water Quality Requirements for Sample Project Outfall

LOCATION			
A	STUDY POINT / OUTFALL NUMBER	**1**	
B	HUC-11	Hackensack River (below Hirshfeld Brook)	
WATER QUALITY REQUIRED		**SQ FEET**	**ACRES**
C	TOTAL PRE-DEVELOPMENT IMPERVIOUS COVERAGE	**400,000 SF**	**9.18 AC**
D	TOTAL POST-DEVELOPMENT IMPERVIOUS AREA	**500,000 SF**	**11.48 AC**
E	NET INCREASE IN IMPERVIOUS COVERAGE *(E = D - C)*	**100,000 SF**	**2.30 AC**
F	EXISTING IMPERVIOUS AREA (PREVIOUSLY CAPTURED & UNDISTURBED) (0% TSS removal required) *(F = D - G - I)*	**150,000 SF**	**3.44 AC**
G	EXISTING IMPERVIOUS AREA (RECONSTRUCTED, NEWLY CAPTURED, OR LOSS OF EXISTING WATER QUALITY)	**200,000 SF**	**4.59 AC**
H	TSS REMOVAL REQUIRED (50% MINIMUM)	**50%**	
I	PROPOSED NEW IMPERVIOUS AREA	**150,000 SF**	**3.44 AC**
J	TSS REMOVAL REQUIRED (80% MINIMUM)	**80%**	
K	EXISTING IMPERVIOUS AREA REMOVED (K=C-F-G)	**50,000 SF**	**1.15 AC**
L	TSS REMOVAL CREDIT FOR PAVEMENT REMOVAL (NOT APPLICABLE AT THIS TIME)	**0%**	
M	TREATMENT REQUIRED (AREA X % TSS REMOVAL) (ACRES OF TREATMENT REQUIRED AT 100% TSS REMOVAL) *(M = G*H + I*J - K*L)*	**5.05 ACRES**	

Table 4.2 - Water Quality Provided for Proposed Pilot Water Quality Mitigation Banking Site

WATER QUALITY PROVIDED						**WATER QUALITY SUMMARY**
N	**O**	**P**		**Q**	**R**	**S**
SWM Facility Type	SWM Facility Number	Impervious Area Treated		TSS Removal Provided by Facility	Area x %	WATER QUALITY CREDIT/(DEFICIT) IN TERMS OF ACRES OF TREATMENT AT 100% TSS REMOVAL *(S = R - M)*
		SQ FEET	ACRES			
Manufactured Treatment Device	1	40,000 SF	0.92 AC	50%	0.46	**- 2.94 AC**
Extended Detention Basin	2	120,000 SF	2.75 AC	60%	1.65	
					-	
					-	
Remaining Untreated Area	NA	340,000 SF	7.81 AC	0%	-	
TOTAL FOR STUDY POINT		500,000 SF	11.48 AC		**2.11**	

Bank System | ABOUT | ADMINISTRATION

| Bank System | Summary | WQSS:(NA) | Outfall:Sample Outfall 1

View modes: (View | Edit | New)

Outfall Details

Outfall Name: Sample Outfall 1

Water Quality Required						
C	Total Pre-Development Impervious Coverage	400000	SF	9.18	AC
D	Total Post-Development Impervious Area	500000	SF	11.48	AC
E	Net Increase in Impervious Coverage (E=D-C)	100000	SF	2.30	AC
F	Existing Impervious Area (Previously captured & undisturbed)(0% TSS removal required)(F=D-G-I)	150000	SF	3.44	AC
G	Existing Impervious Area (Reconstructed, newly captured, or loss of existing water quality)	200000	SF	4.59	AC
H	TSS Removal Required (50% minimum)	50	%		
I	Proposed New Impervious Area	150000	SF	3.44	AC
J	TSS Removal Required (80% minimum)	80	%		
K	Existing Impervious Area Removed (K=C-F-G)	50000	SF	1.15	AC
L	TSS Removal Credit for Pavement(Not Applicable at this time)	0	%		
M	Treatment Required (Area X % TSS removal) (Acres of treatment required at 100% TSS removal) (M=G*H+I*J-K*L)	5.05	AC		

Water Quality Provided								
SWM Facility Type	SWM Facility Number	Impervious Area Treated				TSS Removal Provided by Facility		Area x % (R)
Manufactured Treatment Device	1	40000	SF	0.92	AC	50	%	0.46
Extended Detention Basin	2	120000	SF	2.75	AC	60	%	1.65
Remaining Untreated Area	NA	340000	SF	7.81	AC	-		-
Total for Study Point		500000	SF	11.48	AC			2.11

Water Quality Summary			
S	Water Quality Credit/(Deficit) in Terms of Acres of TreatMent at 100% TSS Removal (S=R-M)	-2.94	AC

Groundwater Recharge			
T	Pre-development Groundwater Recharge Volume	500000	CF
U	Post-development Groundwater Recharge Volume	400000	CF
V	Groundwater Recharge Volume Credit/(Deficit) (V=U-T)	-100000	CF

Runoff Quantity Control		
Reduction in 2 Year Peak Runoff Rate	CFS	
Reduction in 10 Year Peak Runoff Rate	CFS	
Reduction in 100 Year Peak Runoff Rate	CFS	
Outfall/Study Point Coordinates (NJSP NAD 1983)	N 500000.00	E 500000.00

Figure 4.13 Calculation of Water Quality Required and Water Quality Provided for an Example outfall and BMP in Table 4.1 and Table 4.2.

WMA List

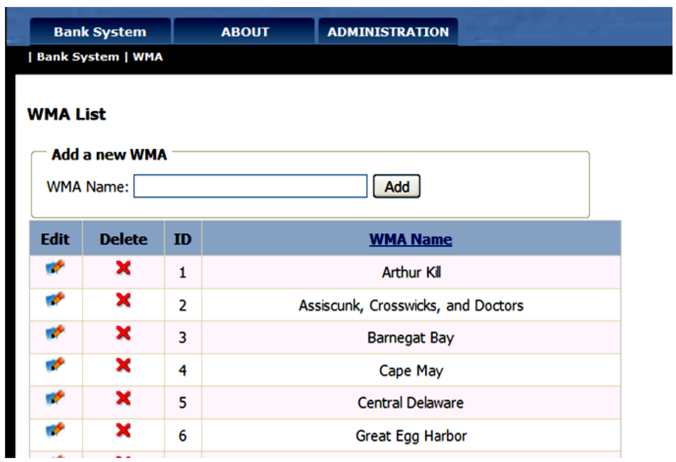
This page presents a list of WMA's in the system. The user can sort the WMA's by name by clicking on the "WMA Name" link and can create a new WMA by using the "Add a new WMA" dialog box. The user can also edit or delete the WMA as shown in Figure 4.14.

Watershed List

This page presents a list of watersheds in the system. The user can view the watershed areas by WMA or by the HUC 11 by choosing the respective options, as shown in Figures 4.15 and 4.16.

Figure 4.15 shows the default view of watershed lists by WMA. One can sort the watersheds by HUC Number and HUC Name by clicking on the respective links. One can also edit/delete the watersheds by choosing the corresponding icon.

The user can also create a new watershed by using the “Add a new HUC in the selected WMA” dialog box.



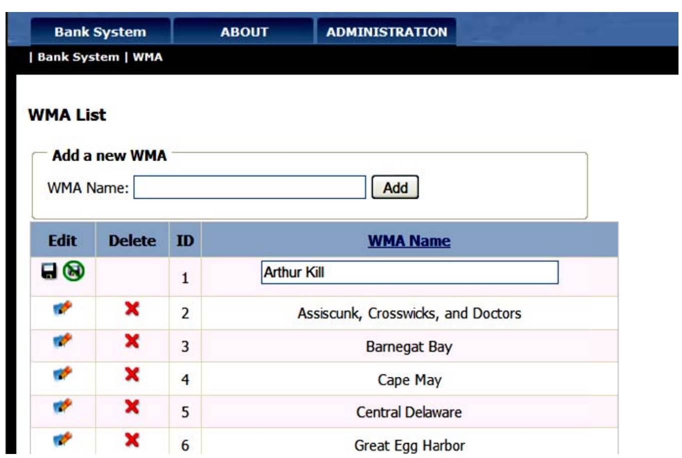


Figure 4.14. WMA List.

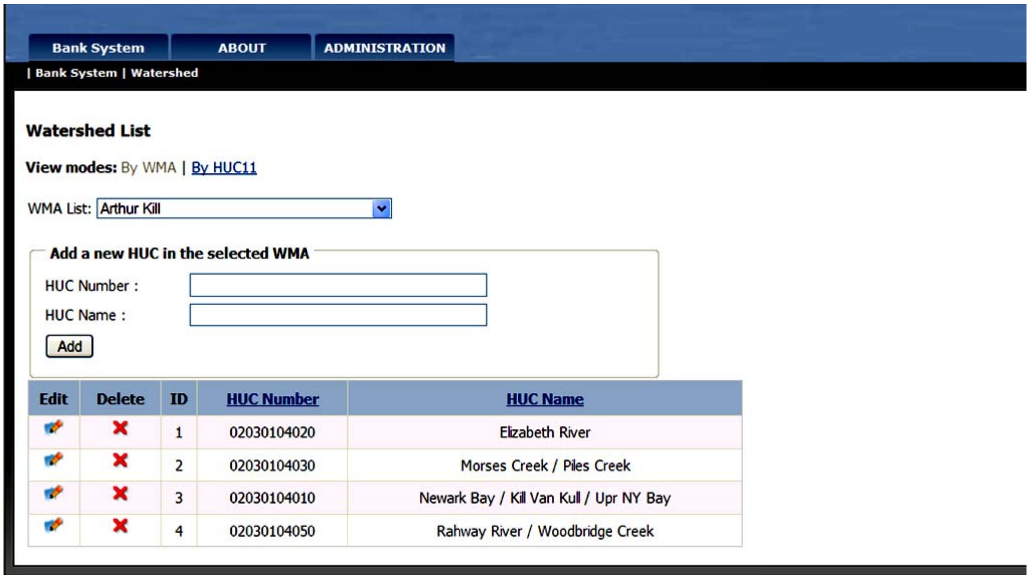


Figure 4.15. Watershed list (Default view by WMA)

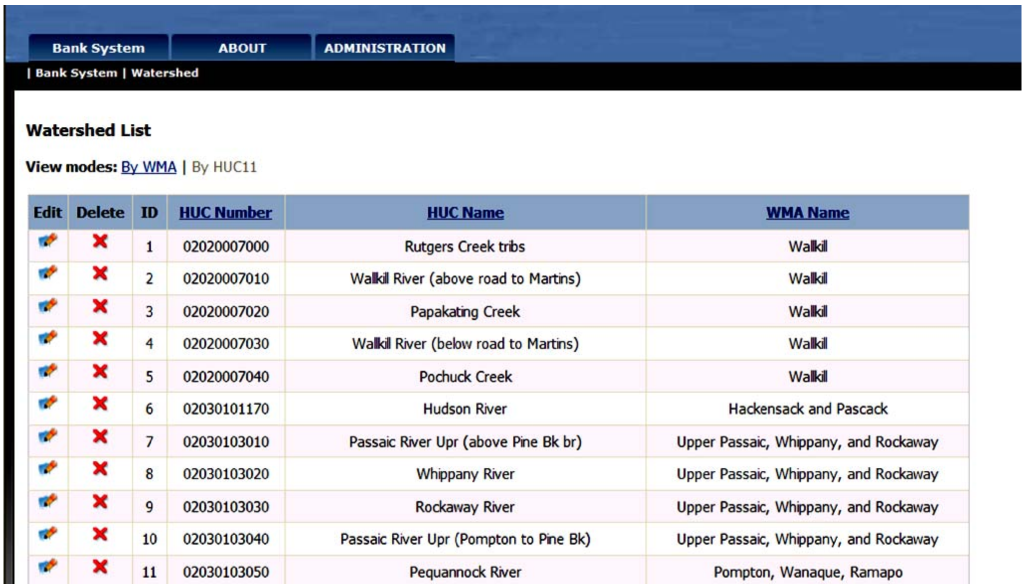


Figure 4.16. Watershed List (View by HUC 11)

About

The About tab has two sub menus which are the "About" and the "Help", as shown below.

Figure 4.17. The About Menu

The "About" sub menu gives a brief introduction about the concept and capabilities of this software (see Figure 4.18) and the "Help" sub menu provides the online operational manual for using this software (see Figure 4.19).

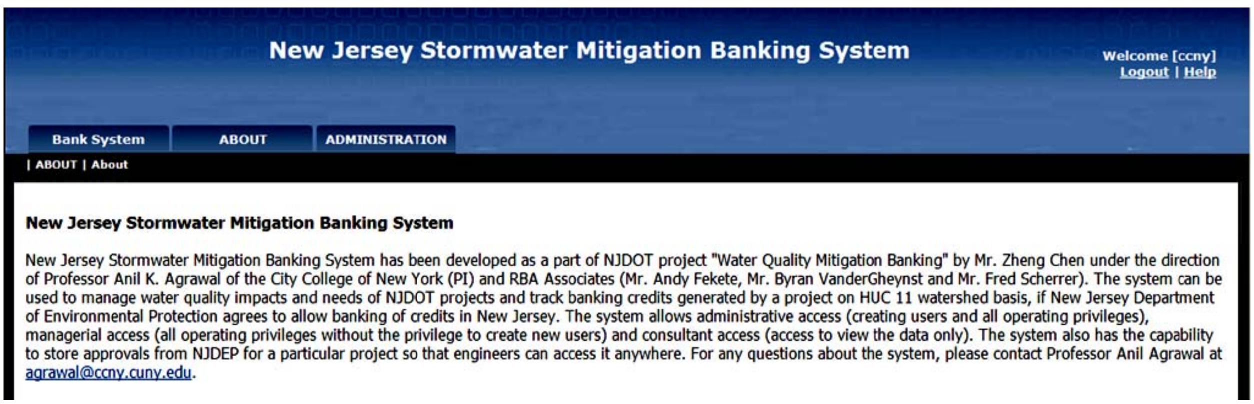


Figure 4.18. The About Sub-Menu

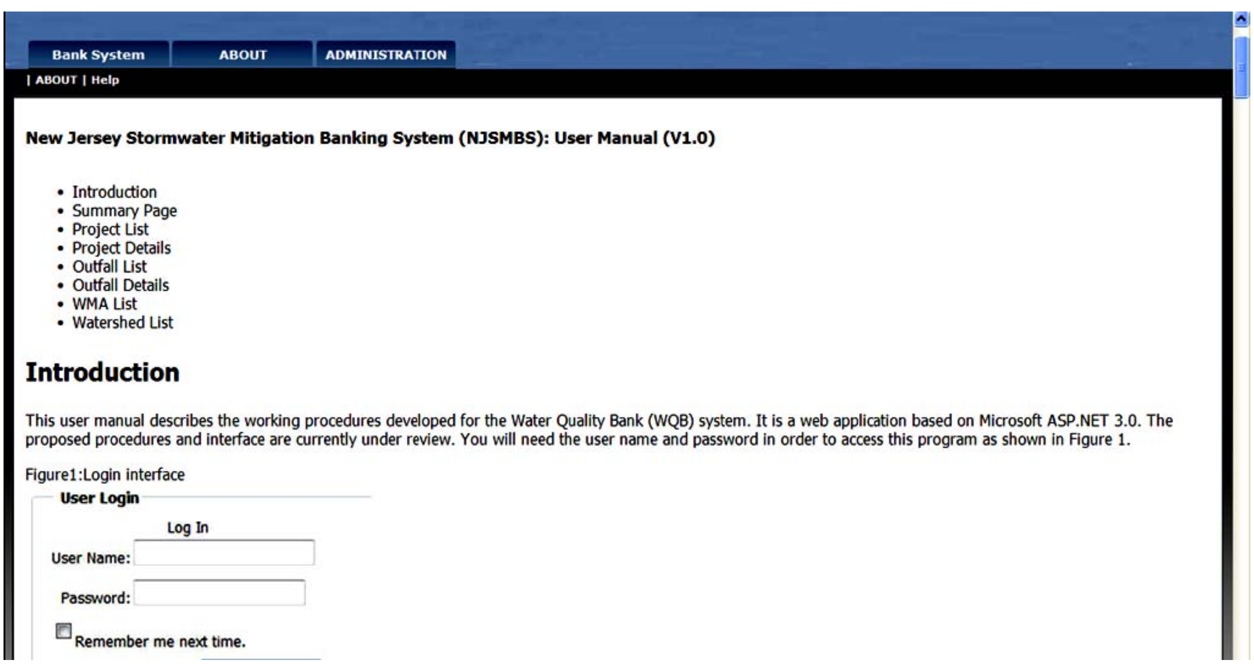


Figure 4.19. The Help Sub-Menu

Administration

The administration tab has two submenus; the Create New user and the List User (see Figure 4.20).

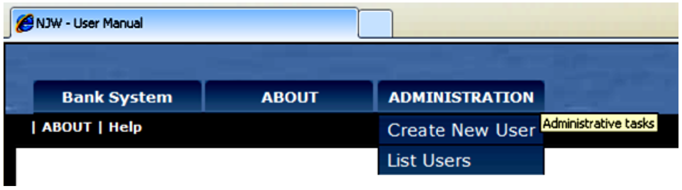


Figure 4.20. The Administration Tab Menu

The Create New user function allows the addition of other users and classifies them according to the operational privileges as Administrator, Manager or Consultant. The system allows administrative access (creating users and all operating privileges), managerial access (all operating privileges without the privilege to create new users) and consultant access (access to view the data only), as shown in Figure 4.21.

The minimum length of the password required is 7 alphanumeric characters (A-Z, a-z, 0-9) and it must contain at least 1 non alphanumeric character (for e.g.!, @,#,$,%). The password and user names are case sensitive. Please make note that the fields marked by an asterisk (*) in Figure 4.21 are compulsory. Keep your username and password in a safe place to avoid unauthorized access to the system. Once all the fields are entered correctly, you will get the confirmation message as shown in the Figure 4.22.

The list user sub menu allows the administrator to view /delete the registered users with the system (see Figure 4.23). It also provides an option to create a new user. The user list provides you the user name, their role, email, creation date, date of last log in, the current status which tells you who is online and finally the delete option which can be used to delete the users from the database.

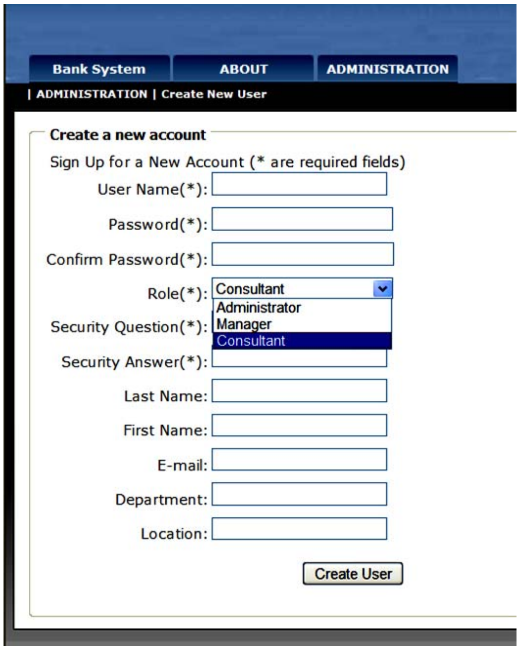


Figure 4.21. The Create New User Page

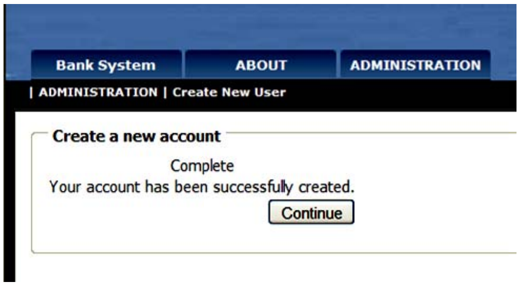


Figure 4.22. Confirmation Message After Creating a New User

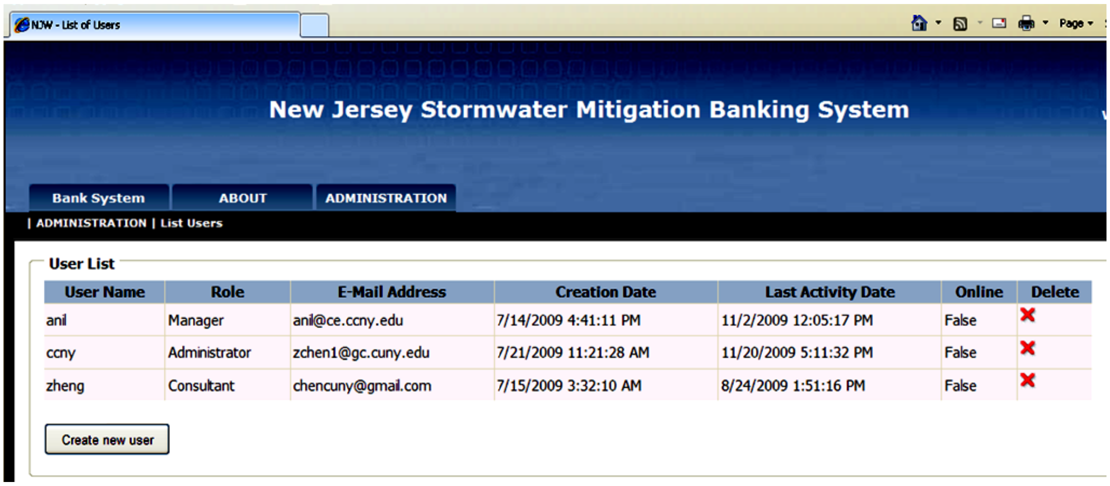


Figure 4.23. The List User Page

CHAPTER 5
CONCLUSIONS

Requirements for mitigating stormwater impacts in New Jersey caused by transportation infrastructure projects are established by the NJDEP Stormwater Regulations (N.J.A.C. 7:8). They outline specific processes to offset impacts to water quality, groundwater recharge and peak rate of runoff/runoff volume resulting from the addition of impervious surfaces. The rules are written to address impacts of individual projects without specific provisions for addressing cumulative programmatic impacts of multiple projects through "mitigation banking". The requirement to design and build separate, "on site" mitigation features for each project results in delayed implementation schedules, inefficient and nominally effective results and excessive maintenance demand. As a result, NJDOT initiated the research project to evaluate the feasibility of using a banking approach for streamlining and enhancing the effectiveness of the mitigation process.

The results of the research include the following:

- Literature review identified two successful water quality banking programs implemented by Maryland Highway Administration and Delaware Department of Transportation; several USEPA documents and other papers which describe water quality management programs using "debit and credit" paradigms which provide a regulatory framework for developing water quality banking models.

- Statewide review of NJDOT planned projects in HUC 11 watersheds produced an inventory of future water quality mitigation needs.

- NJDEP agreed to the use of HUC 11 watersheds for water quality banking purposes. It is also likely that the HUC 11 watershed would be acceptable for banking groundwater recharge credits. However, peak flow control banking is less likely feasible due to the potential for increased flooding of private properties immediately downstream of NJDOT's individual project sites.

- The HUC 11 Hackensack River Watershed was selected for the pilot water quality banking project area.

- A feasible water quality bank site was identified within the Hackensack River Watershed.

- A database based computer program was developed to track and manage banking credits.

- Additional consultation and coordination with NJDEP is required for implementation of the bank.

- Inclusion of additional transportation projects from the NJDOT Local Aid Program can enhance the cost effectiveness of banking.

Based on this particular design, the proposed stormwater wetland facility will treat impervious coverage at a rate of approximately $71,300 per acre of impervious area treated at 100% TSS removal. This equates to $64,200 per acre treated at 80% TSS removal and $35,600 per acre treated at 50% TSS removal. However, the Department should use caution in using this single example and the associated costs as a guideline for the evaluation of BMP alternatives. There are many factors that should weigh into consideration, such as: R.O.W. availability and cost; utility impacts and relocation costs; environmental permitting; long term maintenance; and constructability issues. In addition, the area treated in this instance was dictated by physical (elevation) constraints and the existing drainage infrastructure. If increased impervious area could have been directed to this facility, the increase in construction cost would be nominal. Likewise, for a smaller area of impervious coverage treated, the costs would not have been significantly reduced. In summary, the per-acre cost can vary greatly from site to site, depending on these variables.

Based on a review of contractor bid prices, the per-acre construction cost associated with manufactured treatment devices (MTDs) appears to be comparable with the stormwater wetland facility presented herein. Therefore, it is difficult to conclude with certainty that a centralized facility will result in an immediate cost savings, compared to numerous smaller facilities. However, the more tangible benefit will be realized with the reduction in long-term annual maintenance costs, since costs associated with maintaining numerous MTDs spread sporadically throughout an area will be higher than those associated with a single, central facility.

APPENDIX I: REFERENCES

1. Doll, A.; Scodari, P.F.; and Lindsey, G. (1999) Credits as Economic Incentives for ON-Site Stormwater Management: Issues and Examples, *Proc. National Conf. on Retrofit Opport. for Water Rec. Protect. in Urban Environ.,* Chicago, IL, EPA/625/C-99/001, U.S. EPA, Washington, D.C., 113.
2. EPA (2004), Water Quality Trading Assessment Handbook: Can Water Quality Trading Advance Your Watershed Goals?, U.S Environmental Protection AgencyOffice of Water (4503T) 1200 Pennsylvania Avenue, NW Washington, D.C. 20460, November 2004, Report No. EPA 841-B-04-001.
3. Landry, M., Siems, A. and Stedge, G. (2005), Applying Lessons Learned From Wetlands Mitigation Banking to Water Quality Trading, Report prepared for Office of Policy, Economics and Innovation and Office of Water, U.S. Environmental Protection Agency, Washington, DC 20460, EPA Contract 68-W-99-042.
4. Environmental Law Institute (2005), National Forum on Synergies between Water Quality Trading and Wetland Mitigation Banking, Environmental Law Institute®, Washington, D.C. All rights reserved. ISBN No. 1-58576-099-4, ELI Project No. 0508-01, December 2005.
5. McCleary, R.B. (1999) A Stormwater Banking Alternative for Highway Projects. *Proc. National Conf. on Retrofit Opport. for Water Rec Protect. in Urban Environ.,* Chicago, IL, EPA/625/C-99/001, U.S. EPA, Washington, D.C., 100.
6. Stormwater Management Rule: New Jersey Administrative Code (N.J.A.C.) 7:8
7. New Jersey Department of Environmental Protection, Division of Watershed Management, 2004 New Jersey Stormwater Best Management Practices Manual.

APPENDIX II: MARYLAND WATER QUALITY BANKING MOU

will be required from consultants. Contact K. McClelland with any questions. KGM

Maryland Department of Transportation
State Highway Administration

O. James Lighthizer
Secretary
Hal Kassoff
Administrator

June 2, 1992

MEMORANDUM

HWY. DESIGN DIV.

TO: All District Engineers
Deputy Chief Engineer-Bridge Development
Assistant District Engineers-Construction
Deputy Chief Engineer-Highway Development
Director, Office of Environmental Design

FROM: Charles R. Olsen
Chief Engineer

SUBJECT: Stormwater Management Banking

A Memorandum of Agreement (MOA) has been executed between Maryland Department of Environment's Sediment and Stormwater Administration (SSA) and SHA to establish a banking system for water quality management for SHA projects. This agreement will ensure that SHA meets its responsibility of providing water quality improvements for all projects and yet allow the flexibility of designing the most environmentally effective solution at a reasonable cost. Every effort must still be made to provide water quality measures on each project; however, this agreement allows the latitude to defer water quality treatment in hardship cases.

The highlights of the MOA include:

- Deferral of water quality for new pavement areas up to a total of 5 acres per sub-basin in metropolitan areas and 2 acres in rural areas (A detailed watershed map is attached).
- Credit for treatment of offsite pavement areas (ie., county roads, parking lots) which drain to our facility.
- Credit for wetland mitigation sites designed to MDE criteria which receive pavement runoff.
- Ability to extend use of the bank to other state agencies, subject to approval by the Chief Engineer.
- Establishment of a process to initiate water quality retrofits to clear existing bank debits or create bank credits.

A copy of the agreement is attached, detailing the process and methods of calculating credits and debits.

My telephone number is ______________________

Teletypewriter for Impaired Hearing or Speech
383-7555 Baltimore Metro - 565-0451 D.C. Metro - 1-800-492-5062 Statewide Toll Free
707 North Calvert St., Baltimore, Maryland 21203-0717

The agreement is effective immediately for all design projects for which SSA has not yet issued a permit. Construction projects which request stormwater management modifications (ie., deletion of infiltration trenches) will be allowed subject to this agreement. The Highway Design Division, Hydraulics Section will be maintaining a record of bank balances in order that water quality retrofit projects can be initiated in a timely manner. To ensure the accuracy of these records a summary of water quality treatment (credit or debit) for each project must be forwarded to MDE and carbon copied to Highway Design, attention: Kirk McClelland. A sample summary form is attached for reference. Should you have any questions about the use of this bank, please contact Kirk McClelland at 333-1274.

CRO/dp
Attachments

cc: Mr. Dan O'Leary
Mr. Edward G. Stein
Mr. Kirk G. McClelland

WATER QUALITY SUMMARY SHEET

PROJECT: ______________________________ WATERSHED NUMBER : __________

CONTRACT NUMBER: ____________

AREA NO.	ADDED IMPERVIOUS (ACRES)	TREATMENT TYPE	EFF	ON-SITE PAVEMENT TREATED	NET ON-SITE PAVEMENT TREATED	OFF-SITE PAVEMENT TREATED	NET OFF-SITE PAVEMENT TREATED	NET TREATED (TOTAL)
TOTAL								

NET AREA APPLIED TO SWM QUALITY BANK: __________ ACRES IN ______________________
(WATERSHED SUB-BASIN)

This sheet changed in 2001 w/ new SWM regulations.
All pavement equal credit, offsite 80% credit due to pot. of offsite redevelopment.
No more efficiency for BMP type i.e. All BMP equal.

MEMORANDUM OF AGREEMENT
BETWEEN
THE MARYLAND DEPARTMENT OF THE ENVIRONMENT
AND THE MARYLAND STATE HIGHWAY ADMINISTRATION
CONCERNING
STORMWATER QUALITY MANAGEMENT BANKING

This Memorandum of Agreement (MOA) between the Maryland Department of the Environment (MDE), Sediment and Stormwater Administration (SSA) and the Maryland Department of Transportation, State Highway Administration (SHA) outlines the parameters by which SHA will provide Stormwater Quality Management (Quality Management) on its projects. These projects are reviewed by SSA pursuant to §4-205 of the Environment Article of the Annotated Code of Maryland, State regulations, and Stormwater Management Guidelines for State and Federal Projects. This MOA recognizes that SHA is sometimes unable to provide Quality Management acceptable to SSA on their projects. By this agreement, the parties intend that, where SHA cannot provide acceptable Quality Management on a given project, the "deficit" thus created will be eliminated at another SHA project within the same sub-basin.

1. <u>SCOPE</u>

The terms set forth in this agreement take effect immediately and apply to those projects to be constructed by SHA which have not already received approval from the MDE, Sediment and Stormwater Administration (SSA). This agreement creates a Quality Management "bank" which allows a debit/credit system for stormwater quality management on SHA projects within a given sub-basin. The bank system is to enable SHA to maximize the cost effectiveness of providing Quality Management and keep projects on schedule while meeting or exceeding SSA Quality Management requirements.

2.0 <u>TERMS</u>

2.1 SHA should maximize Stormwater Quality Management on-site to the extent practicable as required by the Stormwater Management Guidelines for State and Federal Projects and agreements thereafter. SSA will make the final determination as to whether off-site Quality Management will be allowed.

2.2 If a Quality Management (credit) project is proposed to reduce the pavement deficit in the bank, the proposed roadway to be treated should be similar to that of the project(s) deferred to the bank. Similar, in this case, means that the roadways at both sites have similar or higher classifications and traffic volumes (A.D.T.), therefore, similar pollutant loadings. Control of rooftop impervious areas will not be considered as water quality treatment.

2.3 When possible, the "banked" pavement areas should be treated off-site by infiltration structures, which is the preferred stormwater management alternative.

2.4 Both credits and debits in the bank will be recorded according to the sub-basin (as defined by DNR's Maryland Watershed Designation) within which they exist. Projects can only deposit or withdraw pavement acreage within their respective sub-basin.

2.5.0 SHA will locate and notify SSA of potential sites for Quality M[m]anagement. SSA will review these sites and participate in the selection process. Then SHA will provide the necessary soils and hydrologic information to develop the plans and finally they will construct the management structure(s).

2.5.1 When a debit of 5 acres is accrued within sub-basins 02-13-07 through 02-13-11 or 02-14-02, SHA will be required to construct Quality Management for at least 5 acres of existing pavement.

2.5.2 All sub-basins except those listed in 2.5.1 are limited to a debit of 2 acres, before a Quality Management project is required.

2.6 Quality management shall be provided through infiltration, retention or extended detention of runoff in accordance with MDE criteria. Infiltration is the most preferred and extended detention is the least preferred means, therefore infiltration must be determined to be infeasible for a site before retention can be tested for feasibility, with extended detention being chosen as a last resort. Credits applied to the bank will be based on the following:

changed in 2001.

A) Quality management constructed within the same drainage (or watershed) area as the impervious area that it was designed to treat will receive 100% credit, ie., 1 acre of pavement drains to an infiltration trench, retention pond, or extended detention basin that will treat that 1 acre of pavement, therefore 0 acre of pavement gets debited and 0 acre of Quality Management is credited to the bank.

B) Untreated pavement requiring Quality Management in one drainage area (DA 1) may be deferred to excess quality management in another drainage area (DA 2) if:

1) Quantitative control in that drainage area (DA 1) is not required, or the presence of a quality control structure as part of a quantity control structure is infeasible (ie. underground storage), and

2) sufficient hardship exists to render quality management in that drainage area (DA 1) infeasible, and

3) there is sufficient, untreated existing pavement in the drainage area (DA 2) where excess quality management is proposed to warrant the deferment, and

4) through infiltration practices, quality management will be credited at 100% for deferred (DA 1) highway pavement treated as long as the storage volume provided does not exceed 1" of runoff from the contributing impervious area, and

5) through retention pond(s), quality management will be credited at 70% for deferred (DA 1) highway pavement treated, and

6) through extended detention basins, quality management will be credited at 40% for deferred (DA 1) highway pavement treated.

C) Off-site pavement draining to a SHA infiltration or retention structure will be credited as quality management at 50% for infiltration, 35% for retention, and 20% for extended detention to be applied to deferred pavement on the project (as outlined in B above) or, in the cases of infiltration or retention, to the bank as credit. Extended detention quality management cannot be used for bank credit.

D) On a project basis, the total amount of impervious requiring quality management shall be weighed against the quality management provided, within the framework of 2.6 A), B) and C), with untreated impervious applied to the bank as a debit or excess quality management applied to the bank as credit.

Proportion of Contributory Pavement Credited on Project

Best Management Practice	Contributory Pavement from Highway	
	In Drainage Area	Out of Drainage Area
Infiltration	100%	100%
Retention	100%	70% 100%
Extended Detention	100%	40% 100%
Detention	N/A	N/A

Proportion of Contributory Pavement Credited to the Bank

Best Management Practice	Highway Pavement	Off Site Pavement
Infiltration	100%	50% 80%
Retention	70% 100%	35% 80%
Extended Detention	N/A	N/A
Detention	N/A	N/A

2.7 Regarding infiltration, an additional ½" of runoff from impervious areas can be stored for extra credit beyond the required ½" (1" total) for use on that project. However, infiltration storage beyond ½" of runoff from the contributory imperviousness cannot be used for off-site bank credit.

2.8 Wetland mitigation sites may be considered for Quality Management credit based on their anticipated pollutant removal efficiencies and the areas that they treat as outlined in 2.6 B) 5) and 2.5 C), as long as they are designed in accordance with MDE publications.

2.9 New soil boring information will be required for all proposed credit projects.

2.10 Removal of existing pavement and replacement with pervious areas will be allowed for credit with respect to Section 2.2 of this MOA.

2.11 State agencies other than SHA will be allowed to withdraw from the bank, but only with the permission of SHA.

2.12 The construction costs of a retrofit project should not exceed $12,000 per acre treated.

not 2006 cost

3. MAINTENANCE

SHA agrees to inspect yearly and maintain all Quality Management structures built under the terms of this MOA in accordance with Section 26.09.02.10 of State Regulations.

4. MODIFICATIONS

The terms of this MOA may be modified upon written agreement of both parties.

5. TERMINATION

This MOA shall be terminated upon mutual agreement between both parties.

Approved:

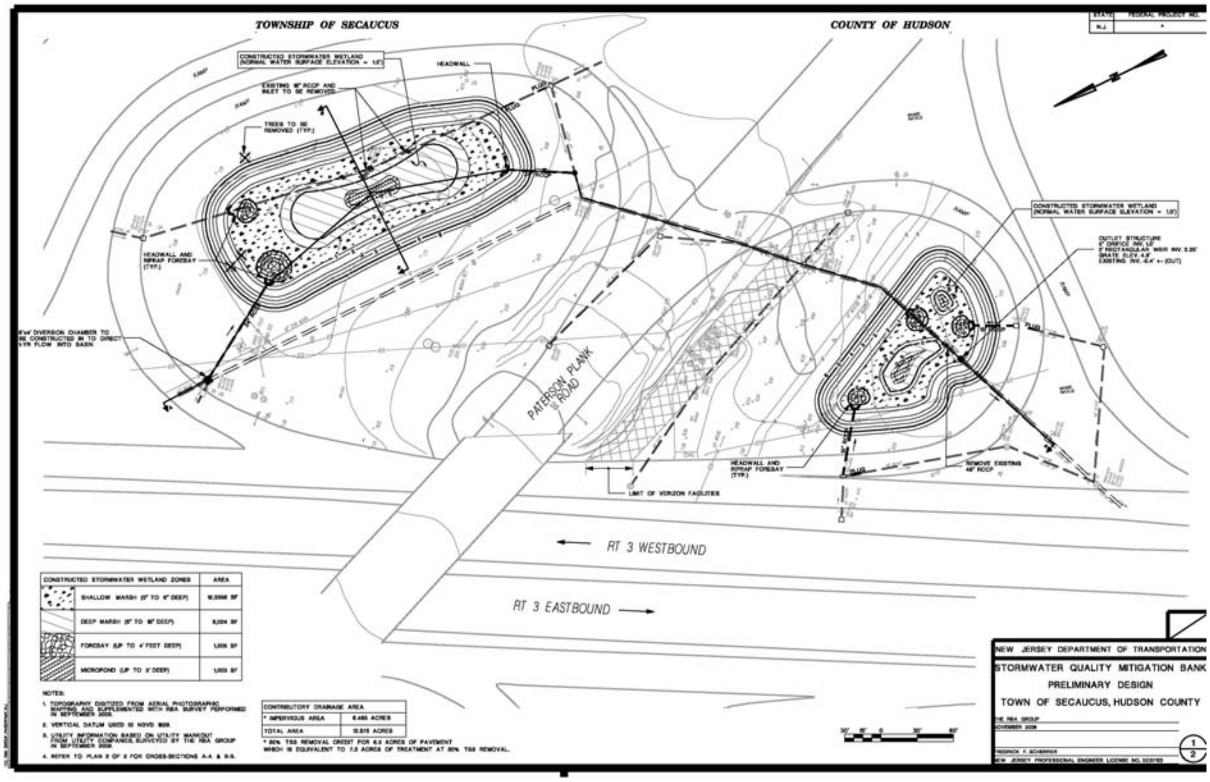
5/14/92
(Date)

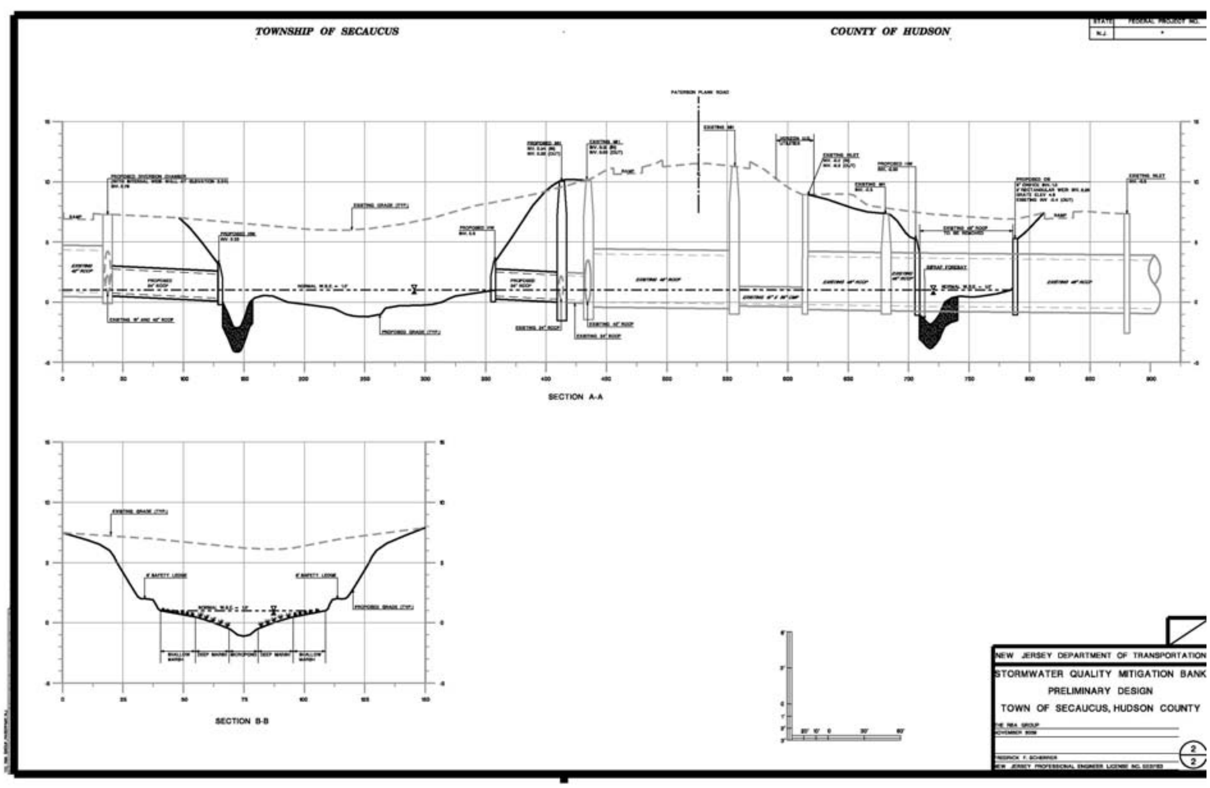
Chief Engineer
Maryland State Highway Administration

5/11/92
(Date)

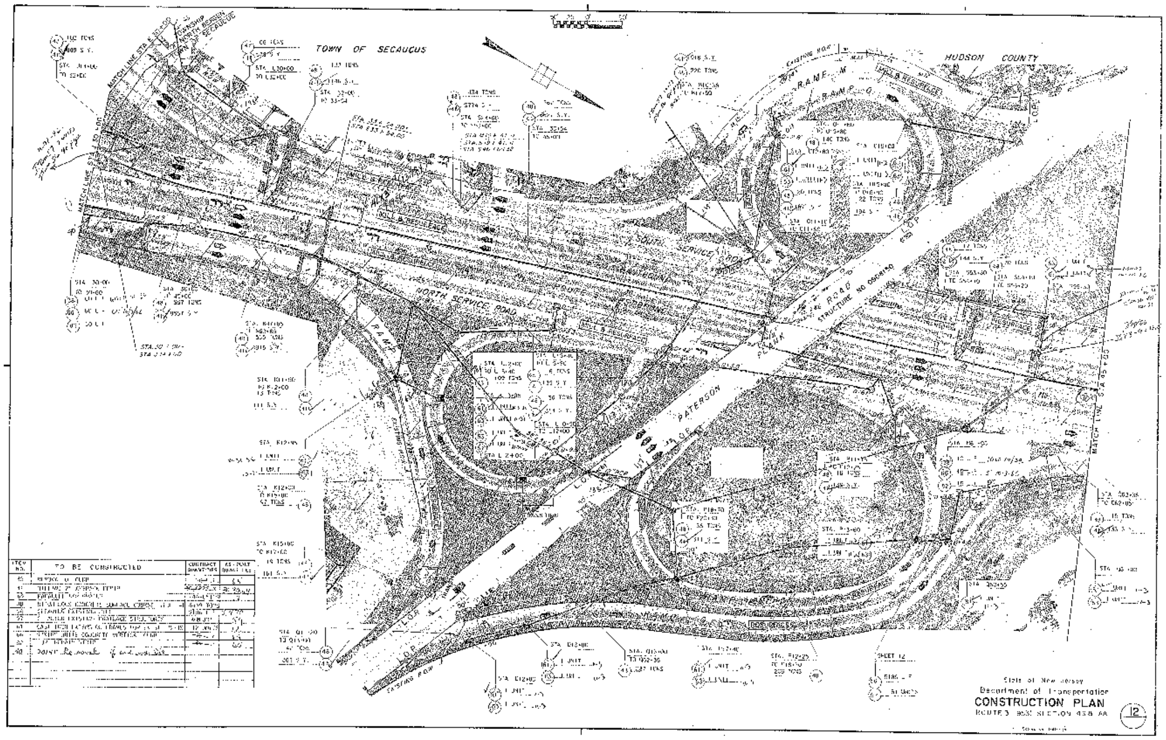
Director
Sediment & Stormwater Administration

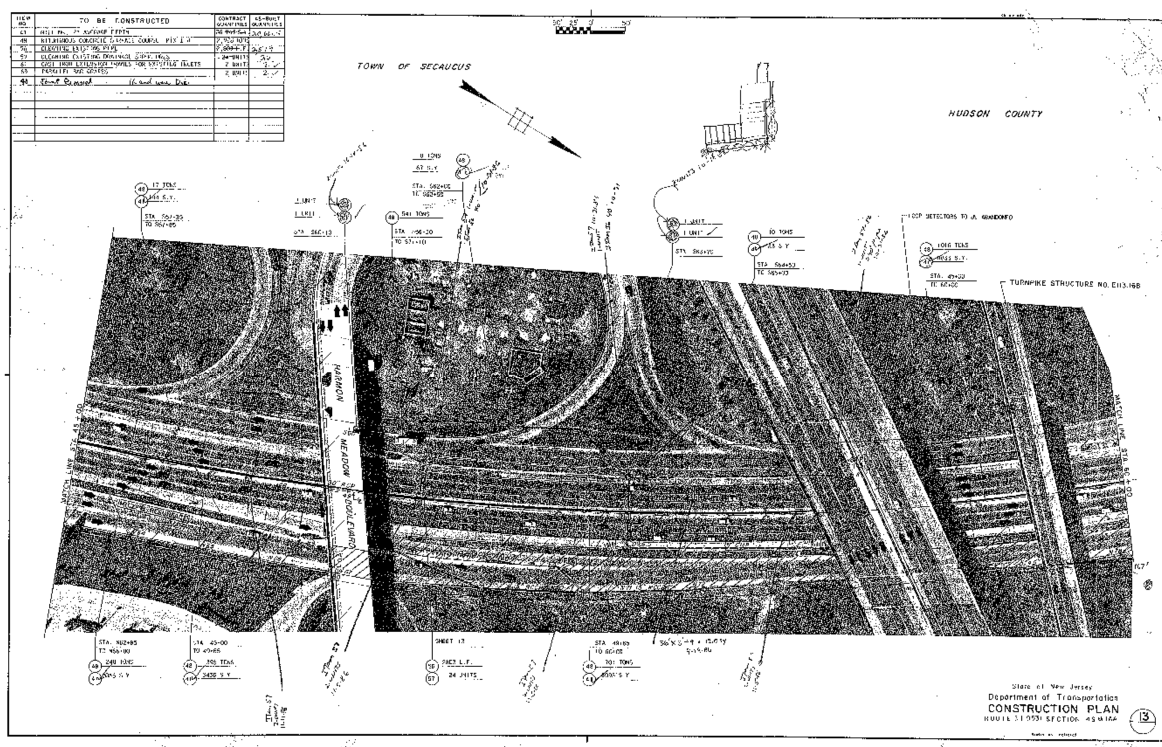
APPENDIX III: PRELIMINARY CONSTRUCTION PLANS AND SECTIONS





APPENDIX IV: AS-BUILT MAPPING OF THE SITE



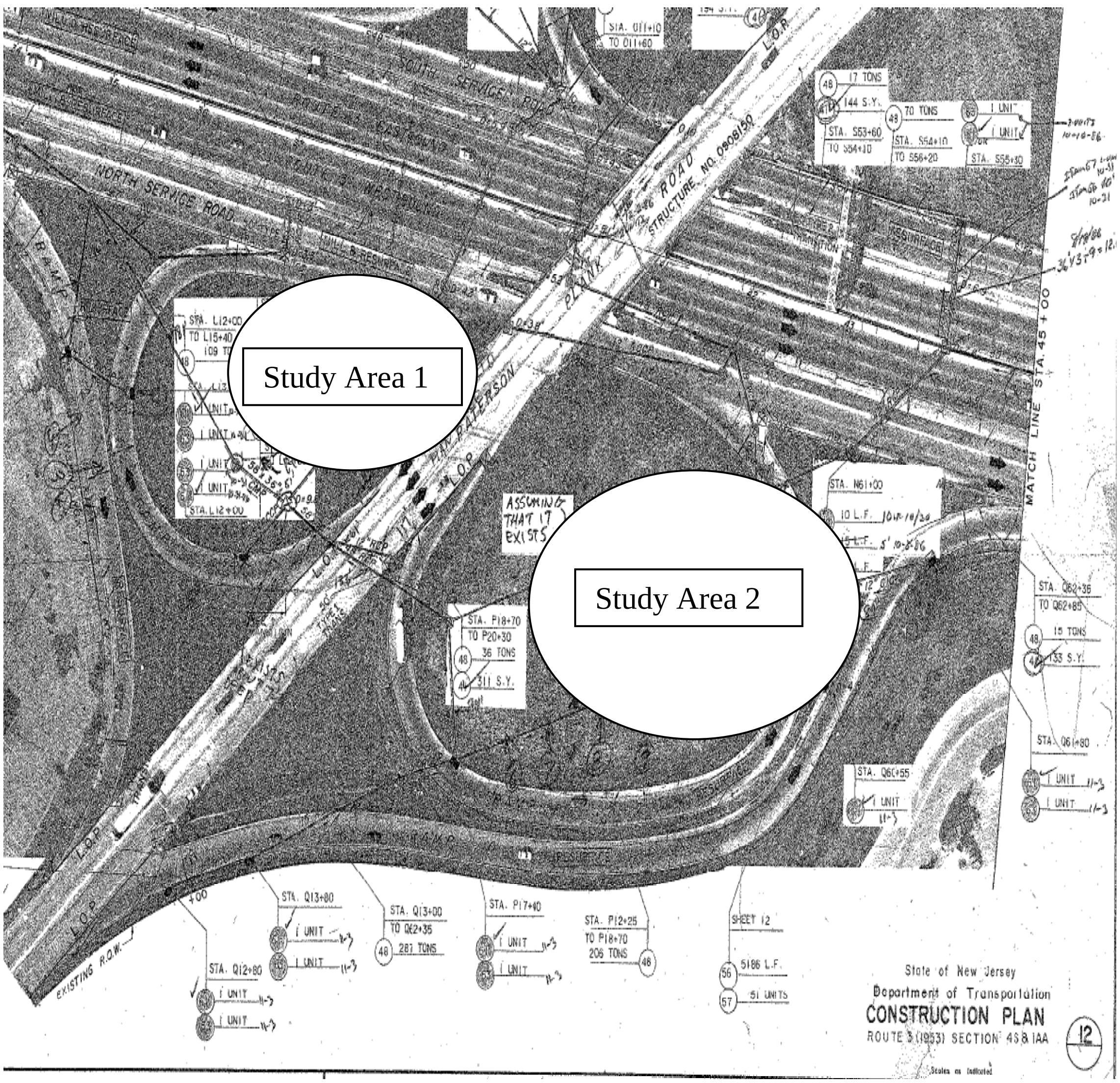


APPENDIX V: ENVIRONMENTAL SCREENING

Evaluation of environmental constraints which may impact feasibility of constructing a retrofit stormwater mitigation site for treatment of existing untreated runoff from NJDOT highways within the Hackensack HUC 11 Watershed has been carried out, as described below.

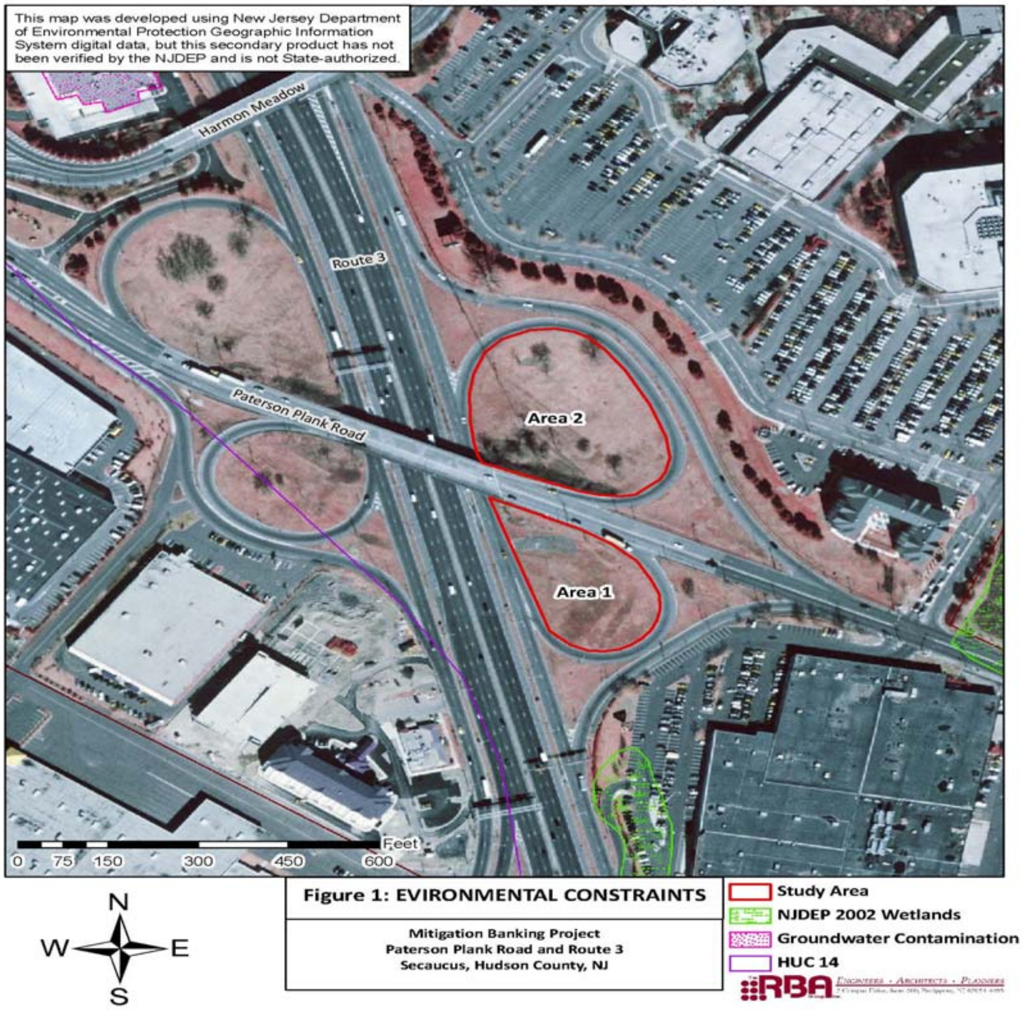
Environmental Screening

The Study Areas comprised of two infield areas of the Route 3/ Patterson Plank Road interchange are located in Secaucus Township in Hudson County, near the boundary of North Bergen Township. Area 1 is the recommended location for construction of the mitigation bank. Area 2 was also evaluated for environmental constraints since drainage system modifications could be required at this location.



An initial GIS mapping analysis was conducted to determine potential site constraints and generate a preliminary idea of site conditions to be expected. All information gathered through GIS should be verified in the field before making any final determinations, as information and site conditions do change over time.

NJDEP's iMap was initially utilized to gather GIS information (Figure 1 – Environmental Constraints). According to iMap the Study Areas are located within the "SE Weehawken NJ-NY" USGS Quadrangle. The Areas are surrounded by commercial development and additional roadways. Mapping shows freshwater wetlands 200 feet south and 500 feet east of the Study



Areas, however, these areas are now paved surfaces. The Areas are within the Hackensack Watershed and there are no C1 waterways in the HUC 14. There are no NHP sites or Critical Environmental or Historical Sites near the Areas. There is a groundwater contamination site north of the Study Areas at 1 Gateway Plaza (KSL ID NJL800316010) that has been under remediation since 1998. There are no other forms of ground or water pollution noted in the area.

The New Jersey Meadowlands Commission also has a GIS mapping program available through the Meadowlands Environmental Research Institute. According to this mapping program the Study Areas are located within the boundary of the Meadowlands, but are not within a floodplain. Mapping also showed a "Riparian Claim" traversing the study areas. It does not appear to be associated with an existing waterway. Further study of the Tidelands Conveyance (Map 707-2166) would be required to determine the relevancy of this information.

Geology iMap shows that the Study Areas are underlain by Lockatong Formation Arkosic Sandstone facies. The lithology of this bedrock type is coarse to fine-grained arkosic sandstone. Mapping lists the soil type within the Study Area as salt-marsh and estuarine deposits that contain abundant organic matter with clay, pebbles and gravel ranging from 100 to 300 feet thick. Aerial photographs indicate that the area has been highly disturbed by roadways and commercial development.

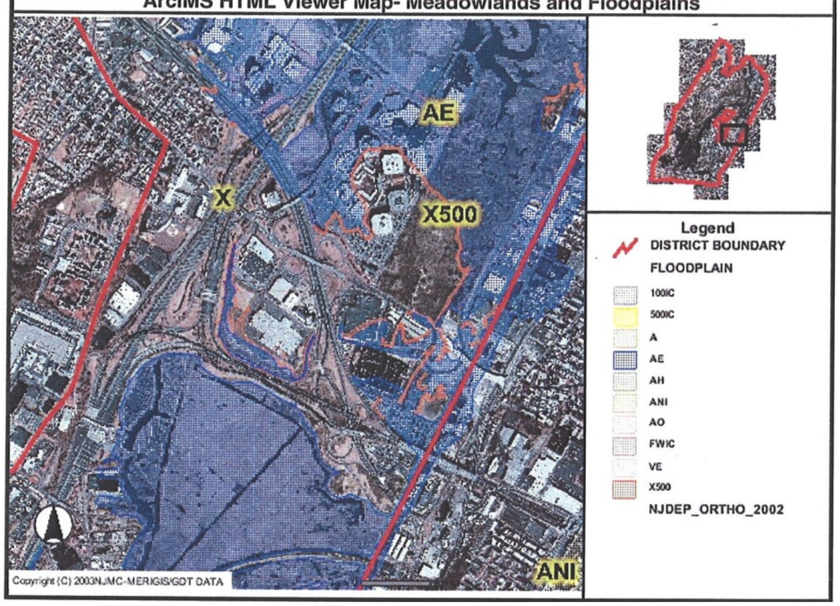
Field Investigation

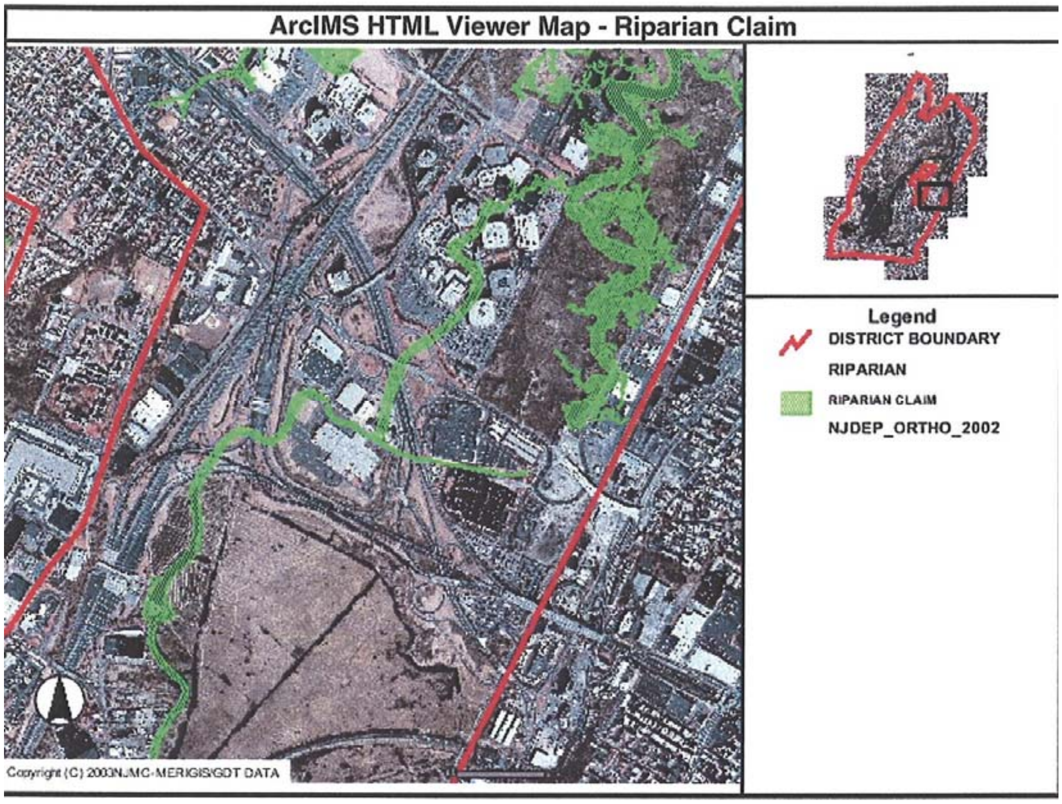
A field investigation of the Study Areas was conducted on July 14th, 2009. Soils samples were taken throughout both Study Areas. On average, the first 10 inches were 10YR 4/4 silty loams. The soils below this depth appeared to be compacted fill. Both Areas are upland field communities dotted with occasional trees and are mostly level. There was no standing water or evidence of hydrology in either area. Photos and a vegetation survey were also conducted. Most species occurred in both Study areas. The indicator status of the species found is either FAC or FACU. Study Area 1 has two small paved areas, 2 storm grates, and 11 manholes labeled Bell Atlantic. Plans from the Department of Transportation show that the Areas are underlain by utility lines, as well as above ground utility lines.

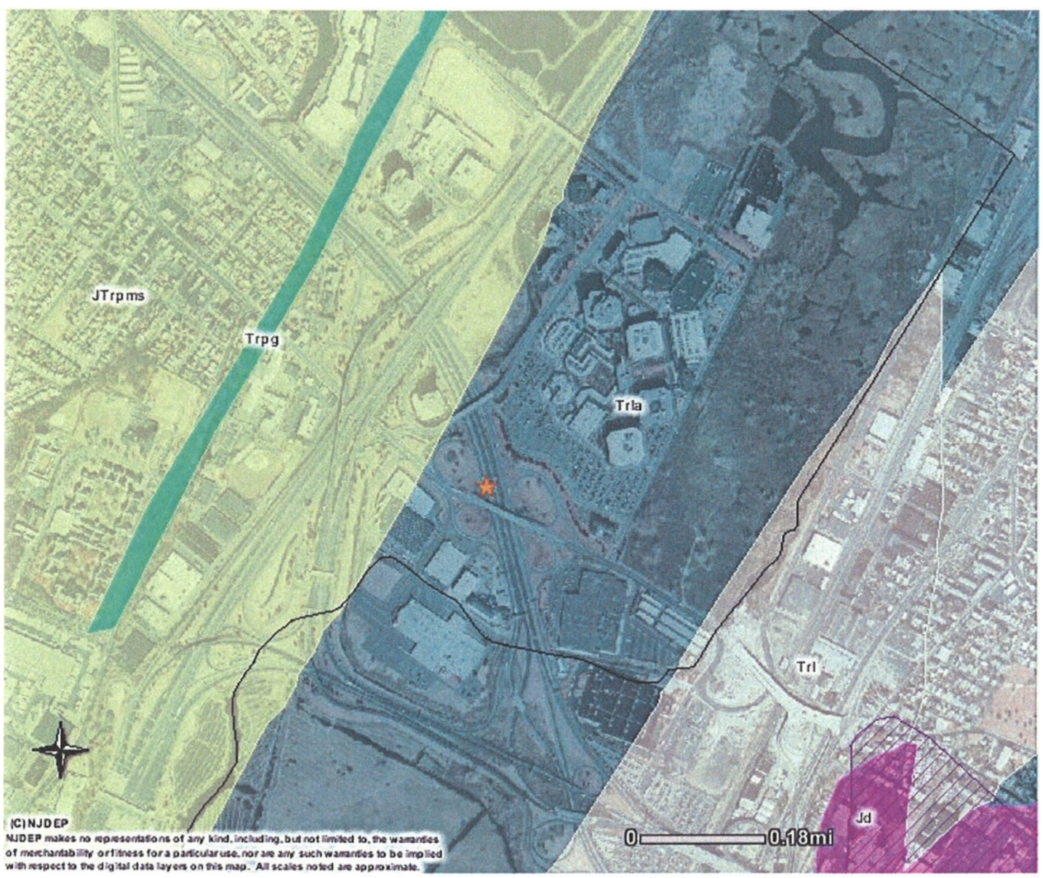
Conclusion

Based on the screening conducted of the Study Area, no environmental constraints were identified which would impede construction of a retrofit stormwater mitigation site. Neither area appears to embody the characteristics of a wetland. While the Areas are within the Meadowlands, there do not appear to be any sensitive or critical habitats in the area, or sightings of any threatened or endangered species. A response letter from the Natural Heritage Program would be required to confirm this finding. There are no listings for contaminated soils or waters. Further investigation should be done regarding the potential need for conveyance of riparian property.

ArcIMS HTML Viewer Map- Meadowlands and Floodplains




ArcIMS HTML Viewer Map - Riparian Claim
Legend
DISTRICT BOUNDARY
RIPARIAN
RIPARIAN CLAIM
NJDEP_ORTHO_2002
Copyright (C) 2003NJMC-MERIGIS/GDT DATA


JTrpms
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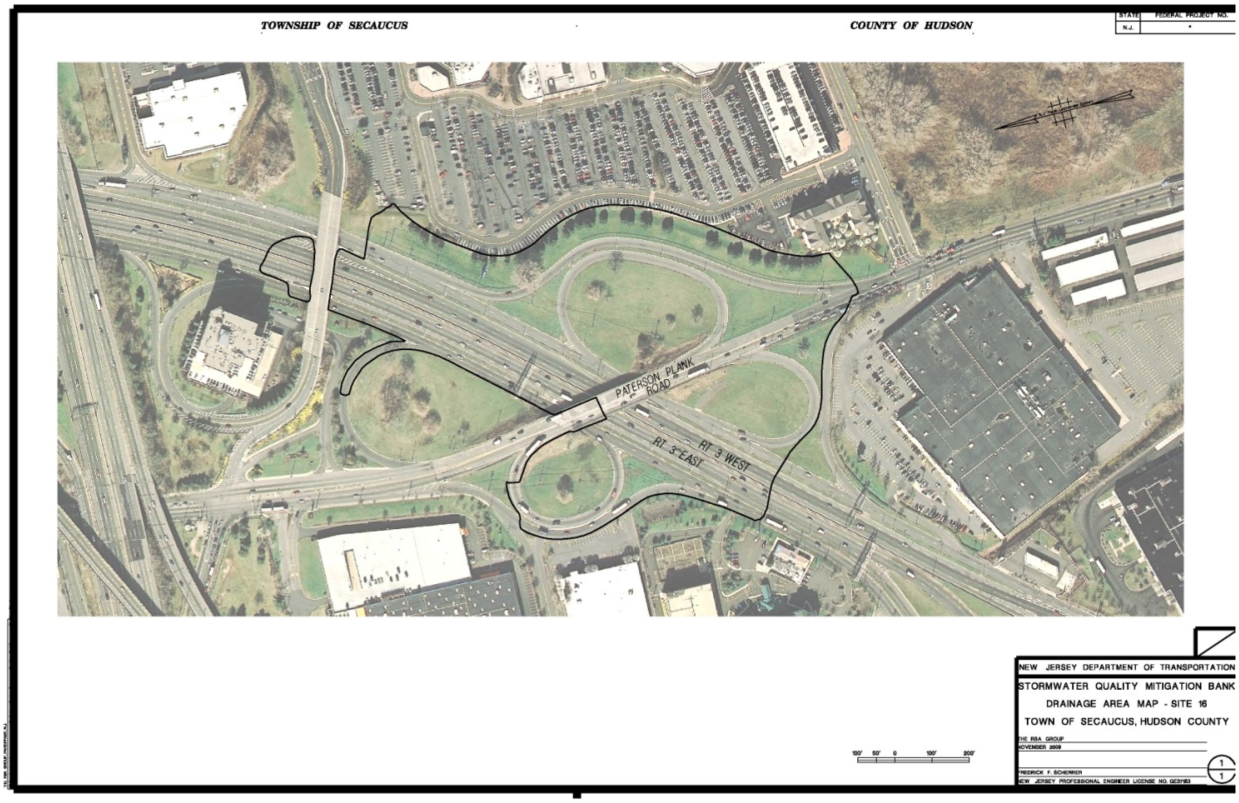
(C) NJDEP
NJDEP makes no representations of any kind, including, but not limited to, the warranties of merchantability or fitness for a particular use, nor are any such warranties to be implied with respect to the digital data layers on this map. All scales noted are approximate.

Species List

Common Name	**Latin Name**	**Indicator Status**
Herbs		
Aster	*Aster spp.*	N/A
Bladder campion	*Silene latifolia*	UPL
Canada thistle	*Cirsium arvense*	FACU
Carolina horsenettle	*Solanum carolinense*	UPL
Common milkweed	*Asclepia syriaca*	UPL
Common plantain	*Plantago major*	FACU
Common wormwood	*Artemisia vulgaris*	FACU
Crown vetch	*Securigera varia*	UPL
Dandelion	*Taraxacum officinale*	FACU-
Fleabane	*Erigeron spp.*	N/A
Goldenrod	*Solidago spp.*	N/A
Japanese knotweed	*Polyganum cuspidatum*	FACU-
Morning Glory	*Ipomoea spp.*	N/A
Oxeye daisy	*Leucanthemum vulgare*	FACU
Purple clover	*Trifolium pratense*	FACU
Queen Anne's lace	*Daucus pusillus*	FACU
Ragwort	*Senecio spp.*	N/A
Smooth sumac	*Rhus glabra*	FAC
Trees		
Tree of Heaven	*Ailanthus altissima*	FAC
Mulberry	*Morus alba*	FAC

APPENDIX VI: DRAINAGE AREA MAP



APPENDIX VII: SOIL LOGS

The RBA Group
Engineers Architects Planners
7 Campus Drive, Suite 300, Parsippany, NJ 07054-4495 (973) 946-5600 FAX (973) 984-5421

SOIL LOG

TEST PIT No.:	1	DATE:	September 2, 2009
M.P. No.:	10.04	SLOPE:	2%
LOCATION:	NJDOT ROW	SOIL SERIES FROM NRCS MAPPING:	Not Avialable
CLIENT:	NJDOT	EXCAVATOR:	Northwest Property Maintenance
MUNICIPALITY:	Township of Secaucus	RBA REP(S):	Michael Thomas, William Garro III
COUNTY:	Hudson	AGENCY REP(S):	NJDOT Traffic Safety
STATE:	New Jersey	RBA JOB No.:	J3998.00

HORIZON	FIRST HORIZON	SECOND HORIZON	THIRD HORIZON	FOURTH HORIZON	FIFTH HORIZON	SIXTH HORIZON
DEPTH (INCHES)	0 TO 12	12 TO 24	24 TO 77	77 TO 115		
COLOR	TOPSOIL	5 YR 3/4 DK. RED. BR.	5 YR 5/4 RED. BR.	7.5 YR 6/1 GRAY		
USDA TEXTURE	-	Sandy Clay Loam	Sandy Loam	Sand		
PERCENTAGE COURSE	<5% GR.	20% GR. 15% COB. 5% ST.	30% GR. 25% COB. 10% ST. (GARBAGE)	50% GR. 10% COB. 2% ST.		
STRUCTURE	-	Subangular Blocky	Subangular Blocky	Subangular Blocky		
CONSISTENCE	Moist-Loose	Moist-Friable	Moist-Friable	Moist-Friable		
LIMITING FACTORS	-	-	-	Mottling: many, very course, prominent		
GROUNDWATER OBSERVATIONS	91.5" after 6 Hours					

The RBA Group
Engineers Architects Planners
7 Campus Drive, Suite 300, Parsippany, NJ 07054-4495 (973) 946-5600 FAX (973) 984-5421

SOIL LOG

TEST PIT No.:	4	DATE:	September 2, 2009
M.P. No.:	10.04	SLOPE:	2%
LOCATION:	NJDOT ROW	SOIL SERIES FROM NRCS MAPPING:	Not Avialable
CLIENT:	NJDOT	EXCAVATOR:	Northwest Property Maintenance
MUNICIPALITY:	Township of Secaucus	RBA REP(S):	Michael Thomas, William Garro III
COUNTY:	Hudson	AGENCY REP(S):	NJDOT Traffic Safety
STATE:	New Jersey	RBA JOB No.:	J3998.00

HORIZON	FIRST HORIZON	SECOND HORIZON	THIRD HORIZON	FOURTH HORIZON	FIFTH HORIZON	SIXTH HORIZON
DEPTH (INCHES)	0 TO 15	15 TO 29	29 TO 45			
COLOR	TOPSOIL	-	-			
USDA TEXTURE	-	-	-			
PERCENTAGE COURSE	<5% GR.	-	-			
STRUCTURE	-	(GARBAGE)	(GARBAGE & SOME SAND)			
CONSISTENCE	Moist-Loose	-	-			
LIMITING FACTORS	-	-	(TEST PIT ABANDONED)	-		
GROUNDWATER OBSERVATIONS	36" after 0.5 Hours					

The RBA Group

Engineers Architects Planners

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SOIL LOG

TEST PIT No.:	2	DATE:	September 2, 2009
M.P. No.:	10.04	SLOPE:	2%
LOCATION:	NJDOT ROW	SOIL SERIES FROM NRCS MAPPING:	Not Avialable
CLIENT:	NJDOT	EXCAVATOR:	Northwest Property Maintenance
MUNICIPALITY:	Township of Secaucus	RBA REP(S):	Michael Thomas, William Garro III
COUNTY:	Hudson	AGENCY REP(S):	NJDOT Traffic Safety
STATE:	New Jersey	RBA JOB No.:	J3998.00

HORIZON	FIRST HORIZON	SECOND HORIZON	THIRD HORIZON	FOURTH HORIZON	FIFTH HORIZON	SIXTH HORIZON
DEPTH (INCHES)	0 TO 9	9 TO 13	13 TO 70	70 TO 82		
COLOR	TOPSOIL	5 YR 5/4 RED. BR.	7.5 YR 7/4 PINK	10 YR 2/2 DK. BR.		
USDA TEXTURE	-	Loamy Sand	Loamy Sand	Sandy Loam		
PERCENTAGE COURSE	<5% GR.	10% GR. 5% COB.	<5% GR. (FILL MATERIAL)	30% GR. 10% COB. 2% ST. (GARBAGE)		
STRUCTURE	-	Single Grain	Single Grain	Subangular Blocky		
CONSISTENCE	Moist-Loose	Dry-Loose	Moist-Loose	Moist-Loose		
LIMITING FACTORS	-	-	Mottling: many, medium, prominent, 63" to 80"	-		
GROUNDWATER OBSERVATIONS	63" after 2 Hours					

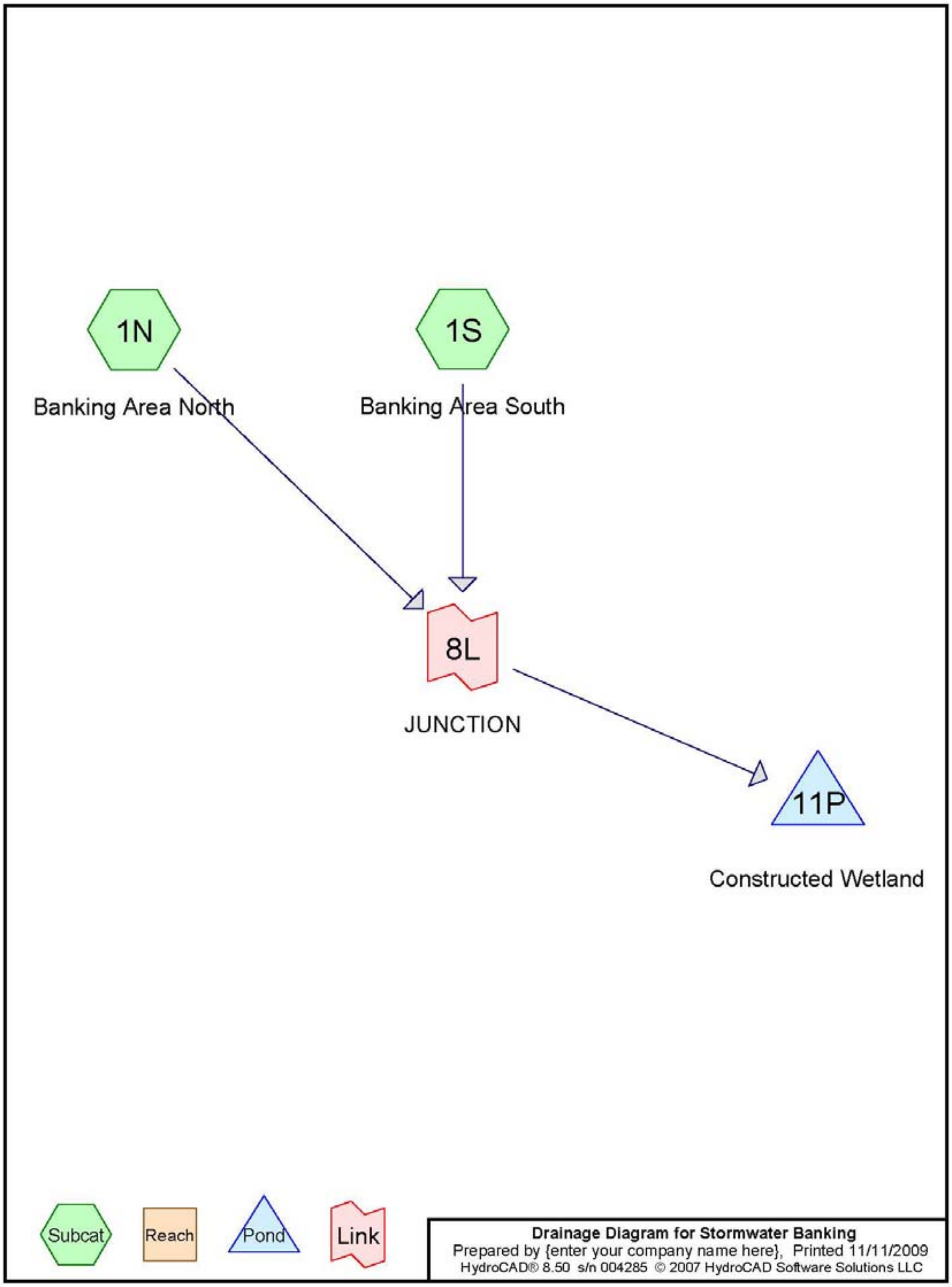
The RBA Group
Engineers Architects Planners
7 Campus Drive, Suite 300, Parsippany, NJ 07054-4495 (973) 946-5600 FAX (973) 984-5421

SOIL LOG

TEST PIT No.:	3	DATE:	September 2, 2009
M.P. No.:	10.04	SLOPE:	2%
LOCATION:	NJDOT ROW	SOIL SERIES FROM NRCS MAPPING:	Not Avialable
CLIENT:	NJDOT	EXCAVATOR:	Northwest Property Maintenance
MUNICIPALITY:	Township of Secaucus	RBA REP(S):	Michael Thomas, William Garro III
COUNTY:	Hudson	AGENCY REP(S):	NJDOT Traffic Safety
STATE:	New Jersey	RBA JOB No.:	J3998.00

HORIZON	FIRST HORIZON	SECOND HORIZON	THIRD HORIZON	FOURTH HORIZON	FIFTH HORIZON	SIXTH HORIZON
DEPTH (INCHES)	0 TO 7	7 TO 26	26 TO 94	94 TO 102		
COLOR	TOPSOIL	5 YR 5/4 RED. BR.	7.5 YR 7/2 PINK GRAY	7.5 YR 3/3 DK. BR.		
USDA TEXTURE	-	Sandy Loam	Loamy Sand	Sandy Loam		
PERCENTAGE COURSE	<5% GR.	25% GR. 10% COB. 5% ST.	<5% GR. (FILL MATERIAL)	20% GR. 25% COB. 20% ST.		
STRUCTURE	-	Subangular Blocky	Single Grain	Subangular Blocky		
CONSISTENCE	Moist-Loose	Moist-Friable	Moist-Loose	Moist-Friable		
LIMITING FACTORS	-	-	-	-		
GROUNDWATER OBSERVATIONS	87" after 1 Hour					

APPENDIX VIII: HYDROLOGIC CALCULATIONS



Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
395,612	80	>75% Grass cover, Good, HSG D (1N,1S)
282,835	98	Paved parking & roofs (1N,1S)

Summary for Subcatchment 1N: Banking Area North

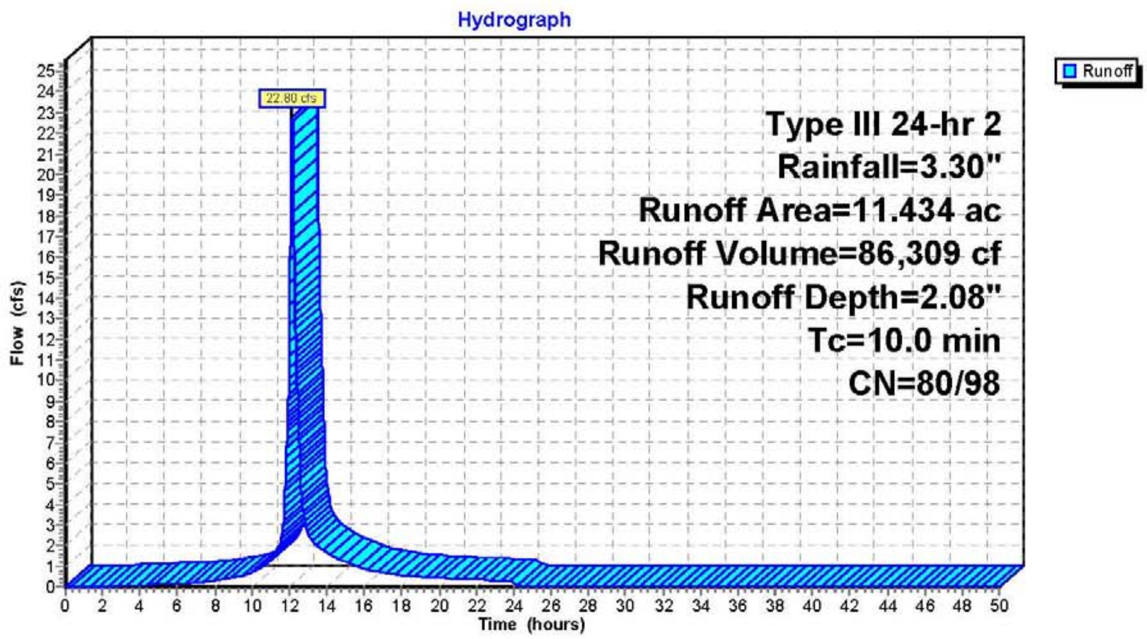
Runoff = 22.80 cfs @ 12.14 hrs, Volume= 86,309 cf, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Rainfall=3.30"

Area (ac)	CN	Description
7.112	80	>75% Grass cover, Good, HSG D
4.322	98	Paved parking & roofs
11.434	87	Weighted Average
7.112	80	Pervious Area
4.322	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1N: Banking Area North



Summary for Subcatchment 1S: Banking Area South

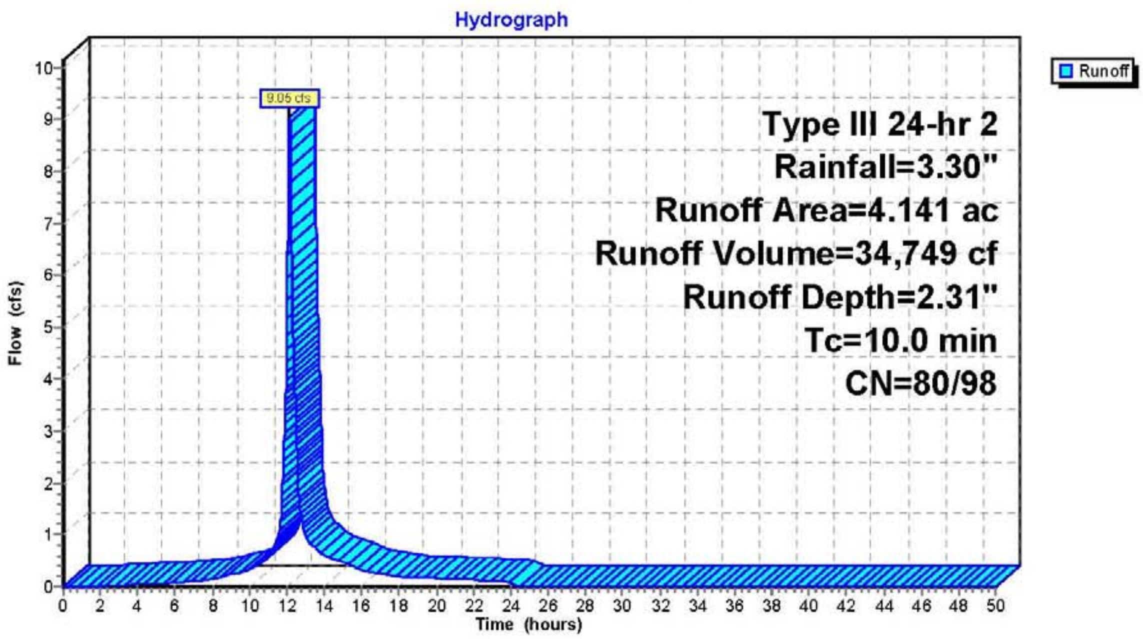
Runoff = 9.05 cfs @ 12.14 hrs, Volume= 34,749 cf, Depth= 2.31"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 Rainfall=3.30"

Area (ac)	CN	Description
1.970	80	>75% Grass cover, Good, HSG D
2.171	98	Paved parking & roofs
4.141	89	Weighted Average
1.970	80	Pervious Area
2.171	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1S: Banking Area South



Summary for Pond 11P: Constructed Wetland

Inflow Area = 678,447 sf, 41.69% Impervious, Inflow Depth = 2.14" for 2 event
Inflow = 31.85 cfs @ 12.14 hrs, Volume= 121,058 cf
Outflow = 5.84 cfs @ 12.66 hrs, Volume= 118,012 cf, Atten= 82%, Lag= 31.0 min
Primary = 5.84 cfs @ 12.66 hrs, Volume= 118,012 cf

Routing by Stor-Ind method, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 3.13' @ 12.66 hrs Surf.Area= 34,936 sf Storage= 60,990 cf

Plug-Flow detention time= 388.1 min calculated for 117,989 cf (97% of inflow)
Center-of-Mass det. time= 373.0 min (1,166.9 - 793.9)

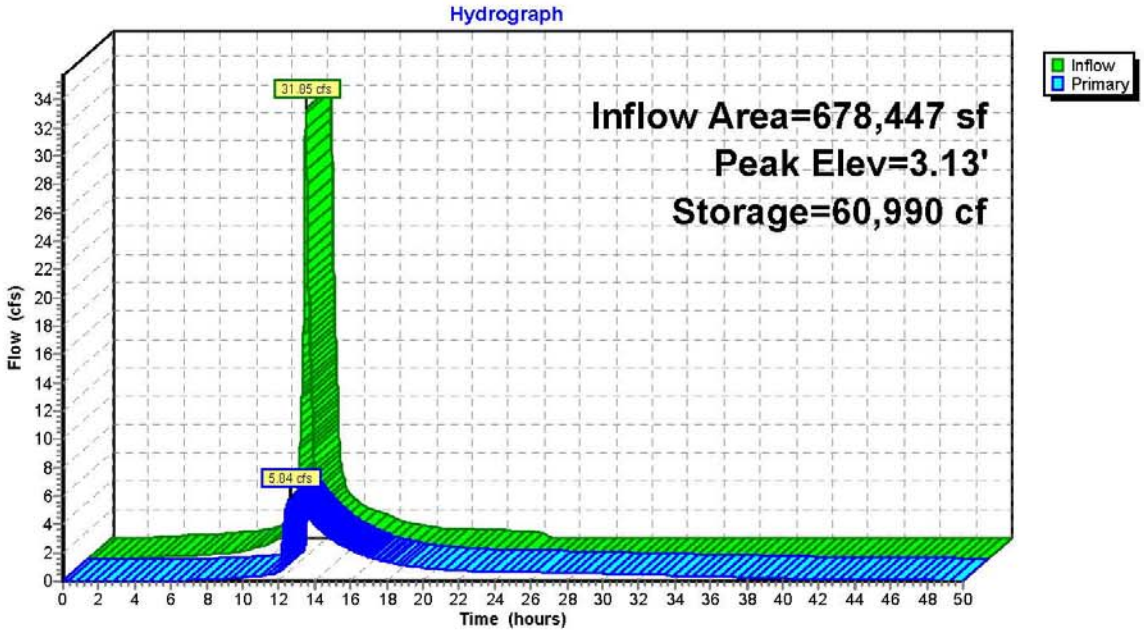
Volume	Invert	Avail.Storage	Storage Description
#1	1.00'	174,965 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1.00	22,572	0	0
2.00	25,387	23,980	23,980
2.10	31,355	2,837	26,817
3.00	34,509	29,639	56,455
4.00	37,776	36,143	92,598
5.00	41,155	39,466	132,063
6.00	44,648	42,902	174,965

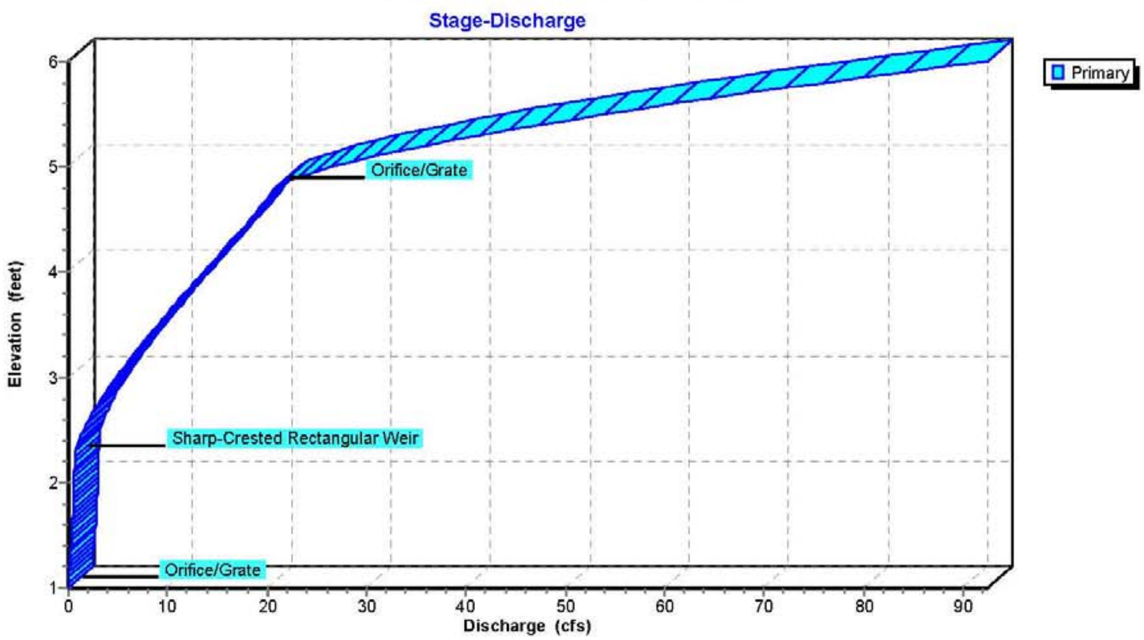
Device	Routing	Invert	Outlet Devices
#1	Primary	1.00'	**5.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.25'	**2.0' long x 2.10' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	4.80'	**4.00' x 3.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=5.84 cfs @ 12.66 hrs HW=3.13' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 0.91 cfs @ 6.68 fps)
├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 4.93 cfs @ 3.07 fps)
└─**3=Orifice/Grate** (Controls 0.00 cfs)

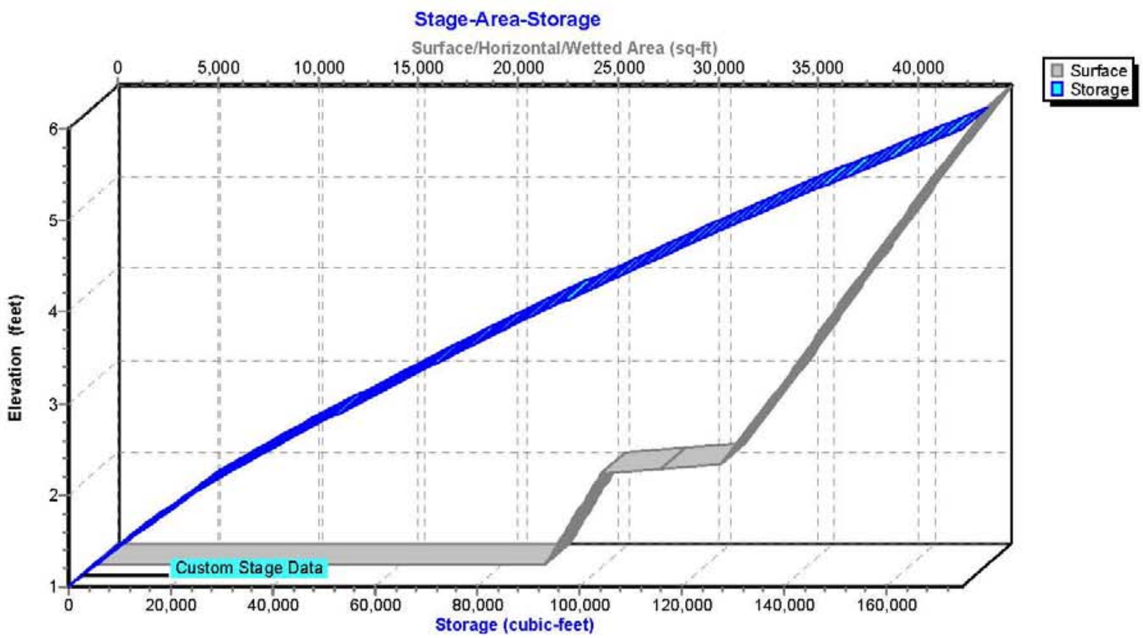
Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland

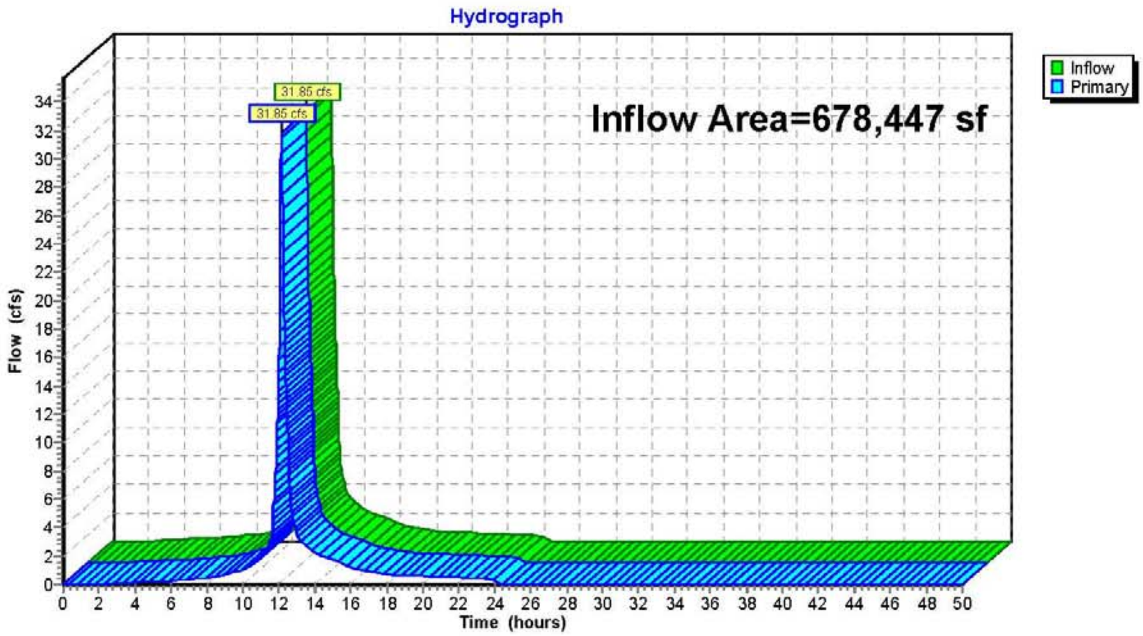


Summary for Link 8L: JUNCTION

Inflow Area =	678,447 sf, 41.69% Impervious,	Inflow Depth = 2.14" for 2 event	
Inflow =	31.85 cfs @ 12.14 hrs,	Volume=	121,058 cf
Primary =	31.85 cfs @ 12.14 hrs,	Volume=	121,058 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs

Link 8L: JUNCTION



Summary for Subcatchment 1N: Banking Area North

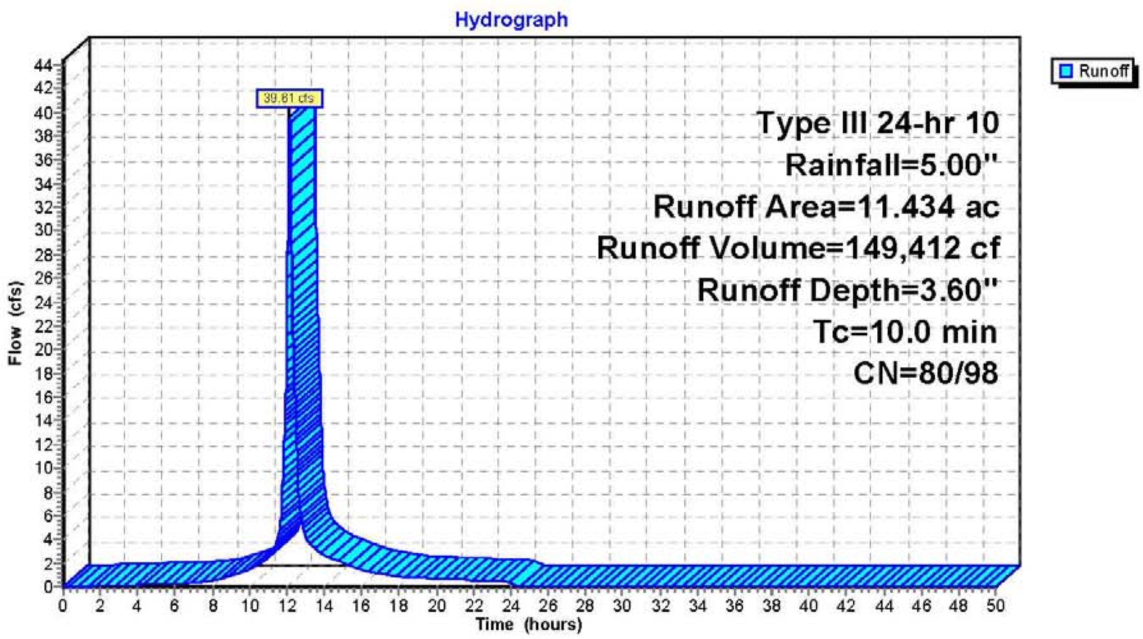
Runoff = 39.61 cfs @ 12.14 hrs, Volume= 149,412 cf, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Rainfall=5.00"

Area (ac)	CN	Description
7.112	80	>75% Grass cover, Good, HSG D
4.322	98	Paved parking & roofs
11.434	87	Weighted Average
7.112	80	Pervious Area
4.322	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1N: Banking Area North



Summary for Subcatchment 1S: Banking Area South

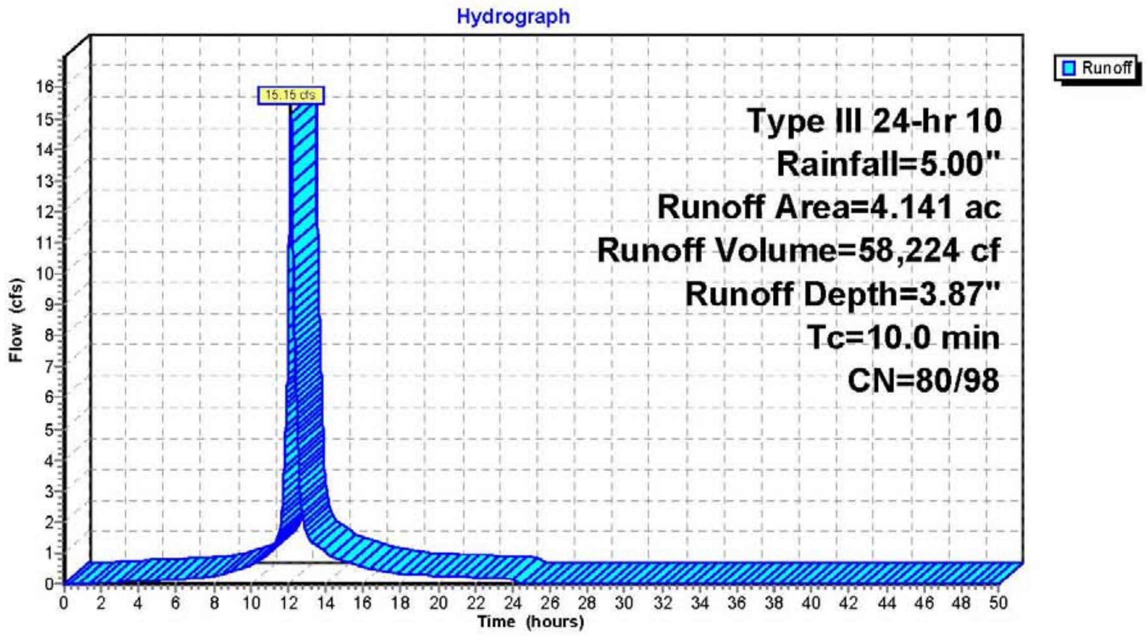
Runoff = 15.15 cfs @ 12.14 hrs, Volume= 58,224 cf, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 Rainfall=5.00"

Area (ac)	CN	Description
1.970	80	>75% Grass cover, Good, HSG D
2.171	98	Paved parking & roofs
4.141	89	Weighted Average
1.970	80	Pervious Area
2.171	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1S: Banking Area South



Summary for Pond 11P: Constructed Wetland

Inflow Area = 678,447 sf, 41.69% Impervious, Inflow Depth = 3.67" for 10 event
Inflow = 54.76 cfs @ 12.14 hrs, Volume= 207,637 cf
Outflow = 14.52 cfs @ 12.55 hrs, Volume= 204,359 cf, Atten= 73%, Lag= 24.8 min
Primary = 14.52 cfs @ 12.55 hrs, Volume= 204,359 cf

Routing by Stor-Ind method, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 4.10' @ 12.55 hrs Surf.Area= 38,110 sf Storage= 96,345 cf

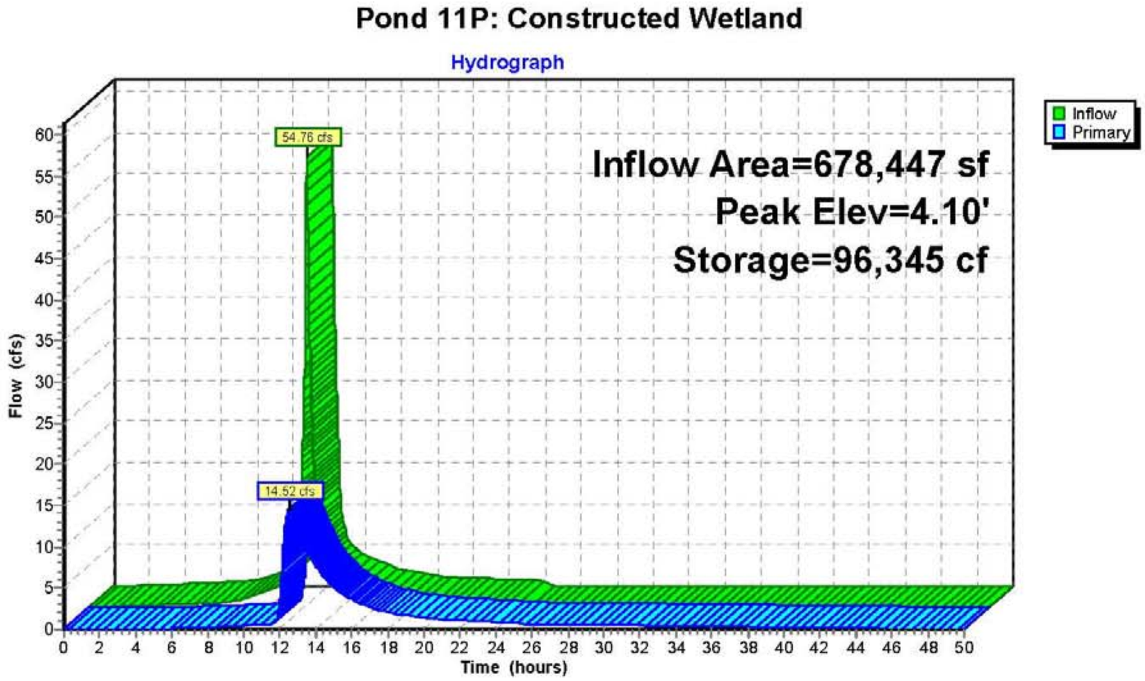
Plug-Flow detention time= 277.2 min calculated for 204,319 cf (98% of inflow)
Center-of-Mass det. time= 267.5 min (1,053.1 - 785.6)

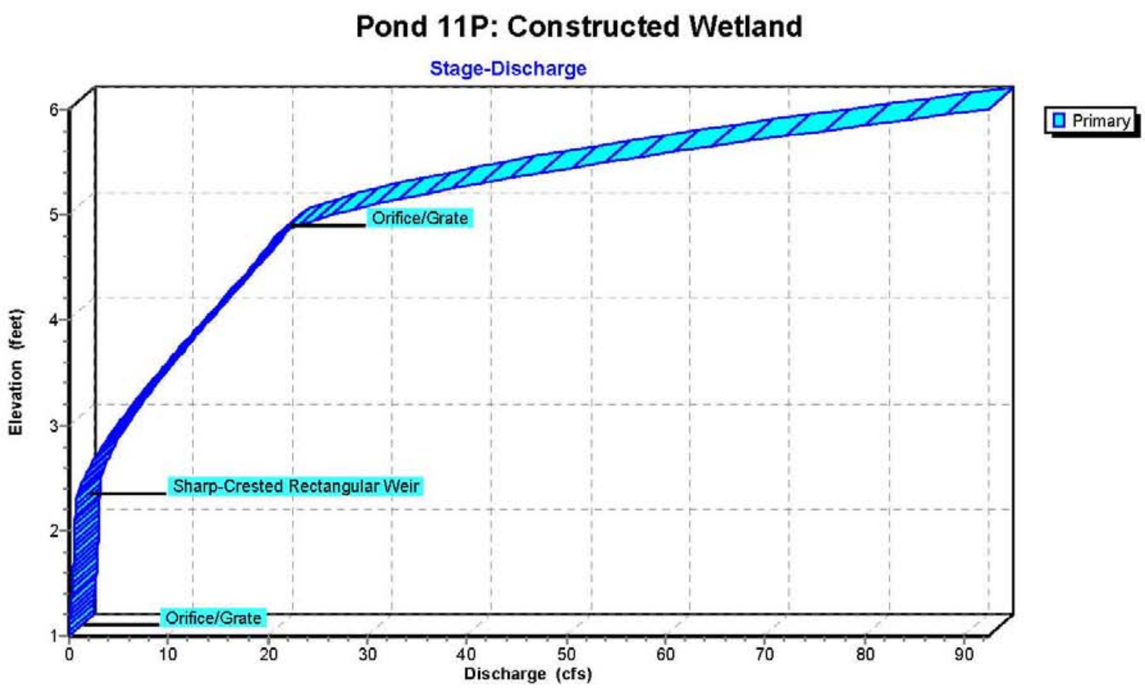
Volume	Invert	Avail.Storage	Storage Description
#1	1.00'	174,965 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1.00	22,572	0	0
2.00	25,387	23,980	23,980
2.10	31,355	2,837	26,817
3.00	34,509	29,639	56,455
4.00	37,776	36,143	92,598
5.00	41,155	39,466	132,063
6.00	44,648	42,902	174,965

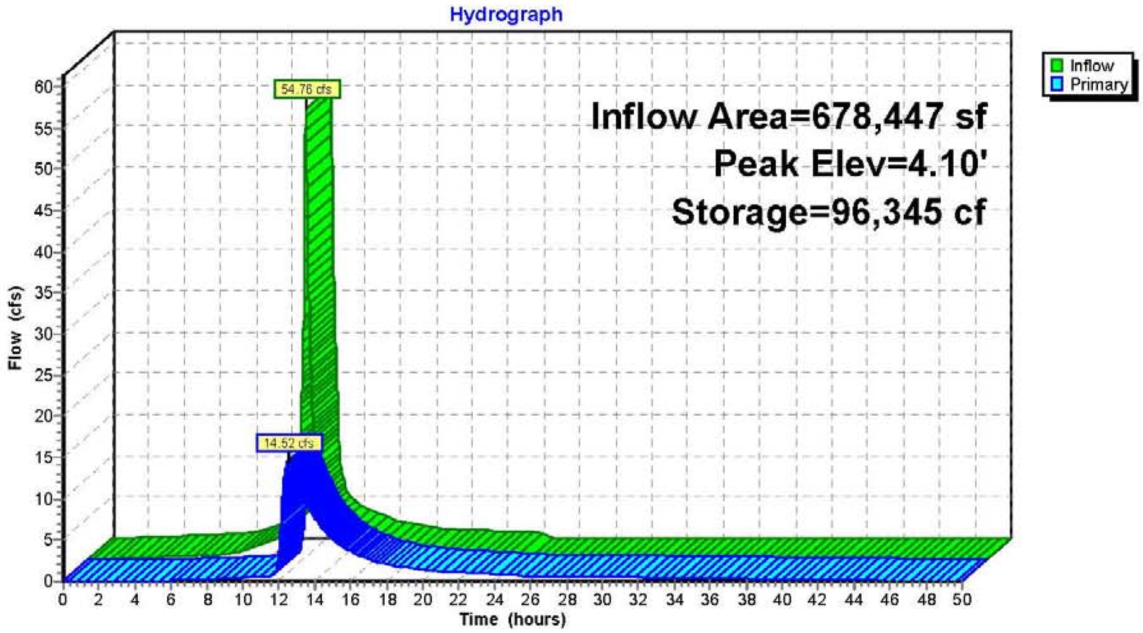
Device	Routing	Invert	Outlet Devices
#1	Primary	1.00'	**5.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.25'	**2.0' long x 2.10' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	4.80'	**4.00' x 3.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=14.52 cfs @ 12.55 hrs HW=4.10' (Free Discharge)
—**1=Orifice/Grate** (Orifice Controls 1.12 cfs @ 8.19 fps)
—**2=Sharp-Crested Rectangular Weir** (Weir Controls 13.40 cfs @ 4.45 fps)
—**3=Orifice/Grate** (Controls 0.00 cfs)

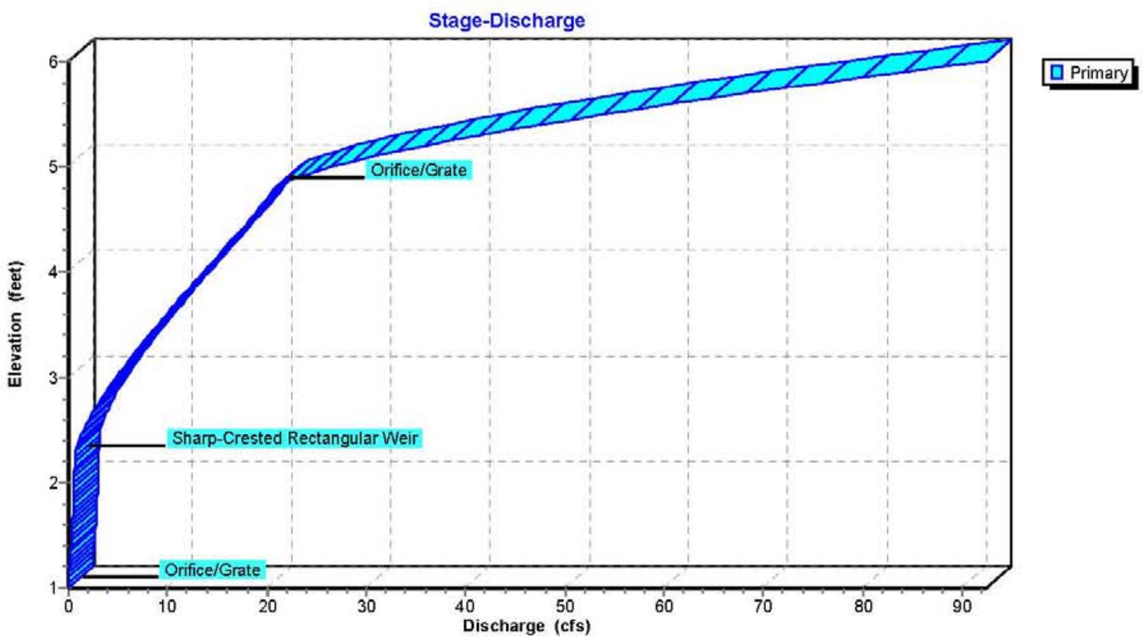

Pond 11P: Constructed Wetland
Hydrograph
Inflow
Primary
54.76 cfs
14.52 cfs
Inflow Area=678,447 sf
Peak Elev=4.10'
Storage=96,345 cf
Flow (cfs)
Time (hours)


Pond 11P: Constructed Wetland
Stage-Discharge
Primary
Orifice/Grate
Sharp-Crested Rectangular Weir
Orifice/Grate
Elevation (feet)
Discharge (cfs)

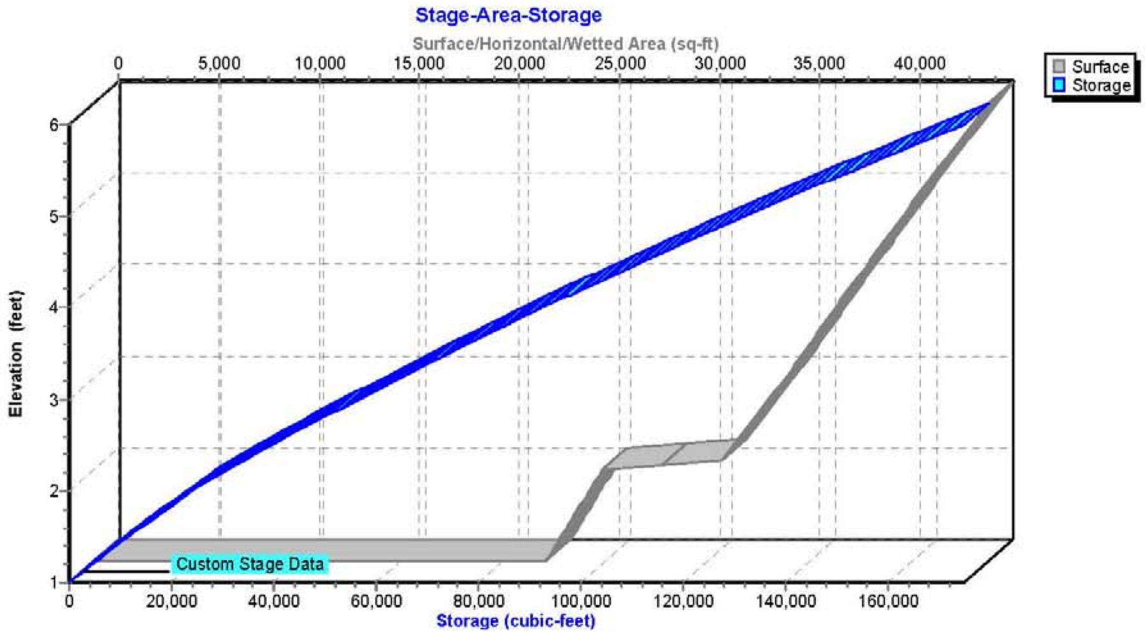
Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland

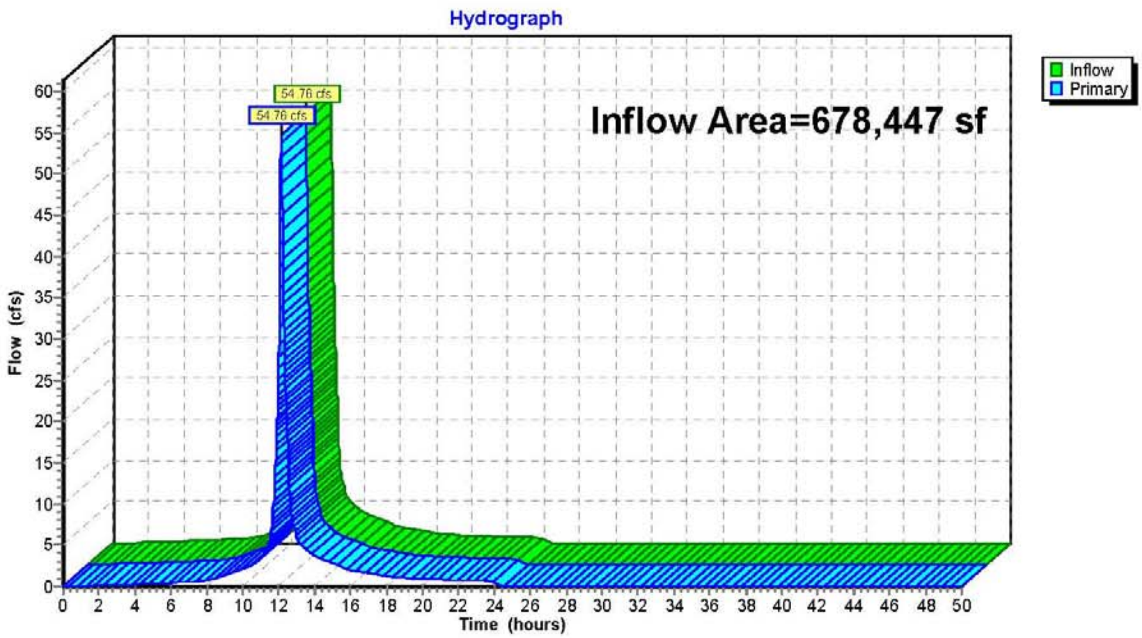


Summary for Link 8L: JUNCTION

Inflow Area =	678,447 sf, 41.69% Impervious, Inflow Depth = 3.67"	for 10 event
Inflow =	54.76 cfs @ 12.14 hrs, Volume=	207,637 cf
Primary =	54.76 cfs @ 12.14 hrs, Volume=	207,637 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs

Link 8L: JUNCTION



Summary for Subcatchment 1N: Banking Area North

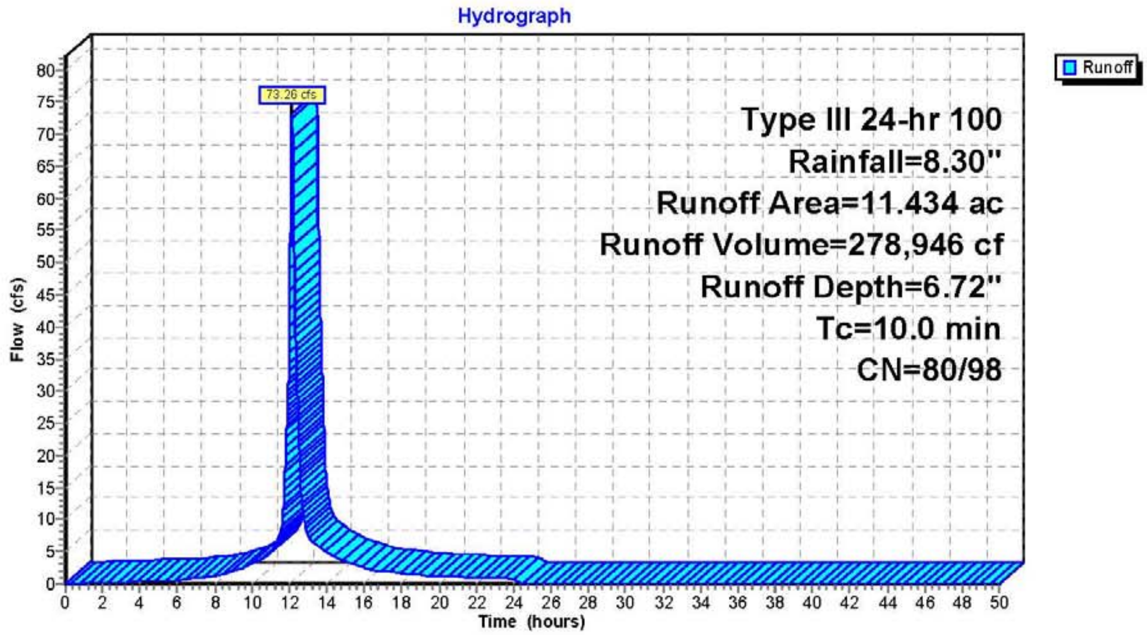
Runoff = 73.26 cfs @ 12.14 hrs, Volume= 278,946 cf, Depth= 6.72"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Rainfall=8.30"

Area (ac)	CN	Description
7.112	80	>75% Grass cover, Good, HSG D
4.322	98	Paved parking & roofs
11.434	87	Weighted Average
7.112	80	Pervious Area
4.322	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1N: Banking Area North



Summary for Subcatchment 1S: Banking Area South

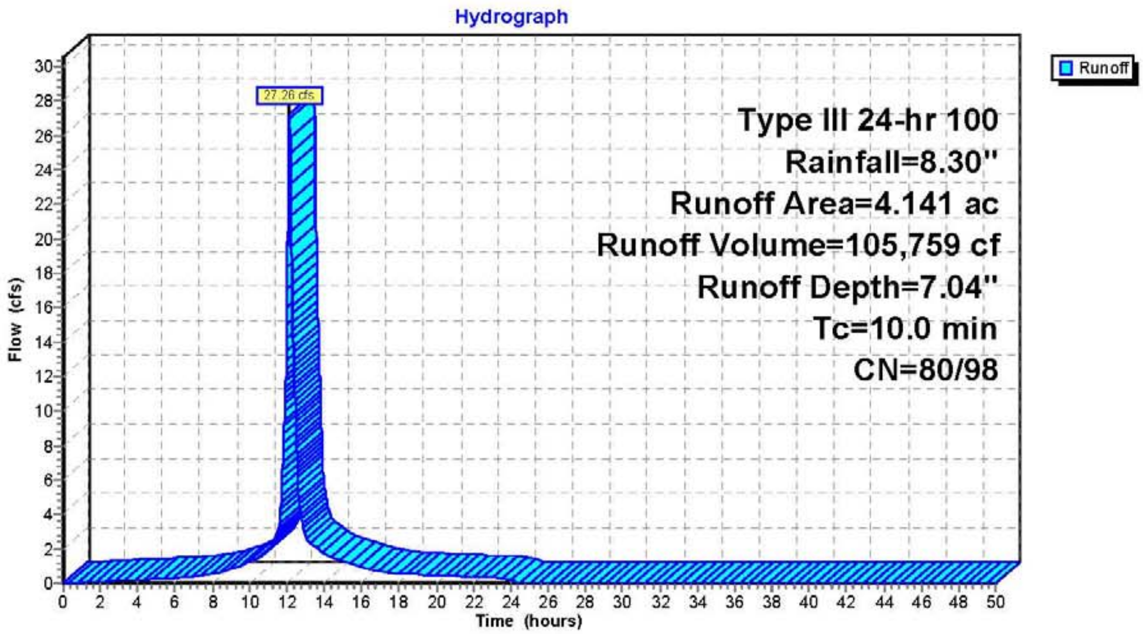
Runoff = 27.26 cfs @ 12.14 hrs, Volume= 105,759 cf, Depth= 7.04"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 Rainfall=8.30"

Area (ac)	CN	Description
1.970	80	>75% Grass cover, Good, HSG D
2.171	98	Paved parking & roofs
4.141	89	Weighted Average
1.970	80	Pervious Area
2.171	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1S: Banking Area South



Summary for Subcatchment 1S: Banking Area South

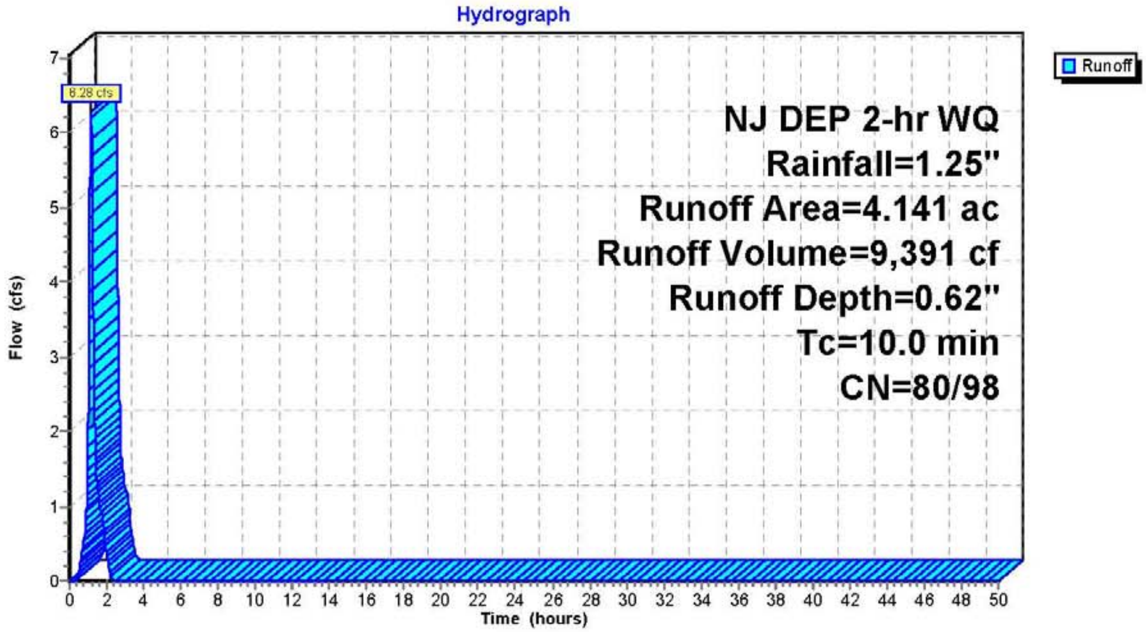
Runoff = 6.28 cfs @ 1.16 hrs, Volume= 9,391 cf, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
NJ DEP 2-hr WQ Rainfall=1.25"

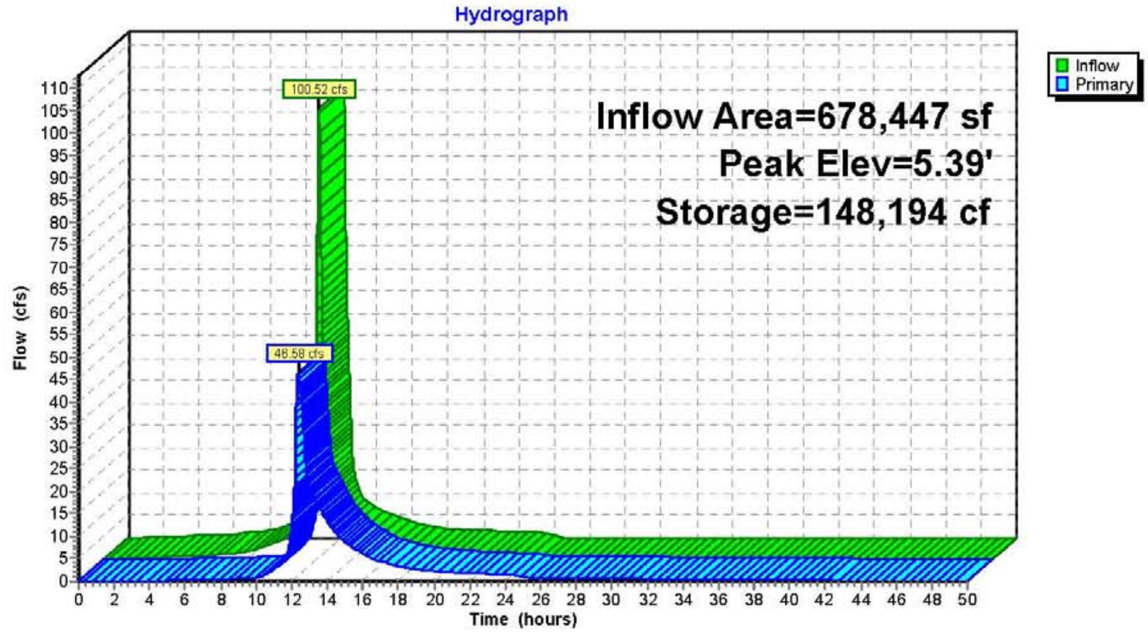
Area (ac)	CN	Description
1.970	80	>75% Grass cover, Good, HSG D
2.171	98	Paved parking & roofs
4.141	89	Weighted Average
1.970	80	Pervious Area
2.171	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

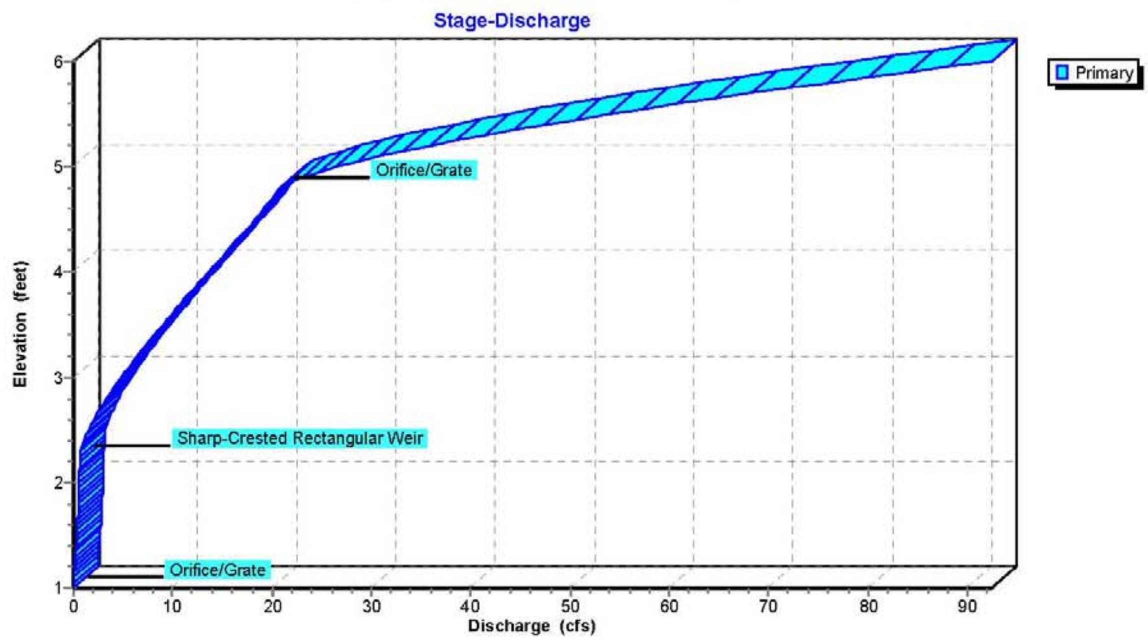
Subcatchment 1S: Banking Area South



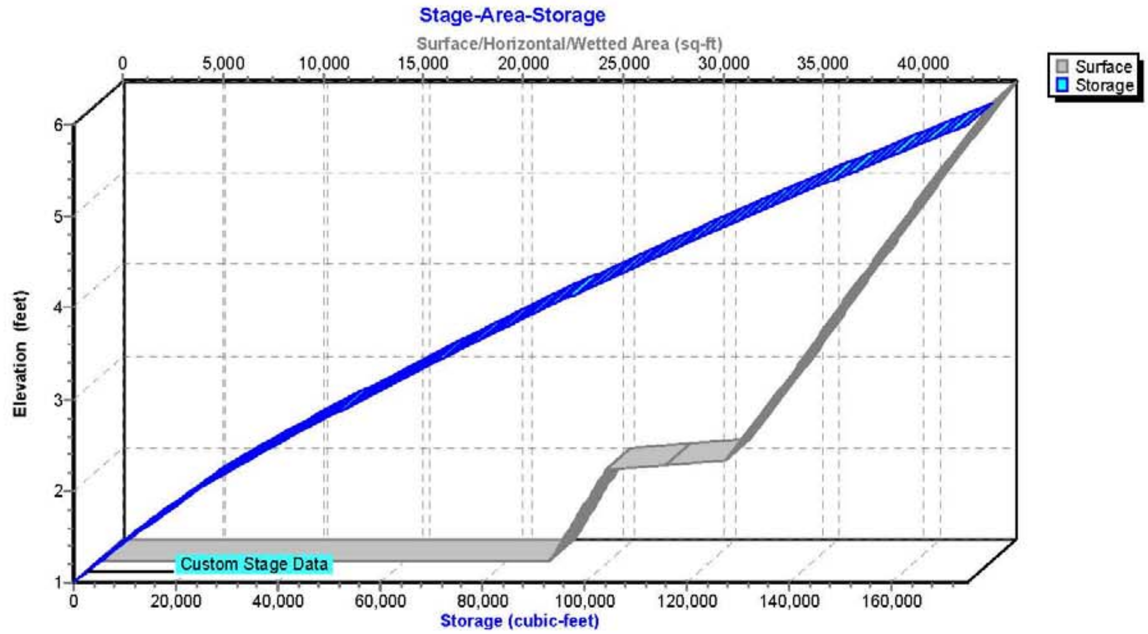
Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland

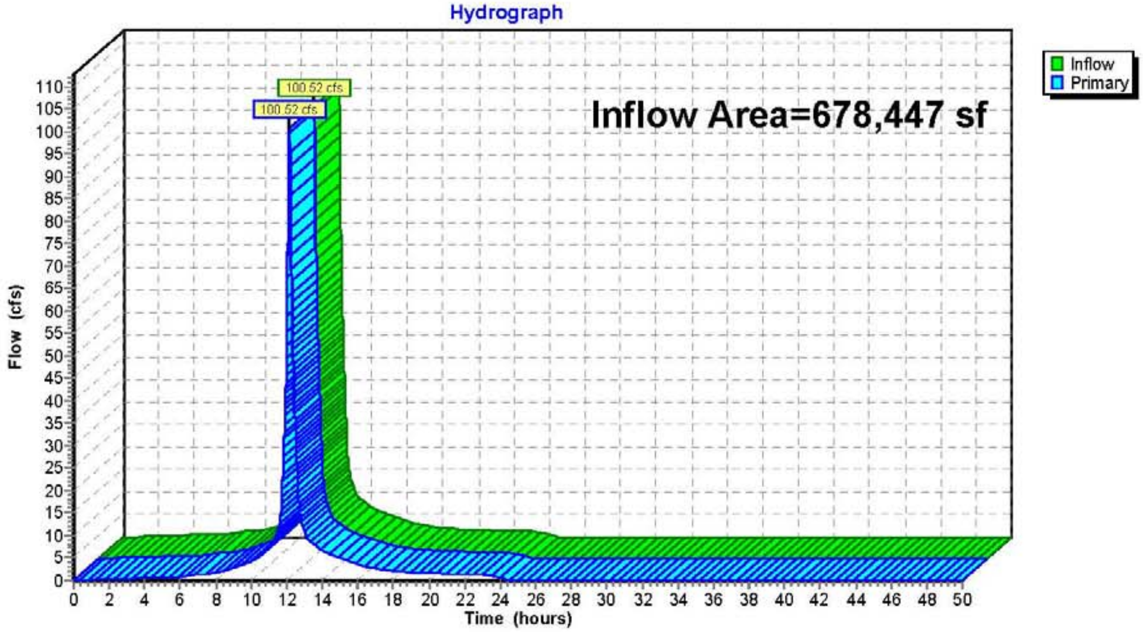


Summary for Link 8L: JUNCTION

Inflow Area = 678,447 sf, 41.69% Impervious, Inflow Depth = 6.80" for 100 event
Inflow = 100.52 cfs @ 12.14 hrs, Volume= 384,705 cf
Primary = 100.52 cfs @ 12.14 hrs, Volume= 384,705 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs

Link 8L: JUNCTION



Summary for Subcatchment 1N: Banking Area North

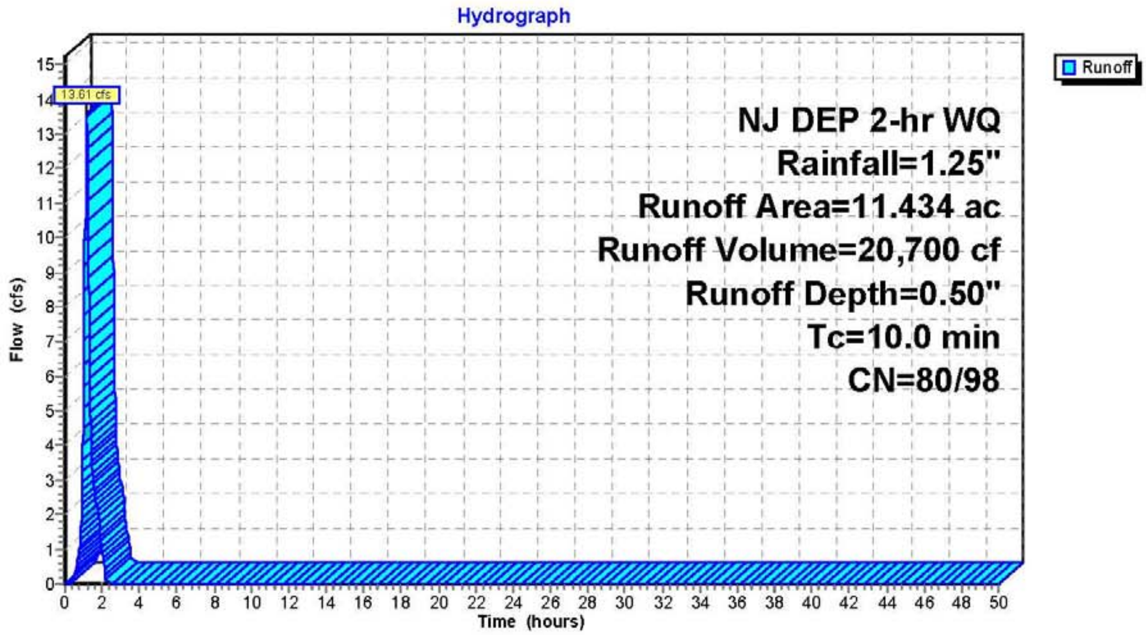
Runoff = 13.61 cfs @ 1.16 hrs, Volume= 20,700 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
7.112	80	>75% Grass cover, Good, HSG D
4.322	98	Paved parking & roofs
11.434	87	Weighted Average
7.112	80	Pervious Area
4.322	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1N: Banking Area North



Summary for Subcatchment 1S: Banking Area South

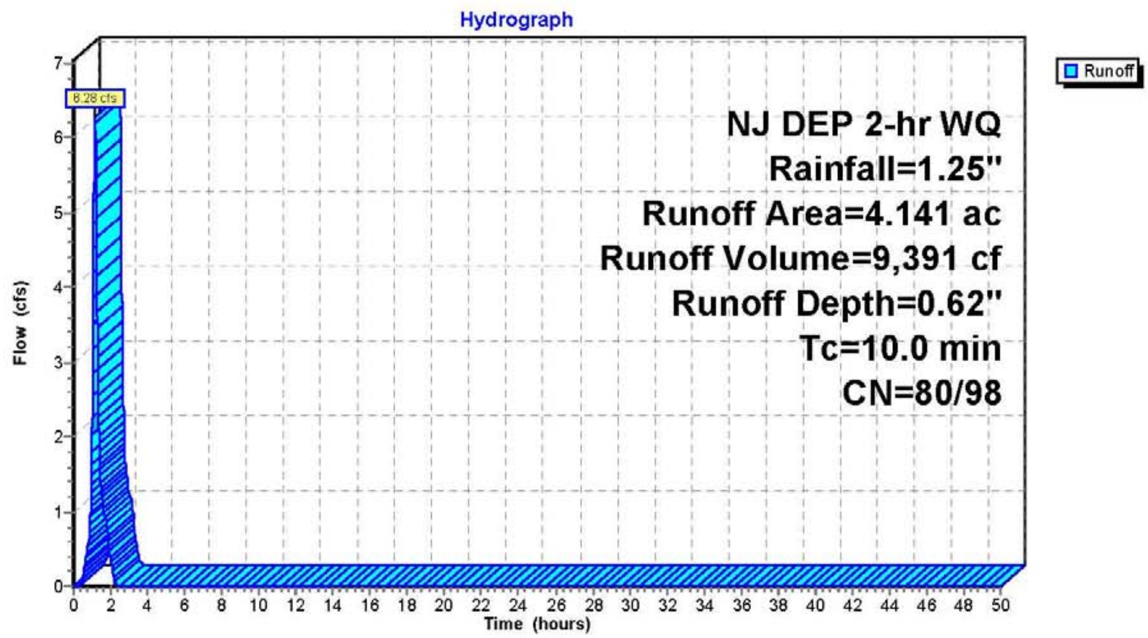
Runoff = 6.28 cfs @ 1.16 hrs, Volume= 9,391 cf, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
NJ DEP 2-hr WQ Rainfall=1.25"

Area (ac)	CN	Description
1.970	80	>75% Grass cover, Good, HSG D
2.171	98	Paved parking & roofs
4.141	89	Weighted Average
1.970	80	Pervious Area
2.171	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 1S: Banking Area South



Summary for Pond 11P: Constructed Wetland

Inflow Area = 678,447 sf, 41.69% Impervious, Inflow Depth = 0.53" for WQ event
Inflow = 19.88 cfs @ 1.16 hrs, Volume= 30,090 cf
Outflow = 0.63 cfs @ 2.13 hrs, Volume= 28,848 cf, Atten= 97%, Lag= 58.0 min
Primary = 0.63 cfs @ 2.13 hrs, Volume= 28,848 cf

Routing by Stor-Ind method, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 2.13' @ 2.13 hrs Surf.Area= 31,465 sf Storage= 27,802 cf

Plug-Flow detention time= 570.4 min calculated for 28,848 cf (96% of inflow)
Center-of-Mass det. time= 568.5 min (644.8 - 76.4)

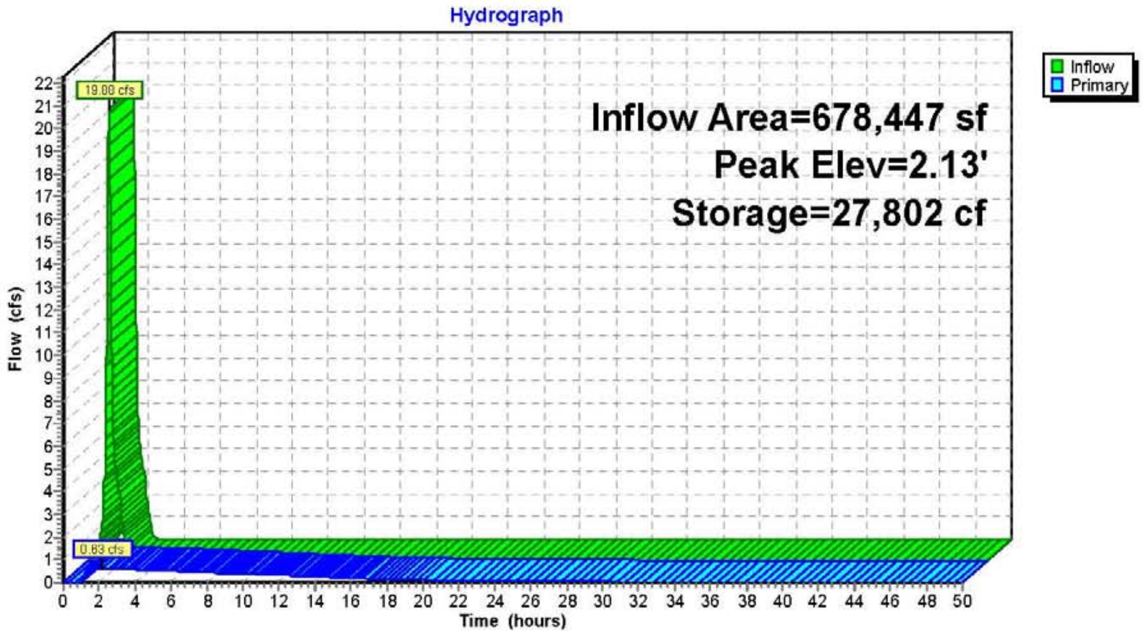
Volume	Invert	Avail.Storage	Storage Description
#1	1.00'	174,965 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1.00	22,572	0	0
2.00	25,387	23,980	23,980
2.10	31,355	2,837	26,817
3.00	34,509	29,639	56,455
4.00	37,776	36,143	92,598
5.00	41,155	39,466	132,063
6.00	44,648	42,902	174,965

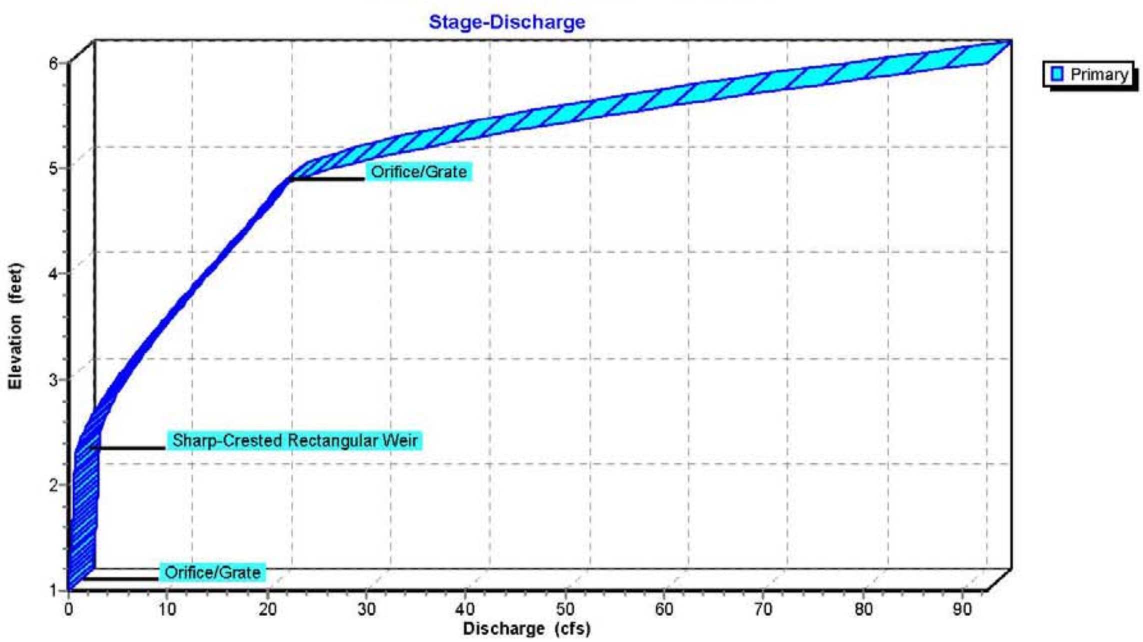
Device	Routing	Invert	Outlet Devices
#1	Primary	1.00'	**5.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	2.25'	**2.0' long x 2.10' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	4.80'	**4.00' x 3.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.63 cfs @ 2.13 hrs HW=2.13' (Free Discharge)
1=**Orifice/Grate** (Orifice Controls 0.63 cfs @ 4.63 fps)
2=**Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
3=**Orifice/Grate** (Controls 0.00 cfs)

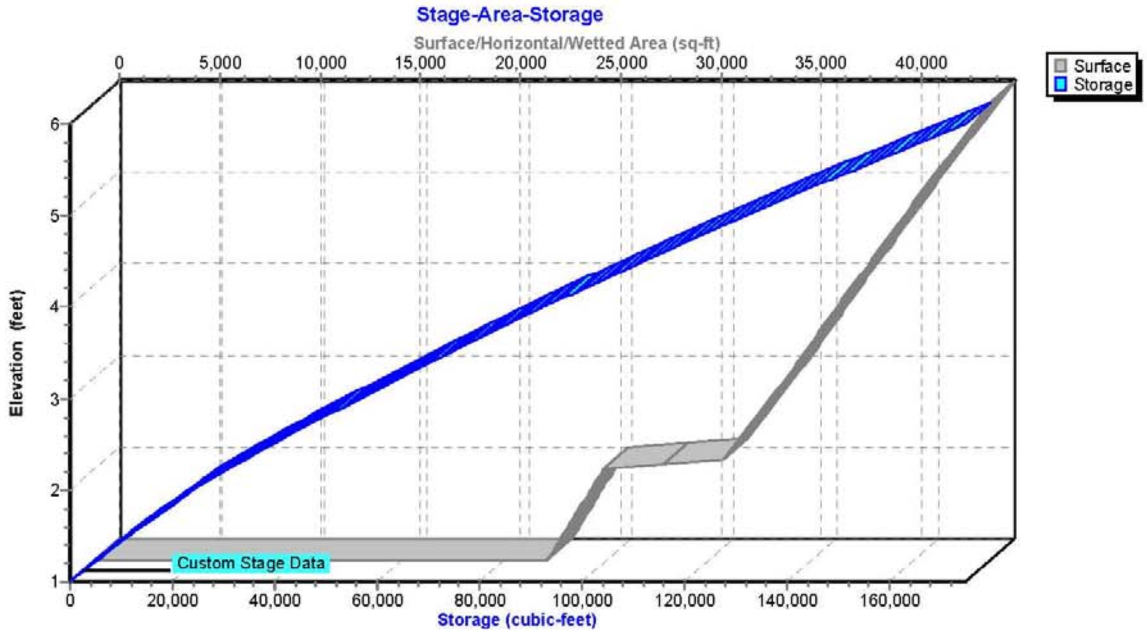
Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland



Pond 11P: Constructed Wetland

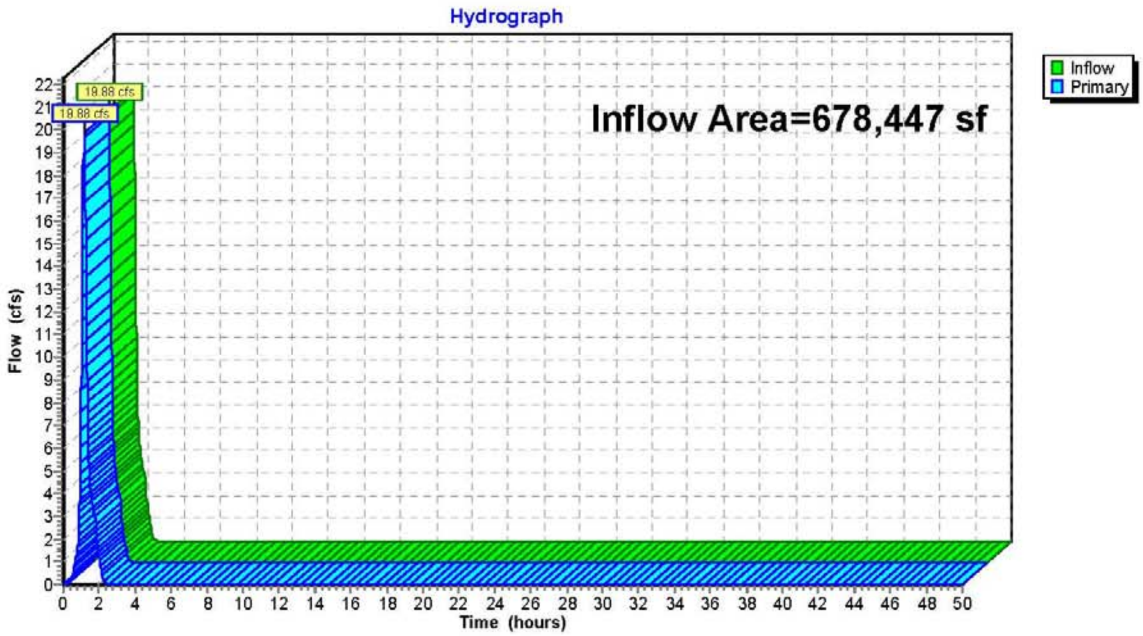


Summary for Link 8L: JUNCTION

Inflow Area =	678,447 sf, 41.69% Impervious,	Inflow Depth = 0.53"	for WQ event
Inflow =	19.88 cfs @ 1.16 hrs,	Volume=	30,090 cf
Primary =	19.88 cfs @ 1.16 hrs,	Volume=	30,090 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-50.00 hrs, dt= 0.01 hrs

Link 8L: JUNCTION



APPENDIX IX: PRELIMINARY CONSTRUCTION COST ESTIMATE

The RBA Group
ENGINEERS • ARCHITECTS • PLANNERS
7 Campus Drive, Suite 300, Parsippany, NJ 07054-4495 (973) 946-5600 • FAX (973) 984-5421

Stormwater Quality Mitigation Bank Cost Estimate

Job #: J3998.00
Location: Secaucus, Hudson County

Computed By: FB
Checked By: FFS
Date: 10/20/09

ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
EXCAVATION, UNCLASSIFIED	7000	CY	$35	$245,000
15" REINFORCED CONCRETE PIPE	87.1	LF	$78	$6,794
24" REINFORCED CONCRETE PIPE	153.1	LF	$77	$11,789
CONCRETE HEADWALL	29.6	CY	$1,275	$37,740
RECONSTRUCTED INLET, TYPE B, USING NEW CASTING	2	UNIT	$1,936	$3,872
RECONSTRUCTED MANHOLE, USING NEW CASTING	2	UNIT	$1,200	$2,400
OUTLET CONTROL STRUCTURE	1	UNIT	$8,250	$8,250
RIPRAP IN FOREBAY (assuming 16" thick, d50=8")	163	SY	$51	$8,330
TOPSOILING, 4" THICK	4961	SY	$2.25	$11,163
FERTILIZING AND SEEDING, BASIN SLOPE	2472	SY	$2.75	$6,799
PLANTINGS, DEEP MARSH AREA	506	UNIT	$2.50	$1,265
PLANTINGS, SHALLOW MARSH AREA	7582	UNIT	$2.50	$18,955
SUBTOTAL				**$362,356**
MOBILIZATION (10%)				$36,236
CONSTRUCTION LAYOUT (2%)				$7,247
CONTINGENCIES (3%)				$10,871
			TOTAL:	**$416,709**

Notes:
1. Unit prices (except for plantings) based on NJDOT project bid history.
2. Contingencies cover smaller, miscellaneous items.

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APPENDIX X: PHOTOGRAPHS OF THE PROJECT SITE AND TEST PITS

Photo 1 – Facing Northeast

Photo 2 – Facing North (Test Pit #1)

Photo 3 – Route 3 West (Test Pit #1)

Photo 4 – Facing East

Photo 5 – Test Pit #2

Photo 6 – Test Pit #2

Photo 7 – Test Pit #3

Photo 8 – Test Pit #3

Photo 9 – Facing North

Photo 10 – Test Pit #4

Photo 11 – Test Pit #4

Photo 12 – Test Pit #4

Views of Site 16, interchange infield area

Views of manholes adjacent to Rt. 3