Walnut Brook Riparian Restoration Project

FINAL REPORT

Raritan Township, Hunterdon County, New Jersey

November 2011

An Implementation Project in conjunction with the *Developing the Neshanic River Watershed Restoration Plan*

Photo by Jill Dodds June 2011

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Bill Kibler	South Branch Watershed Association

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Special thanks to those who helped during concept planning, designing, permitting and construction to cooperatively and quickly address all types of challenges and obstacles faced in completing this restoration project.

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1.0 Abstract

In early 2007, North Jersey Resource Conservation and Development (RC&D) Council received funding to continue the streambank stabilization work along the Walnut Brook as it flows through Mine Brook Park and the Hunterdon County Land Trust (HLTA) owned Dvoor Farm in Raritan Township, Hunterdon County and to create 2.97 acres of forested wetland. The project is managed by North Jersey RC&D. The streambank stabilization portion of the project is part of a large watershed management grant 'Developing the Neshanic River Watershed Restoration Plan' led by New Jersey Institute of Technology and funded by the Office of Policy Implementation and Watershed Restoration (formerly the Division of Watershed Management) of the NJ Department of Environmental Protection (DEP). Additional funding for the streambank stabilization and wetland creation portion of the project is provided by the New Jersey Wetland Mitigation Council. RC&D received $126,000 in funds from the NJDEP and $566,260 in funds from the New Jersey Wetland Mitigation Council to complete the three phases of the riparian restoration project.

Initial restoration work along the Walnut Brook began in fall 2005 in Mine Brook Park. The project funds received for this work totaled $21,250 in grant fund and cash towards the project which came from The National Fish & Wildlife Foundation (5-Star Restoration Program), NRCS-Wildlife Habitat Incentives Program, and from two Raritan Township committees, additionally over $30,000 of in-kind services and material were donated to this initial project.

Mine Brook Park is a 15.8 acre property which is heavily utilized as it supports a playground, soccer and baseball fields plus walking trails. The HLTA Dvoor Farm is a 42 acre preserved farm that abuts Mine Brook Park. Continuous stream-flow monitoring data shows that peak flows in the Walnut Brook have greatly increased since much of the housing development occurred in the watershed in the 1960s – 70's. These increased flows have negatively impacted the stream resulting in serious stream bank erosion, excess sediment, and related impacts to native flora and fauna.

The objectives of the project, as stated in the initial Scope of Work, are outlined below:

1. To restore the riparian functions and values of the Walnut Brook
2. Reconnect 1,000 feet of stream to 2 acres of floodplain for the 2-year storm event and restore an additional 11 acres of floodplain functions and values.
3. Establish 8 acres of new riparian buffer plantings along with the enhancement of 3 acres of existing buffer through invasive exotic vegetation removal and replanting of native species.
4. To transfer the restoration process and techniques used on the site to other interested parties.

5. Transfer technology to 1000 people through outreach efforts such as workshops, newsletters and presentations.

North Jersey RC&D and the project partners can successfully state that the above outlined objectives are being achieved at the project. The original timeline for the scope of work as presented to the New Jersey Wetland Mitigation Council is off by a few years as it took two years to work out the details of permitting the project and in locating and securing the full financial support required to complete the project. Thanks to the additional funding support obtained through the New Jersey Institute of Technology funded *Developing the Neshanic River Watershed Restoration Plan* 319(h) grant through the by New Jersey Department of Environmental Protection.

The riparian buffer planting started in April 2009. The riparian buffer planting occurred in phases throughout the length of the project through August 2011. One hundred and thirty-five volunteers, from within the community up to corporate groups accounted for 578 hours of work at the site. They helped to establish the riparian buffer corridor. The volunteers worked to plant, mulch and place protective caging around the material. Throughout the course of two years the volunteers also assisted with watering the plants as necessary by lack of rainfall during the planting period.

In June 2009, streambank stabilization practices were constructed along the Meander #1 and Meander #2 along approximately 1,000 feet of bank preventing additional scour and erosion of the streambanks and thereby reducing the stream's pollutant load. The construction of the entire stream project was completed in less than two weeks by two local excavating contractors. Construction costs were minimized by using day rates for the equipment onsite and material costs were reduced by donations from private companies. During the US Army Corps *Working Workshop,* which was one week of active construction, 40 people contributed 536 hours of labor to the installation of the streambank stabilization practices. With the guidance and additional oversight obtained from Linda Peterson, PE USDA-NRCS, Mary Paist-Goldman PE, Princeton Hydro and Dave Derrick, US Army Corps of Engineers Research Hydraulic Engineer, North Jersey RC&D was able to have volunteers, both near and far, construct rock vanes, LPSTP (longitudinal peaked stone toe protection), ERR (engineered rock riffle), LL (locked logs), SSBW (single stone bendway weirs), smooshed riprap, angle slam, boulder-log revetment

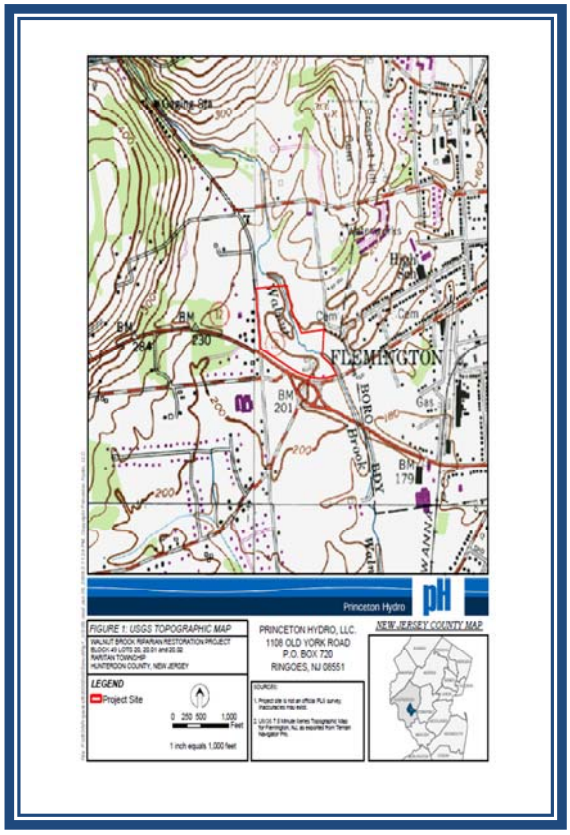
Once completed the streambank stabilization utilized 980 tons of rock; 4,400 willow and sycamore cuttings installed; 2.98 acres of area was treated for the removal of multi-flora rose along with a 5 acre riparian buffer containing 2,061 trees and shrubs and a 1.18 acre of native warm season grasses.

The wetland component, construction started in September 2009 and concluded in March 2010, will further improve stream water quality through retention of stormwater and will increase sediment removal functions associated with the establishment of additional vegetative cover and adjacent 6 acres of native riparian buffer. With the streambank stabilization practices in place and the constructed wetland, this project is achieving the reconnection of the floodplain to the brook, in turn helping to reduce downstream flooding.

2.0 Background

2.1 The Watershed

The site is located on the eastern side of the Route 12 and C.R. 523 circle and north of Mine Street (C.R. 523), in Raritan Township, Hunterdon County, New Jersey and is currently identified as Block 49, Lots 2, 2.01 and 2.02 on the Raritan Township Tax Maps. Lot 2 and 2.02 are owned by the Hunterdon Land Trust Alliance and is currently operated as a farm and future plans to operate as an educational facility. Lot 2.01 is owned by Raritan Township and is operating as a public park, Mine Brook Park. The project site was selected as a potential restoration project site by North Jersey Resource Conservation and Development (RC&D) and Princeton Hydro, LLC in 2004.



Walnut Brook is designated as Freshwater 2 Trout Maintenance (FW2-TM), headwater stream of the First Neshanic River. The First, Second and Third Neshanic rivers join together to form the main stem of the Neshanic which flows to the South Branch of the Raritan River.

Two streambank reaches proposed for stabilization are located along the mainstem of the Walnut Brook. The site is traversed by three watercourses: (1) the mainstem of the Walnut Brook, which generally flows in a north to south direction across the site; (2) an unnamed tributary of the Walnut Brook, which generally flows in a north to east direction before entering the Walnut Brook mainstem on the

site; and (3) a small drainage ditch that drains into the unnamed tributary of the Walnut Brook on the site, which runs in a southwesterly direction.

2.2 Historic Watershed Conditions

The United States Geological Survey (USGS) collected daily stream flow data on the Walnut Brook at Station 01397500 Walnut Brook near Flemington, NJ from 1936 to 1961. This gauge is located approximately one-half mile upstream of the project site. From 1962 to 2006, the USGS only collected annual peak stream flows at this stream gauge. A review of the annual peak flows indicates that a substantial increase in annual peak stream flows occurred in 1971 (1,570 cfs). Prior to 1971, the highest annual peak stream flow recorded was 645 cfs in 1945. The highest peak stream flow ever recorded on the Walnut Brook occurred in 1999 (3,230 cfs). From 2002 through 2006, the highest annual stream peak flows recorded on the Walnut Brook were consistently greater than 1,000 cfs for the first time in the stream's recorded history.

1930-1956

The Walnut Brook watershed was predominantly agricultural during the three decades between 1930 and 1956. Stream flow data indicates that the watercourse was somewhat "flashy". Impervious cover estimates during the 1930s appear to be less than one percent and during 1956 were not significantly higher.

1956-1995/1997

Walnut Brook 1956

During the three decades between 1956 and 1995/1997, the Walnut Brook watershed began to transition from its predominantly agricultural land use to become dominated by more low density residential developments and deciduous forests. Once again, stream flow data indicates that the watercourse was "flashy" in nature. As indicated above, impervious cover estimates during 1956 were not more than one (1) percent. By 1995/1997, there was just fewer than three (3) percent impervious cover in the watershed. Since 1971, the peak annual stream flow recorded at the gauge in the Walnut Brook was greater than 500 cfs approximately 66 percent of the time through 1995/1997. Additionally, the rainfall data available for Flemington, NJ indicates that annual rainfall totals and the number of significant rainfall events increased.

1995/1997 - 2002

Although the period between 1995/1997 and 2002 represents a much shorter timeframe than previously described, it is important to understand the additional impacts realized on the stream during this period. A slight increase in residential development in the watershed occurred during this time period. The overall impervious cover in the watershed as of 2002 was estimated at more than three (3) percent.

2007 Aerial Walnut Brook Raritan Township, Hunterdon County
Red line: 1930's center stream line
Blue line: 2007 center stream line
Yellow line: 1950's ditch centerline

Current (2008) and Future Watershed Conditions

The current Walnut Brook watershed is approximately 2.87 square miles in size which incorporates 1,836 acre drainage area and has undergone its most significant development since 1960. The most up-to-date estimates of impervious cover for the watershed (based on the 2002 NJDEP orthophotographs) are more than three (3) percent. The watershed is not considered built-out by the State's definitions as the zoning indicates that impervious cover in the watershed could increase to as much as 40 percent at full build-out.

As previously mentioned, the watershed has undergone some development pressure during the most recent decade; however, the watershed is not nearly built-out. Since the watershed has not achieved full build-out at the present time, it is essential that Raritan Township continue to enforce the stormwater management regulations and work to increase stormwater detention/retention onsite, disconnect impervious surfaces, and preserve the floodplain of the Walnut Brook wherever possible. Without continued diligence on the part of the Township, the "flashiness" of the watershed will continue to increase and the stream will grow increasingly unstable.

2.3 Channel Characteristics and Geometry

Throughout its history, the Walnut Brook has shifted its location multiple times and has developed substantial instabilities and erosion problems on the subject property.

Historic Channel Characteristics and Geometry

A review of the C.C. Vermeule maps prepared between 1870 and 1887 indicate that the Walnut Brook was a fairly linear stream with an estimated channel slope on the property of more than

half a percent. The most up-to-date USGS quadrangle maps (1970) indicate that the slope of the channel has not changed significantly since that time.

Based on a review of the aerial photos of the project site, the stream channel historically has meandered continually throughout its past. To further support this conclusion, in 2007 test pits were completed throughout the project site. The test pits revealed historic stream bed layers throughout the site at depths ranging from 24 to 60 inches below existing grade.

The aerial photo from 1930 reveals a potentially braided channel on the subject site and indicates that sedimentation may have been a problem as well. Additionally, the stream appears to have been straightened at the northern (upstream) end of the property. The stream was located closer to Old Croton Road in 1930 than in present day. The aerial photo from 1956 indicates that the stream channel was straightened from the 1930 configuration and pulled back from Old Croton Road. The channel also appears to show some instability towards the center of the property (including braiding and erosion). In 1995/1997 and in 2002, the aerial photo shows the channel with substantial indications of erosion and braided channels on the subject property. The exact cause of the erosion of the stream channel is unknown. It can be inferred that the channel has experienced instabilities due to repeated attempts to straighten the channel both upstream and on the subject property and potentially due to increased rainfall in the watershed. The long-time farmer of the Dvoor property indicated that he channelized the stream several times to reduce flooding impacts to his fields. Unfortunately, this most likely exacerbated the erosive conditions on the site that exist today.

Channel Characteristics and Geometry

In 2007, prior to the restoration process there was noted substantial stability problems that existed throughout the entire stream reach. Due to limitations in the project funding, the project only involved the stabilization of two sections of the stream. These sections were identified as those in the most substantial need of stabilization by several stream stabilization experts. These channel sections are identified as Meander #1 and Meander #2 on the engineering drawings.

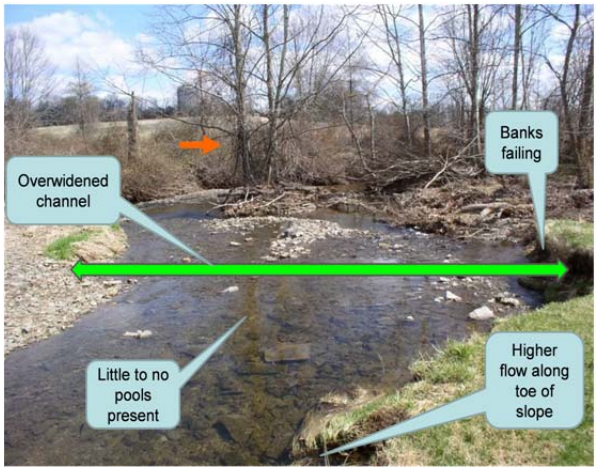
Meander #1 is the most northern meander on the project site. It actually begins on property owned and maintained by Raritan Township as Mine Brook Park. This meander exhibits instability in several ways. The banks are severely incised and the geometry is such that during minor rain events, the stream actually "jumps its banks" and heads across a portion of the HLTA Dvoor Farm fields.

Meander #1 June 2007: pre-construction

Meander #2 is the second most northern meander on the project site. It has migrated since the project initially sought funding from the mitigation council by more than 30 feet. Without stabilization, the meander will continue to shift location and/or cause the stream channel to braid more substantially than it already does on the property. These two meanders were selected as the primary focus for this project after extensive site visits and data collection.

Meander #2 October 2008: pre-construction

Bankfull discharge for the project is approximately 570 cfs (identified as being between the 1- and 2-year return interval storm). It is not anticipated that this discharge will be impacted by the proposed channel geometry. The proposed channel geometry is further described in Section 4.0 below. Additional hydraulic calculations documenting the Flood Hazard Area floodplain as well as the 100-year floodway are described in detail in the report entitled, "Floodplain Delineation of the Walnut Brook and Unnamed Tributary to the Walnut Brook," dated March 10, 2008, as prepared by Princeton Hydro.



Meander #1 Looking downstream- April 2007

2.4 The Project

Background

Restoration of small streams, floodplain and associated wetlands is critical to watershed restoration efforts throughout New Jersey. Nationally, 1st and 2nd order streams constitute almost 95% of all identified

streams/rivers and account for three quarters of the collective length of US waterways. These small headwater streams represent a disproportionately large share of the fluvial system. Stream degradation in these smaller systems has a cumulative effect on the largest NJ watersheds such as the Delaware and the Raritan watersheds. Floodplain wetlands can provide societal values such as flood storage, nutrient and sediment retention, migratory wildlife corridors, threatened and endangered species habitat, ground water recharge, environmental education, passive recreation and more. In recent years, throughout New Jersey, many small streams have become incised and disconnected from their floodplain. Floodplain wetlands have become drier due to lack of frequent flood events and lower ground water levels. Floodplains have been drained, graded, farmed and built upon for many years.

Pre-Construction Conditions

The stream is incised and the stream bottom has cut down significantly in the last 50 years due to channelization and increased impervious area in the watershed. Peak storm flow frequency and quantity has increased dramatically in the last 50 years. However, due to the stream incision, flood elevations are lower in the landscape and discharge of stormwater to the floodplain only occurs during larger storm events. The adjacent hydric soils were also graded for agricultural uses and storm water runs off these fields quickly. Invasive exotic vegetation on site is flourishing, including multiflora rose which dominates the shrub layer in the streamside forests. The agricultural fields are dominated by cool season European grasses such as orchardgrass, reed canarygrass, fescues and ryegrass. Ecological functions such as nutrient cycling and removal, retention of particulates, export of organic carbon, flood water retention, plant biodiversity, and wildlife habitat interspersion are severely compromised in the degraded floodplain and wetlands on the site.

No critical wildlife habitat, as mapped by the NJ Division of Fish & Wildlife's Landscape Project, occurs on the project site. Landscape Project critical habitats for "Emergent Wetland", "Forested Wetland" and "Forest" categories are mapped in properties adjacent to the project site. After the project is complete it is anticipated that the critical wildlife habitats mapped can be expanded to include the Dvoor Farm project site.

The Walnut Brook Riparian Restoration project included elements of wetland restoration, creation, and enhancement that will serve as a public demonstration project for the transferable technology of riparian restoration. Funds were obtained to complete the engineering, design, and construction of the 13 acre restoration site. Major items of work included: earthmoving, installing stream stabilization measures, restoring floodplain wetland areas, and planting riparian areas with native species.

Walnut Brook exhibits a high erosion potential and preliminary observation of the tributary

concluded that it was in poor condition in terms of stability, with stability not noticeably improving directly upstream or downstream. The project team believes that watershed shape, land use, soils and geology, vegetative cover, alterations to channel and overbanks, and quite possibly other causes makes Walnut Brook a flashy stream.

In May 2007, the Natural Resources Conservation Service (NRCS) collected field survey information in order to design the streambank stabilization project for the Walnut Brook Riparian Restoration. According to this survey information the erosion rate of Meander #1 and Meander #2 along the Walnut Brook is on average 7 feet and 3 feet per year, respectively, since 2002. In 2007, Meander #1 and Meander #2 eroded an additional 6 feet and 12 feet, respectively, in the six months between May and November. This bank erosion over the past 5 ½ years has resulted in approximately 5,000 cubic yards of sediment input to the Neshanic stream system. We estimate an annual reduction of approximately 1,000 cubic yards of sediment into the Walnut Brook and eventually the Neshanic River downstream. Non-point source pollution has been identified as the primary water quality problem in the Neshanic Watershed.

Meander #1: Instability of bank, overhanging, severe erosion (May 2007)

Excessive sedimentation decreases aquatic life and habitat. The unstable banks were threatening existing vegetation and larger trees that are critical to the riparian buffer habitat and provide shade to the brook. Additionally the unstable and undermined streambanks were becoming a safety hazard in a heavily used recreational park.

Design Process/Project Process

As part of this project, the project team assessed the existing conditions of the stream bed, banks and floodplain, developed conceptual and final designs, assessed alternatives and diversions and obtained the appropriate permits.

The design utilized the data collected by the various project partners with existing survey data from other sources and it was supplemented by an in-field survey. Concept options were guided by regulations and estimated costs. A thorough hydrologic (HEC-HMS) and hydraulic study (HEC-RAS) was performed to enhance the data collected by the Rosgen method.

Proposed Riparian Restoration Design

All design elements were selected to maximize the use of vegetative techniques wherever possible; however, the velocities and shear stresses anticipated in the channel indicated that some armoring would be required. Again, due to funding limitations for the project, only two (2) meanders on the property were proposed for stabilization during this project. It is anticipated and recommended that the remaining portions of the stream onsite be stabilized at some point in the future.

Earthmoving activities will consist of removal of fill from the floodplain in order to reestablish the natural floodplain topography as it existed prior to the conversion to agriculture. Stream stabilization measures may consist of in-stream grade control features to re-connect the stream to the floodplain caused by channel incision. Other bio-engineered stabilization techniques may be incorporated to reduce excessive bank erosion. Wetland restoration techniques will be applied to floodplain areas to restore the historic wetland hydrology (through surface and subsurface sources); this will be constructed from support from the NJ Wetlands Mitigation Council. The riparian plant community will be restored and enhanced through the removal of invasive and exotic vegetation and with the establishment of native riparian and palustrine forest plant communities.

The project will restore/create 2 acres of riverine wetland in floodplains along Walnut Brook on the HLTA property. A project goal is to restore natural wetland hydrology to 2 acres of floodplain by a combination of raising the level of Walnut Brook through grade control and natural stream channel design and removing soil from the floodplain. These areas will also be planted to native riverine wetland herbaceous and woody vegetation. A challenge in designing the project was the difficulty in identifying a stream and wetland reference reach, as most of the region has also been degraded by agriculture and development pressures that this reach of the Walnut Brook has experienced.

Meander #1: Streambank Stabilization Design

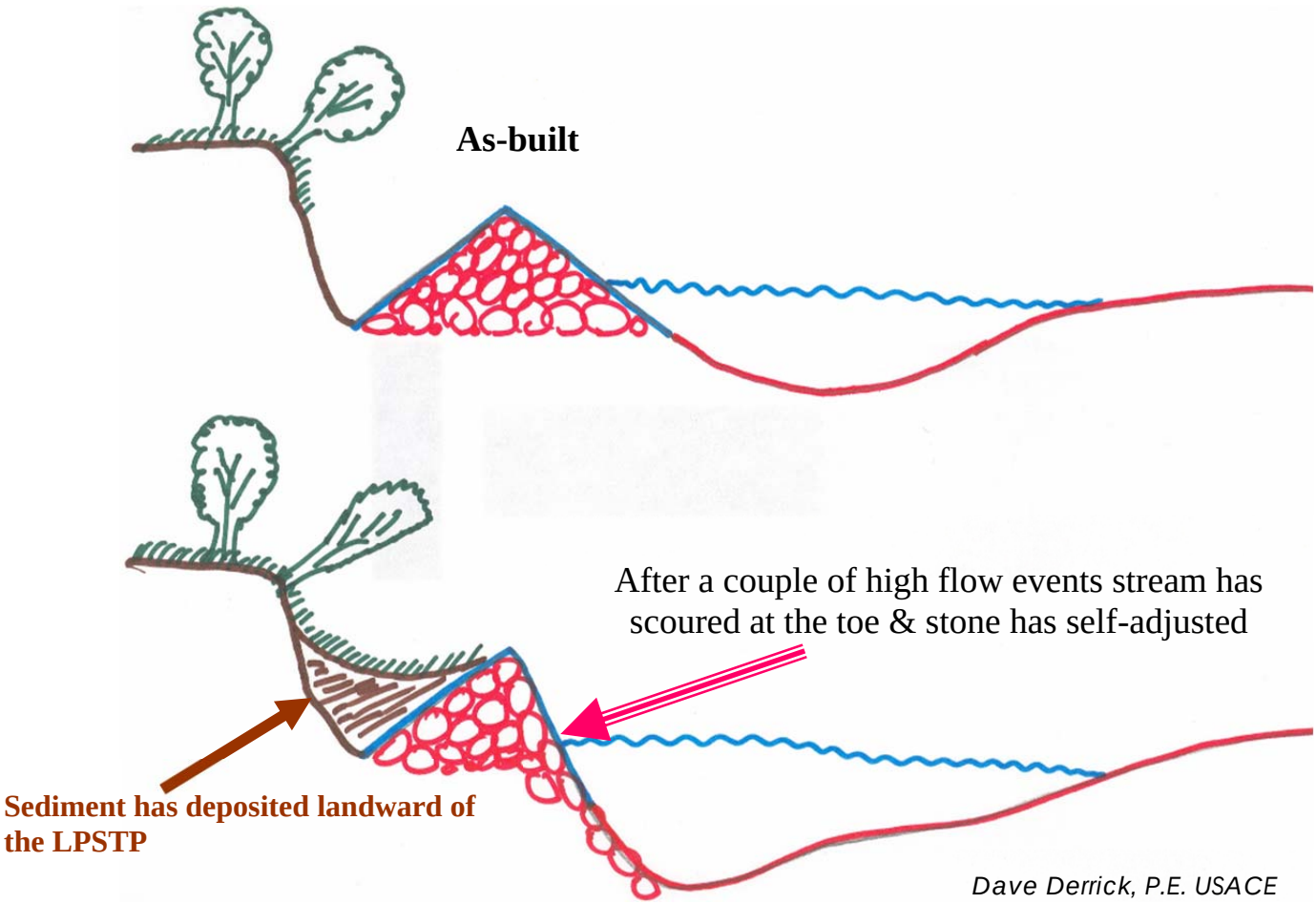
Multiple techniques were proposed including the use of both resistive and re-directive measures for this meander. Approximately 470 linear feet of stream will be stabilized at this location. A majority of the proposed techniques are resistive including the use of the slit trenches to catch debris as it moves down the channel and keep it out of the proposed wetland. In an upstream to downstream direction, the following techniques are proposed:

- *Resistive boulders* are proposed along the left bank (facing downstream) to maintain the bankfull width to depth ratio. These resistive boulders will be placed with keyways to anchor the stones into the bank and minimize the potential for failure. The D50 size

proposed for this technique is 36 inches.

- Immediately downstream three (3) *rock vanes* are proposed as the stream enters the meander. Each rock vane is designed with a D50 size of 36 inches. Between each rock vane additional resistive boulders are proposed with D50 size of 36 inches. Below each rock vane pools will be pre-dug to dissipate energy as the stream enters the meander. The resistive boulders and rock vanes will be keyed into the bank and planted with pole plantings. Additionally locked logs and limbs will be used to resist erosion along the banks.
- Downstream of the third rock vane *single stone bendway weirs* are proposed with D50 size of 48 inches.
- Additionally, a *grade control structure* will be installed across the stream channel. The grade control structure is proposed to ensure that any future headcuts do not jeopardize the stabilization techniques proposed. The grade control structure will be constructed of rock with a D50 size of 48 inches and keyed into the bank.
- At the downstream end of the meander, a *grand slam with longitudinal peak stone toe protection (LPSTP)* is proposed to resist the stream flow as it hits the left streambank. The LPTSP will have a D50 size of 24 inches.
- At the downstream end of the meander stabilization, *resistive boulders* are proposed again and will be keyed into the bank. The D50 size of this rock is 48 inches.

Diagram of Longitudinal Peaked Stone Toe Protection (LPSTP)



Meander #2: Streambank Stabilization Design

Multiple techniques are proposed including the use of both resistive and redirective measures for this meander. Approximately 250 linear feet of stream will be stabilized at this location. A majority of the proposed techniques are resistive including the use of the slit trenches to catch debris as it moves down the channel. In an upstream to downstream direction, the following techniques are being proposed:

- The upstream end of this design includes LPSTP keyed into the banks as well as single stone bendway weirs. The LPSTP and single stone bendway weirs will resist and redirect the stream away from the outside bank of this meander. The D50 size for the LPSTP is 24 inches and the D50 size for the single stone bendway weirs is 48 inches.
- Downstream of the LPSTP a *grade control structure* is proposed at the existing channel invert to protect against migration of future headcuts impacting the proposed stabilization. The D50 size for the grade control structure is 48 inches.
- At the downstream end of the meander an *angle slam* is proposed. The angle slam will be constructed of locked logs with resistive and ballast boulders. The D50 size for this

structure is 36 inches.

As described in detail above, the rock proposed for this design has D50 varying between 24 and 48 inches. All rock was sized using *Figure 16A-1 from Appendix 16A – Size Determination for Rock Riprap in Chapter 16 of the Engineering Field Handbook* as prepared by USDA – NRCS.

It is not anticipated that the proposed stabilization would have any negative hydraulic impacts on the upstream and downstream areas. The proposed stabilization will prevent additional scour and erosion of the streambanks on the subject site.

2.5 Project Team and Funding

The project was managed by North Jersey Resource Conservation and Development (RC&D) with support from the following partners: Hunterdon Land Trust Alliance (HLTA); Hunterdon Central Regional High School; Hunterdon County Freeholders; Hunterdon County Roads, Bridges & Engineering Department; Hunterdon County Soil Conservation District; New Jersey Department of Environmental Protection (NJDEP) Office of Policy Implementation and Watershed Restoration (formerly the Division of Watershed Management); New Jersey Wetlands Mitigation Council, New Jersey Institute of Technology; New Jersey Water Supply Authority; Princeton Hydro LLC; Raritan Township Environmental Commission, Department of Public Works, Recreation Commission, Township Committee and Engineering Department; United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS); South Branch Watershed Association; NJDEP Fish & Wildlife; Trout Unlimited; Beazer Homes USA; U.S. Army Corps of Engineers *Water Operations Technical Support Program* (WOTS); Vollers Excavating; Rudl Fencing and Decking and ShopRite of Hunterdon County Inc.

Unique to the project was the overwhelming support it received from community members, government agencies and local businesses. The resources brought to the table from these partners not only reduced the project's overall cost, but more importantly improved the benefits provided by the project. By 2010 there were twenty-four partner organizations that had contributed to the project.

The streambank construction and stabilization work was overseen by David Derrick a Research Hydraulic Engineer from the US Army Corps of Engineers, the USDA-NRCS, and Princeton Hydro LLC. The riparian buffer restoration was overseen by North Jersey RC&D. Community and corporate volunteers and groups assisted with the implementation of the riparian buffer plantings.

As with many restoration projects obstacles and challenges were faced by the Project Team. To start, it took over two years to receive the funding needed to begin the project. The

contract with our primary funder, the New Jersey Wetlands Mitigation Council, was executed in January 2007. With the project underway the project team met with staff from the NJDEP Division of Land Use Regulation to review the proposed project design.

The project team was aware that an updated version of the Flood Hazard Area Control Act was set to go into effect prior to the permit submission. With that in mind, the purpose of the meeting was to obtain feedback on the design and to determine how the proposed streambank stabilization practices would coincide with the new permitting guidelines. Working with the New Jersey Wetland Mitigation Council and the NJDEP – Division of Watershed Management proved exceptionally helpful during the permitting process for the project as both groups aided the technical reviewers and provided valuable assistance in the progression of the permit issuance.

Later in the process it became apparent that additional funding would be necessary to complete the proposed elements of the plan. In July 2008 North Jersey RC&D obtained construction bids from nine contractors to complete the wetland and stream stabilization construction. Bids exceeded the project budget by $225,000. This funding shortfall was addressed by seeking new funding sources and requesting additional funds from the original funder, the NJ Wetlands Mitigation Council. North Jersey RC&D succeeded in obtaining additional funding support for the project. Through an existing watershed management grant 'Developing the Neshanic River Watershed Restoration Plan' led by New Jersey Institute of Technology and funded by the NJ DEP Division of Watershed Management an additional $126,000 was obtained to off-set the costs of the streambank stabilization portion of the project. The Project Team also successfully obtained $25,000 worth of rock from two partnering organizations as well as other in-kind professional services and donated materials. In total $566,260 was received from the NJ Wetlands Mitigation Council and $126,000 from NJDEP.

A few other challenges and obstacles faced by the Project Team were the issues of land ownership and deed restrictions. The wetland portion of the project proposed for the Hunterdon Land Trust Alliance's Dvoor Farm property was initially purchased with assistance from NJDEP Green Acres Program. Therefore various restrictions were placed on the land regarding its future uses. Approval from the NJDEP Commissioner was required to proceed with the project as designed. Fortunately, it was concluded that since the project will serve to protect and enhance the conservation value of the property the practices were approved as long as we followed a short list of conditions. Such conditions included completion of project within 2 years from start of construction, restoration of land utilized for stockpiling back to pre-existing conditions, the property must still be made available for public access and that Hunterdon Land Trust Alliance must file a Deed of Conservation Restriction that complies with

Green Acres regulation.

During the permit preparation process it came to North Jersey RC&D's attention that Jersey Central Power and Light had an electric transmission easement through the property, thereby disallowing the use of NJ Wetlands Mitigation Council money in this area. The funds obtained from NJDEP Watershed Management proved very useful to help construct the streambank stabilization practices that fell within the easement area. As a condition of the easement holder, the vegetation within the easement could not exceed ten feet in height at maturity.

3.0 Construction

3.1 Streambank Stabilization

At the onset of the project, it was determined that a detailed stream survey was necessary. A tooth-pick survey was conducted to establish some of the key characteristics of the stream channel including the Rosgen classification of the stream reaches. Researching the historic photos of the site revealed that the stream channel was straightened sometime prior to 1956, hence the extreme instability in the channel. A detailed topographic survey of the channel and the floodplain was performed. The riffle-pool sequence proved to be a Type C3 meandering stream. The project team had several meetings to discuss the stream stabilization techniques and several additional field meetings were held.

The hydrology for the stream project was established using HydroCAD Software Solutions' Stormwater Modeling System and hydraulic modeling of the stream was completed using the United States Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS). The hydraulic model established in-stream velocities and shear stresses and provided the basis for the rock sizes specified in the stream stabilization measures proposed.

Due to fisheries concerns, construction could not commence until after June 15th. This meant

Willows being harvested and hauled from NRCS Plant Material Center in Big Flats NY

Willows harvested in March, taken out of cold storage days prior to use and allowed to "soak" in nearby pond.

Root growth after being soaked for few days

that dormant plant materials needed to be harvested and kept dormant until we could install the bio-engineering practices. Willow cuttings were harvested in March and kept cool (33-35 degrees) and moist in large, walk-in coolers. In mid-June the plants were taken out of the coolers and allowed to soak for 2-4 days in a nearby pond prior to installation.

Construction for the access/haul road was delayed by rain storms that had been hitting the area throughout the entire month of June. As of June 20th, there had 2 days without rain and the area had received close to 6 inches of rain.

Meander #1: May 2009

After Construction: Looking Down Stream July 2009

Meander #1: Looking Up Stream at completed Grade Control (Engineered Rock Riffle) July 2009

Meander #1's proposed design as constructed in June 2009 included both resistive and re-directive measures to address several problems, including head-cuts and severe bank erosion. The head-cut movement and channel migration from the time of survey to the time of construction was startling. To address the changes, a large grade control structure in the form of an engineered rock riffle was added during construction. Treatments of Meander #1 included several rock vanes with large keyways and scour pools and longitudinal peaked stone toe protection (LPSTP). The downstream outside bend was stabilized with additional LPSTP and smooshed riprap beneath existing exposed tree roots.

Meander #1: Triangulating Vane construction June 2009

Meander #1: one of the Vanes completed with willows placed in keyway

Meander #2: Looking Up Stream October 2008

Meander #2 although shorter than Meander #1 presented challenges as well. Most severe in this reach was the headcutting in the stream channel and severe bank erosion at the inside bend at the upstream limits and at the outside bend on the downstream limits. The proposed design included the use of single stone bendway weirs (SSBW) and slit trenches to be planted with willow cuttings. The weirs were placed with LPSTP between them and a grade control structure immediately downstream of the weirs. The downstream limit had a boulder-log revetment locked log structure.

Looking Up Stream: May 2010 (after)

Unique to Meander #2 is the t-shaped single-stone bendway weirs. Again, adaptive management during the June 2009 construction required innovative use of some of the irregular boulder sizes and shapes available at the time of construction.

June 2009: Dave Derrick installing willow cuttings with use of yellow machine above LPSTP

All design elements were selected to maximize the use of vegetative techniques wherever possible; however, the velocities and shear stresses anticipated in the channel indicated that some armoring would be required. Again, due to funding limitations for the project, only two meanders on

the property were stabilized.

Construction of the stream project was completed in large part with the aid of volunteers who were led by Linda Peterson PE, USDA-Natural Resources Conservation Service, David Derrick, US Army Corps of Engineers and Mary Paist-Goldman PE, Princeton Hydro LLC. The construction of the entire stream project was completed in less than two weeks by two local excavating contractors. Construction costs were minimized by using day rates for the equipment onsite and material costs were reduced by donations from private companies.

Equipment used in June 2009

Equipment used to complete the streambank stabilization included: Cat 924 Loader, Case 9020 Excavator, Cat D4 Bulldozer, 621 Loader, Skid Steer, CAT 416 Backhoe, York Rake and probably one of the most important machines was an Excavator with a thumb to properly place the rock for the grade control structures.

In spring 2010 the project team had to conduct adaptive management along Meander #1. In mid-June, an additional grade control structure in the form of an engineered rock riffle was installed above Vane #1. This additional structure was submitted to amend the exiting permit and it was approved by NJDEP Land Use for installation. In April and May, the project team worked with the stream contractor to adjust some of the rocks and boulders that had gotten displaced during the past major storm events. It is anticipated that with the installation of the upstream grade control the velocity of the brook will get dissipated prior to hitting Meander #1's vane structures. At this time slit trenches were constructed to install additional willow material that would aid to capture the woody material that occurs due to the out of bank flows. The willows utilized were harvested in March 2010. In a similar fashion as had been completed in 2009, the willows were harvested while dormant. They were kept moist and in a walk-in cooler at 33-35 degrees. Once needed, they were removed from the walk-in cooler and placed in a near-by pond to soak for a few days prior to use. Unfortunately the 2010 spring and summer did not receive a lot of rainfall and the temperatures were considerably hotter than in 2009. A majority of the willows installed in the slit trenches did not survive.

3.2 Riparian Buffer Restoration

This portion of the project focused on the establishment and enhancement of the riparian corridor along a specific length of Walnut Brook and the surrounding land. The project goal is to restore natural stream function and improve overall water quality. This involved planting trees, shrubs and native grasses in areas immediately adjacent to the brook to strengthen its

banks, increase shading on the brook, increase wildlife habitat, and help to reduce the volume of runoff over the landscape. Volunteers played a huge role in working to plant the trees and shrubs in the project area.

Approximately eight (8) acres of floodplain were restored by the increased flooding frequency, native planting and invasive exotic plant removal. The entire 8 acres of floodplain may not meet the jurisdictional definition of wetlands (due to soils and hydrology criteria) but will provide many of the ecological functions discussed previously. Eight acres of riparian buffer were established on farm fields on each side of Walnut Brook to protect the stream from any agricultural runoff or other nonpoint source pollutants such as lawn fertilizers and pesticides, and road runoff. Buffers were planted to native floodplain trees, shrubs, grasses and forbs. A total of 13 acres of riparian restoration represents approximately 30% of the Hunterdon Land Trust Alliance property at the Dvoor Farm. A small portion of the riparian buffer restoration took place at the upstream end of the HLTA property in Mine Brook Park owned by Raritan Township (lot 2.01).

Meadow/field off Shield's Ave
October 2008 (pre)

Over the course of three years, North Jersey RC&D lead the riparian buffer restoration process along the Walnut Brook. North RC&D had the contacts, experience and knowledge to secure volunteers, material and professional services which translated into planting 2,061 native trees and shrubs in 2009, 2010 and 2011. To date 135 people have volunteered to assist with planting or caring for the riparian buffer plantings. The volunteers were invaluable in helping to plant trees and shrubs along both sides of the Walnut Brook. In working with Hunterdon County Roads, Bridges and Engineering Department, North Jersey RC&D was able to secure mulch that was placed around the newly planted trees and shrubs in an attempt to reduce the amount of competitive vegetation and grasses from growing around the buffer plants. The volunteers put mulch around all the plants and placed protective caging around the newly planted material in an attempt to protect the plant from wildlife damage.

Machine removing multi-flora rose
from buffer planting off Shield's Ave

Volunteers from Ethicon Planting
Buffer: April 2009

As designed the buffer installation was completed in phases. The importance to phase the installation of the

plantings was multi-faceted. The benefits were that plantings could occur prior to the proposed major construction activities, the plantings could be completed when volunteer groups were more readily available, the project spread out the risk of losing trees and shrubs to drought or wildlife damage, and areas could be reassessed to make sure that an adequate buffer was planted once the majority of the project was completed. North Jersey RC&D was able to initiate the buffer phase of the project in March 2009. Volunteers planted 660 trees and shrubs along the Walnut Brook prior to the active construction of the streambank stabilization work or the wetland being started. Throughout the spring, summer and fall of 2009 additional plantings occurred with assistance from volunteers. In 2010 another way of plantings occurred focused on the streambank side of the buffer. Plantings were installed between the completed wetland and the constructed streambank stabilization practices. In 2010, due to drought conditions volunteers were enlisted to help water the trees and shrubs. In early 2011 causalities of the drought-like conditions were noted in the buffer. Some reasons why the causalities occurred were from wildlife damage, even on trees and shrubs that were caged, since there were so many plants a handful of them did not have the proper caging around them to protect from deer browse, buck rub or girdling; poor plant material received from nurseries; and plants that did not get enough watering during the drier/drought conditions. Majority of the plantings survived and are thriving.

Since 2009 the following material and quantity has been planted at the restoration site:

Riparian Buffer Planting: Shrubs		
Botanical Name	**Species Name**	**Quantity**
Aronia Melanocarpra	Black Chokeberry	165
Cercis Canadensis	Red Bud	70
Cephalanthus occidentials	Buttonbush	125
Cornus Amomum	Silky Dogwood	25
Cornus Racemosa	Gray Dogwood	400
Myrica Pennsylvanica	Bayberry	190
Rhus Coppalinum	Winged Sumac	180
Sambucus Canadensis	Elderberry	20
Viburnum Dentatum	Arrowood Viburnum	22
Viburnum Prunifolium	Blackhaw	150
Viburnum Trilobum	Cranberry Viburnum	15
	Total	1362

Riparian Buffer Planting: Trees		
Botanical Name	**Species Name**	**Quantity**
Amelanchier Canadensis	Shadbush	94
Betula Nigra	River Birch	20
Carpins Caralinana	Ironwood	106
Celtis Occidentalis	Hackberry	45
Fraxinus Americana	White Ash	132
Fraxinus Pennsylvanica	Green Ash	16
Plantanus Occidentalis	Sycamore	131
Quercus Palustris	Pin Oak	140
Quercus Rubra	Red Oak	15
	Total	699

A unique quality of the project was the ability for the riparian buffer restoration to occur on both sides of the Walnut Brook. The use of the properties was also diversified prior to the restoration work being completed. The bulk of the riparian buffer plantings as noted above occurred along the brook, referred to as the Shield's Avenue side of the project. This portion of the property has historically been maintained as an open field/meadow. It was mowed every so often to help control the multi-floral rose growth. The project partners felt the Shield's Avenue side of the restoration project would be a great place to establish a native warm season grass area. In April 2009, 1.18 acres of the field was prepared to have warm season grasses planted on it. North Jersey RC&D worked with the USDA-NRCS Wildlife Biologist to establish an area along side of the shrub planting area. The following table indicates that species chosen for this section.

Riparian Buffer Planting: Warm Season Grass

Botanical Name	**Species Name**	**Quantity**
Schizachyrium Scoparium	Little Blue Stem	3 lbs
Panicum Virgatum	Switch Grass	1 lbs
	Indian Grass	3 lbs
	Big Blue Stem	3 lbs
Avena sativa	Oats	15 lbs
Asclepias Syriaca	Common Milkweed	0.5 lbs
	Purple Cone Flower	0.5 lbs
Rudbeckia hirta	Black Eyed Susan	0.5 lbs
Chamaecrista Fasciculata	Partridge Pea	1 lbs

The farmer that the Hunterdon Land Trust Alliance works with to mow the field on Shield's Avenue planted the seed with a no-till seeder. Since the warm season grass seed is lighter and fluffier than typical seed a specific no-till seeded is utilized.

Warm Season Grass seed being poured into no-till grass drill: April 2009

Teaching Moment: EvanMadlinger, USDA-NRCS speaking to June 2009 Construction volunteers about establishment of Warm Season Grass planting

4.0 Post-Construction

4.1 Site visits

North Jersey RC&D and the project team knew going into this project that the force and velocity of the water coming down the Walnut Brook, especially during storm events would be the real test for the stabilization practices installed. The design engineers proposed the various practices based on the calculations and their experiences in addressing streams of this nature. As the construction was taking place there were continual discussions regarding the importance of site visits and monitoring of the practices. Little did the Project Team know that the streambank stabilization practices installed would be put to the test so quickly after construction was completed.

In the six months after construction of the stream practices Walnut Brook experienced a few out of bank flows, some being 8 to 12 inches above top of bank. Several major storms hit the area just weeks after the construction was complete dumping close to a total of 5 inches of rain. Typically this stream system dries up by summer and stays dry until late fall. However, 2009 was an atypical year. With the rain events in the watershed the Project Team was able to observe how the practices put in place were functioning.

Around July 29, 2009 another large storm and rain event hit the area. This time approximately two separate rainfall events occurred sending the Walnut Brook out of bank for most of a day. Fortunately the newly seeded areas had a few weeks to get established. Additionally about

85% of installed live stakes are sprouting and achieving new growth. So far the stream stabilization measures are holding in place.

On August 2, 2009 a large rain storm hit the area dropping about 2 inches over a short amount of time. Basically the flow was 8 to 12 inches above the top of bank on both outer bends. So, it was quite a bit greater than bankfull flow. The vegetation looks great even though it took a lot of flow and got hit by a lot of debris. Grass seed is coming on strong, all the dormant live stakes and plantings continue to leaf out and grow. Some of the newly planted trees and shrubs in the buffer area were knocked around by out of bank debris, however most plant material is secure. A lot of bed scour took place where we wanted pools in the bends. A rock launching event occurred with this storm activity. The vanes in meander #1 got a little beat up however no major failures or catastrophe occurred. Minor adjustments will have to be made in the near future.

Due to this last storm in area upstream of the reach, the head-cut has advanced, so we definitely need the additional grade control.

Meander #1 took the brunt of the storm forces and a few individual rocks from the vane structures launched into the Brook. The good news is that these structures were designed to do this without having the lost rock cause any further or new bank erosion. A few of the in-stream structures installed in Meander #1 needed repair but generally they functioned as planned and prevented further streambank erosion.

The storm effects on Meander #2 were a different story. A great pool formed between SSBW #2 and #3. The locked logs performed well, as did the grade control structure. It looked great and the team had the alignment correct. To quote one of the design engineers' is was a "thing of beauty".

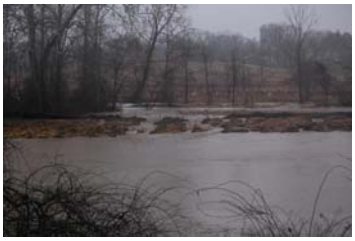
Willow growth observed April 2010

The willow cuttings installed in June 2009 flourished with the rainy weather the site experienced and achieved good growth. By the time the growing season was over about 85% of the live stakes were sprouting and thriving. The weather pendulum swung the other way in 2010 and negatively affected the willows planted in 2009 and the additional plantings added in 2010.

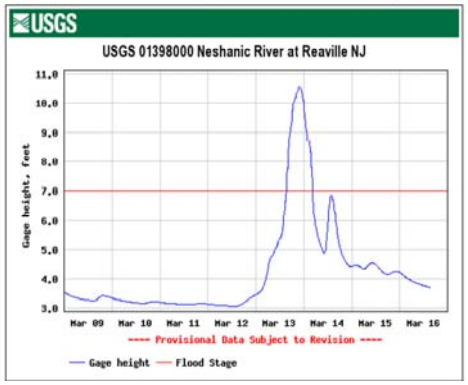
The following is a summary of conditions at Meander #2 after August 2nd 2009 storm. Good pools are forming between the Single Stone Bendway Weirs (SSBW). The rock structures seem

to be holding up nicely, especially considering how many large rainfall events we have had over the last few weeks. The downstream Grade Control is holding up nicely as well. The alignment of the structure is in-tune with the project. Vegetation on the banks including the dormant willow cuttings and black willow posts are stable and achieving new growth.

Once again, during January to March 2010 a fair amount of precipitation in the form of snow and rainfall occurred at the project site. Closely after the events, members of the Project Team would visit the project site and observe how the stream practices were holding up as well as how the wetland area was being affected. Notes were taken about the stability of the in-stream structures, photos were taken and the USGS Reaville stream gage values were noted. An event to note occurred on March 13, 2010. The area received about 2.99" of rain. The area was inundated with water. After the waters receded, the Project Team identified four areas that need to be addressed later in the spring. The corrections will occur with material available on site.



March 2010: During storm that dumped 2.99" of rain in the area. Walnut Brook flooded and overflowed into wetlands



March 2010 rainfall: USGS stream gauge of Neshanic River (downstream of Walnut Brook)

August and September 2011: Some of the smaller trees and shrubs were destroyed by the massive amount of water that moved through the system due to Hurricane Irene during the end of August. It was hard to tell, however if the dead trees found lying in parts of the project site were dead before the storm or were caused by the storm. Some of the older caging methods were overcome by debris and crushed the sheltered trees they were supposed to be protecting. The new shelters that replaced the older ones which were installed by volunteers in early August seem not to collect as much debris and far fewer casualties were noted after Hurricane Irene due to the caging crushing the plant.

All in all, even though the project site has been victim to large rainfall and storm events, the streambank stabilization practices are holding in place and the big achievement is no new bank or streambed erosion is occurring.

4.2 Monitoring

Stream stabilization projects include a level of uncertainty due to the complex nature of stream systems. Historically, these projects were not adequately monitored or maintained due to lack of funding; however, monitoring and maintenance are critical to project success. A well-designed monitoring plan will enable the project team to assess progress and determine when or if additional maintenance or adaptive management is required.

Monitoring is defined as the collection and assessment of repeated observations and/or measurements over time to evaluate the effectiveness of restoration actions. It is intended to:

- Ensure the project is performing as intended;
- Help identify maintenance and adaptive management needs
- Measure the effectiveness of project through time and under range of changing environmental conditions relative to project goals

Three types of monitoring should be considered for stream stabilization projects:

1. *Baseline* – Characterize existing conditions pre-project.
2. *Implementation*- Assess whether project was carried out as planned. Assess whether the restoration measures were installed or constructed correctly. This monitoring is typically conducted during and immediately after implementation.
3. *Effectiveness* – Evaluate whether the project had the desired effect on resource indicators. Assess whether the restoration achieved the desired result. The monitoring variables used shall focus on indicators that document the desired conditions. This type of monitoring is conducted post-implementation, and may continue for several years.

As part of the Walnut Brook Riparian Restoration Project, various types of monitoring were conducted:

- Photomonitoring and visual observations
- Biological monitoring
- Geomorphology surveying
- Vegetation monitoring

Photomonitoring and Visual Observations

North Jersey RC&D and other project partners visit the site periodically to take photographs and make observations regarding performance of the in-stream structures and the new vegetation. These photographs and observations can be compared to those taken before the project occurred. In particular, observations are made during and after significant storm events. This type of monitoring was part of the baseline monitoring, and will be part of the ongoing implementation and effectiveness monitoring.

Biological Monitoring

For the Walnut Brook project, benthic macroinvertebrate samples were collected at three locations utilizing the U.S. EPA *Rapid Bioassessment Protocols for Use in Streams and Rivers* (EPA 841-B-99-002).

Macroinvertebrate monitoring involves testing for the presence of macroinvertebrates within a stream, and basing water quality ratings on the abundance and diversity of the organisms present, as well as the sensitivities of these organisms to pollutants. The advantages of biological assessment include the following:

- Fluctuating environmental conditions can be monitored over time.
- Biological communities can be used as indicators of general ecological integrity.
- Macroinvertebrates are usually abundant in streams and sampling will have no detrimental effect on the community.
- Individuals are easily identified and established tolerance values are readily available.
- Due to the relatively short life cycle of the organisms within a community, impacts are easily measured and ecological changes can be seen quickly.
- Biological monitoring assists in problem identification within an area.
- More detailed chemical testing can be done to determine the exact problem or possibly identify a source indicated by biological monitoring.

The biological assessment project involved the monitoring of three sites in the Walnut Brook watershed for macroinvertebrate communities. These locations bracketed the stabilization activities undertaken by the full project. These stations were used to assess the effectiveness of these efforts in protecting and improving the water quality of the restored stream. Biological assessment monitors trends in the benthic community and is used to determine possible problem sites for further analysis.

The South Branch Watershed Association conducted four sampling events pre-project in 2007 and 2008. The New Jersey Water Supply Authority collected five post-project samples 2008-2010. This type of monitoring was part of the baseline monitoring, and was completed in September 2010. NJ Water Supply Authority completed a full monitoring report for the project, *Walnut Brook Riparian Restoration Benthic Macroinvertebrate Monitoring*, as noted in Appendix B.

Summary: Overall Trends

The sampling events conducted by the South Branch Watershed Association indicate that the

Walnut Brook at Dvoor Farm was non-impaired for macro invertebrates for two of the four sampling events, spring 2007 and spring 2008. The other two sampling events do not indicate a NJ impairment score; this could be due to the small sample size collected during the summer 2007 and fall 2007 sampling events. For the two sampling events where an NJ impairment score was found, only approximately 100 organisms were identified and used in the data calculations. It is unknown how the 100 individuals were selected from the sample, or whether that is the total number of organisms collected. The notes from when SBWA completed this work could not be replicated.

In 2009, North Jersey RC&D contracted with the New Jersey Water Supply Authority (NJWSA) to complete the macro invertebrate monitoring portion of the project. For the NJWSA sampling events, with the exception of the June 2010 and October 2010, the entire sample was identified, sometimes resulting in a sample size of over 100 organisms. The sample size could potentially have an impact on several metrics, resulting in an altered NJ impairment score.

In comparing the data from the five NJWSA sampling events, there are some notable trends that are apparent at all three sampling sites. The Family Biotic Index (FBI) at all three sites increased over the course of the five sampling events. This indicates that families of macroinvertebrates being found in the stream are more tolerant to pollution. Another trend found across all three sites was a decrease in the Percent EPT, which is a measure of the percent of organisms, sampled that are from the orders Ephemeroptera, Plecoptera, and Tricoptera. Species in these orders are generally intolerant of water quality impairments. These changes resulted in a decrease in the NJ Impairment Score. It also altered the ranking of the stream from “non-impaired” to moderately impaired”.

Conclusions and Recommendations

Benthic macro invertebrate monitoring is a cost effective way to obtain data on a particular section of stream. When compared to historic data, the trends can be used to understand how the water quality is changing over time. In the case of a major stream stabilization or restoration, this data is particularly valuable because changes in habitat can have a large impact on the benthic macro invertebrate community.

While the Walnut Brook experienced some reduction in water quality based on the macro invertebrate data, it is likely not linked to the stabilization work. The parameters that changed the most (FBI, percent EPT, total EPT taxa) are closely linked to overall water quality, while the parameters that are associated with habitat such as total taxa richness and percent dominance, generally remained stable. All sites maintained a taxa richness above 10 families, which received the highest value of the NJ Impairment Score metrics. It is also noted that the changes

occurred at all three monitoring sites, upstream, downstream and within the project area. This is an indicator that any impacts that are being exhibited by the macro invertebrate community at the three sampling sites, are likely also occurring throughout the watershed.

For the full detailed_NJ Water Supply Authority monitoring report, *Walnut Brook Riparian Restoration Benthic Macroinvertebrate Monitoring*, please refer to Appendix B.

Geomorphology Monitoring

Stream channels are defined by the transport of water and sediment within the stream banks. Channel morphology is the result of the input and movement of sediment and water through the system. NRCS collected stream survey data prior to the stream stabilization project to assess with project design activities. Post-project, the partners completed a survey documenting the post-construction stream profile and representative cross-sections.

The longitudinal profile documented the overall profile of the stream by measuring points along the stream channel. The longitudinal profile captured approximately 1,400 linear feet beginning above the grade control structure installed above meander one and continuing downstream to the willow slit trenches installed at the top of the bank near the lower constructed wetland.

Measurements at cross-sections will assist in measuring channel form and stream discharge. A total of eight cross sections were documented (four for each meander treated). Monuments were established at each cross section to enable continued monitoring at those exact locations.

Pebble counts were conducted to evaluate the composition of the streambed and the dominant channel material particle size.

The geomorphology monitoring was part of the baseline monitoring, and it continued to be part of the ongoing implementation and effectiveness monitoring. Princeton Hydro and NRCS will utilize these data to determine whether the two meander sections are meeting the criteria set during the design process and whether the stream is functioning within acceptable parameters such as depth and width.

4.3 STEP-L

The **Spreadsheet Tool for Estimating Pollutant Load** (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based

model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices.

As noted in the *Neshanic River Watershed Restoration Plan* the watershed is impaired for aquatic life, phosphorus, total suspended solids (TSS) and copper, and listed on Sublist 5 of the *New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report*. The restoration plan details the management measures needed to achieve the necessary reduction in bacteria and to attain water quality standards for total phosphorus (TP), total suspended solids (TSS), reduce the aquatic life impairments to a non-impaired level, and it outlines the possibility of restoring the base flow of the Neshanic River.

To specifically address the impairment of sediment the Project Team as described *2.4 The Project Team* was assembled to manage the *Walnut Brook Riparian Restoration* project with the anticipation that this would help to reduce the sediment input into the watershed.

Land use changes dramatically alter watershed hydrology. As urban land increases, the impervious surfaces such as rooftops, driveways, additional roads, and parking lots increase while the pervious surfaces such as traditional agricultural lands decrease. The likely outcomes of such changes are decreases in infiltration and groundwater recharge and increases in surface runoff. Urban and suburban development also brings additional roads and stormwater infrastructure such as drainage pipes and ditches with the intention to convey stormwater away from individual properties as quickly as possible. Tile drainage and swale infrastructure are also developed in agricultural lands to quickly disperse agricultural runoff from agricultural fields. In general, agricultural and urban development lead to flashy watershed hydrology, in which runoff reaches the stream quickly with high energy. This leads to stream bank erosion and unstable channel conditions, and the contribution of additional sediment to the stream and degradation of stream habitat.

4.3.1 Sediment

Sediment in streamflow is measured by Total Suspended Solids (TSS) and is a water quality concern in the watershed. The Soil and Water Assessment Tool (SWAT) modeling results indicate that 1,715 tons of sediment is carried away from the watershed by streamflow each year. Multiple assessments indicate streams themselves are the primary source of sediments and contribute 1,021 tons of sediment per year, which accounts for 60 percent of the total annual sediment loads. The sediments could be eroded from the streambanks and resurfaced from the deposited sediments in the stream bed due to the high energy streamflow. The remaining 40 percent of sediments, roughly 694 tons, come from various land uses in the watershed.

4.3.2 Required Load Reductions

NJDEP (2010) designated the Neshanic River and its tributaries as FW2-NT. According to the designated use of FW2-NT from the New Jersey Surface Water Quality Standards (NJAC 7:9B) last amended on January 4, 2010 (42 N.J.R. 68a), the following surface water quality standards are applicable to the pollutants of concern in the Neshanic River and its tributaries:

- *E. coli* shall not exceed a geometric mean of 126 counts per100 milliliter (mL) or a single sample maximum of 235 counts per 100 mL;
- Fecal coliform shall not exceed geometric average of 200 counts per 100 mL, nor shall more than 10 percent of the total samples taken during any 30-day period exceed 400 counts per 100 mL;
- TP shall not exceed 0.1 mg/L;
- TSS shall be less than 40 mg/L; and
- TN shall be below 10 mg/L to protect human health.

For all impaired streams, the U.S. Environmental Protection Agency (EPA) requires the development of Total Maximum Daily Loads (TMDLs) for the pollutants of concern. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Three sets of load duration curves were developed for the watershed. Each set contains five load duration curves for five pollutants, i.e., TSS, TN, TP, fecal coliform and E. coli. The first set of load duration curves are based on observed streamflow and water quality data at the USGS Reaville Gage Station (N1 Station), whose drainage area only contains the upper portion of the watershed. Both TSS and TN satisfy the TMDL water quality goals at the N1 Station. The load reduction targets of 48, 90 and 91 percent for TP, fecal coliform and E. coli, respectively, are required to achieve the specified TMDL goals including MOS and the threshold for the frequency of exceedance at the N1 Station. The second set of load duration curves are based on the streamflow and water quality results simulated by the well-calibrated watershed model SWAT at the N1 station. To satisfy the TMDL requirements, the load reduction targets are 48 percent for TP, 90 percent for fecal coliform and 91 percent for E. coli. There is no reduction for TN and TSS necessary at the N1 station. These pollutant load reduction targets are essentially the same as those based on the monitoring data at the same station. Since there is no observed streamflow and water quality data at the watershed outlet, the third set of load duration curves are only based on the streamflow and water quality results simulated by the SWAT model. The load reduction targets are 9 percent for TSS, 49 percent for TP, 89 percent for both fecal coliform and E. coli in order to meet the TMDL goals at the watershed outlet.

4.3.3 Management Measures to Reduce Nutrient Loads

The complete, *Neshanic River Watershed Restoration Plan,* reports six management measures

that are recommended to reduce nutrient loads to the streams from various sources. In particular the management measure that was applied to this project included:

- Conservation Buffers – Conservation buffers are planned vegetative mixtures of trees, shrubs and grasses placed in landscapes to influence ecological processes and enhance ecosystem goods and services. There are many types of conservation buffers such as contour buffer strips, field borders, grassed waterways, filter strips and riparian forest buffers that should be applied in the watershed wherever appropriate.

4.3.4 Management Measures to Reduce Sediment Loads

The complete, *Neshanic River Watershed Restoration Plan,* reports seven management measures to reduce sediment loads to the streams from various sources. In particular the management measures that were applied to this project included:

- Conservation Buffers – Conservation buffers have multiple water quality benefits and reduce both sediments and nutrient loads to streams. As runoff goes through a conservation buffer, dense vegetation in the buffer acts as a filter, blocking sediments and sediment-absorbed nutrients, pesticides, and pathogens and preventing them from entering streams. Conservation buffers should be installed in proper locations to achieve their optimal effectiveness in improving water quality.
- Streambank stabilization – Streambank erosion contributes significantly to TSS in streams in this watershed. Streambank stabilization can be used as an important measure to reduce streambank erosion, improve water quality, and enhance stream ecology. Although the streambank can be temporarily stabilized through various streambank stabilization measures, permanent stabilization has to be achieved by controlling the amount and velocity of stormwater runoff in the watershed. In order to stabilize the streambanks, any land use activities that disturb the streambank should be prohibited.

After the streambank restoration and riparian buffer planting project was completed, data and information was entered into the STEP-L worksheet. Information entered into the General Watershed Data worksheet included the following: County, State, weather station, HUC-14 number, land use and the soil hydrologic group. Another section focused specifically on the implementation measures focused on the streambank stabilization work. The information captured included: drainage area in acres, drainage area land use, restoration length for right and left bank and lateral recession rate. This information was all entered into the STEP-L excel spreadsheet and an overall BMP Efficiency table was computed. This BMP Efficiency table determines an efficiency rate but it does not equal actual sediment load improvement.

The total load calculated by STEP-L for the watershed by land uses with the associated BMP in place is shown in the table below.

Total load by land uses (with BMP)				
Sources	**N Load (lb/yr)**	**P Load (lb/yr)**	**BOD Load (lb/yr)**	**Sediment Load (t/yr)**
Urban	13578.63	2089.82	52285.62	311.72
Cropland	0.00	0.00	0.00	0.00
Pastureland	0.00	0.00	0.00	0.00
Forest	0.00	0.00	0.00	0.00
Feedlots	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	0.00	0.00	0.00	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	8.11	3.12	16.23	4.41
Groundwater	0.00	0.00	0.00	0.00
Total	13586.74	2092.94	52301.85	316.13

The total load calculated by STEP-L for the subwatershed is shown in the table below. The load for the parameters of Nitrogen (N), Phosphorous (P), Biological Oxygen Demand (BOD) and Sediment were calculated without a BMP.

Total load by subwatershed(s)				
Watershed	**N Load (no BMP)**	**P Load (no BMP)**	**BOD Load (no BMP)**	**Sediment Load (no BMP)**
	lb/year	lb/year	lb/year	t/year
W1	13740.9	2152.3	52610.2	399.9
Total	**13740.9**	**2152.3**	**52610.2**	**399.9**

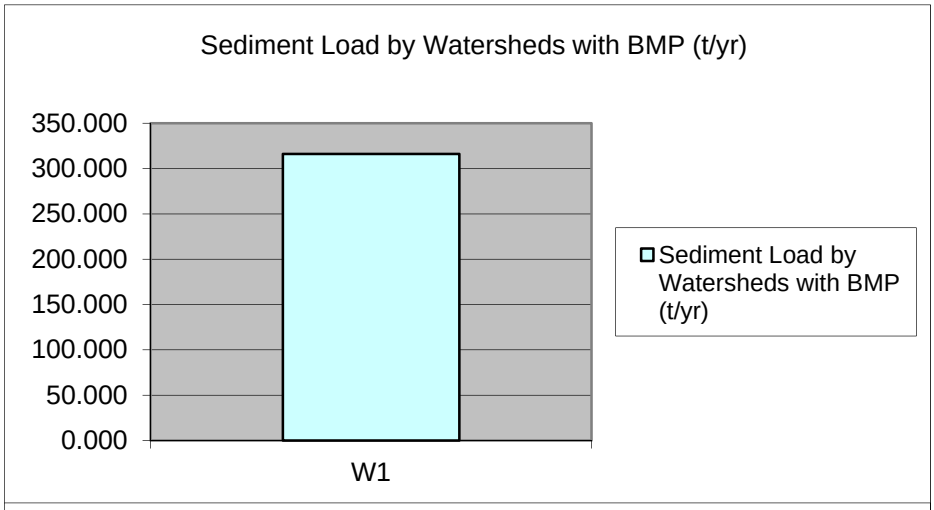
The total load reduction required for N, P, BOD and Sediment are calculated below.

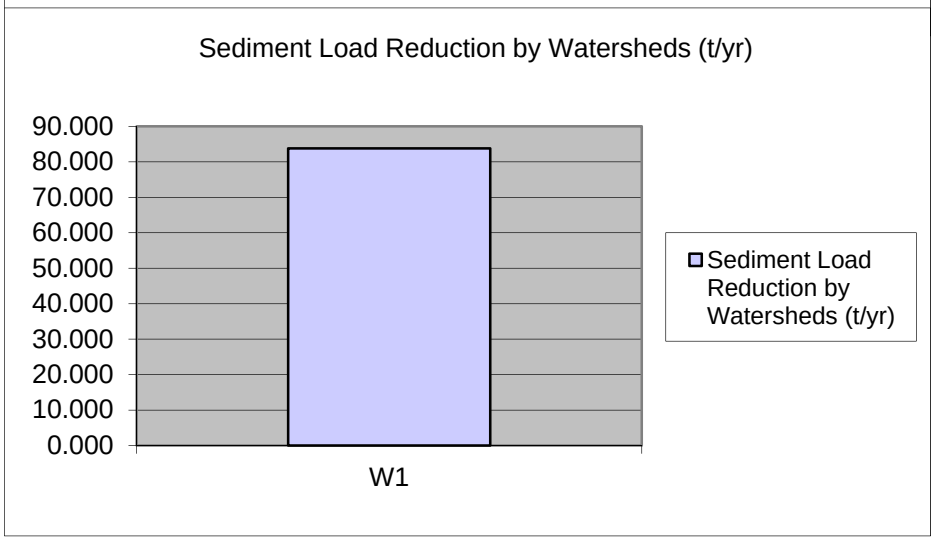
Total load by subwatershed(s)				
Watershed	**N Reduction**	**P Reduction**	**BOD Reduction**	**Sediment Reduction**
	lb/year	lb/year	lb/year	t/year
W1	154.2	59.4	308.3	83.8
Total	**154.2**	**59.4**	**308.3**	**83.8**

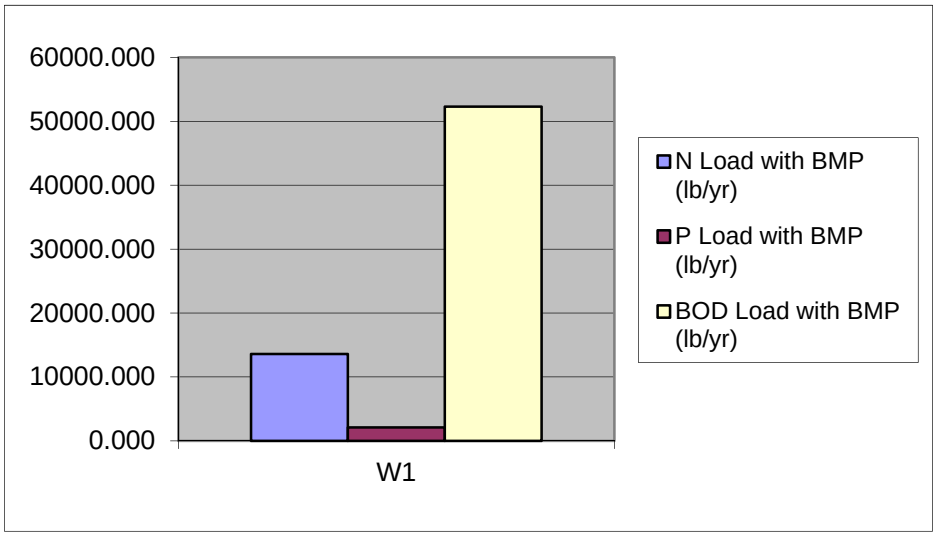
The total load reduction for N, P, BOD and Sediment with the BMP in place is calculated below with the corresponding percent reductions achieved.

Total load by subwatershed(s)

Watershed	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	% Sediment Reduction
	lb/year	lb/year	lb/year	t/year	%	%	%	%
W1	13586.7	2092.9	52301.9	316.1	1.1	2.8	0.6	21.0
Total	**13586.7**	**2092.9**	**52301.9**	**316.1**	**1.1**	**2.8**	**0.6**	**21.0**






60000.000
50000.000
40000.000
30000.000
20000.000
10000.000
0.000
W1
N Load with BMP (lb/yr)
P Load with BMP (lb/yr)
BOD Load with BMP (lb/yr)

5.0 Outreach

Since the project was initially proposed in 2004, North Jersey RC&D and its partners have conveyed information to 500 people through on-site tours, workshops, and presentations. Information about the project has been published in the local newspapers that have 25,000 subscribers. The array of people educated include: community members; HLTA members; HLTA Farmer's Market shoppers; several local environmental and engineering consulting companies as well environmental and engineering companies from Pennsylvania and New York; County and State employees; Raritan Township and Flemington Borough environmental commission and Town Council representatives; U.S. Congressman Leonard Lance; federal agencies such as U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers; corporate organizations; and local business and professional organizations. The Walnut Brook project is contained in the Mine Brook Park and on the Hunterdon Land Trust Dvoor Farm, all publically accessible properties that are open for visitors.

All the great restoration work that was completed on site has been captured in hundreds of photographs and video clips site. Additionally, we were fortunate enough to have a representative from Hunterdon Central T.V. (HCTV) capture hours of video footage of the brook prior to construction as well during active construction. The final product we received, as a donated in-kind product, was a 30-minute video documenting the entire project from 2007 to 2010. This can be viewed from the North Jersey RC&D website.

Other organizations interested in undertaking similar restoration activities, as what North Jersey RC&D has accomplished at the Walnut Brook project site, can locate site specific information on the RC&D website at www.northjerseyrcd.org. We also posted video footage on www.youtube.com and we posted hundreds of photos of progress throughout the life of the project on www.Flickr.com. RC&D will continue to document and showcase the project process from conceptual, to design, to construction at upcoming events.

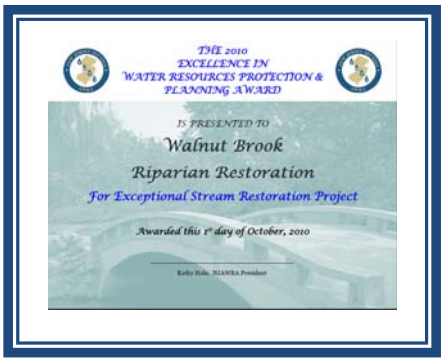
5.1 Awards

After many years of planning, permitting and construction, the Walnut Brook Riparian Restoration project has been fortunate enough to receive numerous awards and accolades.

In 2010 the project received the following awards:

- 2010 NJ Section American Water Resources Association: *Excellence in Water Resources Protection and Planning*

The New Jersey Section American Water Resources Association presented the first annual "Excellence in Water Resources Protection and Planning Awards" on October 1st 2010. The award recipients selected exemplified outstanding projects which are designed to protect and enhance water resources management. The three categories of awards recognized included Storm water management projects, Stream restoration projects, Exceptional water resources management and planning initiatives. The Walnut Brook Riparian Restoration project was given the award for the "stream restoration project". The project was selected because it meets the following criteria:



- Planning and design using a creative new or innovative approach to water resources management and planning
- Innovative site design demonstrating a unique approach in the physical characteristics, representing high standards in site planning and engineering
- Demonstrated cooperation between local officials, applicants, and public thus promoting sound planning and engineering. Significant consideration will be given to nominations that demonstrate public / private partnerships.
- Projects that embody the essence and mission of the NJ section American Water Resources Association.

- 2010 NJ Governor's Environmental Excellence Award: *Healthy Ecosystems*

NJDEP Commissioner Bob Martin, Grace Messinger, Linda Peterson (NRCS), Margaret Waldock (Hunterdon Land Trust), Mark Gallagher (Princeton Hydro), Governor (former) James Florio

This awards program was established in 2000 by the New Jersey Department of Environmental Protection to recongnize outstanding environmental performance, programs and projects in the state. Since its inception, over 100 businesses, individuals, municipalities and institutions have received recogniation.

Healthy Ecosystems Category: this award is presetned to a nominee demonstrating a commitment to and experience in programs or techniques that have resulted in the restoration, protection and enhancemnet of the State's ecological resources: including wetlands, estuaries, coastal areas; and non-game and endanagered species.

- 2010 Hunterdon County Planning and Design Award: *Hermia Lechner Award*

Each year Hunterdon County Planning Board and staff recognize outstanding planning accomplishments in Hunterdon County and the people responsible for them. The Hermia Lechner Award is given to an individual or organization for exceptional planning efforts that promote the conservation of natural resources; may include ordinances, environmental programs, open space plans or other projects that protect the natural environment.

The project was recognized and given the following awards in 2011:

- 2011 Sustainable Raritan Awards: *Remediation and Redevelopment Award*

- 2011 Bowman's Hill Wildflower Preserve Land Ethics Award: Nomination of Excellence

North Jersey RC&D nominated the Walnut Brook Riparian Restoration Project for this award because we felt it was in line with the goal of the award, to honors and recognizes individuals, organizations, government agencies, community groups and business professionals who have made significant contributions to the promotion of native plants and have exhibited a strong land ethic while promoting sustainable designs that protect the environment. Ultimately the project was given

the award; however the review committee felt that the project deserved to be recognized as a 'Nomination of Excellence'. The full nomination was shared on the Bowman's Hill Wildlife Preserve website.

- 2011 Soil and Water Conservation Society Pinelands Nursery sponsored *Environmental Excellence Award*

Each year, the Firman E. Bear Chapter awards an individual contractor, construction company, designer or organization that displays excellence in an ecological restoration project, unique soil and water conservation stabilization project, or innovative habitat development or enhancement project. The presentation of the award will occur at the SWCS annual meeting at the end of November 2011.

5.2 Conferences and Workshops

* 2009: Walnut Brook Stream Stabilization Working Workshop during active week of in-stream construction

In 2009, North Jersey RC&D managed and coordinated the streambank construction with four paid contractors operating machines in conjunction with hosting a *working workshop* whereby we were able to incorporate an educational opportunity with the installation of stabilization practices. During this workshop, RC&D was able to have a renowned Research Hydraulic Engineer from the U.S. Army Corps of Engineers to be on site during the week of construction. During this working workshop important streambank stabilization concepts were conveyed to 42 volunteers that put in over 500 hours of sweat equity to complete the stream construction component of the project. The volunteers, material and professional services donated to this portion of the project to date are valued at $106,000. Volunteers came from as far away as Arkansas and California to take part in our project and to be able to transfer these restoration techniques to their respective parts of the

Volunteers placing rock for LPSTP during June2009 Working Workshop

'Care & Feeding' of June 2009 Working Workshop Volunteers

country.

* 2010 American Water Resources Association Annual Water Resources Conference in Philadelphia PA

In November 2010, North Jersey RC&D presented information regarding the implementation project at the Annual National American Water Resources Conference. The presentation focused specifically on the streambank stabilization and riparian restoration work completed at the site. The project was presented in the Restoration/Mitigation- Streams/Riparian session. There were about 50 people in attendance in this session.

* 2011 New Jersey Floodplain Management/NJ Section American Water Resources Conference

North Jersey RC&D presented at the New Jersey Association of Floodplain Managers annual conference in September 2011. The project was presented under the 'Local floodplain management through the use of innovative techniques and stream restoration'. The presentation is titled: *Walnut Brook: A Floodplain Reconnection Tail.* Approximately 40 people were in attendance for this presentation

* 2011 Northeast Agricultural & Biological Engineering Conference in Vermont

In July, Linda Peterson P.E., NRCS presented "A Model Approach for Restoring Stream Corridors in Urbanizing Areas" at the Northeast Agricultural and Biological Engineering Conference held in Vermont.

NRCS submitted an abstract to present A Model Approach for Restoring Stream Corridors in Urbanizing Areas at the Northeast Agricultural and Biological Engineer conference to be held in South Burlington Vermont in late July. The Northeast Society is in community with the American Society of Agricultural and Biological Engineers (ASABE). ASABE is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. Founded in 1907 and headquartered in St. Joseph, Michigan, ASABE comprises 9,000 members in more than 100 countries.

5.3 Publications and Articles

* 2010 Hunterdon Central TV: Hunterdon Central Regional High School has their own television station. There is professional communications staff working for HCTV. North Jersey RC&D reached out to them to discuss their availability and interest to help document the

construction activities as the Walnut Brook. During the course of about one year, the HCTV staff captured footage from the project site. Interviews were given by Grace Messinger, North Jersey RC&D Project Manager, Dave Derrick, and other volunteers during the week of the Walnut Brook Stream Stabilization Working Workshop. This information was combined with footage after the entire streambank stabilization construction was completed. A 30-minute video was produced for the project. This was aired on the North Jersey RC&D website for many months.

Dave Derrick "teaching" for HCTV Walnut Brook video: June 2009

* Hunterdon County Democrat

October 7, 2010; editorial highlighting the Walnut Brook Riparian Restoration project

July 2, 2009: Photo and caption during construction week at Walnut Brook

* A project display was created for the project that was showcased at the 2010 NJ Governor's Environmental Excellence Awards ceremony

Walnut Brook Riparian Restoration: *A model approach to restoring stream corridors in urbanizing areas*

In 2009, North Jersey RC&D lead a multi-phased stabilization, restoration and creation project along the Walnut Brook in Raritan Township, Hunterdon County. The work was completed in Mine Brook Park and on the Hunterdon Land Trust Dvoor Farm property. Funding support for the project came from NJ Wetlands Mitigation Council, NJDEP Watershed Management Program ($692,000) as well as contributions from project partners, over $106,000 of in-kind services, resources, material and sweat-equity.

The goal of the project is to restore the riparian functions and values of the Walnut Brook. Project objectives included reconnecting the stream to its floodplain, creating and enhancing the riparian buffer, increasing the available flood storage, improving sediment removal within Walnut Brook's riparian floodplain, stabilizing critically eroding sections of the brook, increasing in-stream habitat variability as well as creating a mosaic of wetland habitats.

Stream Stabilization

Project stabilized 1,000 feet along 2 meanders using resistive & re-directive techniques to reduce streambank erosion, reduce high flow velocity and to prevent any further unraveling of channel.

Riparian Restoration

In 2009 and 2010 the contractor and volunteers planted 1,500 native trees and shrubs on the south side of the Walnut Brook.

Trees and shrubs planted include gray dogwood, blackhaw, bayberry and redbud.

The riparian buffer planted will increase shading on the Walnut Brook and further stabilize the banks of the brook.

Wetland Creation

The goal of the project is to store some of the flood waters from the unnamed tributary to the Walnut Brook in the floodplain wetland restoration area and reduce the peak flow timing as the tributary rejoined the Walnut Brook mainstem.

By May 2010, 2.97 acres of forested wetland was created through removal of 9,500 cubic yards of fill. Over 11,000 native wetland herbaceous, trees and shrubs were planted.

Project Partners:

Learn more at www.northjerseyrcd.org or Call Grace Messinger 908-735-0733 ext 110

* 2011 January/February edition: *Land and Water, The Magazine of Natural Resource Management and Restoration*


STREAM STABILIZATION

Walnut Brook Riparian
Restoration Project

Land and Water

An article describing the work completed at the project site was published in the January/February edition of the *Land and Water Magazine*. The *Land and Water Magazine* is published for contractors, landscape architects, consultants and engineers, government officials and those all those individuals involved in natural resource management and restoration, from idea stage through project completion and maintenance. We help our readers gain access to this market by publishing job-site stories, case histories, and the information on the latest developments in the industry. The publication is sent to over 41,000 people and the information is also available on-line. RC&D emailed the information out to about 900 contacts via the Vertical Response.

* 2011 NRCS: Earth Team Volunteer newsletter

* 2011 Mid-Atlantic Chapter, International Erosion Control Association newsletter

North Jersey RC&D was invited to submit an article to the Mid-Atlantic Chapter newsletter for the International Erosion Control Association about the Walnut Brook project. The article was published in the winter newsletter. The International Erosion Control Association is a non-profit, member organization that provides education, resource information and business opportunities for professionals in the erosion and sediment control industry. The association's 3000+ members represent 52 countries and 17 fields of professional practice. IECA's diverse membership supplies a unique network of specialists who are capable of solving a broad range of problems caused by soil and erosion and its by-product ~ sediment.

* Natural Resources Conservation Service All Employees Meeting

North Jersey RC&D created a poster about the project that was displayed at the August 2010 NRCS All Employees meeting. At this meeting, North Jersey RC&D was recognized for the *Most Valuable Use of Volunteers by a Partnership Group* for all the volunteers contributing time via the NRCS Earth Team Volunteer program.

5.4 Events and Site Tours

* Tour with Congressman Lance and local elected officials from Raritan Township & Flemington Borough

In August 2009, North Jersey RC&D coordinated with project partners to host a "Tour" of the newly constructed area to locally elected officials and to Representative Lance. The North Jersey RC&D Watershed Specialist presented information about the project including the history of the project, steps the Project Team took to complete the work, funding sources utilized for the project, total cost of the project, estimated value of in-kind donated materials and volunteer labor and the status of the practices installed along the streambank. For this tour, North Jersey RC&D created a *Walnut Brook Riparian Restoration* fact sheet.

August 2009: U. S. Congressman Lance visits project site along with many local government representatives

* Hunterdon Land Trust Alliance: Twilight Walking Tour, Harvest Festival 2009 & 2010

Princeton Hydro and North Jersey RC&D lead a tour of the project site for the community during the HLTA Famer's Market Harvest Festival day on September 13th 2009. There were 2 HLTA board members on the tour in addition to 8 people from the community.

North Jersey RC&D and NRCS Wildlife Biologist led a walking tour of the project area for six people and showed them the Walnut Brook movie during the September 23, 2010 *Twilight Walking Tour*.

On May 22, 2011, North Jersey RC&D lead a walking tour of the project site during the Hunterdon Land Trust Dvoor Farm Famer's Market. Seven people participated in the talk and walk to the project site. The project poster was displayed at the Farmer's Market.

On May 26, 2011, North Jersey RC&D lead a walking tour for four people in conjunction with the Hunterdon County Green Table. Participants were toured around the project site.

* Flemington Rotary Club presentation

* Rutgers Wetland Ecology Class: 2010 & 2011

In October 2010 and September 2011, North Jersey RC&D lead a tour of the project site for the Rutgers University Wetland Ecology class. Between the two classes 36 students toured the project site and received a project fact sheet.

* NJ Section American Water Resources Association: Stream Restoration Committee

In September 2009, North Jersey RC&D lead a tour of the project site to members of the NJ American Water Resources Association (AWRA) the Stream Restoration Committee at the end of September. There were 5 AWRA members in attendance.

* NJDEP-AmeriCorps Watershed Ambassador Program 2010

On November 3, 2010, North Jersey RC&D gave a presentation, showed the Walnut Brook movie and gave a brief tour of project site to the 2010-2011 AmeriCorps NJ Watershed Ambassadors and associated NJDEP staff at their monthly meeting. There were 24 members and NJDEP staff in attendance.

* Hunterdon County Green Table: 2011

6.0 Conclusion

This was an enormous project that was accomplished with the assistance and support of many individuals, organizations and funders. A project of this magnitude can only be accomplished and considered a huge success through the support of the partners. Even though the project had many obstacles to overcome, the Project Team feels it addressed those obstacles in new and innovative ways. All in all the project can be considered as successful, however the Project Team is fully aware that this project is just one component of a natural resource concern that requires continual improvement and protection. This project almost succeeded in completely meeting the original objectives with the original budget, once the budget was increased in 2009. The Project Team believes that the costs to implement this project were kept in check due to the assistance and resourcefulness of the design engineers and the experienced contractors.

A few points to keep in mind that the Project Team accomplished were that we made contact with the local regulatory agencies. We meet with the NJ DEP Division of Land Use Regulation prior to formally submitting the design plan for permit approval. Additional we invited representatives from the NJDEP Division of Land Use Regulation to participate in the June 2009 Working Workshop activities.

6.1 Lessons Learned

A number of valuable lessons were learned during this project.

Lesson #1: Streams are constantly changing, in other words, what was once "existing conditions" at the site may not be "existing conditions" when construction begins. During the pre-construction meeting, the plans were reviewed with the contractor and the design team and several key differences were noted from the original survey. In the case of Meander #1, the entire stream had migrated more than fifty feet to a former stream channel and several modifications were necessary in the field to accommodate the migration. This kind of project lends itself well to the design-build process, particularly for providing flexibility during construction. Be flexible, but do not work outside of the original work limits.

Lesson #2: Your first instinct is sometimes right! Several times during the course of construction in-field decisions were made resulting in modifications to the initial design plan. Often times, these quick decisions ended up in design changes that added additional material and construction costs. In some cases, these costs could have been avoided. Spend time and money up front with very detailed site surveys.

Lesson #3: When visiting a project site and working on a stabilization or restoration design keep in mind how you access the site throughout the phases of construction and in the future for maintenance and monitoring. The access road initially planned for the project was not sufficient to meet the needs during construction and therefore the time and cost to complete this was greater than expected.

References

Environmental Report for Walnut Brook Riparian Restoration Project, prepared by Princeton Hydro, LLC, March 2008

Engineering Design Report for Walnut Brook Riparian Restoration Project, prepared by Princeton Hydro, LLC, March 2008

Floodplain Delineation Report for the Walnut Brook Riparian Restoration Project, prepared by Princeton Hydro, LLC, March 2008

Neshanic River Watershed Restoration Plan, prepared by New Jersey Institute of Technology, May 2011. In fulfillment of the requirement of the Clean Water Act 319(h) Grant "Developing a Watershed Restoration Plan for the Neshanic River Watershed" Supported by the former Division of Watershed Management at New Jersey Department of Environmental Protection (Grant Contract #RP06-068).

Appendix A

Walnut Brook Design Drawings

WALNUT BROOK
RIPARIAN RESTORATION PLAN

TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

GENERAL NOTES:

1. ALL ELEVATIONS AND QUANTITIES ARE BASED ON IN-SITU CONDITIONS. ONCE DISTURBED, MATERIAL CONDITIONS CAN VARY SIGNIFICANTLY.

2. THE APPROVAL AND USE OF THESE PLANS ARE FOR THE PROJECT APPLICANT AS DEPICTED ON THIS SHEET. THIS PLAN IS NOT TO BE UTILIZED IN THE PREPARATION OF ANY OTHER PROJECTS.

3. AS FIELD CONDITIONS MAY REQUIRE MODIFICATIONS TO PROPOSED TOPOGRAPHIC ELEVATIONS AND FACILITY LOCATIONS, THESE PLANS ARE NOT TO BE UTILIZED AS AS-BUILTS.

4. THESE PLANS ARE NOT TO BE UTILIZED FOR CONSTRUCTION, UNTIL ALL REQUIRED LOCAL, STATE, AND FEDERAL PERMITS ARE OBTAINED.

5. ALL PROPOSED CONSTRUCTION MUST BE SUPERVISED BY A PROFESSIONAL ENGINEER, LICENSED IN THE STATE OF NEW JERSEY, OR BY A DULY AUTHORIZED PROJECT TEAM REPRESENTATIVE.

CONSTRUCTION NOTES:

1. SOIL, ROCK, OR OTHER MATERIALS TO BE UTILIZED FOR FILLING OR BACKFILLING SHALL BE APPROVED BY A QUALIFIED GEOTECHNICAL ENGINEER, OR BY A DULY AUTHORIZED PROJECT TEAM REPRESENTATIVE.

2. ALL MATERIALS SHALL CONFORM TO THE LATEST AMERICAN STANDARDS FOR TESTING AND MATERIALS SPECIFICATIONS (ASTM).

3. PROXIMITY OF STOCKPILES TO THE EDGE OF EXCAVATIONS SHALL BE SUCH THAT THE INFLUENCE OF THE STOCKPILE SURCHARGE ON THE MODIFIED OR EXISTING SLOPE IS REDUCED. WHERE POSSIBLE, STOCKPILES WILL BE PLACED AT A DISTANCE FROM THE EDGE OF EXCAVATION EQUAL TO (OR GREATER THAN) THE HEIGHT OF THE EDGE.

4. UTILITIES SHALL BE LOCATED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

5. NECESSARY PRECAUTIONS SHALL BE TAKEN BY THE CONTRACTOR TO PROTECT EXISTING SERVICES AND MAINS. ANY DAMAGE TO EXISTING SERVICES OR MAINS SHALL BE REPAIRED IMMEDIATELY AT THE CONTRACTOR'S OWN EXPENSE.

6. EXCAVATIONS AND STOCKPILES IN NO WAY SHALL HAVE SLOPES STEEPER THAN 2:1.

7. THE CONTRACTOR SHALL NOTE THAT IN THE CASE OF A DISCREPANCY BETWEEN THE SCALED AND THE FIGURED DIMENSIONS SHOWN ON THESE PLANS, THE FIGURED DIMENSIONS SHALL APPLY.

8. IT SHALL BE DISTINCTLY UNDERSTOOD THAT FAILURE TO MENTION SPECIFICALLY ANY WORK THAT WOULD NORMALLY BE REQUIRED TO COMPLETE THE PROJECT, SHALL NOT RELIEVE THE CONTRACTOR'S RESPONSIBILITY TO PERFORM THAT WORK.

9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND REPLACEMENT OF FENCES, SIGNS, STRUCTURES, VEGETATION, IRRIGATION, LANDSCAPING COMPONENTS, AND ANY OTHER PROPERTY ITEMS THAT ARE REMOVED OR DAMAGED FOR THE PURPOSES OF THE PROJECT LOGISTICS AND ACCIDENTS.

CONSTRUCTION SAFETY AND SECURITY:

1. ALL CONSTRUCTION SHALL ADHERE TO OSHA STANDARDS AND REGULATIONS.

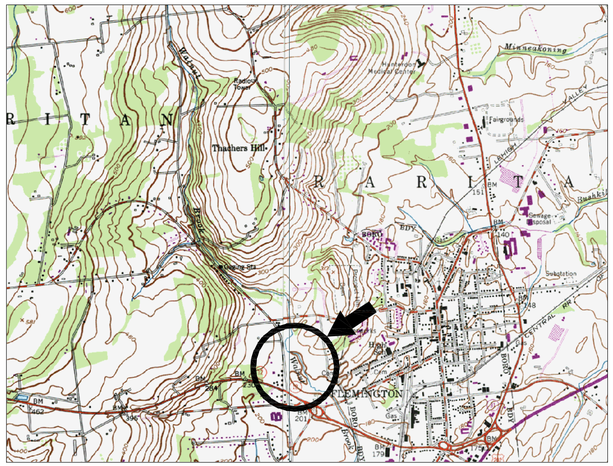
BENCHMARKS AND CONTROL POINTS:

CONCRETE MONUMENT #2 (CM#2): ELEVATION = 202.68
BENCHMARK SET BY HERITAGE CONSULTING ENGINEERS. CONCRETE MONUMENT SET FLUSH WITH GROUND AT SOUTHWEST PROPERTY CORNER OF MINE BROOK PARK OFF OLD CROTON ROAD. ELEVATION IS BASED ON NAVD 88, BM USGS MONUMENT #10563 (ELEVATION 210.224) LOCATED AT THE INTERSECTION OF ROUTE 12 AND OLD CROTON ROAD.

TBM #1: ELEVATION = 195.12
PK NAIL SET IN BASE OF 18-INCH HICKORY TREE ON SOUTH SIDE OF TREE, WEST SIDE OF WALNUT BROOK.

ALL ELEVATIONS ARE RELATIVE TO CONCRETE MONUMENT #2 AND WERE DETERMINED IN THE FIELD BY USDA-NRCS PERSONNEL IN MAY 2007. REFER TO SHEET 3 OF 14 FOR BENCHMARK LOCATIONS.

1 PROJECT SITE LOCATION
2002 AERIAL PHOTOGRAPH
SCALE: 1" = 300'



2 PROJECT VICINITY
SCALE: 1" = 2000'
USGS QUADRANGLE
7.5 MINUTE SERIES
FLEMINGTON, NJ

SHEET INDEX:

PROJECT APPLICANT:

NORTH JERSEY RESOURCE CONSERVATION AND DEVELOPMENT
54 OLD HIGHWAY 22, SUITE 201
CLINTON, NJ 08809

PROJECT CO-APPLICANT:

NJDEP - DIVISION OF WATERSHED MANAGEMENT
401 EAST STATE STREET
P.O. BOX 418
TRENTON, NJ 08625-0418

LAND OWNERS:

HUNTERDON LAND TRUST ALLIANCE
56 MAIN STREET, SUITE 2E
FLEMINGTON, NJ 08822

RARITAN TOWNSHIP
1 MUNICIPAL DRIVE
FLEMINGTON, NEW JERSEY 08822

CALL BEFORE YOU DIG!
NEW JERSEY LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE – STOP CALL
NEW JERSEY ONE CALL SYSTEM, INC.
REFERENCE NEW JERSEY TITLE 48, CHPT. 2, ARTICLE 9
1-800-272-1000

PROJECT NOTES

1. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) STATE PLANE NEW JERSEY (FIPS 2900), FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM (NAVD 88), FEET.

2. TOPOGRAPHIC INFORMATION OBTAINED FROM FIELD SURVEY CONDUCTED BY USDA-NRCS PERSONNEL IN MAY, 2007. BOUNDARY SURVEY FOR BLOCK 49, LOT 2 PREPARED BY NRCS OCTOBER 30, 2006 AND OBTAINED IN DIGITAL FORMAT NOVEMBER 2, 2006.

3. PROPERTY LINE INFORMATION AS BOUNDARY INFORMATION IS BASED ON A PLAN ENTITLED " SUBDIVISON OF LANDS FOR FLEMINGTON/RARITAN RECREATION COMMITTEE" PREPARED BY HERITAGE CONSULTING ENGINEERS DATED JULY, 1982 AND MINOR SUBDIVISON FOR LOT LINE ADJUST FOR BLOCK 49 LOT 2 PREPARED BY RARITAN TOWNSHIP ENGINEERING DEPARTMENT DATES 10/13/99, AS OBTAINED IN DIGITAL FORMAT FROM RARITAN TOWNSHIP.

4. WETLAND DELINEATION CONDUCTED BY PRINCETON HYDRO PERSONNEL IN APRIL 2007.

5. MONITORING WELLS INSTALLED BY PRINCETON HYDRO PERSONNEL ON JANUARY 17, 2008.

DATE	DESCRIPTION

REVISIONS

STATE OF NEW JERSEY CERTIFICATE OF AUTH. NO.: 24GA27976600

MARY L. PAIST-GOLDMAN
Professional Engineer
NJ Lic. No. GE-45798

DATE

PRINCETON HYDRO, LLC
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1108 OLD YORK ROAD, SUITE 1
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FAX. 908.237.5666
WWW.PRINCETONHYDRO.COM

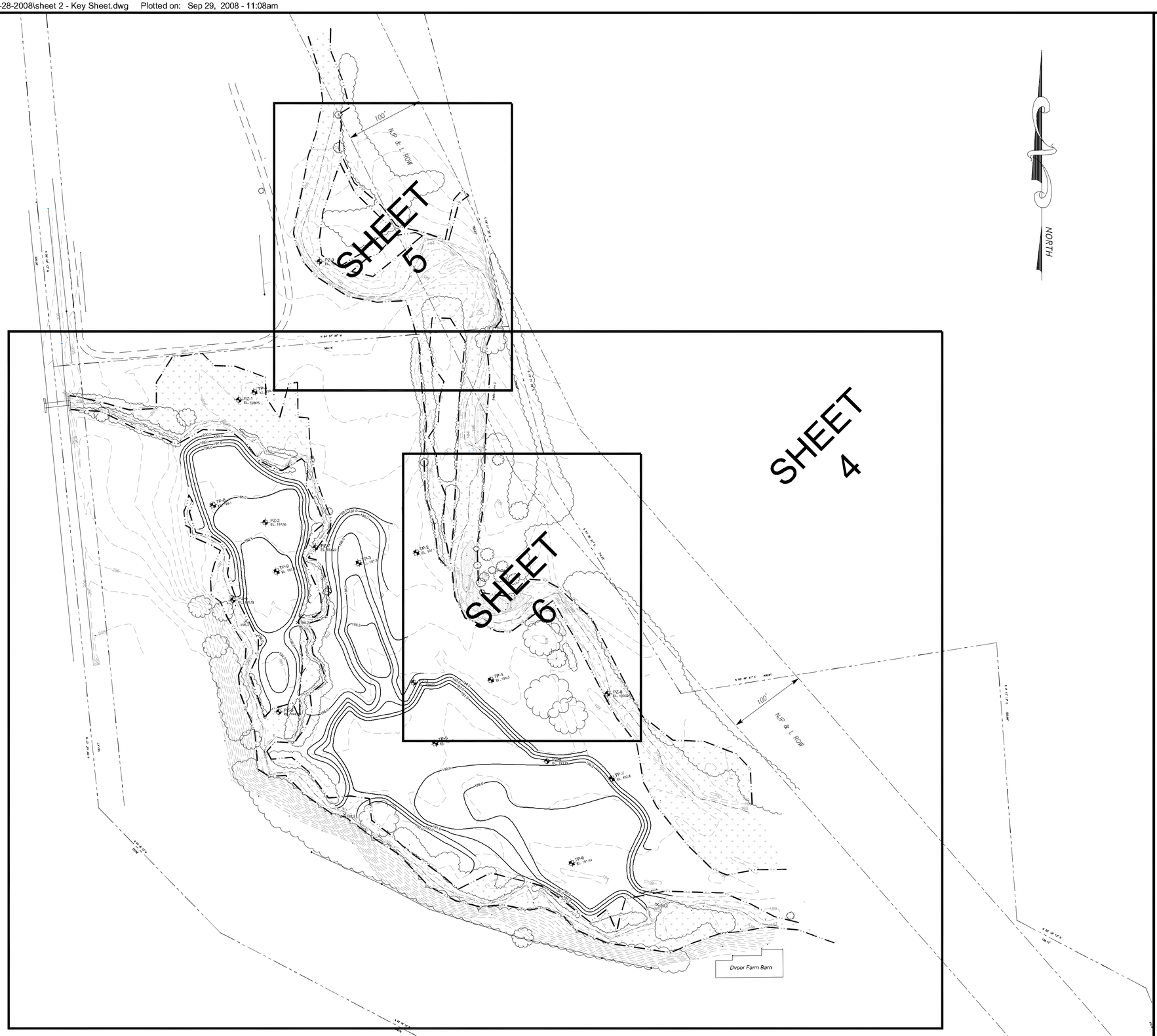
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
TITLE SHEET

DATE:	3/27/08
PROJECT NO.:	0600.003
SCALE:	AS SHOWN
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 1 OF 14

Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 2 - Key Sheet.dwg Plotted on: Sep 29, 2008 - 11:08am



GRAPHIC SCALE

0 15 30 45 60 120 180 240 FEET

SCALE: 1" = 60'

CALL BEFORE YOU DIG!
NEW JERSEY LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE – STOP CALL
NEW JERSEY ONE CALL SYSTEM, INC.
REFERENCE NEW JERSEY TITLE 48, CHPT. 2, ARTICLE 9
1-800-272-1000

PROJECT NOTES

1. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) STATE PLANE NEW JERSEY (FIPS 2900), FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM (NAVD 88), FEET.

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4. WETLAND DELINEATION CONDUCTED BY PRINCETON HYDRO PERSONNEL IN APRIL 2007.

5. MONITORING WELLS INSTALLED BY PRINCETON HYDRO PERSONNEL ON JANUARY 17, 2008.

DATE	DESCRIPTION

REVISIONS

STATE OF NEW JERSEY CERTIFICATE OF AUTH. NO.: 24GA27976800

MARY L. PAIST-GOLDMAN
Professional Engineer
NJ Lic. No. GE-45798

DATE

PRINCETON HYDRO, LLC

SCIENTISTS AND ENGINEERS
1108 OLD YORK ROAD, SUITE 1
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PHONE. 908.237.5660
FAX. 908.237.5666
WWW.PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
KEY SHEET

DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 60'
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO.
2 OF 14

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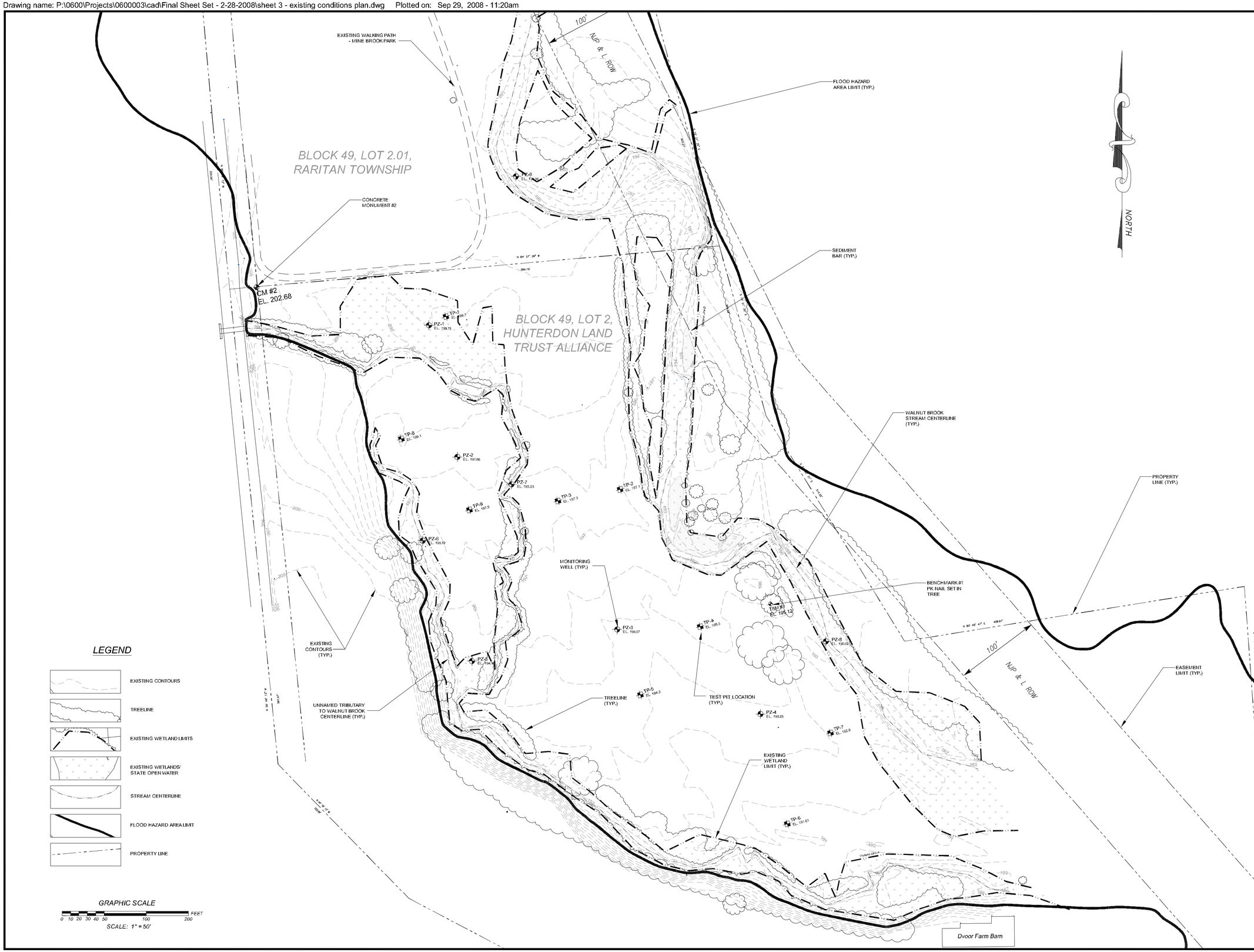

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REVISIONS

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PHONE. 908.237.5660
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WWW.PRINCETONHYDRO.COM

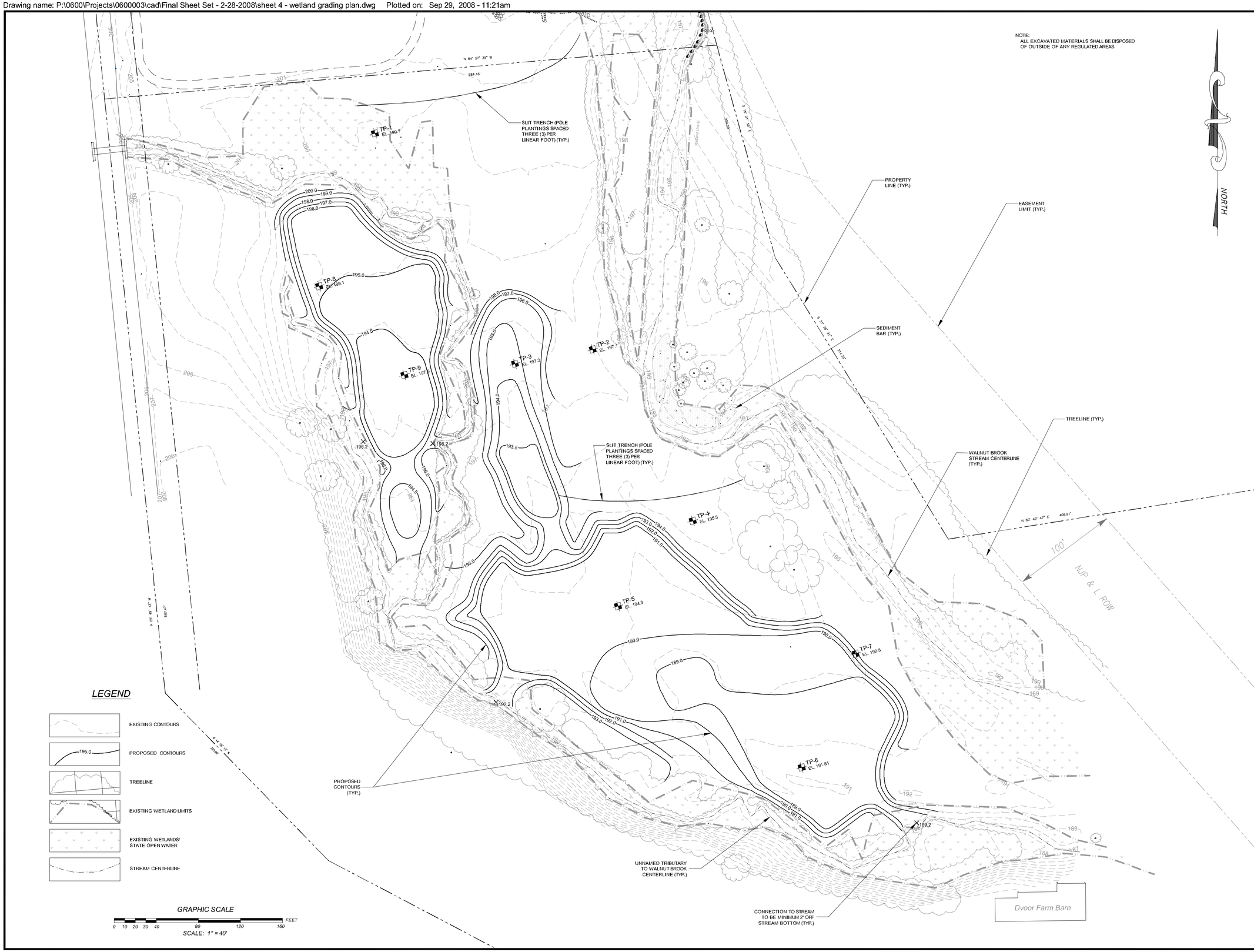
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
EXISTING CONDITIONS

DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 50'
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 3 OF 14

Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 4 - wetland grading plan.dwg Plotted on: Sep 29, 2008 - 11:21am



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1-800-272-1000

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DATE	DESCRIPTION
06/06/2008	REVISIONS AS PER NJDEP COMMENTS

REVISIONS

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WWW.PRINCETONHYDRO.COM

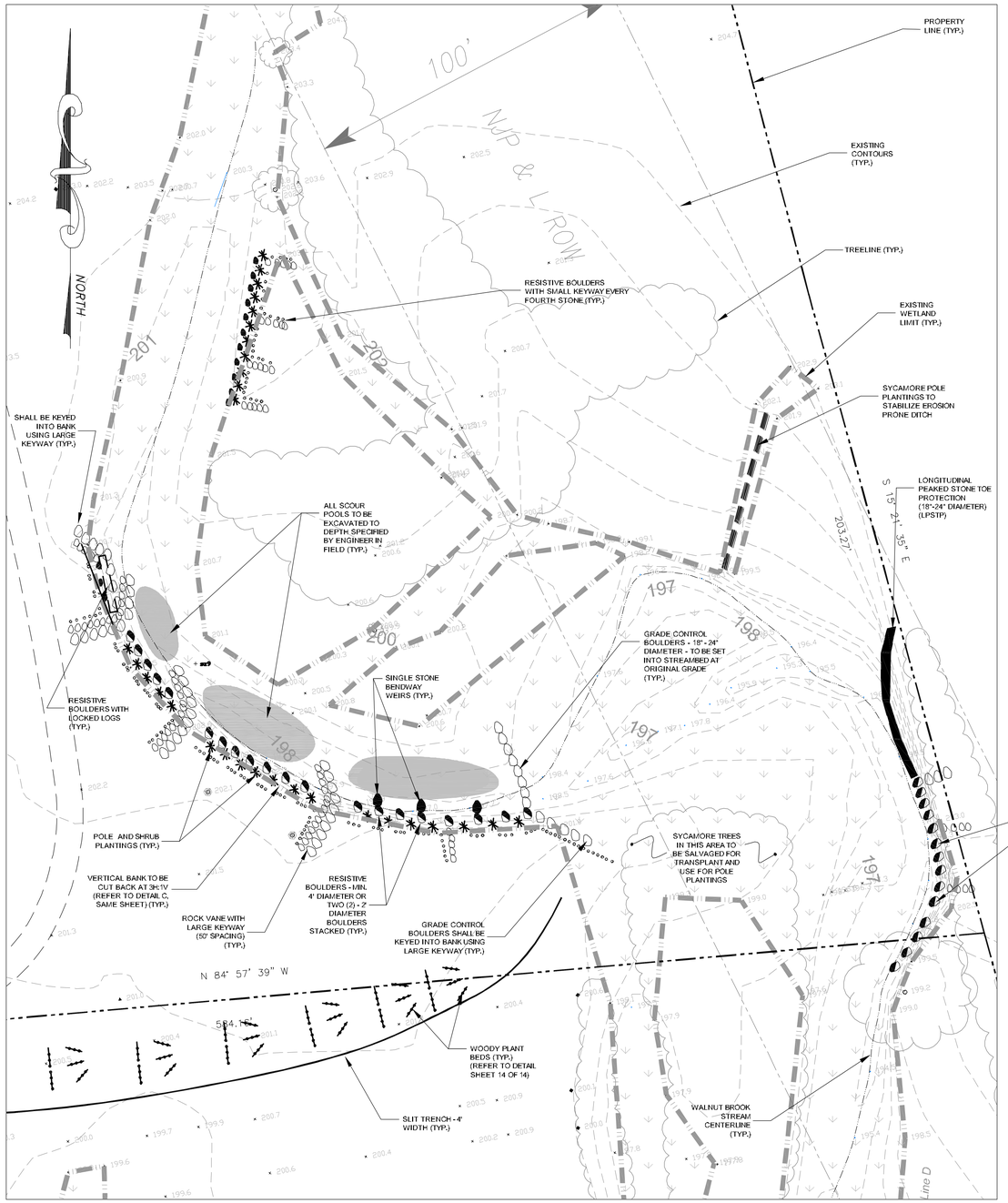
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
WETLAND
GRADING PLAN

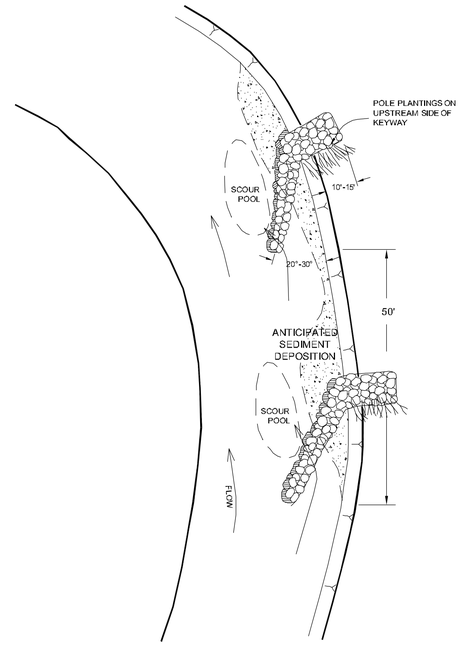
DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 40'
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 4 OF 14

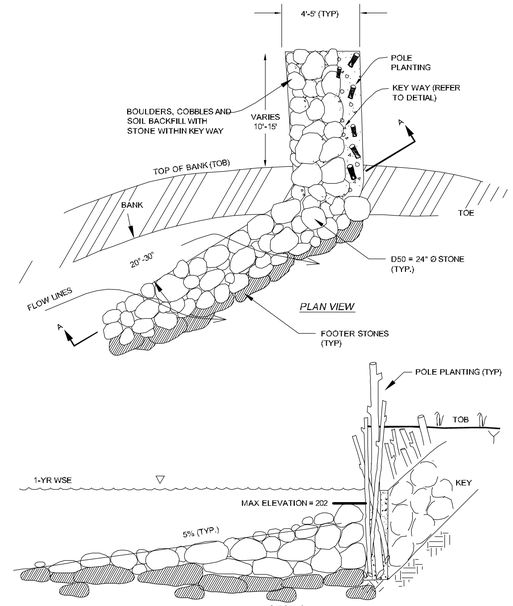
Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 5 - grading meander 1 plan.dwg Plotted on: Sep 29, 2008 - 11:22am



1 UPSTREAM MEANDER (#1)
PROPOSED STREAM/BANK STABILIZATION
SCALE: 1" = 20'



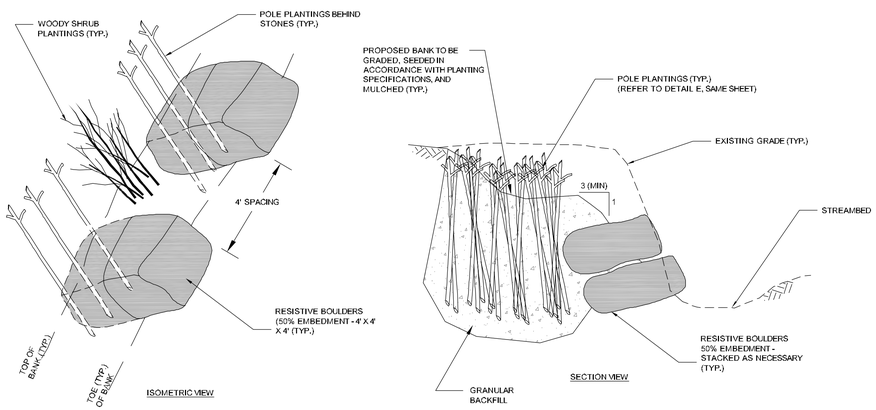
A TYPICAL VANE
(WITH POLE PLANTING)
NOT TO SCALE



NOTES:

1. RELATIVELY LARGE, FLAT FOOTER ROCKS SHOULD BE PLACED 2 VANE ROCK DIAMETERS BELOW THE VANE ROCKS. 2 INORDINATE SCOUR CAN BE MITIGATED BY PLACING A STONE OR GEOTEXTILE UNDER LAYMENT, OR BY USING SELF-LAUNCHING (GRADED) STONE.

B TYPICAL VANE BANK KEY DETAIL
(WITH POLE PLANTING)
NOT TO SCALE



C RESISTIVE BOULDERS WITH SLIT TRENCH
NOT TO SCALE

LEGEND

- EXISTING CONTOURS
- EXISTING WETLANDS/ STATE OPEN WATER
- TREELINE
- STREAM CENTERLINE
- EXISTING WETLAND LIMITS
- SINGLE STONE BENDWAY WEIRS
- RESISTIVE BOULDERS
- LIVE SILTATION PLANTINGS
- WOODY PLANTINGS

GRAPHIC SCALE

0 5 10 15 20 40 60 80 FEET

SCALE: 1" = 20'

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1-800-272-1000

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DATE	DESCRIPTION
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FAX. 908.237.5666
WWW.PRINCETONHYDRO.COM

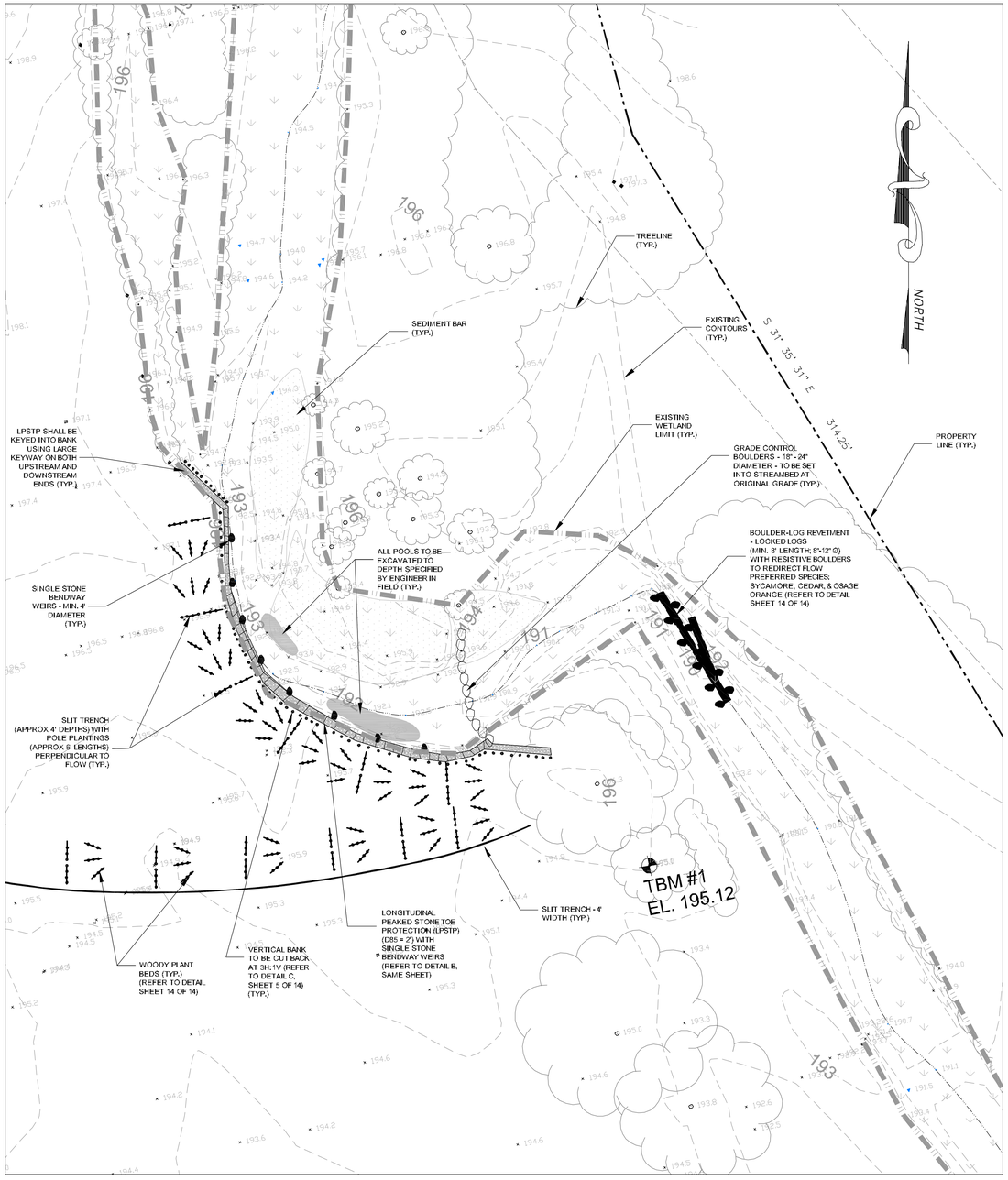
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

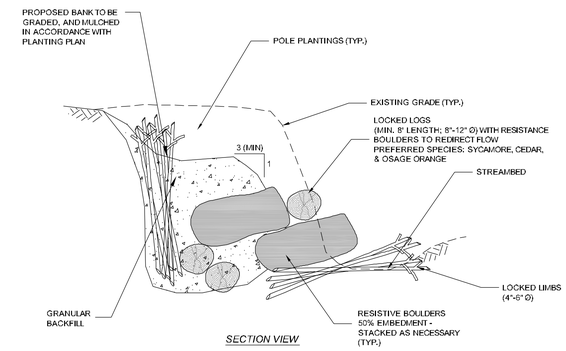
DRAWING NAME:
STREAMBANK STABILIZATION
MEANDER #1

DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 20'
DRAWN BY:	BWB
CHECKED BY:	MPG

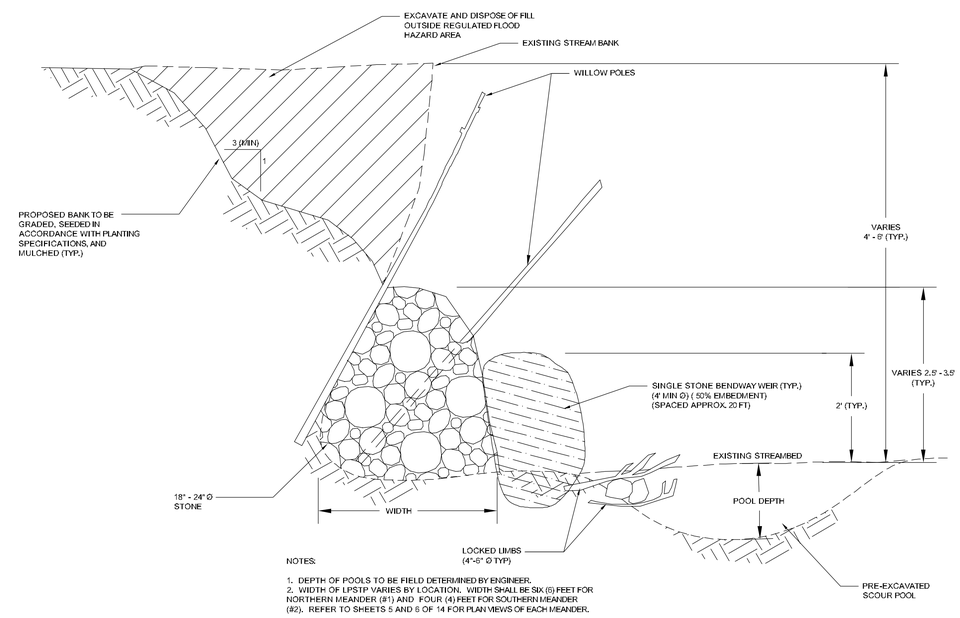
SHEET NO.
5 OF 14

Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 6 - grading meander 2 plan.dwg Plotted on: Sep 29, 2008 - 11:23am





A BOULDER - LOG REVETMENT
NOT TO SCALE



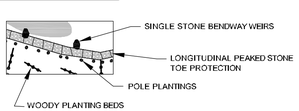
NOTES:

1. DEPTH OF POOLS TO BE FIELD DETERMINED BY ENGINEER.
2. WIDTH OF LPSTP VARIES BY LOCATION. WIDTH SHALL BE SIX (6) FEET FOR NORTHERN MEANDER (#1) AND FOUR (4) FEET FOR SOUTHERN MEANDER (#2). REFER TO SHEETS 5 AND 6 OF 14 FOR PLAN VIEWS OF EACH MEANDER.

B LPSTP WITH SINGLE STONE BENDWAY WEIR
NOT TO SCALE

LEGEND

- EXISTING CONTOURS
- EXISTING WETLANDS/ STATE OPEN WATER
- TREELINE
- STREAM CENTERLINE
- EXISTING WETLAND LIMITS



2 DOWNSTREAM MEANDER (#2)
PROPOSED STREAMBANK STABILIZATION
SCALE: 1" = 20'

GRAPHIC SCALE

0 5 10 15 20 40 60 80 FEET

SCALE: 1" = 20'

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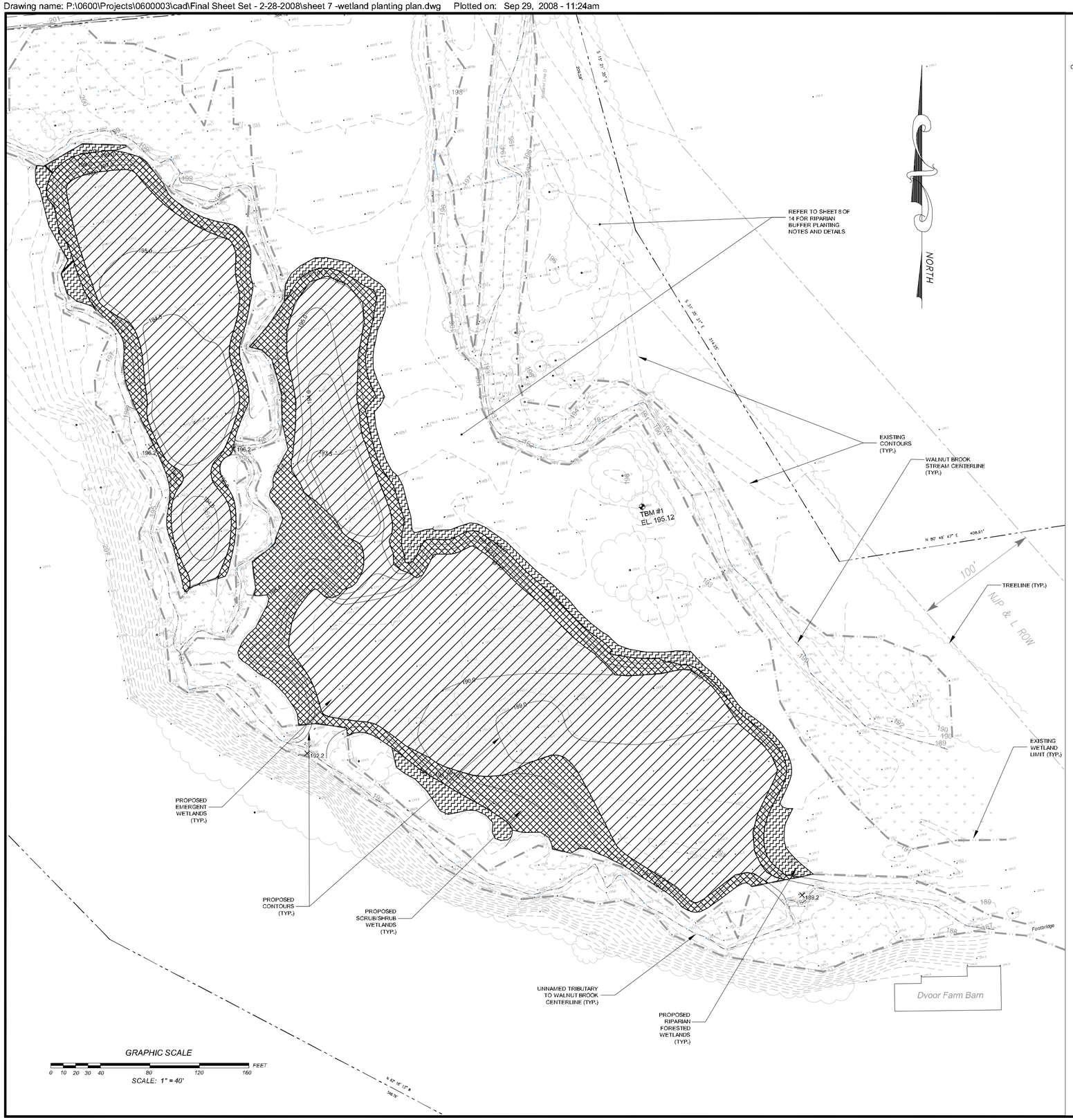
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
STREAMBANK STABILIZATION FOR MEANDER #2

DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 20'
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 6 OF 14

Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 7 -wetland planting plan.dwg Plotted on: Sep 29, 2008 - 11:24am



PLANTING PLAN

OBJECTIVE: THE PLANTINGS PROPOSED FOR THE DVOOR FARM WETLAND MITIGATION PROJECT WERE SELECTED TO FACILITATE THE ESTABLISHMENT OF A SPECIES RICH FLOODPLAIN WETLAND COMMUNITY. THE PROPOSED PLANTING PLAN IS DESIGNED TO ESTABLISH A SPECIES RICH COMMUNITY COMPOSED OF NATIVE HERBACEOUS, SHRUB AND TREE SPECIES.

EW EMERGENT WETLANDS (2.02 ACRES)

THE EMERGENT SPECIES WILL BE PLANTED AT A DENSITY OF THREE FOOT ON CENTER. THE DISTRIBUTION OF THE VARIOUS PROPOSED EMERGENT SPECIES WILL BE BASED ON THEIR INDIVIDUAL MOISTURE REQUIREMENTS AND SITE CONDITIONS. IT IS ANTICIPATED THAT THE EMERGENT WETLAND AREAS OF THE SITE WILL BE INUNDATED FOR EXTENDED PERIODS OF TIME; THEREFORE THESE AREAS WILL ONLY BE PLANTED WITH EMERGENT SPECIES. ALL WETLAND AREAS DISTURBED AS A RESULT OF PROJECT ACTIVITIES WILL BE PLANTED WITH A WETLAND SEED MIX. THE SEED WILL BE LIGHTLY RAKED IN AND COVERED WITH STRAW MULCH. THE SPECIES TO BE PLANTED WILL INCLUDE THE FOLLOWING:

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
TUSSOCK SEDGE	*CAREX STRICTA*	OBL	PEAT POT/PLUGS	1500
SHALLOW SEDGE	*CAREX LURIDA*	OBL	PEAT POT/PLUGS	1500
SOFT RUSH	*JUNCUS EFFESUS*	FACW+	PEAT POT/PLUGS	1500
WOOL GRASS	*SCIRPUS CYPERINUS*	FACW+	PEAT POT/PLUGS	1500
RICE CUTGRASS	*LEERSIA ORYZOIDES*	OBL	PEAT POT/PLUGS	1500
BONESET	*EUPATORIUM PERFOLIATUM*	FACW+	PEAT POT/PLUGS	500
JOE PYE WEED	*EUPATORIUM MACULATUM*	FACW	PEAT POT/PLUGS	500
NEW YORK IRONWEED	*VERNONIA NOVEBORACENSIS*	FACW+	PEAT POT/PLUGS	500
MONKEY FLOWER	*MIMULUS RINGENS*	OBL	PEAT POT/PLUGS	500
SWAMP MILKWEED	*ASCLEPIAS INCARNATA*	OBL	PEAT POT/PLUGS	500

SSW SCRUB/SHRUB WETLANDS (0.75 ACRES)

THE SCRUB SHRUB SPECIES WILL BE PLANTED AT A DENSITY OF APPROX SIX FOOT ON CENTER. COMMUNITY WILL BE ESTABLISHED ALONG THE BORDERS OF THE EMERGENT WETLANDS. THE SPECIES SELECTED ARE COMMON COMPONENTS OF THE FLOODPLAIN SCRUB/SHRUB COMMUNITIES IN THE REGION. THE SPECIES TO BE PLANTED WILL INCLUDE THE FOLLOWING:

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
RED OSIER DOGWOOD	*CORNUS SERICEA*	FACW+	2 GAL CONTAINERS	135
SMOOTH ALDER	*ALNUS SERRULATA*	OBL	2 GAL CONTAINERS	135
ARROWOOD	*VIBURNUM DENTATUM*	FAC	2 GAL CONTAINERS	135
COMMON ELDERBERRY	*SAMBUCUS CANADENSIS*	FACW-	2 GAL CONTAINERS	135
BUTTONBUSH	*CEPHALANTHS OCCIDENTALIS*	OBL	2 GAL CONTAINERS	135
WINTERBERRY	*ILEX VERTICALLATA*	FACW+	2 GAL CONTAINERS	135
PUSSY WILLOW	*SALIX DISCOLOR*	FACW	2 GAL CONTAINERS	135

RFW RIPARIAN FORESTED WETLANDS (0.20 ACRES)

THIS COMMUNITY WILL BE ESTABLISHED IN RELATIVELY HIGHER LANDSCAPE POSITIONS WITHIN WETLAND ENHANCEMENT AREAS. THE PLANTS PROPOSED WERE SELECTED TO FACILITATE THE ESTABLISHMENT OF A FLOODPLAIN FOREST COMMUNITY. THE DESIGN PROPOSED IS TO BE PLANTED WITH A MIX OF SHRUB AND TREE SPECIES. TREES WILL BE PLANTED TEN FOOT ON CENTER AND SHRUBS 8 FOOT ON CENTER. THE SPECIES TO BE PLANTED WILL INCLUDE THE FOLLOWING:

TREE

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
PIN OAK	*QUERCUS PALUSTRIS*		7 GAL CONTAINER	22
GREEN ASH	*FRAXINUS PENNSYLVANICA*		7 GAL CONTAINER	22
RIVER BIRCH	*BETULA NIGRA*		7 GAL CONTAINER	22
SILVER MAPLE	*ACER SACCHARINUM*		7 GAL CONTAINER	22

SHRUBS

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
RED OSIER DOGWOOD	*CORNUS SERICEA*	FACW+	2 GAL CONTAINER	17
SMOOTH ALDER	*ALNUS SERRULATA*	OBL	2 GAL CONTAINER	17
ARROWWOOD	*VIBURNUM DENTALUM*	FAC	2 GAL CONTAINER	17
COMMON ELDERBERRY	*SAMBUCUS CANADENSIS*	FACW-	2 GAL CONTAINER	17
BUTTONBUSH	*CEPHALANTHS OCCIDENTALIS*	OBL	2 GAL CONTAINER	17
WINTERBERRY	*ILEX VERTICILLATA*	FACW+	2 GAL CONTAINER	17
PUSSY WILLOW	*SALIX DISCOLOR*	FACW	2 GAL CONTAINER	17
STEEPLBUSH	*SPIREA LATIFOLIA*	FACW	1 GAL CONTAINER	17

PROPOSED WETLAND SEED MIX

THE WETLAND SEED MIX IS TO BE USED THROUGHOUT ANY CREATED OR DISTURBED WETLAND AREA.

SPECIES NAME:	BOTANICAL NAME:	APPROXIMATE RATE (LBS PURE LIVE SEED/ACRE):
SWITCH GRASS	*PANICUM VIRGATUM*	3
SMOOTH PANIC GRASS	*PANICUM DICHOTOMIFLORUM*	5
BARNYARD GRASS	*ECHINOCLOA MURICATA*	2

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DAYS IN DESIGN STAGE – STOP CALL
NEW JERSEY ONE CALL SYSTEM, INC.
REFERENCE NEW JERSEY TITLE 48, CHPT. 2, ARTICLE 9
1-800-272-1000

PROJECT NOTES

1. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) STATE PLANE NEW JERSEY (FIPS 2900), FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM (NAVD 88), FEET.

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3. PROPERTY LINE INFORMATION AS BOUNDARY INFORMATION IS BASED ON A PLAN ENTITLED " SUBDIVISON OF LANDS FOR FLEMINGTON/RARITAN RECREATION COMMITTEE" PREPARED BY HERITAGE CONSULTING ENGINEERS DATED JULY, 1982 AND MINOR SUBDIVISON FOR LOT LINE ADJUST FOR BLOCK 49 LOT 2 PREPARED BY RARITAN TOWNSHIP ENGINEERING DEPARTMENT DATES 10/13/99, AS OBTAINED IN DIGITAL FORMAT FROM RARITAN TOWNSHIP.

4. WETLAND DELINEATION CONDUCTED BY PRINCETON HYDRO PERSONNEL IN APRIL 2007.

5. MONITORING WELLS INSTALLED BY PRINCETON HYDRO PERSONNEL ON JANUARY 17, 2008.

DATE	DESCRIPTION
06/27/2008	REVISIONS AS PER NJDEP COMMENTS

REVISIONS

STATE OF NEW JERSEY CERTIFICATE OF AUTH. NO.: 24GA27976800

MARY L. PAIST-GOLDMAN
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DATE

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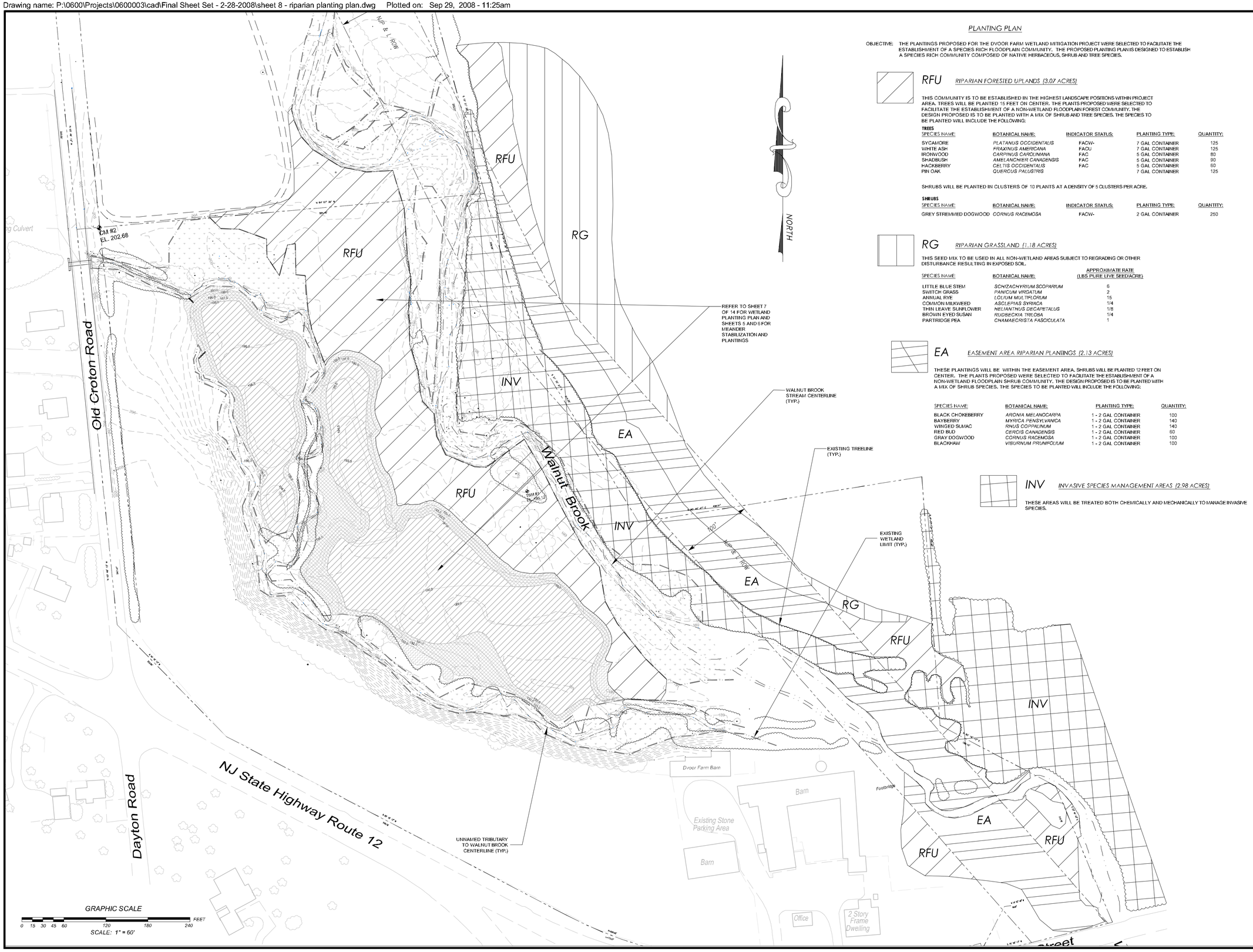
PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
WETLAND
PLANTING PLAN

DATE:	3/27/2008
PROJECT NO.:	0600.003
SCALE:	1" = 40'
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 7 OF 14

Drawing name: P:\0600\Projects\0600003\cad\Final Sheet Set - 2-28-2008\sheet 8 - riparian planting plan.dwg Plotted on: Sep 29, 2008 - 11:25am



PLANTING PLAN

OBJECTIVE: THE PLANTINGS PROPOSED FOR THE DVOOR FARM WETLAND MITIGATION PROJECT WERE SELECTED TO FACILITATE THE ESTABLISHMENT OF A SPECIES RICH FLOODPLAIN COMMUNITY. THE PROPOSED PLANTING PLAN IS DESIGNED TO ESTABLISH A SPECIES RICH COMMUNITY COMPOSED OF NATIVE HERBACEOUS, SHRUB AND TREE SPECIES.

RFU — *RIPARIAN FORESTED UPLANDS (3.07 ACRES)*

THIS COMMUNITY IS TO BE ESTABLISHED IN THE HIGHEST LANDSCAPE POSITIONS WITHIN PROJECT AREA. TREES WILL BE PLANTED 15 FEET ON CENTER. THE PLANTS PROPOSED WERE SELECTED TO FACILITATE THE ESTABLISHMENT OF A NON-WETLAND FLOODPLAIN FOREST COMMUNITY. THE DESIGN PROPOSED IS TO BE PLANTED WITH A MIX OF SHRUB AND TREE SPECIES. THE SPECIES TO BE PLANTED WILL INCLUDE THE FOLLOWING:

TREES

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
SYCAMORE	*PLATANUS OCCIDENTALIS*	FACW-	7 GAL CONTAINER	125
WHITE ASH	*FRAXINUS AMERICANA*	FACU	7 GAL CONTAINER	125
IRONWOOD	*CARPINUS CAROLINIANA*	FAC	5 GAL CONTAINER	80
SHADBUSH	*AMELANCHIER CANADENSIS*	FAC	5 GAL CONTAINER	90
HACKBERRY	*CELTIS OCCIDENTALIS*	FAC	5 GAL CONTAINER	60
PIN OAK	*QUERCUS PALUSTRIS*		7 GAL CONTAINER	125

SHRUBS WILL BE PLANTED IN CLUSTERS OF 10 PLANTS AT A DENSITY OF 5 CLUSTERS PER ACRE.

SHRUBS

SPECIES NAME:	BOTANICAL NAME:	INDICATOR STATUS:	PLANTING TYPE:	QUANTITY:
GREY STREM/MED DOGWOOD	*CORNUS RACEMOSA*	FACW-	2 GAL CONTAINER	250

RG — *RIPARIAN GRASSLAND (1.18 ACRES)*

THIS SEED MIX TO BE USED IN ALL NON-WETLAND AREAS SUBJECT TO REGRADING OR OTHER DISTURBANCE RESULTING IN EXPOSED SOIL.

SPECIES NAME:	BOTANICAL NAME:	APPROXIMATE RATE (LBS PURE LIVE SEED/ACRE)
LITTLE BLUE STEM	*SCHIZACHYRIUM SCOPARIUM*	6
SWITCH GRASS	*PANICUM VIRGATUM*	2
ANNUAL RYE	*LOLIUM MULTIFLORUM*	15
COMMON MILKWEED	*ASCLEPIAS SYRIACA*	1/4
THIN LEAVE SUNFLOWER	*HELIANTHUS DECAPETALUS*	1/8
BROWN EYED SUSAN	*RUDBECKIA TRILOBA*	1/4
PARTRIDGE PEA	*CHAMAECRISTA FASCICULATA*	1

EA — *EASEMENT AREA RIPARIAN PLANTINGS (2.13 ACRES)*

THESE PLANTINGS WILL BE WITHIN THE EASEMENT AREA. SHRUBS WILL BE PLANTED 12 FEET ON CENTER. THE PLANTS PROPOSED WERE SELECTED TO FACILITATE THE ESTABLISHMENT OF A NON-WETLAND FLOODPLAIN SHRUB COMMUNITY. THE DESIGN PROPOSED IS TO BE PLANTED WITH A MIX OF SHRUB SPECIES. THE SPECIES TO BE PLANTED WILL INCLUDE THE FOLLOWING:

SPECIES NAME:	BOTANICAL NAME:	PLANTING TYPE:	QUANTITY:
BLACK CHOKEBERRY	*ARONIA MELANOCARPA*	1 - 2 GAL CONTAINER	100
BAYBERRY	*MYRICA PENSYLVANICA*	1 - 2 GAL CONTAINER	140
WINGED SUMAC	*RHUS COPPALINUM*	1 - 2 GAL CONTAINER	140
RED BUD	*CEROIS CANADENSIS*	1 - 2 GAL CONTAINER	60
GRAY DOGWOOD	*CORNUS RACEMOSA*	1 - 2 GAL CONTAINER	100
BLACKHAW	*VIBURNUM PRUNIFOLIUM*	1 - 2 GAL CONTAINER	100

INV — *INVASIVE SPECIES MANAGEMENT AREAS (2.98 ACRES)*

THESE AREAS WILL BE TREATED BOTH CHEMICALLY AND MECHANICALLY TO MANAGE INVASIVE SPECIES.

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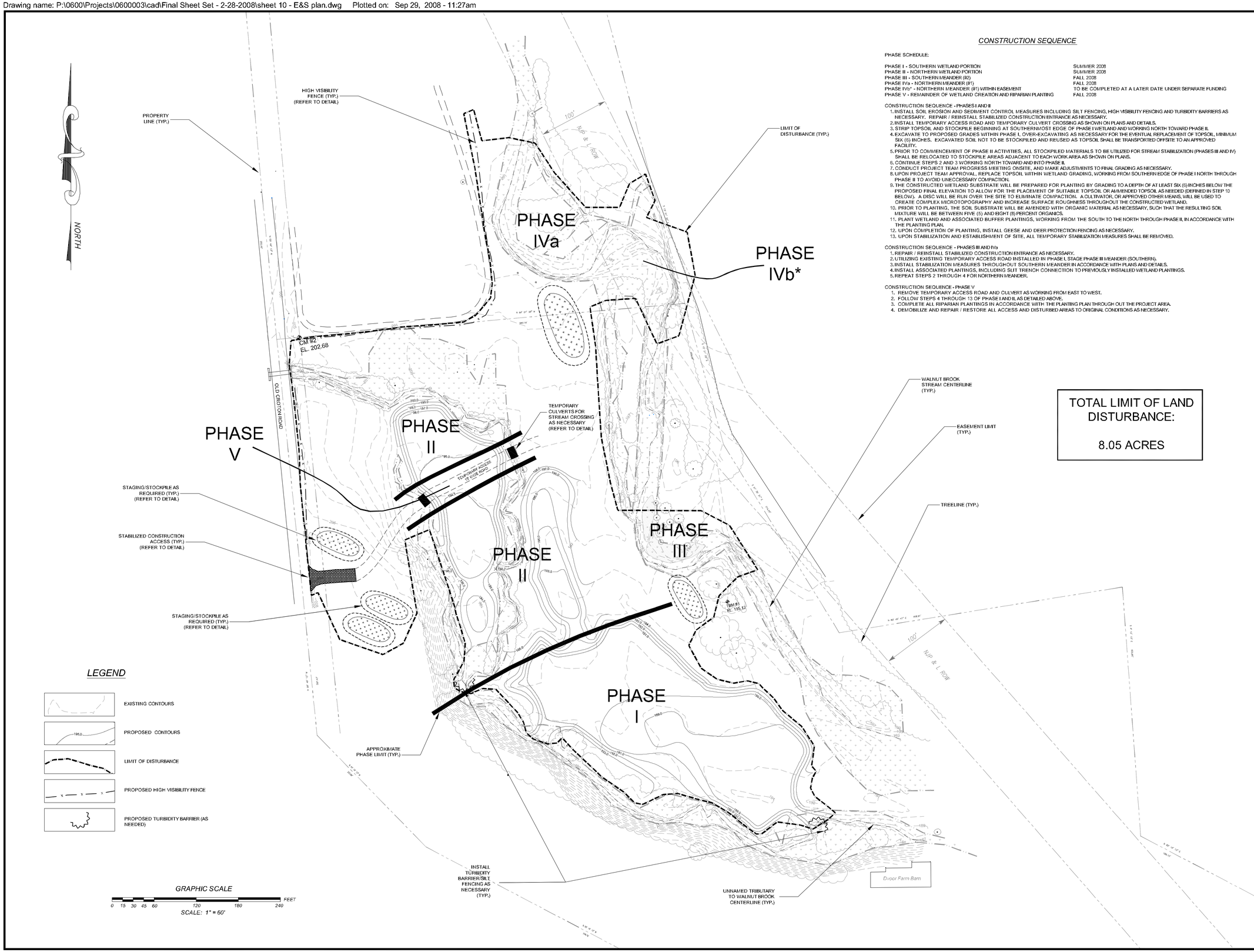

CONSTRUCTION SEQUENCE

PHASE SCHEDULE:

PHASE I - SOUTHERN WETLAND PORTION	SUMMER 2008
PHASE II - NORTHERN WETLAND PORTION	SUMMER 2008
PHASE III - SOUTHERN MEANDER (#2)	FALL 2008
PHASE IVa - NORTHERN MEANDER (#1)	FALL 2008
PHASE IVb* - NORTHERN MEANDER (#1) WITHIN EASEMENT	TO BE COMPLETED AT A LATER DATE UNDER SEPARATE FUNDING
PHASE V - REMAINDER OF WETLAND CREATION AND RIPARIAN PLANTING	FALL 2008

CONSTRUCTION SEQUENCE - PHASES I AND II

1. INSTALL SOIL EROSION AND SEDIMENT CONTROL MEASURES INCLUDING SILT FENCING, HIGH VISIBILITY FENCING AND TURBIDITY BARRIERS AS NECESSARY. REPAIR / REINSTALL STABILIZED CONSTRUCTION ENTRANCE AS NECESSARY.
2. INSTALL TEMPORARY ACCESS ROAD AND TEMPORARY CULVERT CROSSING AS SHOWN ON PLANS AND DETAILS.
3. STRIP TOPSOIL AND STOCKPILE BEGINNING AT SOUTHERNMOST EDGE OF PHASE I WETLAND AND WORKING NORTH TOWARD PHASE II.
4. EXCAVATE TO PROPOSED GRADES WITHIN PHASE I. OVER-EXCAVATING AS NECESSARY FOR THE EVENTUAL REPLACEMENT OF TOPSOIL, MINIMUM SIX (6) INCHES. EXCAVATED SOIL NOT TO BE STOCKPILED AND REUSED AS TOPSOIL SHALL BE TRANSPORTED OFFSITE TO AN APPROVED FACILITY.
5. PRIOR TO COMMENCEMENT OF PHASE II ACTIVITIES, ALL STOCKPILED MATERIALS TO BE UTILIZED FOR STREAM STABILIZATION (PHASES III AND IV) SHALL BE RELOCATED TO STOCKPILE AREAS ADJACENT TO EACH WORK AREA AS SHOWN ON PLANS.
6. CONTINUE STEPS 2 AND 3 WORKING NORTH TOWARD AND INTO PHASE II.
7. CONDUCT PROJECT TEAM PROGRESS MEETING ONSITE, AND MAKE ADJUSTMENTS TO FINAL GRADING AS NECESSARY.
8. UPON PROJECT TEAM APPROVAL, REPLACE TOPSOIL WITHIN WETLAND GRADING, WORKING FROM SOUTHERN EDGE OF PHASE I NORTH THROUGH PHASE II TO AVOID UNNECESSARY COMPACTION.
9. THE CONSTRUCTED WETLAND SUBSTRATE WILL BE PREPARED FOR PLANTING BY GRADING TO A DEPTH OF AT LEAST SIX (6) INCHES BELOW THE PROPOSED FINAL ELEVATION TO ALLOW FOR THE PLACEMENT OF SUITABLE TOPSOIL OR AMMENDED TOPSOIL AS NEEDED (DEFINED IN STEP 10 BELOW). A DISC WILL BE RUN OVER THE SITE TO ELIMINATE COMPACTION. A CULTIVATOR, OR APPROVED OTHER MEANS, WILL BE USED TO CREATE COMPLEX MICROTOPOGRAPHY AND INCREASE SURFACE ROUGHNESS THROUGHOUT THE CONSTRUCTED WETLAND.
10. PRIOR TO PLANTING, THE SOIL SUBSTRATE WILL BE AMENDED WITH ORGANIC MATERIAL AS NECESSARY, SUCH THAT THE RESULTING SOIL MIXTURE WILL BE BETWEEN FIVE (5) AND EIGHT (8) PERCENT ORGANICS.
11. PLANT WETLAND AND ASSOCIATED BUFFER PLANTINGS, WORKING FROM THE SOUTH TO THE NORTH THROUGH PHASE II, IN ACCORDANCE WITH THE PLANTING PLAN.
12. UPON COMPLETION OF PLANTING, INSTALL GEESE AND DEER PROTECTION FENCING AS NECESSARY.
13. UPON STABILIZATION AND ESTABLISHMENT OF SITE, ALL TEMPORARY STABILIZATION MEASURES SHALL BE REMOVED.

CONSTRUCTION SEQUENCE - PHASES III AND IVa

1. REPAIR / REINSTALL STABILIZED CONSTRUCTION ENTRANCE AS NECESSARY.
2. UTILIZING EXISTING TEMPORARY ACCESS ROAD INSTALLED IN PHASE I, STAGE PHASE III MEANDER (SOUTHERN).
3. INSTALL STABILIZATION MEASURES THROUGHOUT SOUTHERN MEANDER IN ACCORDANCE WITH PLANS AND DETAILS.
4. INSTALL ASSOCIATED PLANTINGS, INCLUDING SLIT TRENCH CONNECTION TO PREVIOUSLY INSTALLED WETLAND PLANTINGS.
5. REPEAT STEPS 2 THROUGH 4 FOR NORTHERN MEANDER.

CONSTRUCTION SEQUENCE - PHASE V

1. REMOVE TEMPORARY ACCESS ROAD AND CULVERT AS WORKING FROM EAST TO WEST.
2. FOLLOW STEPS 4 THROUGH 13 OF PHASE I AND II, AS DETAILED ABOVE.
3. COMPLETE ALL RIPARIAN PLANTINGS IN ACCORDANCE WITH THE PLANTING PLAN THROUGH OUT THE PROJECT AREA.
4. DEMOBILIZE AND REPAIR / RESTORE ALL ACCESS AND DISTURBED AREAS TO ORIGINAL CONDITIONS AS NECESSARY.

TOTAL LIMIT OF LAND DISTURBANCE:

8.05 ACRES

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PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
SOIL EROSION
AND SEDIMENT CONTROL
PLAN

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SCALE:	1" = 60'
DRAWN BY:	BWB
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HUNTERDON COUNTY SOIL EROSION AND SEDIMENT CONTROL GENERAL NOTES

1. THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT REQUIRES AN ADVANCED 48-HOUR WRITTEN NOTIFICATION PRIOR TO THE START OF ANY LAND DISTURBANCE. A FAILURE OF THIS NOTIFICATION PRIOR TO THE START OF CONSTRUCTION WILL RESULT IN THE ISSUANCE OF A STOP CONSTRUCTION ORDER AND MAY BE CAUSE FOR LEGAL ACTION. NOTICE MAY BE FAXED TO (908) 788-0795 OR MAILED TO:

HUNTERDON COUNTY SOIL CONSERVATION DISTRICT
687 PITTSTOWN ROAD, SUITE #1
FRENCHTOWN, NJ 08825

2. LAND DISTURBANCE AND CONSTRUCTION WORK START INCLUDES ANY DEMOLITION OR CLEARING THAT TAKES PLACE ON THE PROJECT SITE. APPROPRIATE SOIL EROSION AND SEDIMENT CONTROL MEASURES MUST BE INSTALLED AND MAINTAINED AT THE PROPOSED DEMOLITION AREAS.

3. THE PROJECT APPLICANT AND CONTRACTOR ARE TO BE AWARE THAT ADDITIONAL SOIL EROSION AND SEDIMENT CONTROL MEASURES MAY BE REQUIRED BY THE SOIL CONSERVATION DISTRICT OR MUNICIPAL ENGINEER IF FIELD CONDITIONS OR UNFORESEEN SITUATIONS WARRANT THEM.

4. THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT REQUIRES THE INSTALLATION AND STABILIZATION OF PERMANENT DETENTION OR RETENTION FACILITIES FROM THE START OF THE PROJECT INSTEAD OF USING THESE FACILITIES AS SEDIMENT BASINS. THIS IS PARTICULARLY IMPORTANT ON ACCOUNT OF THE STEEP TOPOGRAPHY AND SOILS OF HUNTERDON COUNTY. PRIORITY IS TO BE SET ON CONSTRUCTION OF ANY THE DETENTION BASIN OR RETENTION BASIN FACILITY PRIOR TO ANY SIGNIFICANT AMOUNT OF LAND DISTURBANCE. THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT REQUIRES THAT ALL DETENTION/RETENTION BASINS BE COMPLETED AND PERMANENTLY STABILIZED (ALONG WITH CONDUIT OUTLET PROTECTION AND LOW-FLOW CHANNEL) BEFORE ANY STORM DRAINAGE PIPING IS INSTALLED TO THE BASIN AND SAME PIPING IS FUNCTIONING. NO PAVING IS TO TAKE PLACE ON THE PROJECT SITE UNTIL ALL STORMWATER DETENTION/RETENTION FACILITIES ARE ADEQUATELY STABILIZED AS PER PLAN. FAILURE TO SET PRIORITY ON THE DETENTION FACILITY OR TO NOT MAINTAIN IT IS WORKING ORDER DURING CONSTRUCTION MAY BE GROUNDS FOR ISSUANCE OF A STOP CONSTRUCTION ORDER BY THE SOIL CONSERVATION DISTRICT.

5. THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT DOES NOT SUPPORT NOR ENDORSE MASS EXCAVATION. THE AMOUNT OF SOIL DISTURBED AT ONE TIME, AND SUBJECT TO EROSION, IS TO BE KEPT TO A MINIMUM. IT IS THE POLICY OF THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT THAT OVER SIX ACRES OF SOIL EXPOSED AT ONE TIME ON A PROJECT WILL REQUIRE A DETAILED PLAN AND TIME-LINE FOR GETTING AREAS STABILIZED. THE STANDARD FOR SEDIMENT BARRIERS WILL BE USED FOR LIMITING LARGE AREAS OF EXCAVATION. IF EXCAVATIONS ARE PROPOSED THAT EXCEED THE SEDIMENT BARRIER STANDARD, THEN ADDITIONAL MEASURES ARE TO BE DESIGNED AND DETAILED AND A DETAILED SEQUENCE OF CONSTRUCTION BE SUBMITTED FOR RE-CERTIFICATION AND APPROVAL. AS A MINIMUM, SOILS EXPOSED FOR LONGER THAN 30 DAYS WILL REQUIRE TEMPORARY STABILIZATION FOLLOWING THE AGRONOMIC SPECIFICATIONS ON THE PLAN.

6. A COPY OF THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLAN IS TO BE KEPT ON THE PROJECT SITE DURING CONSTRUCTION AND AVAILABLE FOR REVIEW BY THE CONTRACTOR AND SOIL CONSERVATION DISTRICT INSPECTORS.

7. THE LAND DISTURBANCE IS TO PROCEED IN ACCORDANCE WITH THE APPROVED SEQUENCE OF CONSTRUCTION AND THE CERTIFIED PLAN. ALL REQUIRED SOIL EROSION AND SEDIMENT CONTROL MEASURES MUST BE INSTALLED AND MAINTAINED AS OUTLINED IN THE PLAN.

8. THE SOIL CONSERVATION DISTRICT IS TO BE NOTIFIED AND REPRESENTED AT A PRECONSTRUCTION CONFERENCE (USUALLY HELD AT THE MUNICIPAL ENGINEERS OFFICE) PRIOR TO THE START OF CONSTRUCTION OR ANY LAND DISTURBANCE.

9. ALL DISTURBED AREAS THAT ARE NOT BEING GRADED, NOT UNDER ACTIVE CONSTRUCTION, OR NOT SCHEDULED TO BE PERMANENTLY SEEDED WITHIN 30 DAYS MUST BE TEMPORARILY STABILIZED AS PER SPECIFICATIONS BELOW.

10. ALL EXPOSED AREAS WHICH ARE TO BE PERMANENTLY VEGETATED, ARE TO BE SEEDED AND MULCHED WITHIN 10 DAYS OF FINAL GRADING.

11. STRAW MULCH (HAY MULCH MAY BE SUBSTITUTED IF APPROVED BY THE DISTRICT) IS TO BE APPLIED TO ALL SEEDINGS AT A RATE OF 1-1/2 TO 2 TONS PER ACRE (APPROX. 100 TO 130 BALES PER ACRE).

12. MULCH ANCHORING IS REQUIRED AFTER MULCHING TO MINIMIZE LOSS BY WIND OR WATER. THIS IS TO BE DONE USING ONE OF THE METHODS (CRIMPING, LIQUID MULCH BINDERS, NETTINGS, ETC.) IN THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY".

13. EXISTING WEEDY AND POORLY-VEGETATED AREAS WITH LESS THAN 80 PERCENT PERENNIAL GRASS COVER MUST RECEIVE PERMANENT STABILIZATION AS PER THESE SPECIFICATIONS.

14. ALL BAGS NEED TO BE SAVED FOR LIME, FERTILIZER, SEED, AND LIQUID MULCH BINDER (IF MULCH ANCHORING METHOD). SUCH PROOFS NEED TO BE SUBMITTED TO THE DISTRICT INSPECTOR FOR VERIFICATION OF MATERIALS AND QUANTITIES USED FOR ALL SEEDINGS.

15. AN ADDITIONAL FEE PER INSPECTION (AS PER THE CURRENT HUNTERDON COUNTY SOIL CONSERVATION DISTRICT FEE SCHEDULE AT THE TIME OF INSPECTION) WILL BE ASSESSED ON THOSE SITES WHERE ADDITIONAL INSPECTIONS ARE NECESSITATED AS A RESULT OF NON-COMPLIANCE WITH THE APPROVED PLAN. THIS INCLUDES ADDITIONAL INSPECTIONS PERFORMED AFTER THE FAILURE OF AN INITIAL REPORT OF COMPLIANCE INSPECTION. THE ENTIRE PROJECT SITE IS INSPECTED AT THE TIME OF A REQUEST FOR REPORT OF COMPLIANCE.

16. SOILS IN HUNTERDON COUNTY REQUIRE THAT ALL STONE TRACKING PADS (STABILIZED CONSTRUCTION ENTRANCE) BE INSTALLED AT A MINIMUM OF 100 FT. IN LENGTH FOR ROADWAY GRADES OF 0% TO 2% AND 200 FT. FOR ACCESS GRADES GREATER THAN 2%. THIS REQUIREMENT IS THE SAME, REGARDLESS IF MAIN PROJECT ENTRANCE OR INDIVIDUAL DWELLING LOT. STONE TRACKING PADS OR OTHER MEASURES APPROVED BY THE SOIL CONSERVATION DISTRICT ARE TO BE INSTALLED AT ALL CONSTRUCTION ACCESSES TO PAVEMENT. SEE DETAIL PLAN SHEET 11.

THE CONSTRUCTION ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO ROADWAYS. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO ROADWAYS (PUBLIC OR PRIVATE) OR OTHER IMPERVIOUS SURFACES MUST BE REMOVED IMMEDIATELY.

17. CONDUIT OUTLET PROTECTION (RIP-RAP APRONS OR SCOUR HOLES) MUST BE DESIGNED AND INSTALLED AT ALL PIPE OUTLETS AS PER THE CERTIFIED PLANS AND STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY. CONDUIT OUTLET PROTECTION MUST BE INSTALLED IMMEDIATELY FOLLOWING PIPE INSTALLATION AND PRIOR TO ANY PIPE FLOW. CONDUIT OUTLET PROTECTION MUST BE MAINTAINED AS PER DESIGN UNTIL THE COMPLETION OF THE PROJECT AND ISSUE OF FINAL REPORT OF COMPLIANCE. SEE CONDUIT OUTLET PROTECTION DETAIL AND SPECIFICATION TABLE ON PLAN SHEET__.

18. ALL STORMWATER INLET PROTECTION NEEDS TO BE MAINTAINED PERIODICALLY WITH FRESH HAYBALES OR CLEAN STONE BERMS (STONE SIZED 1 1/2"-2 1/2") OR APPROVED METHOD TO COMPLETELY ENCIRCLE, BUT NOT BLOCK THE INLETS. SEE DETAIL ON PLAN SHEET__.

INSPECTIONS OF STORMWATER INLET PROTECTION SHALL BE FREQUENT. MAINTENANCE, REPAIR, AND REPLACEMENT SHALL BE MADE PROMPTLY, AS NEEDED. INLET PROTECTION NEEDS TO BE MAINTAINED UNTIL ALL AREAS OF THE SITE, OR AS A MINIMUM THE AREA DRAINING TO THE INLET ARE PERMANENTLY STABILIZED AND APPROVED BY SOIL CONSERVATION DISTRICT INSPECTORS.

19. DUST CONTROL MEASURES ARE TO BE USED DURING ALL PHASES OF CONSTRUCTION OF THE PROJECT. SEE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY PAGES 16-1 AND 16-2. SEE DUST CONTROL MATERIALS TABLE ON PLAN SHEET__.

20. ALL TREES THAT ARE TO BE PROTECTED FROM ENVIRONMENTAL AND MECHANICAL INJURY DURING CONSTRUCTION ARE TO BE ADEQUATELY MARKED IAND FENCED-OFF PRIOR TO CONSTRUCTION AND MAINTAINED DURING CONSTRUCTION. FOR FURTHER INFORMATION SEE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY PAGES 9-1 THROUGH 9-7. SEE PROPER TREE PROTECTION DETAIL ON PLAN SHEET 12.

21. DEWATERING METHODS ARE TO BE FOLLOWED TO PROPERLY REMOVE SUSPENDED SEDIMENTS IN WATER FROM EXCAVATIONS AND/OR TRENCHES PRIOR TO DISCHARGE TO DOWNSTREAM AREAS AND/OR WATERCOURSES. THESE METHODS ARE TO FOLLOW THOSE FOUND IN THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY, PAGES 14-1 TO 14-7.

22. ON SUBDIVISION PLANS, INDIVIDUAL LOTS ON STEEP SLOPES (GREATER THAN 10%) OR IN CLOSE PROXIMITY TO A DRAINAGEWAY, REQUIRE AN INDIVIDUAL SOIL EROSION AND SEDIMENT CONTROL/GRADING TO BE SUBMITTED AND CERTIFIED PRIOR TO OBTAINING A BUILDING PERMIT AND BEFORE ANY LAND DISTURBANCE ON THAT LOT. THESE INDIVIDUAL LOT PLANS ARE CONSIDERED MINOR REVISIONS TO A CERTIFIED PLAN AND WILL BE SUBJECT TO A RESUBMISSION FEE FOR REVIEW AND CERTIFICATION AS PER THE CURRENT HUNTERDON COUNTY SOIL CONSERVATION DISTRICT FEE SCHEDULE AT THE TIME OF SUBMISSION. THE LOTS REQUIRING INDIVIDUAL LOT PLANS FOR THIS PROJECT ARE__.

23. AS PER THE TRAFFIC CONTROL STANDARD IN THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY (PAGE 33-1) STEEP BANKS, WETLAND BUFFERS, WATERWAYS, AND OTHER SENSITIVE AREAS ARE TO BE AVOIDED BY CONSTRUCTION TRAFFIC. WETLAND BUFFER AND WETLAND AREAS ARE TO BE ADEQUATELY MARKED IN FIELD PRIOR TO CONSTRUCTION AND MAINTAINED DURING CONSTRUCTION.

24. ANY FORMER AGRICULTURAL CROP FIELDS THAT ARE EITHER IN CROPS, CROP RESIDUE, OR ANNUAL WEED COVER ARE TO BE STABILIZED FOLLOWING THE AGRONOMIC SPECIFICATIONS FOR HUNTERDON COUNTY. THIS IS TO BE EITHER A COVER CROP FROM THE PERIOD OF LAST HARVEST AND CONSTRUCTION START-UP OR TEMPORARY STABILIZATION THROUGH SEEDING AND MULCHING. AREAS THAT ARE NOT GOING TO BE EITHER BUILT ON OR CONTINUED TO BE FARMED ARE TO RECEIVE PERMANENT STABILIZATION.

25. IF EXCESS FILL OR ANY OTHER MATERIAL IS TO BE REMOVED FROM THE SITE, THE PROJECT OWNER/APPLICANT SHALL BE RESPONSIBLE FOR ITS PROPER DISPOSAL AND WILL NOTIFY THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT AS TO THE PLANNED DISPOSAL SITE LOCATION. IF APPLICABLE, A SOIL EROSION AND SEDIMENT CONTROL PLAN MUST BE SUBMITTED TO, REVIEWED AND CERTIFIED BY THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT PRIOR TO ANY MATERIAL REMOVAL FROM THE PROJECT SITE. REMOVAL OF ANY SOIL MATERIAL FROM THE PROJECT SITE WITHOUT WRITTEN AUTHORIZATION FROM THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT IS A VIOLATION OF THE STATE SOIL EROSION AND SEDIMENT CONTROL ACT.

26. STOCKPILING OF FINES (SAND, QUARRY-PROCESS-BLEND,ETC.) IS NOT ALLOWED ON PAVED SURFACES OF THE PROJECT SITE.

27. ANY GABION BASKETS USED ON THE PROJECT ARE TO BE COATED WITH PLASTIC OR PVC AND FILLED WITH 4"-7" ANGULAR ROCK. THE GABION THICKNESS IS TO BE AT LEAST THE CALCULATED STONE D50 SIZE OF A REGULAR RIP-RAP APRON. FILTER FABRIC IS TO BE INSTALLED BETWEEN THE SUBGRADE AND THE GABIONS.

28. THE LIMITS OF DISTURBANCE SHOWN ON THE PLANS ARE NOT TO BE EXCEEDED UNLESS AUTHORIZED BY THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT AND A REVISED PLAN SUBMITTED FOR CERTIFICATION.

29. ALL DISTURBED ROADSIDE AREAS NEED TO BE TOPSOILED, FINAL-GRADED, LIMED,FERTILIZED, SEEDED, MULCHED, AND MULCH-ANCHORED (FOLLOWING DISTRICT AGRONOMIC SPECIFICATIONS FOR PERMANENT SEEDING) FOR A MINIMUM DISTANCE APPROVED BY THE DISTRICT BACK FROM THE CURB-LINE PRIOR TO APPROVAL OF PERMANENT IMPROVEMENT.

30. THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT DOES NOT RECOMMEND THE USE OF RIP-RAP D50 SIZES SMALLER THAN 6" FOR APRONS OR SCOUR HOLES SINCE SMALLER STONE SIZES (3"-4") TEND TO WASH/ERODE UNDER HIGH INTENSITY RAIN STORMS. THE HUNTERDON DISTRICT RECOMMENDS THAT THE SMALLEST D50 STONE SIZE BY SPECIFIED AS 6" WITH THICKNESS SPECIFIED AS 12" WITH FILTER FABRIC OR 18" WITHOUT FABRIC.

31. TEMPORARY DIVERSIONS TO DIRECT WATER OFF OF A GRADED RIGHT-OF-WAY ONTO A STABLE AREA ARE NEEDED DURING CONSTRUCTION. FOR FURTHER INFORMATION REFER TO THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY, (PAGE 15.3 ITEM 2 AND FIGURE 15-4) FOR THE REQUIRED DIMENSIONS AND SPACING. SEE DETAIL AND SPACING ON PLAN SHEET__.32. A SEDIMENT BARRIER MUST BE INSTALLED ABOVE ANY DETENTION/RETENTION BASINS (BETWEEN THE ROADWAY/BUILDING CONSTRUCTION AND DETENTION BASIN). THIS IS TO PROTECT THE DETENTION BASIN NEWLY GRADED/SEEDED AREAS WHILE THE OTHER CONSTRUCTION IS BEING COMPLETED AND ALL UPSTREAM AREAS ARE PERMANENTLY STABILIZED.

33. HYDROSEEDING/HYDROMULCHING ARE NOT ACCEPTABLE PRACTICES IN HUNTERDON COUNTY DUE TO THE HIGH FAILURE RATE OF SEEDINGS, STEEP TOPOGRAPHY, POOR SEED-TO-SOIL CONTACT AND POOR GROUND SURFACE COVERAGE. ALL SEED MUST BE INCORPORATED INTO THE SOIL. HYDROSEEDING EQUIPMENT MAY BE USED IN CONJUNCTION WITH STRAW/HAY MULCH FOR THE PURPOSE OF ANCHORING THE MULCH WITH LIQUID MULCH BINDERS.

34. IF SUBSURFACE WATER PROBLEMS ARE DISCOVERED DURING CONSTRUCTION, THEY WILL BE RECTIFIED FOLLOWING THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY (SUBSURFACE DRAINAGE, PAGE 32-1 THROUGH 32-4).

35. ALL DEVELOPMENT ROADWAYS ARE TO BE KEPT SCRAPED/SWEPT TO REMOVE SEDIMENT ACCUMULATIONS ALONG CURBS AND AROUND STORMWATER INLETS.

36. THE MAXIMUM ALLOWABLE VEGETATED SLOPE IS 2:1. SLOPES IN EXCESS OF 3:1 (BETWEEN 2:1 AND 3:1) REQUIRE TEMPORARY EROSION CONTROL MATTING, SUCH AS EXCELSIOR "CURLEX" OR EQUIVALENT, FOR STABILIZATION. THE MATTING IS TO BE PROPERLY INSTALLED WITH SPECIFIED OVERLAP, CHECK SLOTS, ANCHORING SPACING, AND ANCHORING DEVICE TYPE, GAUGE, AND SIZE.

37. ALL DISTURBED AREAS THAT ARE NOT BEING GRADED, NOT UNDER ACTIVE CONSTRUCTION, OR NOT SCHEDULED TO BE PERMANENTLY SEEDED WITHIN 30 DAYS MUST BE TEMPORARILY STABILIZED AS PER THE AGRONOMIC SPECIFICATIONS.

38. A REPORT OF COMPLIANCE FROM THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT IS REQUIRED FOR EACH DWELLING LOT PRIOR TO ISSUANCE OF A CERTIFICATE OF OCCUPANCY ON THAT LOT. FAILURE TO MAINTAIN OR COMPLY WITH THE SOIL EROSION AND SEDIMENT CONTROL PLAN FOR THE PROJECT WILL BE CAUSE FOR COMPLIANCE FAILURE ON AN INDIVIDUAL LOT.

39. IT IS THE OWNER/APPLICANTS RESPONSIBILITY TO NOTIFY THE DISTRICT OF ALL PROPERTY CONVEYANCES AND SALE OF INDIVIDUAL LOTS ON A PROJECT. SOIL EROSION AND SEDIMENT CONTROL PLAN APPLICATIONS ARE TO BE FILED BY ANY NEW OWNERS ON PROJECTS/LOTS WHERE CONSTRUCTION ACTIVITIES ARE TO STILL TAKE PLACE.

40. PURSUANT TO THE NEW JERSEY SOIL EROSION AND SEDIMENT CONTROL ACT, CHAPTER 251, P.L. 1975, THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT HAS REVIEWED THE PLANS FOR THIS PROJECT AND CERTIFIED THE SOIL EROSION AND SEDIMENT CONTROL PLAN.

41. PLANS SUBMITTED TO THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT MUST BE CONSISTENT WITH PLANS ANY PLANS SUBMITTED TO A REGULATORY AGENCY SUCH AS NJDEP, MUNICIPALITY, ETC. ANY REVISIONS REQUIRED BY ANY REVIEWING AUTHORITY WOULD REQUIRE A RESUBMISSION TO THE DISTRICT FOR REVIEW.

42. ALL REVISIONS AND MUNICIPAL RENEWALS OF THIS PROJECT WILL REQUIRE RESUBMISSION AND APPROVAL BY THE SOIL CONSERVATION DISTRICT.

43. BEFORE ANY CERTIFICATE OF OCCUPANCY CAN BE GRANTED, A WRITTEN REPORT OF COMPLIANCE FOR PERMANENT MEASURES TO CONTROL EROSION MUST BE ISSUED BY THE SOIL CONSERVATION DISTRICT.

44. PURSUANT TO AUTHORITY GRANTED BY N.J.S.A. 4:24-47, THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT PERIODICALLY INSPECTS THE PROJECT SITE FOR COMPLIANCE WITH THE CERTIFIED SOIL EROSION AND SEDIMENT CONTROL PLANS AND THE STATE SOIL EROSION AND SEDIMENT CONTROL ACT. FAILURE TO COMPLY WITH THE PLANS AND THE ACT MAY BE CAUSE FOR COURT ACTION AND PENALTIES, PURSUANT TO N.J.S.A. 4:24-53. THE MAXIMUM STATUTORY PENALTY PROVIDED BY LAW FOR VIOLATIONS OF THE SOIL EROSION AND SEDIMENT CONTROL ACT IS A FINE OF UP TO $3,000 EACH DAY AND AN INJUNCTIVE ORDER OF THE SUPERIOR COURT.

45. IT IS POLICY OF THE HUNTERDON COUNTY SOIL CONSERVATION DISTRICT TO PERIODICALLY EVALUATE ALL PROJECTS TO DETERMINE IF THE COSTS FOR REVIEW AND INSPECTION EXCEED THE PAID FEES. PRIOR TO THE FEES BEING EXCEEDED AN ADDITIONAL FEE WILL BE ASSESSED. THIS FEE WILL BE BASED ON TEH INCOMPLETE PORTION(S) OF THE PROJECT, REGARDLESS IF PRESENTLY UNDER CONSTRUCTION OR NOT, AS PER THE CURRENT HUNTERDON COUNTY SOIL CONSERVATION DISTRICT FEE SCHEDULE AT THE TIME OF EVALUATION.

46. A VEGETATIVE FILTER STRIP IS TO BE SEEDED A MINIMUM OF 20 FEET ABOVE SEDIMENT BARRIERS (SILT FENCE, HAYBALES, STONE BARRIERS, ETC.) BY MEANS OF TEMPORARY OR PERMANENT STABILIZATION STANDARD.

STANDARD FOR TRAFFIC CONTROL

DEFINITION

THE CONTROL OF ON-SITE CONSTRUCTION TRAFFIC (CONSTRUCTION EQUIPMENT, SERVICE VEHICLES, AUTOS, ETC.) DURING DEVELOPMENT OF A PARCEL OF LAND

PURPOSE

TO MINIMIZE LAND DISTURBANCE.

WHERE APPLICABLE

ANY AREA WHERE VEHICULAR TRAFFIC DISTURBS THE LAND TO THE EXTENT OF REDUCING PROTECTIVE VEGETATION, COMPACTING SOIL, OR OTHERWISE DETERIORATING THE ENVIRONMENT.

WATER QUALITY ENHANCEMENT

MANAGING CONSTRUCTION TRAFFIC TO MINIMIZE THE DAMAGE OR LOSS OF PROTECTIVE VEGETATION COVER AND MINIMIZE THE COMPACTION OF SOILS WILL HELP TO MINIMIZE OFF-SITE EROSION AND TRANSPORTATION OF ASSOCIATED POLLUTANTS.

PLANNING CRITERIA

RESTRICT CONSTRUCTION TRAFFIC TO PREDETERMINED ROUTES ACCORDING TO TYPES AND NUMBERS OF VEHICLE ANTICIPATED. MARKERS OR TEMPORARY FENCING MAY BE HELPFUL.

AVOID DAMAGE TO WATERWAYS BY CONSTRUCTION OF SUITABLE CROSSING FACILITIES AND AVOID TRAFFIC IN OR ALONG STREAMS.

PREDETERMINE STEEP BANKS AND VEGETATIVE AREAS TO BE AVOIDED BY TRAFFIC

TRAFFIC DURING WET WEATHER SHOULD BE MINIMIZED.

SEDIMENT FROM TIRE WASHING OPERATIONS SHALL BE RETAINED ON SITE. WATER SHALL BE CONVEYED TO A STABLE OUTLET.

SOIL COMPACTION RESULTING FROM CONSTRUCTION TRAFFIC CAN IMPACT THE INFILTRATION RATE OF THE SOIL. RESTORATION OF COMPACTED SOILS THROUGH DEEP TILLAGE (6" TO 12") AND THE ADDITION OF ORGANIC MATTER MAY BE REQUIRED IN PLANNED PERVIOUS AREAS TO ENHANCE THE INFILTRATION RATE OF THE DISTURBED SOIL.

STANDARD FOR TEMPORARY VEGETATIVE COVER FOR SOIL STABAILIZATION

DEFINITION:

ESTABLISHMENT OF TEMPORARY VEGETATIVE COVER ON EXPOSED SOILS WHERE PERENNIAL VEGETATION IS NEEDED FOR SHORT TERM PROTECTION.

PURPOSE:

TO TEMPORARILY STABILIZE THE SOIL, ASSURING CONSERVATION OF SOIL AND WATER, AND TO ENHANCE THE ENVIRONMENT.

WATER QUALITY ENHANCEMENT:

SLOWS THE OVER LAND MOVEMENT OF STORMWATER RUNOFF, INCREASES INFILTRATION AND RETAINS SOIL AND NUTRIENTS ON SITE, PROTECTING STREAMS OR OTHER STORMWATER CONVEYANCES.

WHERE APPLICABLE:

ON EXPOSED SOILS THAT HAVE A POTENTIAL FOR CAUSING OFF-SITE ENVIRONMENTAL DAMAGE.

METHODS AND MATERIALS:

1. SITE PREPARATION
   - A. GRADE AS NEEDED AND FEASIBLE TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR SEEDBED PREPARATION, SEEDING, MULCH APPLICATION, AND MULCH ANCHORING. ALL GRADING SHOULD BE DONE IN ACCORDANCE WITH STANDARD FOR LAND GRADING ("STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, JULY, 1999, PAGE 19-1.)
   - B. IMMEDIATELY PRIOR TO TOPSOILING, THE SURFACE SHOULD BE SCARIFIED 6 TO 12 INCHES WHERE THERE HAS BEEN SOIL COMPACTION. THIS WILL HELP ENSURE A GOOD BOND BETWEEN THE TOPSOIL AND SUBSOIL. *THIS PRACTICE IS PERMISSIBLE ONLY WHERE THERE IS NO DANGER TO UNDERGROUND UTILITIES (CABLES, IRRIGATION SYSTEMS, ETC.)*
   - C. EMPLOY NEEDED EROSION CONTROL PRACTICES SUCH AS DIVERSIONS, GRADE STABILIZATION STRUCTURES, CHANNEL STABILIZATION MEASURES, SEDIMENTATION BASINS, AND WATERWAYS. SEE STANDARDS 11 THROUGH 42, "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, JULY 1999.
2. SEEDBED PREPARATION
   - A. APPLY FERTILIZER ACCORDING TO SOIL TEST RECOMMENDATIONS SUCH AS OFFERED BY RUTGERS CO-OPERATIVE EXTENSION. SOIL SAMPLE MAILERS ARE AVAILABLE FROM THE LOCAL RUTGERS COOPERATIVE EXTENSION OFFICES. FERTILIZER SHALL BE APPLIED AT THE RATE OF 500 POUNDS PER ACRE OR 11 POUNDS PER 1,000 SQUARE FEET OF 10-20-10 OR EQUIVALENT WITH 50% WATER INSOLUBLE NITROGEN UNLESS A SOIL TEST INDICATES OTHERWISE.
   - B. WORK FERTILIZER INTO THE SOIL AS NEARLY AS PRACTICAL TO A DEPTH OF 4 INCHES WITH A DISC, SPRINGTOOTH HARROW, OR OTHER SUITABLE EQUPMENT. THE FINAL HARROWING OR DISCING OPERATION SHOULD BE ON THE GENERAL CONTOUR. CONTINUE TILLAGE UNTIL A REASONABLE UNIFORM SEEDBED IS PREPARED.
   - C. IMMEDIATELY PRIOR TO TOPSOILING, THE SURFACE SHOULD BE SCARAFIED 6 TO 12 INCHES WHERE THERE HAS BEEN SOIL COMPACTION. THIS WILL HELP INSURE A GOOD BOND BETWEEN THE TOPSOIL AND SUBSOIL. *THIS PRACTICE IS PERMISSIBLE ONLY WHERE THERE IS NO DANGER TO UNDERGROUND UTILITIES (CABLES, IRRIGATION SYSTEMS, ETC.)*
   - D. A UNIFORM APPLICATION TO A DEPTH OF 5 INCHES (UNSETTLED) IS RECOMMENDED. SOILS WITH A pH OF 4.0 OR LESS OR CONTAINING IRON SULFIDE SHALL BE COVERED WITH A MINIMUM DEPTH OF 12 INCHES OF SOIL HAVING A pH OF 5.0 OR MORE, IN ACCORDANCE WITH THE STANDARD FOR MANAGEMENT OF HIGH ACID PRODUCING SOIL, ("STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, JULY 1999, PAGE 1-1.)

STANDARD FOR TEMPORARY VEGETATIVE COVER FOR SOIL STABILIZATION (CONT.)

3. SEEDING
   - A. SELECT SEED FROM RECOMMENDATIONS IN TABLE 7-2.
   - B. **CONVENTIONAL SEEDING** IS PERFORMED BY APPLYING SEED UNIFORMLY BY HAND, CYCLONE (CENTRIFUGAL) SEEDER, DROP SEEDER, DRILL OR CULTIPACKER. EXCEPT FOR DRILLED, HYDROSEEDED OR CULTIPACKED SEEDINGS, SEED SHALL BE INCORPORATED INTO THE SOIL WITHIN 24 HOURS OF SEEDBED PREPARATION TO A DEPTH OF 1/4 TO 1/2 INCH, BY RAKING OR DRAGGING. DEPTH OF SEED PLACEMENT MAY BE 1/4 INCH DEEPER ON COARSE TEXTURED SOIL.
   - C. **HYDROSEEDING** IS A BROADCAST SEEDING METHOD USUALLY INVOLVING A TRUCK OR TRAILER MOUNTED TANK, WITH AN AGITATION SYSTEM AND HYDRAULIC PUMP FOR MIXING SEED, WATER AND FERTILIZER AND SPRAYING THE MIX ONTO THE PREPARED SEEDBED. MULCH SHALL NOT BE INCLUDED IN THE TANK WITH SEED. SHORT FIBERED MULCH MAY BE APPLIED WITH A HYDROSEEDER FOLLOWING SEEDING. (ALSO SEE SECTION IV MULCHING BELOW) HYDROSEEDING IS NOT A PREFERRED SEEDING METHOD BECAUSE SEED AND FERTILIZER ARE APPLIED TO THE SURFACE AND INCORPORATED INTO THE SOIL. POOR SEED TO SOIL CONTACT OCCURS REDUCING SEED GERMINATION AND GROWTH. HYDROSEEDING MAY BE USED FOR AREAS TOO STEEP FOR CONVENTIONAL EQUIPMENT TO TRAVERSE OR TOO OBSTRUCTED WITH ROCKS, STUMPS, ETC.
   - E. AFTER SEEDING, FIRMING THE SOIL WITH A CORRUGATED ROLLER WILL ASSURE GOOD SEED TO SOIL CONTACT, RESTORE CAPILLARITY, AND IMPROVE SEEDLING EMERGENCE. THIS IS THE PREFERRED METHOD. WHEN PERFORMED ON THE CONTOUR, SHEET EROSION WILL BE MINIMIZED AND WATER CONSERVATION ON SITE WILL BE MAXIMIZED.
4. MULCHING

MULCHING IS REQUIRED ON ALL SEEDING. MULCH WILL INSURE AGAINST EROSION BEFORE GRASS IS ESTABLISHED AND WILL PROMOTE FASTER AND EARLIER ESTABLISHMENT. THE EXISTENCE OF VEGETATION SUFFICIENT TO CONTROL SOIL EROSION SHALL BE DEEMED COMPLIANCE WITH THIS MULCHING REQUIREMENT.

A. **STRAW OR HAY.** UNROTTED SMALL GRAIN STRAW, HAY FREE OF SEEDS, OR SALT HAY TO BE APPLIED AT THE RATE OF 1-1/2 TO 2 TONS PER ACRE (70 TO 90 POUNDS PER 1,000 SQUARE FEET), EXCEPT THAT WHERE A CRIMPER IS USED INSTEAD OF LIQUID MULCH-BINDER (TACKIFYING OR ADHESIVE AGENT), THE RATE OF APPLICATION IS 3 TONS PER ACRE. MULCH CHOPPER-BLOWERS MUST NOT GRIND THE MULCH. HAY MULCH IS NOT RECOMMENDED FOR ESTABLISHING FINE TURF OR LAWNS DUE TO THE PRESENCE OF WEED SEED.

APPLICATION. SPREAD MULCH UNIFORMLY BY HAND OR MECHANICALLY SO THAT APPROXIMATELY 85% OF THE SOIL SURFACE WILL BE COVERED. FOR UNIFORM DISTRIBUTION OF HAND-SPREAD MULCH, DIVIDE AREA INTO APPROXIMATELY 1,000 SQUARE FEET SECTIONS AND DISTRIBUTE 70 TO 90 POUNDS WITHIN EACH SECTION.

ANCHORING. ANCHORING SHALL BE ACCOMPLISHED IMMEDIATELY AFTER PLACEMENT TO MINIMIZE LOSS BY WIND AND WATER. THIS MAY BE DONE BY ONE OF THE FOLLOWING METHODS, DEPENDING UPON THE SIZE OF THE AREA, STEEPNESS OF SLOPES, AND COSTS.

1. PEG AND TWINE. DRIVE 8 TO 10 INCH WOODEN PEGS TO WITHIN 2 TO 3 INCHES OF THE SOIL SURFACE EVERY 4 FEET IN ALL DIRECTIONS. STAKES MAY BE DRIVEN BEFORE OR AFTER APPLYING MULCH. SECURE MULCH TO SOIL SURFACE BY STRETCHING TWINE BETWEEN PEGS IN A CRISS-CROSS AND SQUARE PATTERN. SECURE TWINE AROUND EACH PEG WITH TWO OR MORE TURNS.
2. MULCH NETTINGS. STAPLE PAPER, JUTE, COTTON, OR PLASTIC NETTINGS TO THE SOIL SURFACE. USE A DEGRADABLE NETTING IN AREAS TO BE MOVED.
3. CRIMPER (MULCH ANCHORING COULTER TOOL). A TRACTOR-DRAWN IMPLEMENT, SOMEWHAT LIKE A DISC HARROW, ESPECIALLY DESIGNED TO PUSH OR CUT SOME OF THE BROADCAST LONG FIBER MULCH 3 TO 4 INCHES INTO THE SOIL SO AS TO ANCHOR IT AND LEAVE PART STANDING UPRIGHT. THIS TECHNIQUE IS LIMITED TO AREAS TRAVERSABLE BY A TRACTOR, WHICH MUST OPERATE ON THE CONTOUR OF SLOPES. STRAW MULCH RATE MUST BE 3 TONS PER ACRE. NO TACKIFYING OR ADHESIVE AGENT IS REQUIRED.
4. LIQUID MULCH BINDERS. MAY BE USED TO ANCHOR SALT HAY, HAY AND STRAW MULCH.
   - a. APPLICATIONS SHOULD BE HEAVIER AT EDGES WHERE WIND MAY CATCH THE MULCH, IN VALLEYS, AND AT CRESTS OF BANKS. THE REMAINDER OF THE AREA SHOULD BE UNIFORM IN APPEARANCE.
   - b. USE ONE OF THE FOLLOWING:
     - (1) ORGANIC AND VEGETABLE BASED BINDERS. NATURALLY OCCURRING, POWDER BASED, HYDROPHILIC MATERIALS WHEN MIXED WITH WATER FORMULATES A GEL AND WHEN APPLIED TO MULCH UNDER SATISFACTORY CURING CONDITIONS WILL FORM MEMBRANE NETWORKS OF INSOLUBLE POLYMERS. THE VEGETABLE GEL SHALL BE PHYSIOLOGICALLY HARMLESS AND NOT RESULT IN A PHYTOTOXIC EFFECT OR IMPEDE GROWTH OF TURFGRASS. USE AT A RATE AND WEATHER CONDITIONS AS RECOMMENDED BY THE MANUFACTURER TO ANCHOR MULCH MATERIALS. MANY NEW PRODUCTS ARE AVAILABLE, SOME OF WHICH MAY NEED FURTHER EVALUATION FOR USE IN THIS STATE.
     - (2) SYNTHETIC BINDERS. HIGH POLYMER SYNTHETIC EMULSION, MISCIBLE WITH WATER WHEN DILUTED AND FOLLOWING APPLICATION TO MULCH, DRYING AND CURING SHALL NO LONGER BE SOLUBLE OR DISPERSIBLE IN WATER. IT SHALL BE APPLIED AT RATES RECOMMENDED BY THE MANUFACTURER AND REMAIN TACKY UNTIL GERMINATION OF GRASS.

       NOTE: NAMES GIVEN ABOVE ARE REGISTERED TRADE NAMES. THIS DOES NOT CONSTITUTE A RECOMMENDATION OF THESE PRODUCTS TO THE EXCLUSION OF OTHER PRODUCTS.

TABLE 7-2

TEMPORARY VEGETATIVE STABILIZATION GRASSES, SEEDING RATES, DATES AND DEPTH

SEED SELECTION	SEEDING RATE[1] (POUNDS)		OPTIMUM SEEDING DATE[2] BASED ON PLANT HARDINESS ZONE[3]			OPTIMUM SEEDING DEPTH[4] (INCHES)
	PER ACRE	PER 1000 SQ. FT.	ZONE 5b, 6a	ZONE 6b	ZONE[4] 7a,b	
COOL SEASON GRASSES						
1. PERENNIAL RYEGRASS	100	1.0	3/15 - 6/1 8/1 - 9/15	3/1 - 5/15 8/15 - 10/1	2/15 - 5/1 8/15 - 10/15	0.5
2. SPRING OATS	86	2.0	3/15 - 6/1 8/1 - 9/15	3/1 - 5/15 8/15 - 10/1	2/15 - 5/1 8/15 - 10/15	1.0
3. WINTER BARLEY	96	2.2	8/1 - 10/1	8/15 - 10/1	8/15 - 10/15	1.0
4. WINTER CEREAL RYE	112	2.8	8/1 - 11/1	8/1 - 11/15	8/1 - 12/15	1.0
WARM SEASON GRASSES						
1. PEARL MILLET	20	0.5	6/1 - 8/1	5/15 - 8/15	5/1 - 9/1	1.0
2. MILLET (GERMAN OR HUNGARIAN)	30	0.7	6/1 - 8/1	5/15 - 8/15	5/1 - 9/1	1.0
3. WEEPING LOVEGRASS	5	0.2	6/1 - 8/1	5/15 - 8/15	5/1 - 9/1	0.25

1 SEEDING RATE FOR WARM SEASON GRASS, SELECTIONS 5-7 SHALL BE ADJUSTED TO REFLECT THE AMOUNT OF PURE LIVE SEED (PLS) AS DETERMINED BY A GERMINATION TEST RESULT. NO ADJUSTMENT IS REQUIRED FOR COOL SEASON GRASSES.

2 MAY BE PLANTED THROUGHOUT SUMMER IF SOIL MIOSTURE IS ADEQUATE OR SEEDED AREA CAN BE IRRIGATED.

3 TWICE THE DEPTH FOR SANDY SOILS.

4 THIS PROJECT IS LOCATED IN ZONE 7a, AS INDICATED IN FIGURE 4-1, "PLANT HARDINESS ZONES", "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, JULY 1999, PAGE 4-15.

5 ALL WETLAND AREAS WILL BE STABILIZED WITH ANNUAL RYE.

B. **WOOD FIBER OR PAPER FIBER MULCH.** SHALL BE MADE FROM WOOD, PLANT FIBERS OR PAPER CONTAINING NO GROWTH OR GERMINATION INHIBITING MATERIALS, USED AT THE RATE OF 1,500 POUNDS PER ACRE (OR AS RECOMMENDED BY THE PRODUCT MANUFACTURER) AND MAY BE APPLIED BY A HYDROSEEDER. THIS MULCH SHALL NOT BE MIXED IN THE TANK WITH SEED. USE IS LIMITED TO FLATTER SLOPES AND DURING OPTIMUM SEEDING PERIODS IN SPRING AND FALL.

C. **PELLETIZED MULCH.** COMPRESSED AND EXTRUDED PAPER AND/OR WOOD FIBER PRODUCT, WHICH MAY CONTAIN CO-POLYMERS, TACKIFIERS, FERTILIZERS AND COLORING AGENTS. THE DRY PELLETS, WHEN APPLIED TO A SEEDED AREA AND WATERED, FORM A MULCH MAT. PELLETIZED MULCH SHALL BE APPLIED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS. MULCH MAY BE APPLIED BY HAND OR MECHANICAL SPREADER AT THE RATE OF 60-75 POUNDS PER 1,000 SQUARE FEET AND ACTIVATED WITH 0.2 TO 0.4 INCHES OF WATER. THIS MATERIAL HAS BEEN FOUND TO BE BENEFICIAL FOR USE ON SMALL LAWN OR RENOVATION AREAS, SEEDED AREAS WHERE WEED-SEED FREE MULCH IS DESIRED OR ON SITES WHERE STRAW MULCH AND TACKIFIER AGENT ARE NOT PRACTICAL OR DESIRABLE. APPLYING THE FULL 0.2 TO 0.4 INCHES OF WATER AFTER SPREADING PELLETIZED MULCH ON THE SEED BED IS EXTREMELY IMPORTANT FOR SUFFICIENT ACTIVATION AND EXPANSION OF THE MULCH TO PROVIDE SOIL COVERAGE.

METHODS AND MATERIALS:

1. LIMIT THE EXCAVATION AREA AND EXPOSURE TIME WHEN HIGH ACID PRODUCING SOILS ARE ENCOUNTERED.

2. TOPSOIL STRIPPED FROM THE SITE SHALL BE STORED SEPARATELY FROM TEMPORARILY STOCKPILED HIGH ACID PRODUCING SOILS.

3. STOCKPILES OF HIGH ACID PRODUCING SOIL SHOULD BE LOCATED ON LEVEL LAND TO MINIMIZE ITS MOVEMENT, ESPECIALLY WHEN THE MATERIAL HAS A HIGH CLAY CONTENT.

4. TEMPORARILY STOCKPILED HIGH ACID PRODUCING SOIL MATERIAL TO BE EXPOSED MORE THAN 30 DAYS SHOULD BE COVERED WITH PROPERLY ANCHORED, HEAVY GRADE SHEETS OF POLYETHYLENE WHERE POSSIBLE. IF NOT POSSIBLE, STOCKPILES SHALL BE COVERED WITH A MINIMUM OF 3 TO 6 INCHES OF WOOD CHIPS TO MINIMIZE EROSION OF THE STOCKPILE. SILT FENCE SHALL BE INSTALLED AT THE TOE OF SLOPE TO CONTAIN MOVEMENT OF THE STOCKPILED MATERIAL. TOPSOIL SHALL NOT BE APPLIED TO THE STOCKPILES TO PREVENT TOPSOIL CONTAMINATION WITH HIGH ACID PRODUCING SOIL.

5. HIGH ACID PRODUCING SOILS WITH A pH OF 4 OR LESS, OR CONTAINING IRON SULFIDE, (INCLUDING BORROW FROM CUTS) SHALL BE ULTIMATELY PLACED OR BURIED WITH LIMESTONE APPLIED AT A RATE OF 6 TONS PER ACRE (OR 275 POUNDS PER 1,000 SQUARE FEET OF SURFACE AREA) AND COVERED WITH A MINIMUM OF 12 INCHES OF SETTLED SOIL WITH A pH OF 5 OR MORE EXCEPT AS FOLLOWS:

a. AREAS WHERE TREES OR SHRUBS ARE TO BE PLANTED SHALL BE COVERED WITH A MINIMUM OF 24 INCHES OF SOIL WITH A pH OF 5 OR MORE.

b. DISPOSAL AREAS SHALL NOT BE LOCATED WITHIN 24 INCHES OF ANY SURFACE OF A SLOPE OR BANK, SUCH AS BERMS, STREAM BANKS, DITCHES AND OTHERS TO PREVENT POTENTIAL LATERAL LEACHING DAMAGES.

6. EQUIPMENT USED FOR MOVEMENT OF HIGH ACID PRODUCING SOILS SHOULD BE CLEANED AT THE END OF EACH DAY TO PREVENT SPREADING OF HIGH ACID SOIL MATERIALS TO OTHER PARTS OF THE SITE, INTO STREAMS OR STORMWATER CONVEYANCES AND TO PROTECT MACHINERY FROM ACCELERATED RUSTING.

7. NON VEGETATIVE EROSION CONTROL PRACTICES (STONE TRACKING PADS, STRATEGICALLY PLACED LIMESTONE CHECK DAM, SILT FENCE, WOODCHIPS) SHOULD BE INSTALLED TO LIMIT THE MOVEMENT OF HIGH ACID PRODUCING SOILS FROM, AROUND OR OFF THE SITE.

8. FOLLOWING BURIAL OR REMOVAL OF HIGH ACID PRODUCING SOIL, TOPSOILING AND SEEDING OF THE SITE, (SEE PERMANENT VEGETATIVE COVER FOR SOIL STABILIZATION, SAME SHEET) MONITORING SHOULD CONTINUE FOR APPROXIMATELY 6 TO 12 MONTHS TO ASSURE THERE IS ADEQUATE STABILIZATION AND THAT NO SOIL PROBLEMS EMERGE. IF PROBLEMS STILL EXIST THE AFFECTED AREA MUST BE TREATED AS INDICATED ABOVE TO CORRECT THE PROBLEM.

9. MONITORING OF AREAS WHERE HIGH ACID PRODUCING SOIL HAS BEEN PLACED OR BURIED SHOULD BE PERFORMED FOR AT LEAST 2 YEARS OR LONGER IF PROBLEMS OCCUR, TO ASSURE THERE IS NO MIGRATION OF POTENTIAL ACID LEACHATE.

HUNTERDON COUNTY SOIL CONSERVATION DISTRICT
AGRONOMIC SPECIFICATIONS

FOR LAWNS AND CONTRUCTION SITES
GENERAL

1. ALL DISTURBED AREAS THAT ARE NOT BEING GRADED, NOT UNDER ACTIVE CONSTRUCTION, OR NOT SCHEDULED TO BE PERMANENTLY SEEDED WITHIN 30 DAYS MUST BE TEMPORARILY STABILIZED AS PER SPECIFICATIONS BELOW.
2. ALL EXPOSED AREAS WHICH ARE TO BE PERMANENTLY VEGETATED, ARE TO BE SEEDED AND MULCHED WITHIN 10 DAYS OF FINAL GRADING.
3. **STRAW MULCH** (HAY MULCH MAY BE SUBSTITUTED IF APPROVED BY THE DISTRICT) IS TO BE APPLIED TO ALL SEEDINGS AT A RATE OF 1-1/2 TO 2 TONS PER ACRE (APPROX. 100 TO 130 BALES PER ACRE).
4. **MULCH ANCHORING IS REQUIRED** AFTER MULCHING TO MINIMIZE LOSS BY WIND OR WATER. THIS IS TO BE DONE USING ONE OF THE METHODS (CRIMPING, LIQUID MULCH BINDERS, NETTINGS, ETC.) IN THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY".
5. EXISTING WEEDY AND POORLY VEGETATED AREAS WITH LESS THAN 80 PERCENT PERENNIAL GRASS COVER MUST RECEIVE PERMANENT STABILIZATION (AS SPECIFIED ON BACK).
6. ALL BAGS NEED TO BE SAVED FOR LIME, FERTILIZER, SEED, AND LIQUID MULCH BINDER (IF MULCH ANCHORING.
7. AN ADDITIONAL FEE OF **$125.00** PER INSPECTION WILL BE ASSESSED ON THOSE SITES WHERE ADDITIONAL INSPECTIONS ARE NECESSITATED AS A RESULT OF NON-COMPLIANCE WITH THE APPROVED PLAN. THIS INCLUDES ADDITIONAL INSPECTIONS PERFORMED AFTER THE FAILURE OF AN INITIAL REPORT OF COMPLIANCE INSPECTION. THE ENTIRE PROJECT SITE IS INSPECTED AT THE TIME OF A REQUEST FOR REPORT OF COMPLIANCE.

SEED-BED PREPARATION FOR ALL SEEDINGS

SUB-SOIL PREPERATION: IMMEDIATELY PRIOR TO SEEDING AND TOPSOIL APPLICATION, THE SURFACE SHOULD BE SCARIFIED TO A DEPTH OF 6" TO 12" WHERE THERE HAS BEEN SOIL COMPACTION (E.G. AREAS OF HEAVY CONSTRUCTION TRAFFIC). THIS PRACTICE IS TO BE APPLIED TO ALL COMPACTED AREAS WHERE THERE IS NO DANGER TO UNDERGROUND UTILITIES (CABLES, IRRIGATION SYSTEMS, ETC.).

TOPSOILING: AREAS TO BE SEEDED SHOULD HAVE A MINIMUM OF 5" OF FRIABLE, LOAMY, TOPSOIL FREE OF OBJECTIONABLE WEEDS, STONES AND DEBRIS.

FINAL GRADING: GRADING IS TO BE SMOOTH OF RUTS AND FREE OF OBJECTIONABLE STONES, DEPRESSIONS, VEHICLE TRACKS, AND ROUGH EDGES. THERE IS TO BE POSITIVE DRAINAGE AWAY FROM ALL BUILDINGS AND DWELLINGS. REFUSE FROM SEEDBED PREPARATION (ROOTS, STICKS, STONES, CONSTRUCTION DEBRIS) MUST BE DISPOSED OF PROPERLY.

LIMING/FERTILIZING: APPLY LIMESTONE AND FERTILIZER TO SOIL TEST RECOMMENDATIONS OR AS FOLLOWS:
- A. **LIME** IS TO BE APPLIED AT THE RATE OF 2 TONS (4,000 LBS.) PER ACRE. LIME MAY BE ANY PRODUCT TYPE AS LONG AS THE CCE CALCIUM CARBONATE EQUIVALENCY = 2 TONS PER/ACRE. PELLETIZED AND LIQUID PRODUCTS MAY BE PREFERRED BECAUSE OF THEIR LACK OF DUST AND EASE OF HANDLING BUT MUST MEET THE FORE-MENTIONED CRITERIA.
- B. **STARTER FERTILIZER**, SPECIFIED AS **10-20-10**, IS TO BE APPLIED AT **500 LBS. PER ACRE.**
- C. **LIME AND FERTILIZER** ARE TO BE WORKED INTO THE SOIL TO A DEPTH OF 4 INCHES. **TEMPORARY STABILIZATION WITH MULCH ONLY**

STRAW MULCH (HAY MULCH MAY BE SUBSTITUTED IF APPROVED BY THE DISTRICT) IS TO BE SPREAD UNIFORMLY AT THE RATE OF 2 TO 2-1/2 TONS PER ACRE (TOTAL GROUND SURFACE COVERAGE). THIS PRACTICE IS LIMITED TO PERIODS WHEN VEGETATIVE COVER CANNOT BE ESTABLISHED DUE TO THE SEASON OR OTHER CONDITIONS. MULCH MUST BE ANCHORED IN ACCORDANCE WITH NEW JERSEY STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL. MULCH ALONE CAN ONLY BE USED FOR SHORT PERIODS AND WILL REQUIRE MAINTENANCE AND RENEWAL. OTHER MULCH MATERIALS MAY BE UTILIZED IF APPROVED BY THE DISTRICT.

TEMPORARY SEEDING
TEMPORARY SEEDING IS TO BE USED ON ALL DISTURBED AREAS WHERE PERMANENT STABILIZATION WILL NOT BE ACCOMPLISHED FOR A PERIOD OF UP TO 6 MONTHS.

PRODUCT	RATE	RECOMMENDED OPTIMUM SEEDING DATES
PERENNIAL RYEGRASS	100 LBS. PER ACRE	3/15-5/15 & 8/15-10/1
SPRING OATS	86 LBS. PER ACRE	3/15-6/1 & 8/1-10/1
WINTER CEREAL RYE	112 LBS. PER ACRE	8/1-11/15
WINTER BARLEY	96 LBS. PER ACRE	8/15-10/1
PEARL MILLET	20 LBS. PER ACRE	5/15-8/15
GERMAN OR HUNGARIAN MILLET	30 LBS. PER ACRE	5/15-8/15

STABILIZATION WITH SOD
STABILIZATION WITH SOD IS PERMITTED IN AREAS WHERE MAINTENANCE AND IRRIGATION ARE ADEQUATE TO INSURE PROPER ESTABLISHMENT AND LONGEVITY. SEEDBED PREPARATION IS TO BE CONSISTENT WITH ANY OTHER STABILIZATION REQUIREMENTS. (LIME AND FERTILIZER BAGS ARE TO BE RETAINED FOR DISTRICT INSPECTION.) ON SLOPES GREATER THAN 3 TO 1, SOD MUST BE PROPERLY ANCHORED TO THE SLOPE IN ACCORDANCE WITH THE NJ STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL.

PERMANENT SEEDING
- D. SEED IS TO BE INCORPORATED INTO THE SOIL TO A DEPTH OF ¼"-½".
- E. LAWN SEEDINGS ARE TO BE MIXTURE OF BLUEGRASSES, TURF-TYPE FESCUES, AND TURF-TYPE PERENNIAL RYEGRASSES TO INSURE LONGEVITY, TOLERANCE, AND DURABILITY. NO SEED SHALL BE ACCEPTED WITH A GERMINATION TEST DATE OF MORE THAN 12 MONTHS OLD UNLESS RETESTED.
- F. PROFESSIONAL SEED MIXTURES ARE RECOMMENDED RATHER THAN MIXING SEEDS YOURSELF.
- G. SEED MIXTURE (AS SPECIFIED BELOW) IS TO BE **APPLIED AT A MINIMUM RATE OF 200 LBS. PER ACRE OF PERENNIAL SEED.**
- H. **OPTIMUM SEEDING PERIOD FOR HUNTERDON COUNTY IS FROM MARCH 1 TO MAY 15 AND AUGUST 15 TO OCTOBER 1.** OUTSIDE OF THOSE PERIODS, THE SEEDING RATES ARE TO BE **INCREASED BY 50%** (I.E. 300 LBS. PER ACRE OF PERENNIAL SEED INSTEAD OF THE REQUIRED 200 LBS. PER ACRE DURING OPTIMUM PERIODS).
- I. SEEDINGS SHOULD RECEIVE AN APPLICATION OF FERTILIZER SUCH AS 10-10-10 OR EQUIVALENT AT 400 LBS. PER ACRE APPROXIMATELY 6 MONTHS AFTER FIRST APPLICATION.

SEEDING MIXTURE FOR GENERAL SEEDING - (EXAMPLE: LAWNS)

40% TURF-TYPE TALL FESCUE 10% CREEPING RED FUSCUE 10% CHEWINGS FESCUE 10% KENTUCKY BLUEGRASS 30% TURF-TYPE PERENNIAL RYEGRASS	**OR**	50% KENTUCKY BLUEGRASS 20% TURF-TYPE PERENNIAL RYEGRASS 20% CHEWINGS FESCUE

SEEDING MIXTURE FOR HIGH TRAFFIC & CRITICAL AREAS
(EXAMPLES: ATHLETIC FIELD, WATERWAYS, DIVERSIONS, ETC.)
80% TURF-TYPE TALL FESCUE
10% KENTUCKY BLUEGRASS
10% TURF-TYPE PERENNIAL RYEGRASS

OTHER SEED MIXTURES, SUCH AS BLENDED VARIETIES OF PERENNIAL TURF TYPE RYEGRASSES, TURF-TYPE TALL FESCUES, OR BLUEGRASSES MAY ALSO BE ACCEPTABLE IF APPROVED BY THE DISTRICT.

TABLE 4-3

PERMANENT VEGETATIVE MIXTURES, PLANTING RATES AND PLANTING DATES

SEED MIXTURE	PLANTING RATE		PLANTING DATES O = OPTIMAL PLANTING PERIOD A = ACCEPTABLE PLANTING PERIOD PLANT HARDINESS ZONES (SEE FIGURE 4-1)[1]									MAINTENANCE LEVEL /4	REMARKS
			ZONE 5B, 6A			ZONE 6B			ZONE 7A, 7B				
	LBS/ACRE	LBS/1000 SQ FT	3/15-5/31	6/1-7-31	8/1-10/31	3/1-4/30	5/1-8/14	8/15-11/15	2/1-4/30	5/1-8/14	8/15-11/30		
WARM SEASON SEED MIXTURES													
5. SWITCHGRASS BIG BLUESTEM LITTLE BLUESTEM SAND LOVEGRASS COASTAL PANICGRASS	10 5 5 4 10	.25 .10 .10 .10 .25	O			O			O			C-D	NATIVE WARM-SEASON MIXTURE

1. SEE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", THE NEW JERSEY STATE SOIL CONSERVATION COMMITTEE, JULY 1999, PAGE 4-7

CALL BEFORE YOU DIG!
NEW JERSEY LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE – STOP CALL
NEW JERSEY ONE CALL SYSTEM, INC.
REFERENCE NEW JERSEY TITLE 48, CHPT. 2, ARTICLE 9
1-800-272-1000

PROJECT NOTES

1. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983 (NAD 83) STATE PLANE NEW JERSEY (FIPS 2900), FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM (NAVD 88), FEET.

2. TOPOGRAPHIC INFORMATION OBTAINED FROM FIELD SURVEY CONDUCTED BY USDA-NRCS PERSONNEL IN MAY, 2007. BOUNDARY SURVEY FOR BLOCK 49, LOT 2 PREPARED BY NRCS OCTOBER 30, 2006 AND OBTAINED IN DIGITAL FORMAT NOVEMBER 2, 2006.

3. PROPERTY LINE INFORMATION AS BOUNDARY INFORMATION IS BASED ON A PLAN ENTITLED " SUBDIVISON OF LANDS FOR FLEMINGTON/RARITAN RECREATION COMMITTEE" PREPARED BY HERITAGE CONSULTING ENGINEERS DATED JULY, 1982 AND MINOR SUBDIVISON FOR LOT LINE ADJUST FOR BLOCK 49 LOT 2 PREPARED BY RARITAN TOWNSHIP ENGINEERING DEPARTMENT DATES 10/13/99, AS OBTAINED IN DIGITAL FORMAT FROM RARITAN TOWNSHIP.

4. WETLAND DELINEATION CONDUCTED BY PRINCETON HYDRO PERSONNEL IN APRIL 2007.

5. MONITORING WELLS INSTALLED BY PRINCETON HYDRO PERSONNEL ON JANUARY 17, 2008.

DATE	DESCRIPTION
06/06/2008	REVISIONS AS PER NJDEP COMMENTS

REVISIONS

STATE OF NEW JERSEY CERTIFICATE OF AUTH. NO.: 24GA27976800

MARY L. PAIST-GOLDMAN
Professional Engineer
NJ Lic. No. GE-45798

DATE

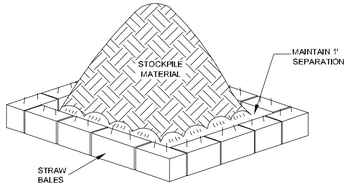
PRINCETON HYDRO, LLC
pHi
SCIENTISTS AND ENGINEERS
1108 OLD YORK ROAD, SUITE 1
P.O. BOX 720
RINGOES, NEW JERSEY 08551
PHONE. 908.237.5660
FAX. 908.237.5666
WWW.PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
WALNUT BROOK
RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
SOIL EROSION AND
SEDIMENT CONTROL
NOTES

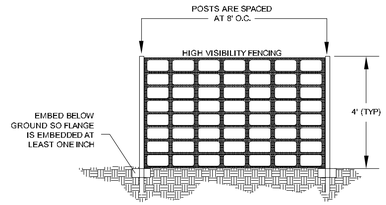
DATE:	3/27/2008
PROJECT NO.:	600.003
SCALE:	N/A
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO. 11 OF 14

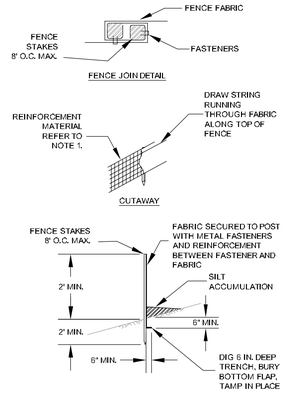


NOTE:
UPON PRIOR APPROVAL FROM ENGINEER: SILT FENCING MAY BE SUBSTITUTED FOR STRAW BALES, AND TEMPORARY SEEDING OF STOCKPILES MAY BE SUBSTITUTED FOR PLASTIC COVERING.

A STOCKPILE CONTROL DETAIL
NOT TO SCALE



B HIGH VISIBILITY FENCE
NOT TO SCALE



NOTES:

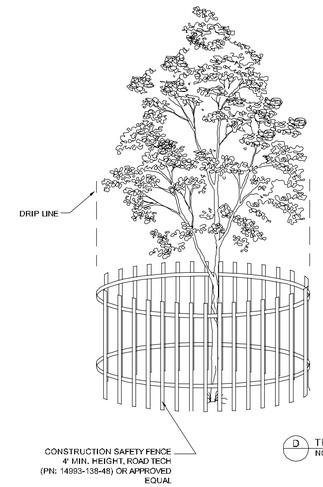
1. FENCE POSTS SHALL BE SPACED 8 FEET CENTER TO CENTER OR CLOSER. THE POSTS SHALL EXTEND AT LEAST 2 FEET INTO THE GROUND AND EXTEND AT LEAST 2 FEET ABOVE THE GROUND AND SHALL BE CONSTRUCTED OF HARDWOOD WITH A MINIMUM DIAMETER THICKNESS OF 1.5 INCHES.

2. A METAL FENCE WITH 6 INCH OR SMALLER OPENINGS AND AT LEAST 2 FEET HIGH MAY BE UTILIZED, FASTENED TO THE FENCE POSTS, TO PROVIDE REINFORCEMENT AND SUPPORT TO THE GEOTEXTILE FABRIC WHERE SPACE FOR OTHER PRACTICES IS LIMITED AND HEAVY SEDIMENT LOADING IS EXPECTED.

3. A GEOTEXTILE FABRIC, RECOMMENDED FOR SUCH USE BY THE MANUFACTURER, SHALL BE BURIED AT LEAST 6 INCHES DEEP IN THE GROUND. THE FABRIC SHALL EXTEND AT LEAST 2 FEET ABOVE THE GROUND. FABRIC MUST BE SECURELY FASTENED TO THE POSTS USING A SYSTEM CONSISTING OF METAL FASTENERS (NAILS OR STAPLES) AND HIGH STRENGTH REINFORCEMENT MATERIAL (NYLON WEBBING, GROMMETS, WASHERS, ETC.) PLACED BETWEEN THE FASTENER AND THE GEOTEXTILE FABRIC. THE FASTENING SYSTEM SHALL RESIST TEARING AWAY FROM THE POST. THE FABRIC SHALL INCORPORATE A DRAWSTRING IN THE TOP PORTION OF THE FENCE FOR ADDED STRENGTH.

4. SEDIMENTS SHALL BE REMOVED WHEN THE ACCUMULATION HEIGHT REACHES ONE QUARTER THE GROUND HEIGHT OF THE FENCE.

C SILT FENCE DETAIL
ONLY TO BE USED AS NECESSARY
NOT TO SCALE



NOTES:

1. TO PREVENT GENERAL MECHANICAL DAMAGE TO TREES INSTALL TREE PROTECTION AS INDICATED IN DETAIL.

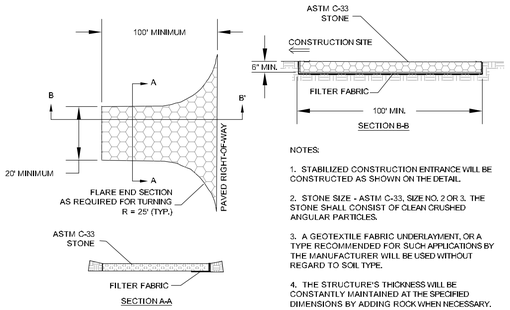
2. BOX TREES WITHIN 25 FEET OF BUILDINGS SITE TO PREVENT MECHANICAL INJURY. FENCING OR OTHER BARRIER SHOULD BE INSTALLED AT THE DRIP LINE OF THE TREE BRANCHES OR BEYOND. TREE ROOT SYSTEMS COMMONLY EXTEND WELL BEYOND THE DRIP LINE.

3. BOARDS WILL NOT BE NAILED TO TREES DURING CONSTRUCTION.

4. FEEDER ROOTS SHOULD NOT BE CUT IN AN AREA INSIDE THE DRIP LINE OF THE TREE BRANCHES

5. DAMAGED TRUNKS OR EXPOSED ROOTS SHOULD HAVE DAMAGED BARK REMOVED IMMEDIATELY AND NO PAINT SHALL BE APPLIED. EXPOSED ROOTS SHOULD BE COVERED WITH TOPSOIL IMMEDIATELY AFTER EXCAVATION IS COMPLETE. ROOTS SHALL BE PRUNED TO GIVE A CLEAN, SHARP SURFACE AMENABLE TO HEALING. ROOTS EXPOSED DURING HOT WEATHER SHOULD BE IRRIGATED TO PREVENT PERMANENT TREE INJURY. CARE FOR SERIOUS INJURY SHOULD BE PRESCRIBED BY A PROFESSIONAL FORESTER OR CERTIFIED TREE EXPERT.

D TREE PROTECTION DETAIL
NOT TO SCALE



NOTES:

1. STABILIZED CONSTRUCTION ENTRANCE WILL BE CONSTRUCTED AS SHOWN ON THE DETAIL.

2. STONE SIZE - ASTM C-33, SIZE NO. 2 OR 3. THE STONE SHALL CONSIST OF CLEAN CRUSHED ANGULAR PARTICLES.

3. A GEOTEXTILE FABRIC UNDERLAYMENT, OR A TYPE RECOMMENDED FOR SUCH APPLICATIONS BY THE MANUFACTURER WILL BE USED WITHOUT REGARD TO SOIL TYPE.

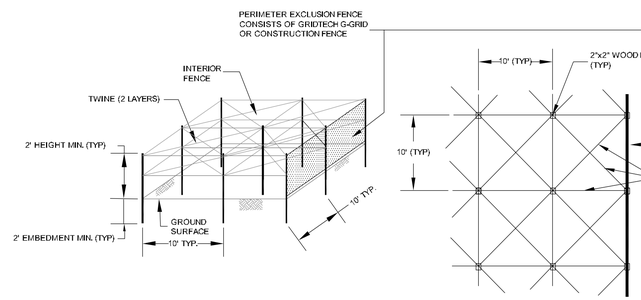
4. THE STRUCTURE'S THICKNESS WILL BE CONSTANTLY MAINTAINED AT THE SPECIFIED DIMENSIONS BY ADDING ROCK WHEN NECESSARY.

5. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO PUBLIC RIGHTS-OF-WAY MUST BE REMOVED IMMEDIATELY.

PERCENT SLOPE OF ROADWAY	LENGTH OF STONE REQUIRED	
	COARSE GRAINED SOILS	FINE GRAINED SOILS
0 TO 2%	50 FT	100 FT
2 TO 5%	100 FT	200 FT

** AS PRESCRIBED BY LOCAL ORDINANCE OR OTHER GOVERNING AUTHORITY.

E STABILIZED CONSTRUCTION ENTRANCE
NOT TO SCALE



GOOSE FENCE INSTALLATION NOTES

IN ORDER TO PROTECT THE NEWLY PLANTED SHORELINE STABILIZATION PLANTINGS, TEMPORARY GOOSE EXCLUSION MEASURES WILL BE REQUIRED IN THE PROPOSED EMERGENT WETLAND AND LITTORAL ZONES UNTIL THE SUCCESSFUL ESTABLISHMENT OF VEGETATION. THE EXCLUSION MEASURE SHALL CONSIST OF A GOOSE EXCLUSION FENCE PLACED BEYOND THE LAKEWARD AND LANDWARD LIMIT OF THE PLANTING AREA. GOOSE EXCLUSION FENCE SHOULD CONSIST OF GRIDTECH G-GRID OR APPROVED EQUAL MATERIAL. THE FENCE MATERIAL SHOULD BE ATTACHED TO WOODEN STAKES PLACED AT 8-10 FOOT INTERVALS AROUND THE PLANTING AREA. ON THE LAKEWARD SIDE THE FENCE SHOULD BE ATTACHED TO THE STAKES TO ALLOW 5-8 INCHES OF FENCE TO EXTEND BELOW THE WATERS SURFACE. IN ADDITION TO THE PERIMETER GOOSE EXCLUSION FENCE, A ROW OF WOODEN STAKES SHALL BE PLACED WITHIN THE PLANTING AREA TO CREATE INTERIOR FENCING. THREE ROWS OF TWINE SHALL BE TIED BETWEEN THE STAKES AND THE EXTERIOR FENCING TO FURTHER DETER ACCESS TO THE PLANTING AREA BY GEESE.

F TEMPORARY GOOSE CONTROL DETAIL
NOT TO SCALE

TEMPORARY CROSSING NOTES:

1. NJDOT NO. 1 COARSE AGGREGATE OR LARGER WILL BE USED TO FORM THE CROSSING.

2. THE LENGTH OF PIPE INSTALLED AS THE TEMPORARY CONVEYENCE SHALL BE CONSTRUCTED OF MATERIALS STRONG ENOUGH TO CARRY THE EXPECTED EQUIPMENT TRAFFIC. THE PIPE SHALL BE OF ADEQUATE LENGTH TO ACCOMIDATE THE FULL WIDTH OF THE CROSSING AND WILL BE INSTALLED WITH A SLOPE OF AT LEAST 0.25 INCH PER FOOT.

3. THE TEMPORARY CROSSING WILL BE ALIGNED WITH THE CURRENT CHANNEL AT RIGHT ANGLES. WHERE APPROACH CONDITIONS DICTATE, THE CROSSING MAY VARY 15° FROM A LINE DRAWN PERPENDICULAR TO THE CENTER LINE OF THE CHANNEL.

4. THE CENTERLINE OF THE ROADWAY APPROACHES ON BOTH SIDES OF THE CROSSING SHALL COINCIDE WITH THE CROSSING ALIGNMENT CENTERLINE FOR A MINIMUM OF 50 FEET FROM EACH BANK OF THE CROSSING.

5. THE APPROACH PADS WILL CONSIST OF NJDOT NO. 1 COARSE AGGREGATE, A MINIMUM THICKNESS OF 12 INCHES AND A MINIMUM WIDTH OF 20 FEET OR AS INDICATED ON THE ATTACHED DETAIL TABLE.

6. THE APPROACH PADS WILL BE OF REVERSED GRADE FROM THE CROSSING STRUCTURE. IF REVERSE GRADING IS NOT POSSIBLE DIVERSION CHANNELS WILL BE INSTALLED IN THE APPROACH AREA TO PREVENT WATER FROM ENTERING THE STREAM AT THE CROSSING.

TEMPORARY CROSSING MAINTENANCE NOTES:

ALL STRUCTURES SHALL BE INSPECTED AFTER EVERY RAINFALL AND AT LEAST ONCE A WEEK. ANY DAMAGES OBSERVED SHALL BE REPAIRED IMMEDIATLY.

7. CLEARING AND EXCAVATING OF THE STREAM BED SHALL BE KEPT TO A MINIMUM.

8. THE INVERT ELEVATION OF THE CULVERT SHALL BE INSTALLED ON THE NATURAL STREAMBED GRADE TO MINIMIZE INTERFERENCE WITH FISH MIGRATION.

9. FILTER FABRIC PLACED UNDER THE CROSSING (MIRAFI FW 700 OT APPROVED EQUAL) SHALL BE PLACED ON THE STREAMBED AND STREAM/BANKS PRIOR TO PLACEMENT OF THE PIPE CULVERT(S) AND AGGREGATE. THE FILTER CLOTH SHALL COVER THE STREAMBED AND EXTEND A MINIMUM OF SIX (6) INCHES AND A MAXIMUM OF ONE (1) FOOT BEYOND THE END OF THE CULVERT AND BEDDING MATERIAL.

10. THE CULVERT SHALL EXTEND A MINIMUM OF ONE (1) FOOT BEYOND THE UPSTREAM AND DOWNSTREAM TOE OF THE AGGREGATE PLACED AROUND THE CULVERT. IN NO CASE SHALL THE CULVERT EXCEED 40 FEET IN LENGTH.

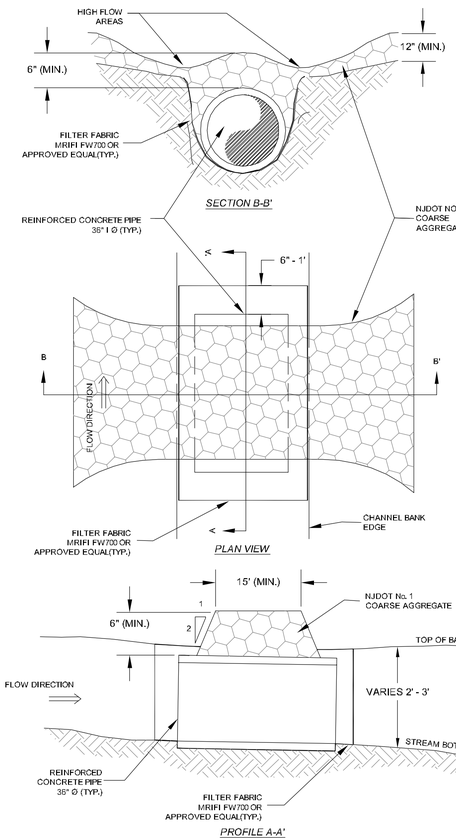
11. THE CULVERT SHALL BE COVERED WITH A MINIMUM OF ONE (1) FOOT OF AGGREGATE OR AS INDICATED ON THE DETAIL.

12. UPON CONCLUSION OF THE PROJECT THE CULVERT AND ALL ITS ASSOCIATED MATERIALS SHALL BE REMOVED COMPLETELY AND THE STREAMBED AND STREAM/BANKS WILL BE RETURNED TO THE PRECONSTRUCTION CONDITIONS.

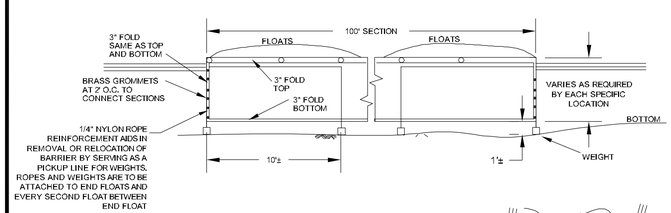
13. THE CENTERLINE OF THE ROADWAY APPROACHES ON BOTH SIDES OF THE CROSSING SHALL COINCIDE WITH THE CROSSING ALIGNMENT CENTERLINE FOR A MINIMUM OF 50 FEET FROM EACH BANK OF THE CROSSING.

14. THE APPROACH PADS WILL CONSIST OF ASTM C-33, SIZE NO. 2 (2.5 TO 1.5 IN) STONE, A MINIMUM THICKNESS OF 6 INCHES AND A MINIMUM WIDTH OF 20 FEET OR AS INDICATED ON THE ATTACHED DETAIL TABLE.

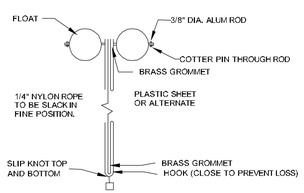
15. THE APPROACH PADS WILL BE REVERSED GRADE FROM THE CROSSING STRUCTURE. IF REVERSE GRADING IS NOT POSSIBLE DIVERSION CHANNELS WILL BE INSTALLED IN THE APPROACH AREA TO PREVENT WATER FROM ENTERING THE STREAM AT THE CROSSING.



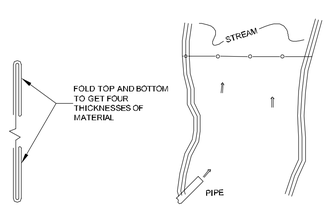
H TEMPORARY CULVERT CROSSING DETAIL
NOT TO SCALE



GENERAL NOTES:
SILT BARRIER TO PREVENT DRIFTING OF SILT CAUSED BY DISCHARGE CONSTRUCTION, DREDGING OR FILLING OPERATIONS. EXACT PLACEMENT OF SILT BARRIER SHALL BE SO AS TO EFFECTIVELY CONTROL SILT DISPERSION UNDER THE CONDITIONS PRESENT ON A PARTICULAR PROJECT. THE DETAILS SHOWN HEREON ARE SUGGESTED METHODS, ONLY ALTERNATE SOLUTIONS AND USAGE OF MATERIALS MAY BE USED AS APPROVED BY THE ENGINEER. AT SHALLOW WATER LOCATIONS THE PLASTIC SHEET OR MATERIAL ALTERNATE MAY BE ATTACHED TO STAKES DRIVEN INTO THE BOTTOM IN LIEU OF FLOATS AND WEIGHTS.

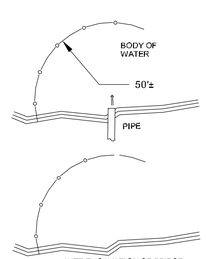


SECTION THROUGH BARRIER



FOLDING DETAIL

TYPICAL APPLICATIONS



G TURBIDITY BARRIER DETAIL
ONLY TO BE USED AS NECESSARY
NOT TO SCALE

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RIPARIAN RESTORATION PLAN
TOWNSHIP OF RARITAN
HUNTERDON COUNTY, NEW JERSEY

DRAWING NAME:
SOIL EROSION AND SEDIMENT CONTROL DETAILS

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SCALE:	AS SHOWN
DRAWN BY:	BWB
CHECKED BY:	MPG

SHEET NO.
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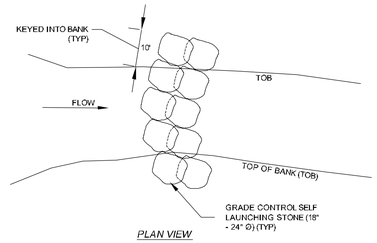
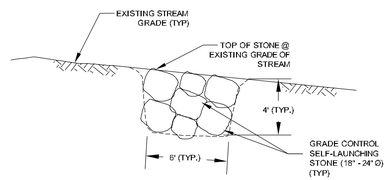
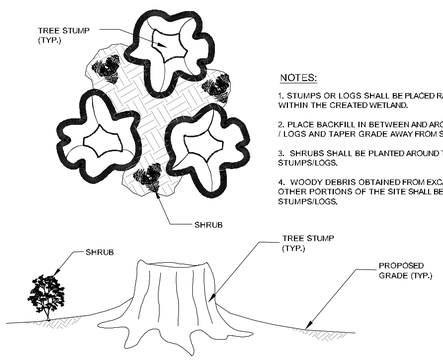


PLAN VIEW



ELEVATION VIEW

B GRADE CONTROL
NOT TO SCALE



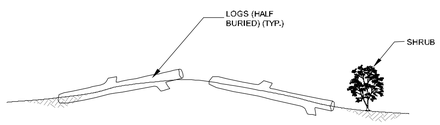
NOTES:

1. STUMPS OR LOGS SHALL BE PLACED RANDOMLY WITHIN THE CREATED WETLAND.

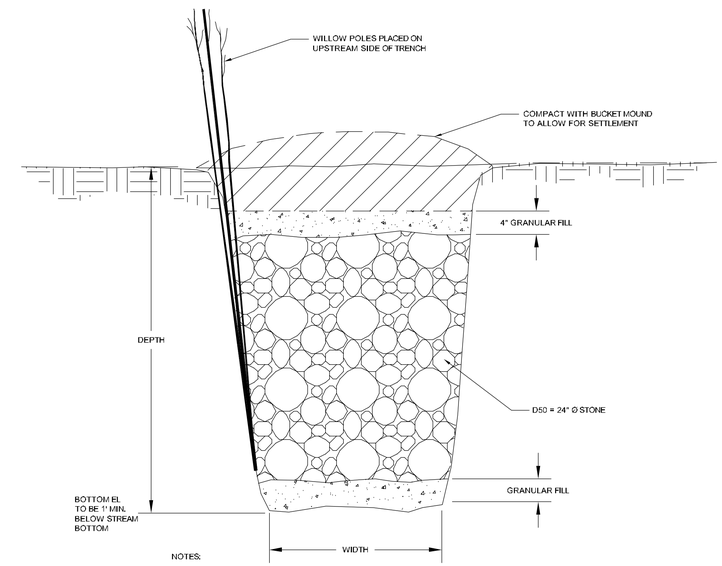
2. PLACE BACKFILL IN BETWEEN AND AROUND STUMPS / LOGS AND TAPER GRADE AWAY FROM STUMP/LOG.

3. SHRUBS SHALL BE PLANTED AROUND THE STUMPS/LOGS.

4. WOODY DEBRIS OBTAINED FROM EXCAVATION OF OTHER PORTIONS OF THE SITE SHALL BE REUSED AS STUMPS/LOGS.



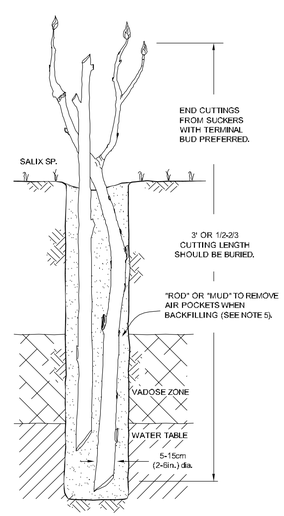
D HUMMOCK/HOLLOW DETAIL
NOT TO SCALE



NOTES:

1. CHOKE VOIDS IN STONE WITH SOIL THEN FILL WITH WATER
2. WIDTH FOR SMALL KEY SHALL BE TWO (2) FEET. WIDTH FOR LARGE KEY SHALL BE BETWEEN FOUR (4) AND FIVE (5) FEET.
3. DEPTH FOR SMALL KEY SHALL BE THREE (3) FEET. DEPTH FOR LARGE KEY SHALL BE BETWEEN FIVE (5) AND SIX (6) FEET.
4. LENGTH INTO BANK FOR SMALL KEY SHALL BE BETWEEN SIX (6) AND EIGHT (8) FEET. LENGTH INTO BANK FOR LARGE KEY SHALL BE BETWEEN TEN (10) TO FIFTEEN (15) FEET.
5. REFER TO PLAN SHEETS 5 AND 8 OF 14 FOR LOCATION OF PROPOSED KEYWAYS.

C KEYWAY SECTION
BOTH LARGE AND SMALL KEYS
NOT TO SCALE



NOTES:
1. POLE CUTTINGS OF WILLOW WILL BE USED OR APPROVED EQUAL.

2. THE POLE CUTTINGS SHOULD EXTEND THROUGH THE VADOSE ZONE AND INTO THE PERMANENT WATER TABLE. AT LEAST 1/2 TO 2/3 OF THE POLE SHOULD BE BELOW THE GROUND, AT LEAST 3 FT., AND LONG ENOUGH TO EMERGE ABOVE ADJACENT VEGETATION.

3. "MUDDYING" - FILLING THE HOLE WITH WATER AND THEN SOIL TO MAKE A MUD SLURRY CAN REMOVE AIR POCKETS.

E WILLOW POSTS & POLES
NOT TO SCALE

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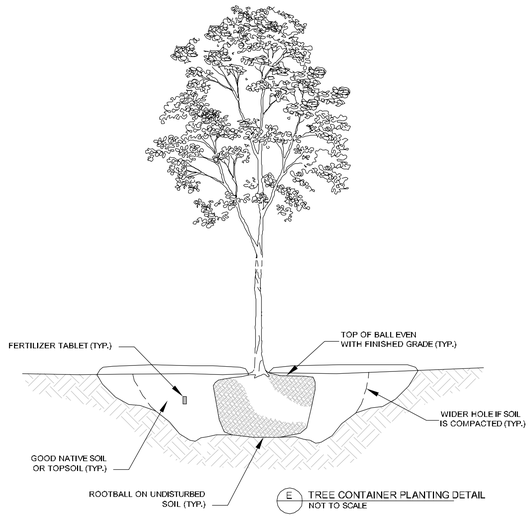
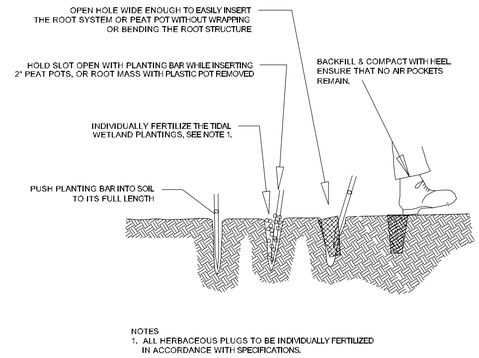
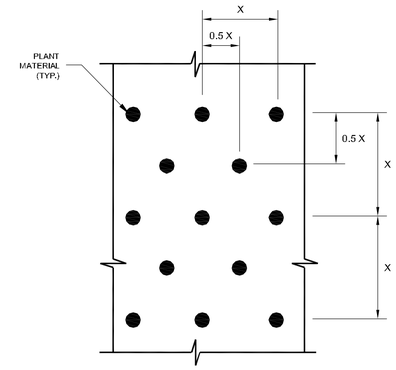


E TREE CONTAINER PLANTING DETAIL
NOT TO SCALE



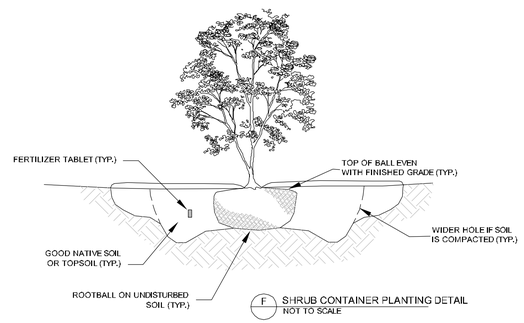
NOTES
1. ALL HERBACEOUS PLUGS TO BE INDIVIDUALLY FERTILIZED IN ACCORDANCE WITH SPECIFICATIONS.

C HERBACEOUS PLANTING INSTALLATION DETAIL (TYP)
NOT TO SCALE

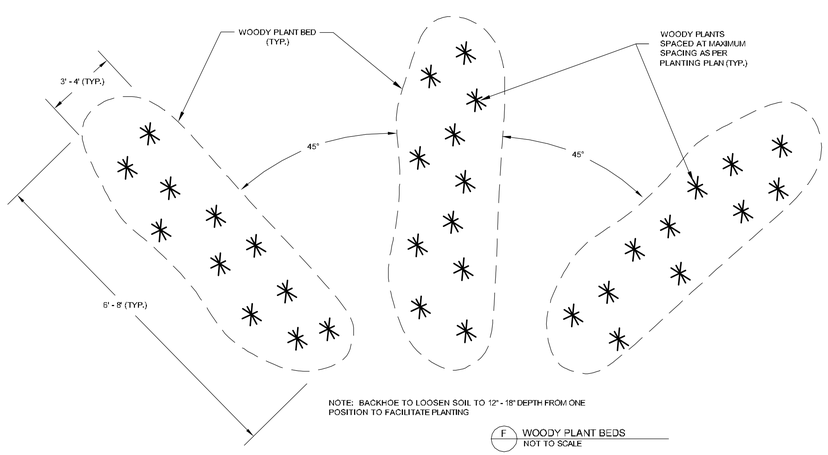


NOTE:
VARIES, REFER TO PLANTING PLAN FOR DIMENSION 'X'.

D PLANT MATERIAL SPACING DETAIL
C.C. SPACING PLAN
NOT TO SCALE

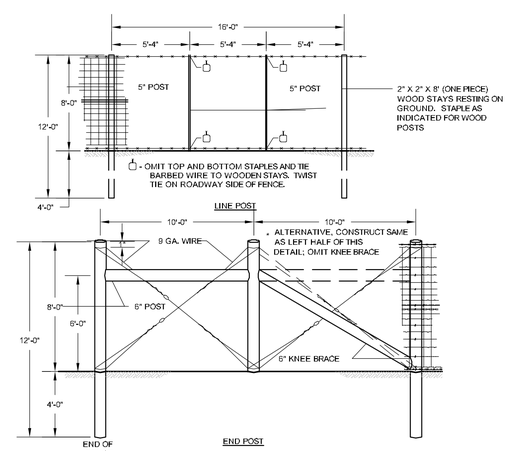


F SHRUB CONTAINER PLANTING DETAIL
NOT TO SCALE



NOTE: BACKHOE TO LOOSEN SOIL TO 12" - 18" DEPTH FROM ONE POSITION TO FACILITATE PLANTING

F WOODY PLANT BEDS
NOT TO SCALE



G DEER FENCE DETAIL
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14 OF 14

Appendix B

Walnut Brook Benthic

Macroinvertebrate Sampling

Final Report

Walnut Brook Stream Stabilization Project

Benthic Macroinvertebrate Sampling

FINAL REPORT

New Jersey Water Supply Authority (NJWSA)
Watershed Protection Programs
74 East Main Street
Somerville, NJ 08876-2312
(908) 685-0315
www.raritanbasin.org

EST. 1981

March 31, 2011

Contents

Appendices

A. Laboratory Macroinvertebrate Bench Sheets
B. Benthic Macroinvertebrate Field Data Sheets
C. South Branch Watershed Association Macroinvertebrate Sampling Results 2007-2008
D. Photos

I. Introduction and Background

a. Project Overview

North Jersey Resource Conservation and Development Council (RC&D) is a 501(c)3 nonprofit organization that serves as the project leader on the Walnut Brook Riparian Restoration. North Jersey RC&D was originally established in 1974 as the Warren-Sussex RC&D, and now serves Sussex, Warren, Hunterdon, Somerset, Morris and Union counties. North Jersey RC&D focuses on addressing regional resource issues by establishing partnerships with local, state and federal government officials as well as watershed and environmental organizations.

Approximately 25% of the Walnut Brook watershed is developed, and the watershed therefore presents the problems seen in many urbanizing watersheds. Development in the 1950's and 60's led to increases in impervious cover, greatly impacting the peak streamflow. The stream became flashy, incised and disconnected from its floodplain.

In 2007, North Jersey RC&D began a long-term stream stabilization and wetland mitigation project on a reach of the Walnut Brook. North Jersey RC&D has been working to construct forested wetlands, implement innovative bio-engineering practices along two severely eroding meanders of the Walnut Brook, and restore the riparian buffer. The project, known as the *Walnut Brook Riparian Restoration Project*, is located within Raritan Township, Hunterdon County, New Jersey, located in Mine Brook Park and on the Hunterdon Land Trust Alliance's (HLTA) Dvoor Farm property just south of Mine Brook Park. Construction occurred in 2009 and 2010.

Through this project, the stream channel was reconnected to its floodplain, and a total of 13 acres of wetland and riparian habitat were restored. Project partners completed a thorough assessment of the site and watershed hydrology. Utilizing a design team approach the restoration plan has been developed and is being implemented. There are numerous members included in the project team who are committed to providing in-kind resources to ensure the project's success.

Earthmoving activities included removal of fill from the floodplain in order to reestablish the natural floodplain topography as it existed prior to the conversion to agriculture. Stream stabilization measures consisted of in-stream grade control features to reconnect the stream to the floodplain to mitigate the channel incision. Wetland restoration techniques were applied to floodplain areas to restore the historic wetland hydrology (through surface and subsurface sources). The riparian plant community was restored and enhanced through the removal of invasive and exotic vegetation and the establishment of native riparian and palustrine forest plant communities.

The project also included the restoration/creation of two acres of riverine wetland in floodplains along Walnut Brook on the HLTA property. Natural wetland hydrology was restored to two acres of floodplain by a combination of raising the level of Walnut Brook through grade control and natural stream channel design and removing soil from the floodplain. These areas were planted to native riverine wetland herbaceous and woody vegetation. Concurrent to the streambank stabilization and wetland restoration, New Jersey Institute of Technology (NJIT) is serving as project lead for the Neshanic River Watershed Restoration and Protection Plan.

b. Macroinvertebrate Sampling

Macroinvertebrate monitoring involves testing for the presence of macroinvertebrates within a stream, and basing water quality ratings on the abundance and diversity of the organisms present, as well as the sensitivities of these organisms to pollutants. The advantages of biological assessment include the following:

- Fluctuating environmental conditions can be monitored over time
- Biological communities can be used as indicators of general ecological integrity
- Macroinvertebrates are usually abundant in streams and sampling will have no detrimental effect on the community
- Individuals are easily identified and established tolerance values are readily available
- Due to the relatively short life cycle of the organisms within a community, impacts are easily measured and ecological changes can be seen quickly
- Biological monitoring assists in problem identification within an area
- More detailed chemical testing can be done to determine the exact problem or possibly identify a source indicated by biological monitoring

The biological assessment project involved the monitoring of three sites in the Walnut Brook Watershed for macroinvertebrate communities. These locations bracketed the stabilization activities undertaken by the project team (figure 1). These stations were used to assess the effectiveness of these efforts in protecting and improving the water quality of the restored stream. Biological assessment monitors trends in the benthic community and is used to determine possible problem sites for further analysis. The U.S. EPA *Rapid Bioassessment Protocols for Use in Streams and Rivers* (EPA 841-B-99-002) established guidelines for collection and analysis and modified versions of these protocols for temperature analysis and macroinvertebrate sample collection were followed for this study.

Macroinvertebrate sampling was conducted by South Branch Watershed Association (SBWA) four times between May 2007 and June 2008 and by New Jersey Water Supply Authority (NJWSA) five times between December 2008 and September 2010. This report offers a brief overview of SBWA's data and summarizes the findings of the data collected by NJWSA.

c. Intended Usage of Data

The data gathered from this biological sampling effort were used to evaluate the effectiveness of the stabilization activities that were implemented at the Walnut Brook Stream Stabilization Project. Sampling was conducted prior to stream stabilization by the South Branch Watershed Association. The locations of the samples collected by SBWA were not included in the data summarization. NJWSA began macroinvertebrate sampling in 2008 and conducted five sampling rounds through to September 2010. The sampling sites were established upstream and downstream of the project activities, as indicated in Figure 1.

d. Collection Methods

Biological assessment monitors trends in the benthic community and is used to determine possible problem sites for further analysis. The U.S. EPA *Rapid Bioassessment Protocols for Use in Streams and Rivers* (EPA 841-B-99-002) established guidelines for collection and analysis and modified versions of these protocols for temperature analysis and macroinvertebrate sample collection are followed for this

study. This process advocates for an integrated assessment that compares habitat, biodiversity and other conditions with reference conditions. The goal of the Rapid Bioassessment Protocol is to characterize the existence and severity of any impairment, identify the source of these impairments, and evaluate the effectiveness of control actions and restoration measures.

The Multihabitat Approach was used to gather macroinvertebrate samples. Habitat types appropriate for macroinvertebrates were sampled by using a D-frame net to collect 20 samples from a variety of these habitats. Two samplers used the net and kicked at each of the collection areas to dislodge macroinvertebrates into the net. All samples were combined to form a composite of the stream reach and preserved using 95% ethanol.

e. Field Sampling Procedures

Before sampling, the Physical Characterization Field Data Sheet was completed to document site description, weather conditions, and land use. After sampling, this information was reviewed for accuracy and completeness. A map of the sampling reach was included on the field data sheets. The hand drawn maps included in-stream attributes (e.g., riffles, falls, fallen trees, pools, bends, etc.) and important structures, plants, and attributes of the bank and near stream areas. Arrows indicate the direction of flow.

f. Sampling Equipment

Table 1 – Sampling Equipment

SAMPLING EQUIPMENT	SAMPLE HOLDING CONTAINER
D-frame net with 500 um mesh, waders, data sheets, forceps, pencil, magnifying glass	24 ounce Wide-Mouthed Plastic Bottle with 95% ethanol alcohol preservative

g. Multihabitat Approach

The Multihabitat Approach is the sampling technique used by the samplers. Different types of habitat were sampled in approximate proportion to their representation of surface area of the total macroinvertebrate habitat in the reach. For example, if snags comprise 50% of the habitat in a reach and riffles comprise 20%, then 10 kicks were taken in snag material and four kicks were taken in riffle areas. The remainder of the kicks (six) were taken in any remaining habitat types. Habitat types contributing less than 5% of the stable habitat in the stream reach were not sampled. In this case, the remaining kicks were spread out proportionately among the predominant substrates. The number of kicks taken in each habitat type was recorded on the field data sheet.

Sampling began at the downstream end of the reach (WB3) and proceeded upstream (WB1). A total of 20 kicks were taken over the length of the reach; a *kick* is a stationary sampling accomplished by positioning the net and disturbing the substrate for a distance of 0.5 m upstream of the net for 60

seconds. The kicks collected from the individual areas were composited to obtain a single homogeneous sample. Large debris was removed after rinsing with a squirt bottle in the net and inspecting it for organisms; any organisms found were placed into the sample container. The sample was transferred from the net to sample container(s) and preserved in enough 95% ethanol to cover the entire sample. Forceps were used to remove organisms from the net.

Details indicating the site name, date, stream name, sampling location, and collector name were recorded on the bottle. This information was completed using a waterproof and alcohol-proof pen. The top portion of the Benthic Macroinvertebrate Field Data Sheet was completed, which duplicates information from the Physical Characterization Field Data Sheet. The percentage of each habitat type in the reach was also recorded. The sampling gear used was recorded and comments on conditions of the sampling, e.g., high flows, low flow, treacherous rocks, difficult access to stream, or anything that would indicate adverse sampling conditions were also included.

h. Habitat Types & Appropriate Sampling Methods

The major stream habitat types listed here are in reference to those that are colonized by macroinvertebrates and generally support the diversity of the macroinvertebrate assemblage in stream ecosystems. A combination of these habitats was sampled in the multihabitat approach depending on habitats present along the stream reach.

Cobble (hard substrate) - Cobble will be prevalent in the riffles (and runs), which are a common feature throughout most mountain and piedmont streams. In many high-gradient streams, this habitat type will be dominant. Sample shallow areas with coarse (mixed ravel, cobble or larger) substrates by holding the bottom of the dip net against the substrate and dislodging organisms by kicking the substrate for 0.5 m upstream of the net for a period of 60 seconds.

Snags - Snags and other woody debris that have been submerged for a relatively long period (not recent deadfall) provide excellent colonization habitat. Sample submerged woody debris by kicking in medium-sized snag material (sticks and branches). The snag habitat will be kicked to help dislodge organisms, but only after placing the net downstream of the snag. Accumulated woody material in pool areas are considered snag habitat. Large logs should be avoided because they are generally difficult to sample adequately.

Vegetated banks - When lower banks are submerged and have roots and emergent plants associated with them, they are sampled in a fashion similar to snags. Submerged areas of undercut banks are good habitats to sample. Sample banks with protruding roots and plants by using the net to jab into the habitat. Bank habitat will be kicked first to help dislodge organisms, but only after placing the net downstream.

Submerged macrophytes - Submerged macrophytes are seasonal in their occurrence and may not be a common feature of many streams, particularly those that are high-gradient. Sample aquatic plants that are rooted on the bottom of the stream in deep water by drawing the net through the vegetation from the bottom to the surface of the water (maximum of 0.5 m each jab). In shallow water, sample by bumping or jabbing the net along the bottom in the rooted area, avoiding sediments where possible.

Sand (and other fine sediment) - Usually the least productive macroinvertebrate habitat in streams, it may be the most prevalent in some streams. Sample banks of unvegetated or soft soil by bumping the net along the surface of the substrate rather than dragging the net through soft substrates; this reduces the amount of debris in the sample.

II. Evaluation Metrics

a. Metrics

1. Family Biotic Index (FBI)

This metric uses the tolerance of benthic macroinvertebrates to organic enrichment levels assigned to organisms identified to family level taxonomy. Families are assigned a score of 0 (intolerant) to 10 (tolerant) based upon the Hilsenhoff Index (Hilsenhoff 1982). The biotic index is calculated by multiplying the number of each species by their assigned family tolerance level (source: NJDEP 4-18-06 FTVs) and summing these, and then dividing by the total number of individuals in the sample. The biotic index was designed to measure the stream impairment due to organic waste loading rather than from inorganic inputs (e.g. toxic substances or heavy metals.)

$FBI = Sum (X_i T_i) / N$

Where:

FBI = Family Biotic Index

X_i = total number of individuals within each taxon

T_i = tolerance value of a taxon (using Hilsenhoff's family tolerance values)

N = total number of organisms in the sample

2. Total Taxa Richness

This is simply a measure of the total number of macroinvertebrate families identified from a sample collection. The number of taxa represented is an indicator of the general health of the stream. A reduction in taxa types may indicate a pollution stressor. Those taxa that are least tolerant to changes within the stream are the first to disappear when the stream is impacted.

3. EPT Richness

This measures the number of **E**phemeroptera (mayflies), **P**lecoptera (stoneflies) and **T**ricoptera (caddisflies) families in a collection. These three groups are the most sensitive to changes in water quality. Their absence or presence is a reliable indicator of water quality.

4. Percent EPT

This is a measure of the percent of the sample that consists of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) families (EPT taxa). This is an indicator of the number of families represented that are known to be sensitive to poor water quality.

5. Percent Dominance

Diverse numbers of relatively pollution-intolerant macroinvertebrate taxa that have abundances relatively proportional to one another, characterize healthy macroinvertebrate communities. As water quality becomes degraded the less pollution-tolerant taxa begin to disappear and an increase in the number of more tolerant species occurs. The percent dominance measures the percentage of the sample that is represented by the family with the most individuals sampled. A high percent dominance means that the sample is not very diverse.

6. New Jersey Impairment Score

The above metrics are combined using the following tables:

Table 2 – Metric Values

METRIC	STREAM IMPAIRMENT VALUE		
	6	3	0
Family Biotic Index	0-4	4-6	6-10
Total Taxa Richness	>10	10-5	4-0
EPT Richness	>5	5-3	2-0
Percent EPT	>35%	35-10%	<10%
Percent Dominance	<40%	40-60%	>60%

The Biological Assessment results from the sum of all the Stream Impairment Values for each metric. The total score is then used to develop the New Jersey Impairment Score using the table below:

Table 3 – NJ Impairment Score

TOTAL SCORES FROM METRICS	BIOLOGICAL ASSESSMENT
24-30	Non-Impaired
9-21	Moderately Impaired
0-6	Severely Impaired

III. Sampling Locations and Events

a. Sampling Sites

Three sampling sites were selected during the initial round of preconstruction sampling conducted by South Branch Watershed Association. One sampling reach was located downstream of the stabilization

area, one reach was located within the stabilization area, and one reach was located upstream of the sampling area. The figure below identifies the sampling sites as well as the stabilization area.

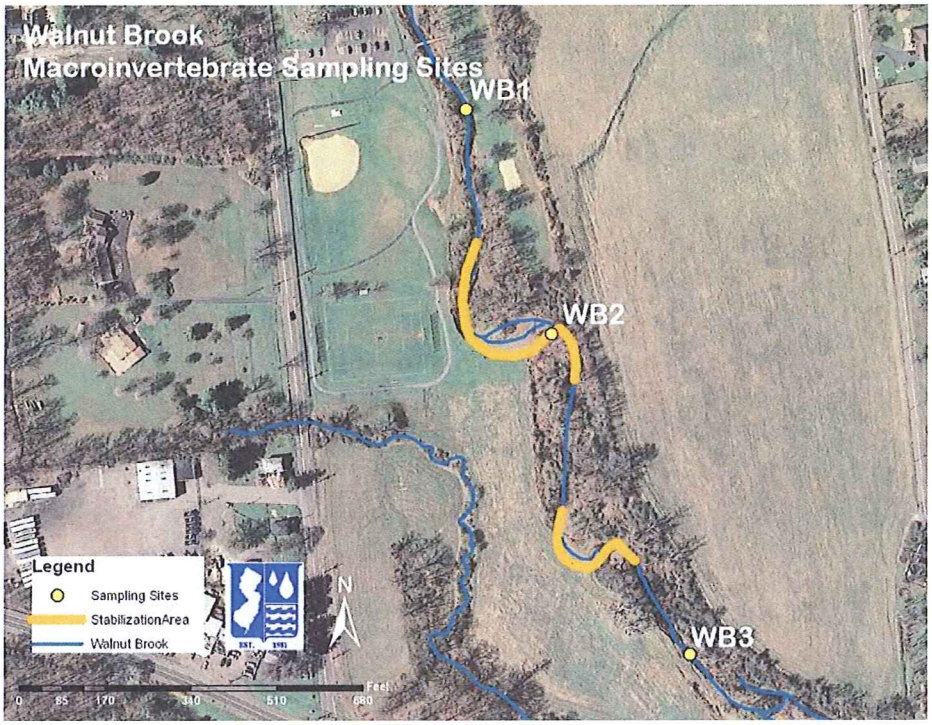


Figure 1

b. Sampling Events

The South Branch Watershed Association (SBWA) conducted four rounds of preconstruction macroinvertebrate sampling in 2007 and 2008. Three rounds were conducted in the Spring, Summer and Fall of 2007 and one sampling event was conducted in the Spring of 2008. The exact locations of these sampling events cannot be confirmed, nor can the quality control measures followed by SBWA. The scores for these sampling rounds were reported according to the metrics listed in the section above and will be discussed in the data summarization section below. The data are attached as an appendix to this document.

There were a total of five sampling events conducted during the term of the benthic macroinvertebrate monitoring subcontract agreement between New Jersey Water Supply and North Jersey Resource Conservation and Development Council. Two of the sampling events occurred prior to the stream stabilization project and the remaining three samples were collected after the stabilization project. The table below identifies the date and samplers for each sampling event.

Table 4 – Dates of Sampling Events

DATE OF SAMPLING EVENT	INITIALS OF SAMPLERS	SAMPLES COLLECTED (SITES)
12/8/08	TP, SS	WB1, WB2, WB3
6/15/09	SS, HB, MK	WB1, WB2, WB3

Construction (summer 2009)		
9/30/09	RA, HB	WB1, WB2, WB3
Additional Construction (summer 2010)		
6/25/10	RA, HB	WB1, WB2, WB3
10/22/10	RA, CL	WB1, WB2, WB3

Samplers for the December 8, 2008 event reported clear weather. The June 15, 2009 sampling events was reported to be clear and sunny with a heavy rain occurring within the last seven days. Cloudy weather was reported for the September 30, 2009 event, with no heavy rain in the previous seven days. Samplers reported very low flow and areas of dry stream bed during the June 25, 2010 sampling event. It is also noted on the data sheet that more recent construction (an additional grade control structure at the upstream end of the stabilization area) had taken place and was blocking flow. For the final sampling event on October 22, 2010, clear and sunny weather was reported, as was heavy rain within the last seven days.

IV. Summary of Results

a. Overall Trends

The sampling events conducted by the SBWA indicate that the Walnut Brook at Dvoor Farm was non-impaired for macroinvertebrates for two of the four sampling events (Spring 2007 and Spring 2008). The other two sampling events do not indicate a NJ impairment score; this could be due to the small sample size collected during the Summer 2007 and Fall 2007 sampling events (62 and 41 organisms, respectively). For the two sampling events where an NJ impairment score was found, only approximately 100 organisms were identified and used in the data calculations. It is unknown how the 100 individuals were selected from the sample, or whether that is the total number of organisms collected. For most of the NJWSA sampling events, with the exception of the June 2010 and October 2010 NJWSA sampling events, the entire sample was identified, sometimes resulting in a sample size of over 1000 organisms. The sample size could potentially have an impact on several metrics, resulting in an altered NJ impairment score.

In comparing the data from the five NJWSA sampling events, there are some notable trends that are apparent at all three sampling sites. The Family Biotic Index at all three sites increased over the course of the five sampling events. This indicates that families of macroinvertebrates being found in the stream are more tolerant to pollution. Another trend found across all three sites was a decrease in Percent EPT, which is a measure of the percent of organisms sampled that are from the orders Ephemeroptera, Plecoptera, and Tricoptera. Species in these orders are generally intolerant of water quality impairments. These changes resulted in a decrease in the NJ impairment Score. It also altered the ranking of the stream from "non-impaired" to "moderately impaired". The table below summarizes all of the data produced from the five sampling events.

Table 5 – Summary of Data Results

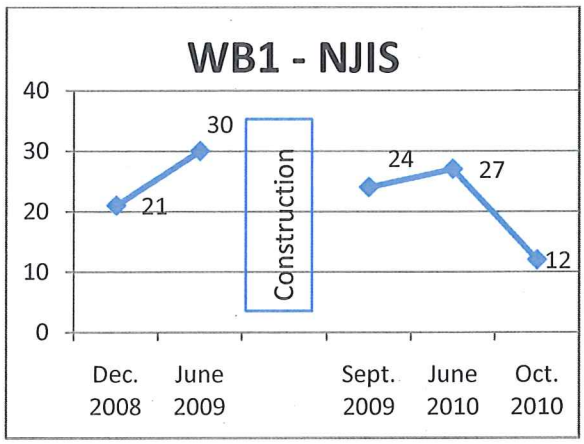
Station	Date	taxa rich-ness	Total # organ-isms	Dominant species	% Dominance	FBI	EPT Richn ess	% EPT	NJ Impairment Score	Biological Assessment
WB1	12/8/2008	9	1021	Capniidae	47.69%	1.99	4	86.87%	21	Moderately Impaired
WB1	6/15/2009	16	93	Perlidae	21.50%	3.79	10	70.97%	30	Non-Impaired
WB1	9/30/2009	14	756	Baetidae	30.56%	4.86	5	58.47%	24	Non-Impaired
WB1	6/25/2010	18	181	Chironomidae	35.90%	4.74	7	49.10%	27	Non-Impaired
WB1	10/22/2010	10	151	Chironomidae	82.80%	5.83	5	10.59%	12	Moderately Impaired
WB2	12/8/2008	19	1433	Capniidae	48.57%	2.18	11	84.00%	27	Non-Impaired
WB2	6/15/2009	20	210	Chironomidae	38.57%	4.95	9	34.29%	24	Non-Impaired
WB2	9/30/2009	17	294	Hydropsychidae	71.09%	4.27	6	82.65%	21	Moderately Impaired
WB2	6/25/2010	12	108	Chironomidae	57.40%	6.16	3	9.25%	12	Moderately Impaired
WB2	10/22/2010	10	161	Oligochaeta	42.23%	6.66	3	14.25%	12	Moderately Impaired
WB3	12/8/2008	15	1074	Capniidae	46.83%	2.41	7	80.54%	27	Non-Impaired
WB3	6/15/2009	16	106	Chironomidae	19.81%	4.55	7	52.83%	27	Non-Impaired
WB3	9/30/2009	14	628	Hydropsychidae	75.16%	4.23	4	86.46%	21	Moderately Impaired
WB3	6/25/2010	11	162	Chironomidae	64.80%	5.89	7	20.37%	18	Moderately Impaired
WB3	10/22/2010	12	176	Chironomidae	50.56%	6.66	4	10.22%	15	Moderately Impaired

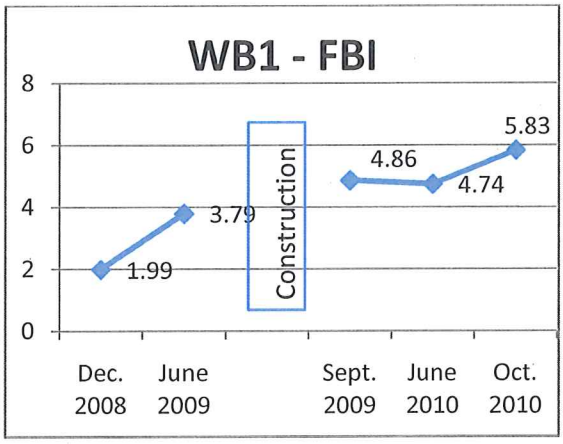
Although not a metric used to find the NJ Impairment score, an important indicator of water quality is the dominant species found. In the preconstruction sampling events, the dominant species was Capniidae, a type of stonefly with a very low pollution tolerance. In the later sampling rounds, the dominant family was typically Chironomidae, or the midge family. Species in this family are more tolerant of various water quality issues. It is likely these increase in impairments are related to watershed wide issues since they are occurring at all three sites (upstream, within and downstream of the project area) and are more closely related to water quality than any loss of habitat.

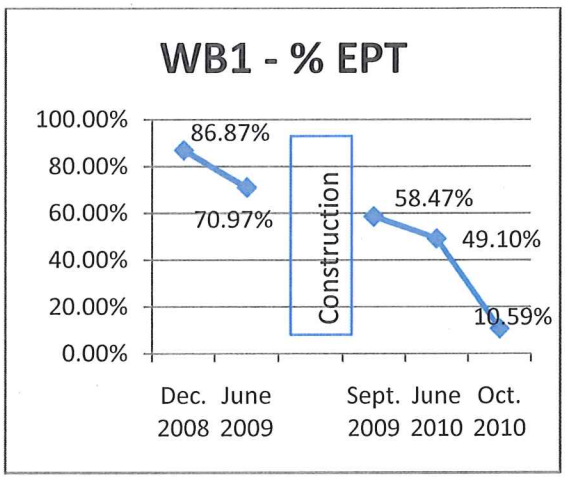
b. Site Specific Trends

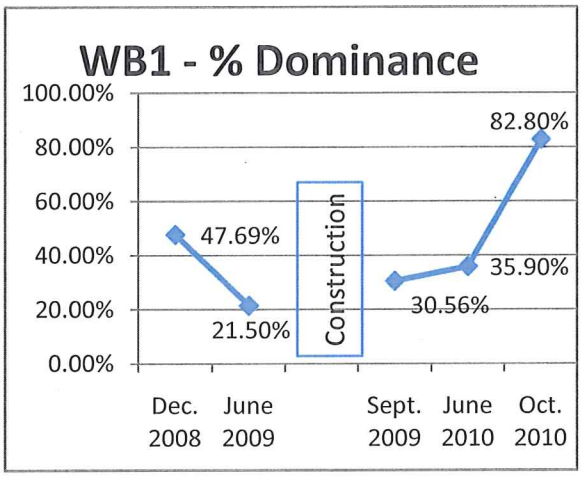
WB1 The site upstream of the stabilization project, WB1, indicated some degradation. The first sampling event in December 2008 was scored "moderately impaired". This was because only nine taxa were found in the sample, and the sample had a very high percent dominance rating. Considering that the dominant species is highly sensitive to water quality impairments, the lower score (higher percentage) for percent dominance is not as much of a concern if the dominant species was of a higher tolerant family, as in the October 22, 2009 sampling event where the percent dominance was 82% and the dominant family was the Chironomidae. The June 2009, September 2009 and the June 2010

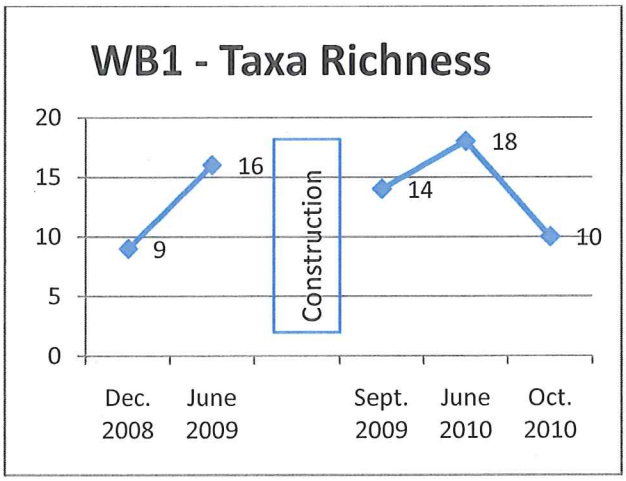
sampling events all received rankings of "non-impaired". The October 2010 event was ranked "moderately impaired", but for different reasons than the December 2008 event. The percent dominance and family biotic index (FBI) was much higher during the October 2010 event and the percent EPT was much lower. The graphs below summarize the data observed at WB1.



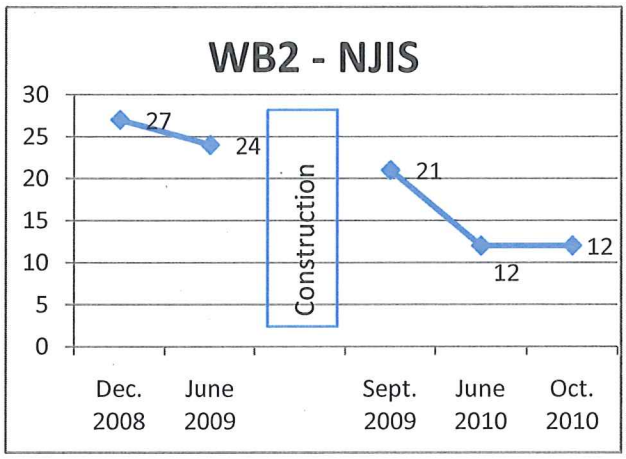


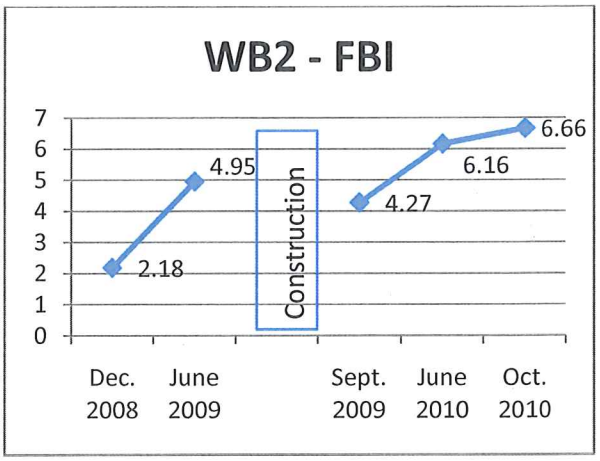


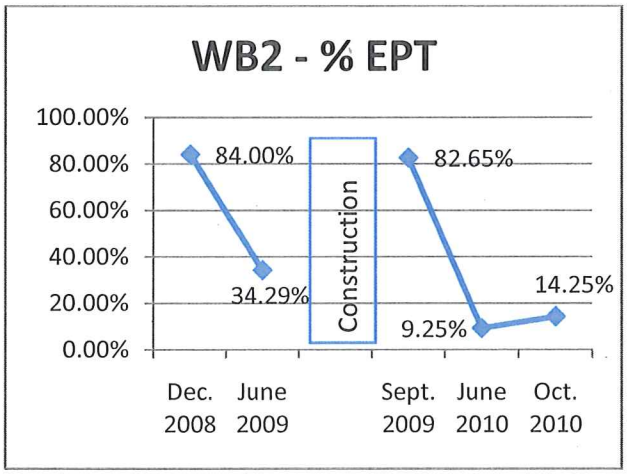


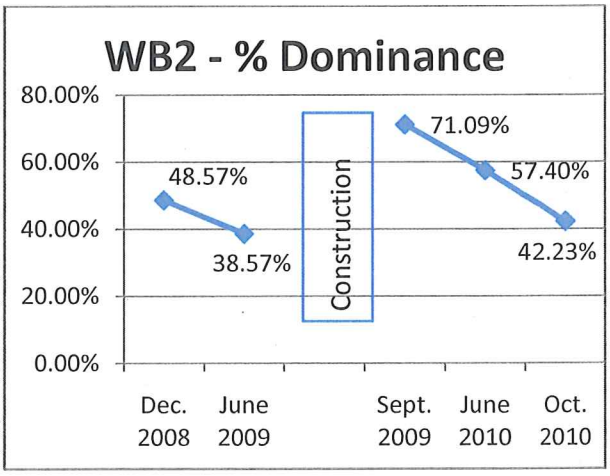


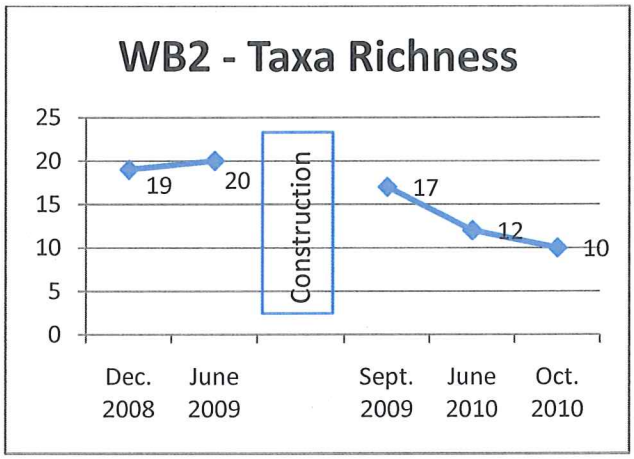
WB2 The monitoring reach within the stabilization area, WB2, exhibited similar decreases in NJ impairment score, increase in FBI and percent dominance and reduction in percent EPT species present as WB1, however, WB2 did not show as drastic of an increase in percent dominance that was found in the data at WB1. While taxa richness did decrease over the course of the sampling period, the number of families reported did not drop below ten, which still receives the total value for that parameter of the NJ Impairment Score. Due to the changes listed above, the ranking for this sampling reach was changed from "non-impaired" for the first two events in the sampling period to "moderately impaired" for the final three events in the sampling period. The graphs below summarize the data collected at WB2 from December 2008 to October 2010.



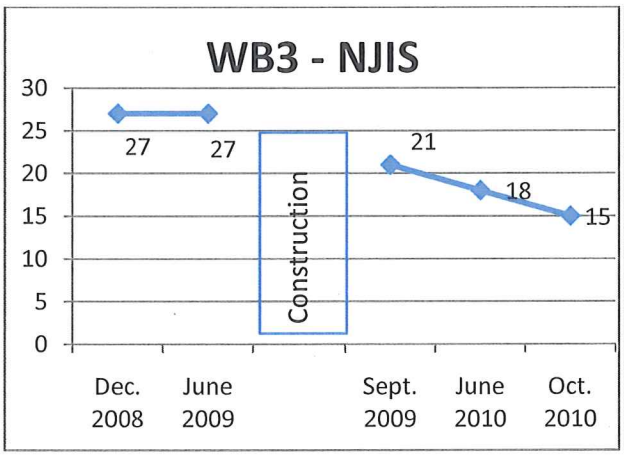


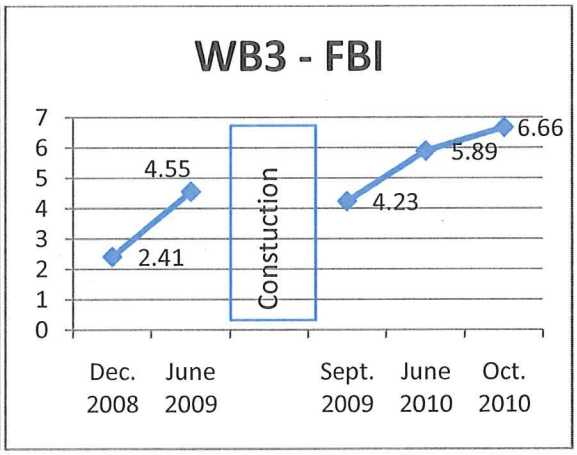


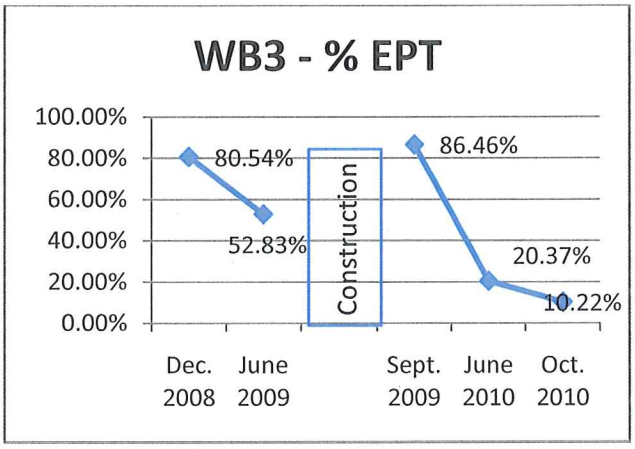


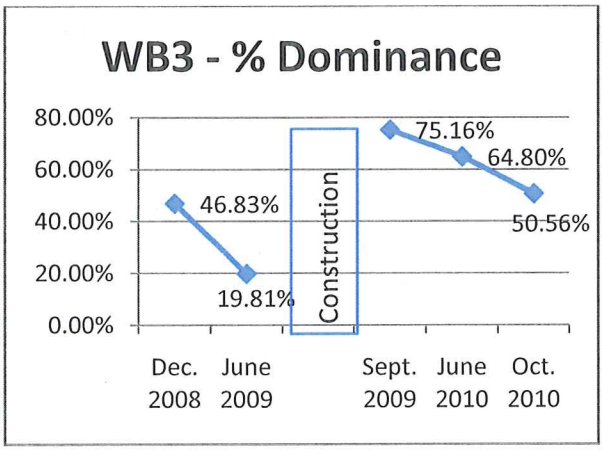


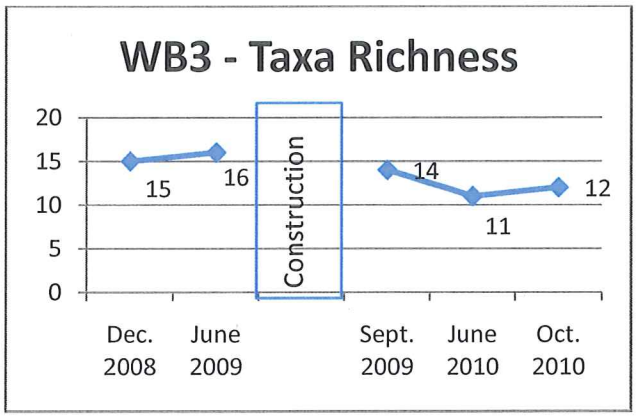
WB3 Like the two other sites, WB3, the downstream monitoring reach, exhibited decreases in NJ Impairment score and % EPT and an increase in FBI. Taxa richness did not drop below 11 families present. The drop in NJ Impairment score changed the reach ranking from "non-impaired" to "moderately impaired". The graphs below summarize the data collected at WB3.











V. Conclusion and Recommendations

Benthic Macroinvertebrate monitoring is a cost efficient way to obtain data on a particular section of stream. When compared to historic data, the trends can be used to understand how the water quality is changing over time. In the case of a major stream stabilization or restoration, this data is particularly valuable because changes in habitat can have a large impact on the benthic macroinvertebrate community.

While the Walnut Brook experienced some reduction in water quality based on the macroinvertebrate data, it is likely not linked to the stabilization work. The parameters that changed the most (FBI, percent EPT, total EPT taxa) are closely linked to overall water quality, while the parameters that are associated with habitat such as total taxa richness and percent dominance, generally remained stable. All sites maintained a taxa richness above 10 families, which receives the highest value on the New Jersey Impairment Score metrics. It is also noted that the changes occurred at all three monitoring sites, upstream, downstream and within the project area. This is an indicator that any impacts that are being exhibited by the macroinvertebrate community at the three sampling sites, are likely also occurring throughout the watershed.

While steps are taken to minimize the variability, there are some considerations to be made when interpreting the data. Dry periods and sampling after heavy rain events contributes to the variability of the samples. Additionally, while the samplers all received training on the proper techniques, there could be some variation as a result of individual error. Lastly, the size of the sample can have an impact on how the data is interpreted. The wide range of individuals identified during each sampling event could alter the metrics, thereby changing the resulting scores. In the initial samples, all of the individuals were identified. In the final six samples, the taxonomists identified the sample with a subsample target of 100 individuals.

In order to better understand the trends in the macroinvertebrate community, more monitoring should be conducted. Sampling two to three times a year for an extended time period will provide sufficient data to understand how the benthic community responds over the course of several seasons.

Appendix A

Laboratory Macroinvertebrate Bench Sheets

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page _____ of _____

STREAM NAME Walnut Brooke	LOCATION
STATION # WB-1 RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY T. Petti DATE 12/8/08	LOT #
TAXONOMIST TCB DATE 1/29/10	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera					
Isopoda											
Amphipoda						Diptera	Chironomidae	69	I		
							Simuliidae	17	I		
Decapoda							Tipulidae	21	I		
Ephemeroptera	Ameletidae	72									
						Gastropoda					
						Pelecypoda					
Plecoptera	Nemouridae	327	I								
	Capniidae	487	I								
						Other	Oligochaeta	26	I		
							Isopoda	1			
Trichoptera	Brachycentridae	1	I								
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 1021 Total No. Taxa 9

FBI = 1.99

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter _____

Date _____

Number of grids picked: _____

Time expenditure _____ No. of organisms 1021

Indicate the presence of large or obviously abundant organisms:

Capniidae n= 487 Nemouridae n=327

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷ (	# organisms recovered by checker	+	# organisms originally sorted	) =	% sorting efficiency
[ ]		[ ]		[ ]		[ ]

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID TCB

Date 1/28/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):

QC: ☑ YES ☐ NO QC Checker MCB

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page _____ of _____

STREAM NAME Walnut Brook	LOCATION Hunterdon Co
STATION # WB-2 RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY T. Pettit DATE 12.9.08	LOT #
TAXONOMIST MCB DATE Feb 3, 2010	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☐ ~~Other~~ All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera					
Isopoda											
Amphipoda						Diptera	Empididae	9	I	MCB	1
							Simuliidae	12	IP	MCB	1
Decapoda							Chironomidae	130	IP	MCB	1
Ephemeroptera	Ephmerellidae	1	I	MCB	1						
	Ameletidae	84	I	MCB	1	Gastropoda	Gastropoda	1	I	MCB	1
	Baetidae	4	I	MCB	1						
						Pelecypoda					
Plecoptera	Taeniopterygidae	28	I	MCB	1						
	Nemouridae	345	I	MCB	1						
	Capniidae	696	I	MCB	1	Other	Oligochaeta	55	I/A	MCB	1
	Plecoptera	39	I	MCB	1						
	Perlidae	4	I	MCB	1	Plecoptera —	Chloroperlidae	1	I	MCB	1
Trichoptera	Rhyacophilidae	1	I	MCB	1						
	Polycentropodidae	1	I	MCB	1		Planariidae	12	I/A	MCB	1
	Uenoidae	1	I	MCB	1		Acari	9	I/A	MCB	1
Hemiptera											

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ~~1432~~ 1433 Total No. Taxa ~~18~~ 19

FBI = 2.18

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION	
Sorter: McB Date: Feb 1, 2010	Number of grids picked: — Time expenditure: — No. of organisms: 1433 Indicate the presence of large or obviously abundant organisms: Capniidae, Nemouridae, Chironomidae QC: ☐ YES ☑ NO QC Checker: _____ (# organisms originally sorted ÷ (# organisms recovered by checker + # organisms originally sorted)) = % sorting efficiency ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID: McB Date: Feb 3, 2010	Explain TCR ratings of 3-5: — Other Comments (e.g. condition of specimens): — QC: ☐ YES ☑ NO QC Checker: _____ Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Walnut Brook	LOCATION
STATION # WB-3 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY T. pettij DATE 12-8-08	LOT #
TAXONOMIST TCB Feb 5, 2010 DATE ____	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera	Dytiscidae	1	A		
Isopoda											
Amphipoda						Diptera	Empididae	3	I		
							Tipulidae	2	I		
Decapoda							Simuliidae	38	I		
							Chironomidae	115	I		
Ephemeroptera	Baetidae	1	I								
	Ephemerellidae	1	I			Gastropoda					
	Ameletidae	16	I								
						Pelecypoda					
Plecoptera	Plecoptera	28	I								
	Capniidae	503	I								
	Nemouridae	311	I			Other	Planariidae	3			
	Taeniopterygidae	5	I				Oligochaeta	44			
							Acari	3			
Trichoptera											
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 1074 Total No. Taxa 15

FBI = 2.41

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter _____

Date _____

Number of grids picked: _____

Time expenditure _____ No. of organisms _____

Indicate the presence of large or obviously abundant organisms:

Capniidae

Nemouridae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷	(# organisms recovered by checker	+	# organisms originally sorted)	=	% sorting efficiency
[ ]	÷	[ ]	+	[ ]	=	[ ]

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID TCB

Date Feb 5, 2010

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):

QC: ☐ YES ☑ NO QC Checker _____

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME	Walnut Brook	LOCATION	Hunterdon Co.
STATION #	WB-1 RIVERMILE ____	STREAM CLASS	
LAT ____	LONG ____	RIVER BASIN	
STORET #		AGENCY	NJWM
COLLECTED BY	SS, HB, MK DATE 6/15/09	LOT #	
TAXONOMIST	TCB DATE 12/9/09	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other	All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera	Elmidae	1	I		
							Psephenidae	2	I		
Isopoda											
Amphipoda						Diptera	Simuliidae	3	I		
							Chironomidae	7	I		
Decapoda											
Ephemeroptera	Baetidae	14	I								
	Ephemerellidae	10	I			Gastropoda					
	Leptophebiidae	11	I								
						Pelecypoda					
Plecoptera	Nemouridae	2	I								
	Chloroperlidae	1	I								
	Perlodidae	1	I			Other	Libellulidae	1	I		
	Perlidae	20	I				Oligochaeta	13	F		
Trichoptera	Hydrophilidae	1	I								
	Philopotamidae	1	I								
	Hydropsychidae	5	I								
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 93 Total No. Taxa 16

FBI = 3.79

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter _____

Date _____

Number of grids picked: _____

Time expenditure _____ No. of organisms 93

Indicate the presence of large or obviously abundant organisms:

Perlidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷ (	# organisms recovered by checker	+	# organisms originally sorted	) =	% sorting efficiency
[ ]		[ ]		[ ]		[ ]

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID TCB

Date 12/9/09

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):

QC: ☑ YES ☐ NO QC Checker MCB

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Walnut Brook	LOCATION
STATION # WB2 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY DATE 6/15/09	LOT #
TAXONOMIST TCB DATE ~~[illegible]~~ 1/18/09	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta				TB		Megaloptera				TB	
Hirudinea						Coleoptera	Dytiscidae	4	~~I~~		
Isopoda							Psephenidae	2	I		
Amphipoda						Diptera	tabanidae	1	I		
Decapoda							tipulidae	3	I		
							Simuliidae	9	I		
							Chironomidea	81	I		
Ephemeroptera	Leptophlebiidae	15	I			Gastropoda					
	Ephemerellidae	5	I								
	Baetidae	10									
						Pelecypoda					
Plecoptera	Nemouridae	13	I								
	Perlodidae	3	I								
	Perlidae	11	I			Other	Gomphidae	1	I		
							Lepidoptera	1	P		
							Oligochaeta	13	I		
Trichoptera	Philopotamidae	2	I				Gastropoda	9			
	Hydropsychidae	11	I				Isopoda	14			
	Rhycophilidae	2	I								
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 210 Total No. Taxa 20

FBI = 4.95

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter _____

Date _____

Number of grids picked: _____

Time expenditure 2.5hrs No. of organisms 240

Indicate the presence of large or obviously abundant organisms:

Chironomidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷	(# organisms recovered by checker	+	# organisms originally sorted)	=	% sorting efficiency

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID TCB

Date 1/18/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):

QC: ☑ YES ☐ NO QC Checker MEB

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page _____ of _____

STREAM NAME	Walnut Brook	LOCATION	
STATION # WB3	RIVERMILE _____	STREAM CLASS	
LAT _____	LONG _____	RIVER BASIN	
STORET #		AGENCY	NJWA
COLLECTED BY SS HB MK	DATE 6/15/09	LOT #	
TAXONOMIST TCB	DATE 1/18/09	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other All	

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta				TB	1	Megaloptera				TB	1
Hirudinea						Coleoptera	Haliplidae	1	A		
							Dytiscidae	3	I		
Isopoda							Hydrophilidae	5	I		
							Psephenidae	1	I		
Amphipoda						Diptera	Simuliidae	12	I		
							Chironomidae	21	I		
Decapoda											
Ephemeroptera	Baetidae	4	I								
	Leptophlebidae	12	I			Gastropoda					
						Pelecypoda					
Plecoptera	Perlodidae	2	I								
	Perlidae	9	I								
	Nemouridae	15	I			Other	Oligochaeta	10			
							Planariidae	1			
							Gastropoda	6			
Trichoptera	Hydropsychidae	13	I								
	Leuctridae	1	I								
Hemiptera											

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ~~116~~ 106 RDA Total No. Taxa (~~16~~) 16

FBI = 4.55

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION Sorter _____ Date _____	Number of grids picked: _____ Time expenditure _____ No. of organisms 116 Indicate the presence of large or obviously abundant organisms: Chironomidae Nemouridae QC: ☐ YES ☐ NO QC Checker _____ # organisms originally sorted [ ] ÷ (# organisms recovered by checker [ ] + # organisms originally sorted [ ]) = % sorting efficiency [ ] ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID TCB Date 1/18/09	Explain TCR ratings of 3-5: Other Comments (e.g. condition of specimens): QC: ☑ YES ☐ NO QC Checker MCB Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Walnut Brooke	LOCATION
STATION # WB1 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY RA, HB DATE 9/30/09	LOT #
TAXONOMIST TCB DATE 1/21/10	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera	Psephenidae	5	I		
Isopoda											
Amphipoda						Diptera	Tipulidae	1	I		
							Chironomidae	62	I		
Decapoda							Simuliidae	218	I		
Ephemeroptera	Heptageniidae	2	I								
	Baetidae	231	I			Gastropoda					
						Pelecypoda					
Plecoptera	Perlidae	1	I								
						Other	Planariidae	5	I		
							Coleopteryoda	1	I		
							Bivalvia	1			
Trichoptera	Philopotamidae	26	I				Oligochaeta	20			
	Hydropsychidae	142	I				Decapoda	1	A		
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 756 Total No. Taxa 14

FB1-4.86

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION Sorter _____ Date _____	Number of grids picked: _____ Time expenditure _____ No. of organisms 756 Indicate the presence of large or obviously abundant organisms: Baetidae Hydropsychidae Simuliidae QC: ☐ YES ☐ NO QC Checker _____ # organisms originally sorted [ ] ÷ (# organisms recovered by checker [ ] + # organisms originally sorted [ ]) = % sorting efficiency [ ] ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID TCB Date 1/21/09	Explain TCR ratings of 3-5: Other Comments (e.g. condition of specimens): QC: ☑ YES ☐ NO QC Checker MCB Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page _____ of _____

STREAM NAME	Walnut Brook	LOCATION	
STATION #	WB-2 RIVERMILE _____	STREAM CLASS	
LAT _____	LONG _____	RIVER BASIN	
STORET #		AGENCY	NJWA
COLLECTED BY	RA, HB DATE 9.30.09	LOT #	
TAXONOMIST	TCB DATE 1/22/09	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☑ Other	All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta	[illegible]			1	TB	Megaloptera				1	TB
Hirudinea						Coleoptera	Psephenidae	1	I		
Isopoda											
Amphipoda						Diptera	Chironomidae	29	I		
							Simuliidae	2	I		
Decapoda							Tipulidae	1	I		
							Empididae	2	I		
Ephemeroptera	Heptageniidae	16	I								
	Baetidae	13	I			Gastropoda					
	Ephemerellidae	1	I								
						Pelecypoda					
Plecoptera	Perlidae	2	I								
						Other	Decapoda	1	A		
							Isopoda	4			
							Gastropoda	6			
Trichoptera	Hydropsychidae	209	I				Oligochaeta	1			
	Philopotamidae	2	I				Gomphidae	2	I		
							Planariidae	2			
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms ~~294~~ ~~295~~ 294 Total No. Taxa ~~18~~ 17

FBI = 4.27

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION Sorter _____ Date _____	Number of grids picked: _____ Time expenditure _____ No. of organisms _____ Indicate the presence of large or obviously abundant organisms: Hydropsychidae QC: ☐ YES ☐ NO QC Checker _____ # organisms originally sorted [ ] ÷ (# organisms recovered by checker [ ] + # organisms originally sorted [ ]) = % sorting efficiency [ ] ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID TCB Date 1/22/07	Explain TCR ratings of 3-5: Other Comments (e.g. condition of specimens): QC: ☑ YES ☐ NO QC Checker MCB Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page ____ of ____

STREAM NAME Walnut Brook	LOCATION
STATION # WB-3 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY NJWA
COLLECTED BY RA, HM DATE 9/30/09	LOT #
TAXONOMIST TCB DATE 1/24/10	SUBSAMPLE TARGET ☐ 100 ☐ 200 ☐ 300 ☒ Other All

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta						Megaloptera					
Hirudinea						Coleoptera	Dytiscidae	2	A		
							Pesphnidae	6	I		
Isopoda											
Amphipoda						Diptera	Simuliidae	18	I		
							Chironomidae	22	I		
Decapoda											
Ephemeroptera	Baetidae	36	I								
						Gastropoda					
						Pelecypoda					
Plecoptera	Perlidae	3	I								
						Other	Nemertea	2			
							Planariidae	4			
							Oligochaeta	12			
Trichoptera	Philopotamidae	32	I				Heptageniidae	3	I		
	Hydropsychidae	472	I				Calopterygidae	3	I		
							Gastropoda	13			
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 628 Total No. Taxa 14

FBI = 4.23

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION Sorter _____ Date _____	Number of grids picked: _____ Time expenditure _____ No. of organisms _____ Indicate the presence of large or obviously abundant organisms: QC: ☐ YES ☐ NO QC Checker _____ # organisms originally sorted [ ] ÷ (# organisms recovered by checker [ ] + # organisms originally sorted [ ]) = % sorting efficiency [ ] ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID TCB Date 1/25/10	Explain TCR ratings of 3-5: Other Comments (e.g. condition of specimens): QC: ☑ YES ☐ NO QC Checker MCB Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 1 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ Water Authority
COLLECTED BY RAnthes, H.Barrett DATE 6/28/10	LOT #
TAXONOMIST S. Liguori DATE 11/11/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other

Enter Family and/or Genus and Species name on blank line.

	Organisms	No.	LS	TI	TCR
Oligochaeta	Oligochaeta	3	I/A	SLL	1
Hirudinea					
Isopoda					
Amphipoda					
Decapoda					
Ephemeroptera	Heptageniidae	4	I	SLL	1
	Baetidae	14	I	SLL	1
	Ephemeroptera	6	I	SLL	1
Plecoptera					
Trichoptera	Hydropsychidae	56	I	SLL	1
	Philopotamidae	4	I	SLL	1
	Rhyacophilidae	1	I	SLL	1
	Glossosomatidae	1	P	SLL	1
	Glossosomatidae	3	I	SLL	1
Hemiptera					

	Organisms	No.	LS	TI	TCR
Megaloptera					
Coleoptera	Psephenidae	1	A	SLL	1
Coleoptera	Dytiscidae	1	A	SLL	1
	Psephenidae	1	I	SLL	1
	Elmidae	3	A	SLL	1
	Elmidae	1	I	SLL	1
Diptera	Tipulidae	2	I	SLL	1
	Simuliidae	3	I	SLL	1
	Chironomidae	65	I	SLL	1
	Chironomidae	2	P	SLL	1
Gastropoda	Gastropoda	1	I/A	SLL	1
Pelecypoda					
Other Odonata	Aeshnidae	5	I	SLL	1
Nemertea	Nemertea	2	I/A	SLL	1

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 181 Total No. Taxa 18

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter S. Liguori

Date 11/10/10

-Sorted 1/2 of sample

Number of grids picked: _____ + sorted w/ tray + scope

Time expenditure ≈2 hrs. No. of organisms _____

Indicate the presence of large or obviously abundant organisms:
-large Aeshnidae + Tipulidae
-abundant Hydropsychidae + Chironomidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷ (	# organisms recovered by checker	+	# organisms originally sorted	) =	% sorting efficiency

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID S. Liguori

Date 11/11/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):
-Ephemeroptera (6) too tiny to ID to family + one is just a head

QC: ☐ YES ☐ NO QC Checker _____

Organism recognition ☐ pass ☐ fail
Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 2 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ Water Authority
COLLECTED BY R. Anthes, K. Barrett DATE 6/25/10	LOT #
TAXONOMIST S. Liguori DATE 11/12/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other ___

Enter Family and/or Genus and Species name on blank line.

	Organisms	No.	LS	TI	TCR		Organisms	No.	LS	TI	TCR
Oligochaeta	Oligochaeta	21	I/A	SLL	1	Megaloptera					
Hirudinea						Coleoptera	Psephenidae	7	I	SLL	1
Isopoda											
Amphipoda						Diptera	Chironomidae	62	I	SLL	1
							Chironomidae	1	P	SLL	1
Decapoda	Cambaridae	1	A	SLL	1						
Ephemeroptera	Heptageniidae	8	I	SLL	1						
	Baetidae	1	I	SLL	1	Gastropoda	Gastropoda	1	I/A	SLL	1
						Pelecypoda					
Plecoptera											
						Other Odonata	Aeshnidae	1	I	SLL	1
							Gomphidae	2	I	SLL	1
						Turbellaria	Planariidae	1	I/A	SLL	1
Trichoptera	Polycentropodidae	1	I	SLL	1						
Hemiptera	~~Heteroptera~~ Veliidae	1	A	SLL	1						

Taxonomic certainty rating (TCR) 1-5; 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage; I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 108 Total No. Taxa 12

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION Sorter S. Liguori Date 11/12/10 ~ 1/2 of sample sorted	Number of grids picked: _____ → sorted w/ tray + scope Time expenditure _____ No. of organisms _____ Indicate the presence of large or obviously abundant organisms: ~abundant Chironomidae QC: ☐ YES ☐ NO QC Checker _____ # organisms originally sorted [ ] ÷ (# organisms recovered by checker [ ] + # organisms originally sorted [ ]) = % sorting efficiency [ ] ≥90%, sample passes _____ <90%, sample fails, action taken _____
TAXONOMY ID S. Liguori Date 11/12/10	Explain TCR ratings of 3-5: Other Comments (e.g. condition of specimens): QC: ☐ YES ☐ NO QC Checker _____ Organism recognition ☐ pass ☐ fail Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 3 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ water Authority
COLLECTED BY R. Anthes, H. Barrett DATE 6/25/10	LOT #
TAXONOMIST S. Ligori DATE 11/22/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other ___

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta	Oligochaeta	20	I/A	SLL	1	Megaloptera					
Hirudinea						Coleoptera					
Isopoda											
Amphipoda						Diptera	Chironomidae	105	I	SLL	1
Decapoda											
Ephemeroptera	Heptageniidae	3	I	SLL	1						
	Leptophlebiidae	1	I	SLL	1	Gastropoda	Gastropoda	3	I/A	SLL	1
	Baetidae	12	I	SLL	1						
						Pelecypoda					
Plecoptera	Perlidae	2	I	SLL	1						
						Other Odonata	Gomphidae	1	I	SLL	1
Trichoptera	Hydropsychidae	13	I	SLL	1						
	Philopotamidae	1	I	SLL	1						
	Tricoptera	1	I	SLL	1						
Hemiptera											

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 162 Total No. Taxa 11

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter: S. Liguori

Date: 11/19/10

-Sorted 1/4 of sample

Number of grids picked: _____ → used tray & scope

Time expenditure: ≈2 hrs No. of organisms: over 100 target

Indicate the presence of large or obviously abundant organisms:
-abondant Chironomidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷	(# organisms recovered by checker	+	# organisms originally sorted)	=	% sorting efficiency

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID: S. Liguori

Date: 11/22/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):
-Tricoptera (1) could not be ID'ed to family → just a head

QC: ☐ YES ☐ NO QC Checker _____

Organism recognition ☐ pass ☐ fail
Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 1 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ Water Authority
COLLECTED BY R. Anthes, C. Lin DATE 10/22/10	LOT #
TAXONOMIST S. Liguori DATE 11/9/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other ____

Enter Family and/or Genus and Species name on blank line:

	Organisms	No.	LS	TI	TCR		Organisms	No.	LS	TI	TCR
Oligochaeta	Oligochaeta	5	I/A	SLL	1	Megaloptera					
Hirudinea						Coleoptera					
Isopoda											
Amphipoda						Diptera	Simuliidae	1	I	SLL	1
						(125)	Chironomidae	125	I	SLL	1
Decapoda							Chironomidae	2	P	SLL	1
							Ceratopogonidae	1	I	[illegible]	1
Ephemeroptera	Baetidae	1	I	SLL	1						
	Ephemeroptera	1	I	MCB	1	Gastropoda					
						Pelecypoda					
Plecoptera	Capniidae/Leuctridae	1	I	SLL	1						
	Plecoptera	1	I	SLL	1						
						Other	Planariidae	1	I/A	SLL	1
Trichoptera	Hydropsychidae	2	I	SLL	1						
Hemiptera											

Taxonomic certainty rating (TCR) 1-5; 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 151 Total No. Taxa 10

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter: S. Liguori

Date: 11/8/10

-Sorted whole (1) sample

Number of grids picked: _____ → Sorted w/ tray + scope

Time expenditure: ≈2hrs. No. of organisms: 151

Indicate the presence of large or obviously abundant organisms:
-abundant Chironomidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷	(# organisms recovered by checker	+	# organisms originally sorted)	=	% sorting efficiency
[ ]	÷	[ ]	+	[ ]	=	[ ]

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID: S. Liguori

Date: 11/9/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):
Plecoptera (1) → very tiny, unable to ID to family level. Same as ephemeroptera (1).

QC: ☐ YES ☐ NO QC Checker _____

Organism recognition ☐ pass ☐ fail
Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 2 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ Water Authority
COLLECTED BY R. Anthes, C. Lin DATE 10/22/10	LOT #
TAXONOMIST S. Liguori DATE 11/9/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other ___

Enter Family and/or Genus and Species name on blank line.

Organisms		No.	LS	TI	TCR	Organisms		No.	LS	TI	TCR
Oligochaeta	Oligochaeta	68	I/A	SLL	1	Megaloptera					
Hirudinea						Coleoptera	Psephenidae	1	I	SLL	1
							Dytiscidae	1	A	SLL	2
Isopoda							Hydrophilidae	1	I	MCB	1
Amphipoda						Diptera	Simuliidae	4	I	SLL	1
							Chironomidae	60	I	SLL	1
Decapoda	~~Decapoda~~ Cambaridae	1	A	SLL	1		Chironomidae	2	P	SLL	1
Ephemeroptera	Baetidae (7)	87	I	SLL	1		~~Tipulidae~~	~~1~~	~~A~~	~~SLL~~	~~2A~~
	Ephemerellidae	1	I	SLL	1	Gastropoda					
						Pelecypoda					
Plecoptera	Capniidae/Leuctridae	15	I	SLL	2						
						Other					
Trichoptera											
Hemiptera											

Taxonomic certainty rating (TCR) 1-5:1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 161 Total No. Taxa 10

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter: S. Liguori

Date: 11/9/10

- Sorted whole (1) sample

Number of grids picked: _____ → sort w/ tray & scope

Time expenditure: ≈2 hrs. No. of organisms: 161

Indicate the presence of large or obviously abundant organisms:
- abundant Oligochaeta & Chironomidae

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷ (	# organisms recovered by checker	+	# organisms originally sorted	) =	% sorting efficiency

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID: S. Liguori

Date: 11/9/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):

QC: ☐ YES ☐ NO QC Checker _____

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

page 1 of 1

STREAM NAME Walnut Brook	LOCATION Hunterdon Co., NJ
STATION # 3 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY NJ Water Authority
COLLECTED BY R. Anthes, C. Lin DATE 10/22/10	LOT #
TAXONOMIST S. Ligori DATE 11/9/10	SUBSAMPLE TARGET ☒ 100 ☐ 200 ☐ 300 ☐ Other ___

Enter Family and/or Genus and Species name on blank line.

	Organisms	No.	LS	TI	TCR		Organisms	No.	LS	TI	TCR
Oligochaeta	Oligochaeta	54	I/A	SL	1	Megaloptera					
Hirudinea						Coleoptera	Dytiscidae	1	A	SL	1
Isopoda	Asellidae	1	A	SL	1						
Amphipoda						Diptera	Simuliidae	8	I	SL	1
							Chironomidae	89	I	SL	1
Decapoda	Cambaridae	1	A	SL	1		Chironomidae	2	P	SL	1
							Ephydridae	1	I	SL	2
Ephemeroptera	Baetidae	8	I	SL	1						
						Gastropoda	~~Physidae~~ Gastropoda	1	I/A	SL	2
						Pelecypoda					
Plecoptera	Capniidae/Leuctridae	54	I	SL	2						
	~~Nemouridae~~	~~1~~	~~I~~	~~SL~~	~~2~~						
	~~Perlodidae~~ Plecoptera	2	I	SL	1	Other					
Trichoptera	Hydropsychidae	3	I	SL	1						
Hemiptera											

n=89

Taxonomic certainty rating (TCR) 1-5: 1=most certain, 5=least certain. If rating is 3-5, give reason (e.g., missing gills). LS= life stage: I = immature; P = pupa; A = adult TI = Taxonomists initials

Total No. Organisms 176 Total No. Taxa 12

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

SUBSAMPLING/SORTING INFORMATION

Sorter S. Liguori

Date 11/9/10

- Sorted whole (1) sample

Number of grids picked: _____ → Sort with tray & scope

Time expenditure _____ No. of organisms _____

Indicate the presence of large or obviously abundant organisms:
- abundant Oligochaeta & Chironomidae
- large Isopoda (1)

QC: ☐ YES ☐ NO QC Checker _____

# organisms originally sorted	÷ (	# organisms recovered by checker	+	# organisms originally sorted	)	=	% sorting efficiency

≥90%, sample passes _____

<90%, sample fails, action taken _____

TAXONOMY

ID S. Liguori

Date 11/10/10

Explain TCR ratings of 3-5:

Other Comments (e.g. condition of specimens):
- Plecoptera (2) too tiny to ID to family level

QC: ☐ YES ☐ NO QC Checker _____

Organism recognition ☐ pass ☐ fail

Verification complete ☐ YES ☐ NO

Appendix B

Benthic Macroinvertebrate Field Data Sheets

12/8/08

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut BK	LOCATION WB1 US Site	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT_____ LONG_____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS SUGAMI, TAKA		LOT NUMBER
FORM COMPLETED BY TPeMA	DATE _____ TIME _____ AM PM	REASON FOR SURVEY pre restoration

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 75% ☐ Snags____% ☒ Vegetated Banks 25 % ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble 10 ☐ Snags____ ☒ Vegetated Banks 1 ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS		
FORM COMPLETED BY	DATE 12/9/08 TIME 9:00 (AM) PM	REASON FOR SURVEY pre restoration

WEATHER CONDITIONS	Now: ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ___%☐ %cloud cover ☒ clear/sunny Past 24 hours: ☐ ☐ ☐ ☐ ___% ☒ Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No Air Temperature +3 °C Other_____
SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph)

STREAM CHARACTERIZATION	Stream Subsystem: ☒ Perennial ☐ Intermittent ☐ Tidal Stream Type: ☒ Coldwater ☐ Warmwater Stream Origin: ☐ Glacial ☒ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other_____ Catchment Area_____km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other PARK ☐ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☒ Grasses ☐ Herbaceous **dominant species present** _____
INSTREAM FEATURES 30%	**Estimated Reach Length** 35 m **Estimated Stream Width** 5 m **Sampling Reach Area** _____ m² **Area in km² (m²x1000)** _____ km² **Estimated Stream Depth** .35 m **Surface Velocity (at thalweg)** _____ m/sec **Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded open **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 35 % ☐ Run _____ % ☐ Pool 5 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m² **Density of LWD** _____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** 25 %
WATER QUALITY	**Temperature** 2 °C **Specific Conductance** _____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity (if not measured)** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	5			
Cobble	64-256 mm (2.5"-10")	60	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	35	Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE 12/8/08 TIME _____ AM PM	REASON FOR SURVEY pre restoration

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut BK	LOCATION Walnut BK 2
STATION #_____ RIVERMILE_____	STREAM CLASS
LAT_____ LONG_____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	LOT NUMBER
FORM COMPLETED BY TPEM	DATE 12/8/08 TIME 11:30 AM/PM — REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☑ Cobble 70 % ☐ Snags____% ☑ Vegetated Banks 40 % ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☐ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☐ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble 15 ☐ Snags____ ☑ Vegetated Banks 5 ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	reach contains low DS end of meander bend.

105/20

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

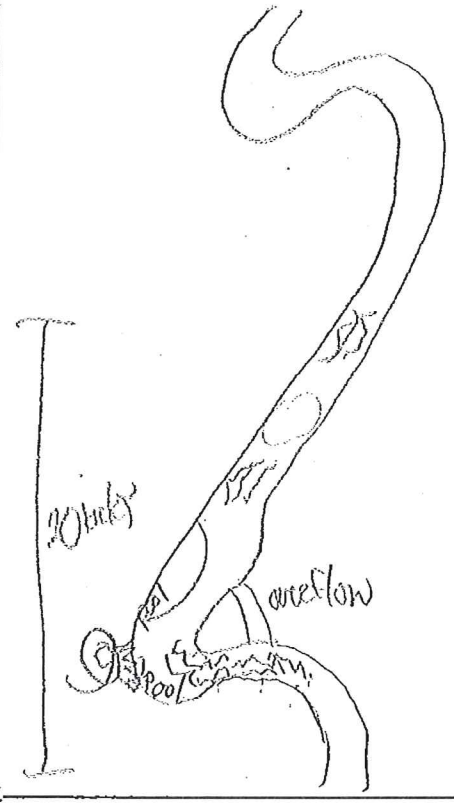
FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT_____ LONG_____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE_____ TIME_____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now / Past 24 hours ☐ storm (heavy rain) ☐ ☐ rain (steady rain) ☐ ☐ showers (intermittent) ☐ ____% ☐ %cloud cover ☐ ____% ☒ clear/sunny ☐ Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No Air Temperature 1 °C Other_____
SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph) 
STREAM CHARACTERIZATION	Stream Subsystem ☒ Perennial ☐ Intermittent ☐ Tidal Stream Type ☒ Coldwater ☐ Warmwater Stream Origin ☐ Glacial ☒ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other_____ Catchment Area_____km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other rock ☐ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 35 m **Estimated Stream Width** _____ m **Sampling Reach Area** _____ m^2 **Area in km^2 (m^2x1000)** _____ km^2 **Estimated Stream Depth** _____ m **Surface Velocity (at thalweg)** _____ m/sec **Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded 40% canopy cover **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☒ Riffle 60 % ☐ Run _____ % ☒ Pool 40 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m^2 **Density of LWD** _____ m^2/km^2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** 85 %
WATER QUALITY	**Temperature** 0 °C **Specific Conductance** _____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity (if not measured)** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	5			
Cobble	64-256 mm (2.5"-10")	33	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	33			
Sand	0.06-2mm (gritty)	33	Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE 12·6·06 TIME _____ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 (9) 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut BK	LOCATION Walnut BK 3	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT_____ LONG_____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble 15 % ☐ Snags____% ☐ Vegetated Banks 25 % ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other (_____)____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 5 ☐ Snags____ ☒ Vegetated Banks 5 ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other (_____)____
GENERAL COMMENTS	

25
25
50

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

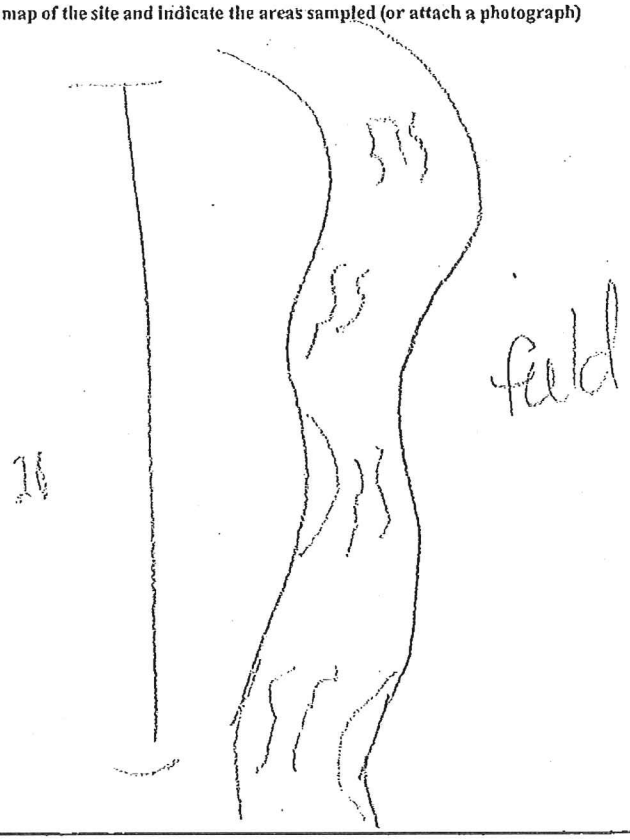
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now	Past 24 hours	Has there been a heavy rain in the last 7 days? ☐ Yes ☒ No
	☐ storm (heavy rain)	☐	Air Temperature_____° C
	☐ rain (steady rain)	☐	
	☐ showers (intermittent)	☐	Other_____
	____%☐ %cloud cover	☐____%	
	☒ clear/sunny	☐	
SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph)		
STREAM CHARACTERIZATION	**Stream Subsystem** ☐ Perennial ☐ Intermittent ☐ Tidal		**Stream Type** ☐ Coldwater ☐ Warmwater
	Stream Origin ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other_____		**Catchment Area**_____km²



PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other _____ ☒ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☒ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☒ Shrubs ☒ Grasses ☐ Herbaceous **dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 30 m **Estimated Stream Width** _____ m **Sampling Reach Area** _____ m^2 **Area in km^2 (m^2x1000)** _____ km^2 **Estimated Stream Depth** _____ m **Surface Velocity (at thalweg)** _____ m/sec **Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded 30% **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 50 % ☐ Run _____ % ☒ Pool 50 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m^2 **Density of LWD** _____ m^2/km^2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** 90%
WATER QUALITY	**Temperature** _____ °C **Specific Conductance** _____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other _____ **Turbidity (if not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____
SEDIMENT/ SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☐ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	30	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	30			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated in sampling reach

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

6/15/09

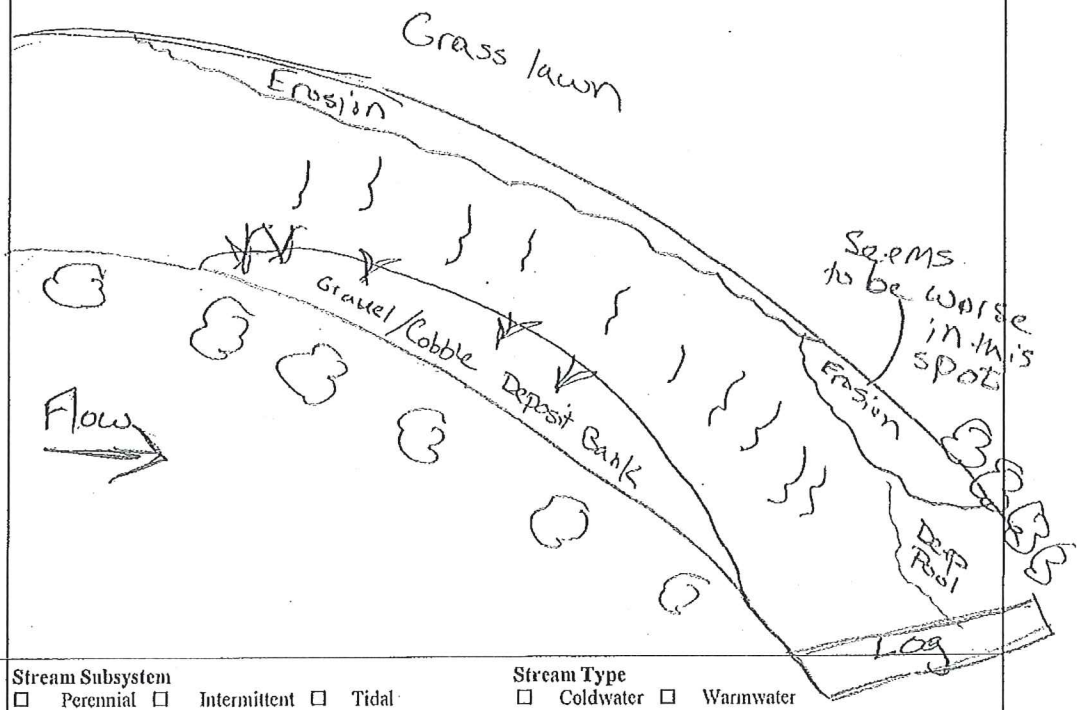
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME Walnut Brook	LOCATION	
STATION # WB1	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY S. Skrzenski	DATE _____ TIME _____ AM PM	REASON FOR SURVEY Pre-restoration

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature 23 °C
	☐ ___%	% Cloud cover	☐ ___%	Other:
	☐	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi²

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION	
STATION # WB1a RIVERMILE_____	STREAM CLASS	
LAT_____ LONG_____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE 6/15 TIME 8:30 (AM) PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble 80 % ☐ Snags 1 % ☐ Vegetated Banks 4 % ☐ Sand____% ☐ Submerged Macrophytes____% ☒ Other (Gravel) 15 %
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other_____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 12 ☒ Snags 1 ☒ Vegetated Banks 2 ☐ Sand____ ☐ Submerged Macrophytes____ ☒ Other (Gravel) 5
GENERAL COMMENTS	Erosion at Bench seems worse

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

4

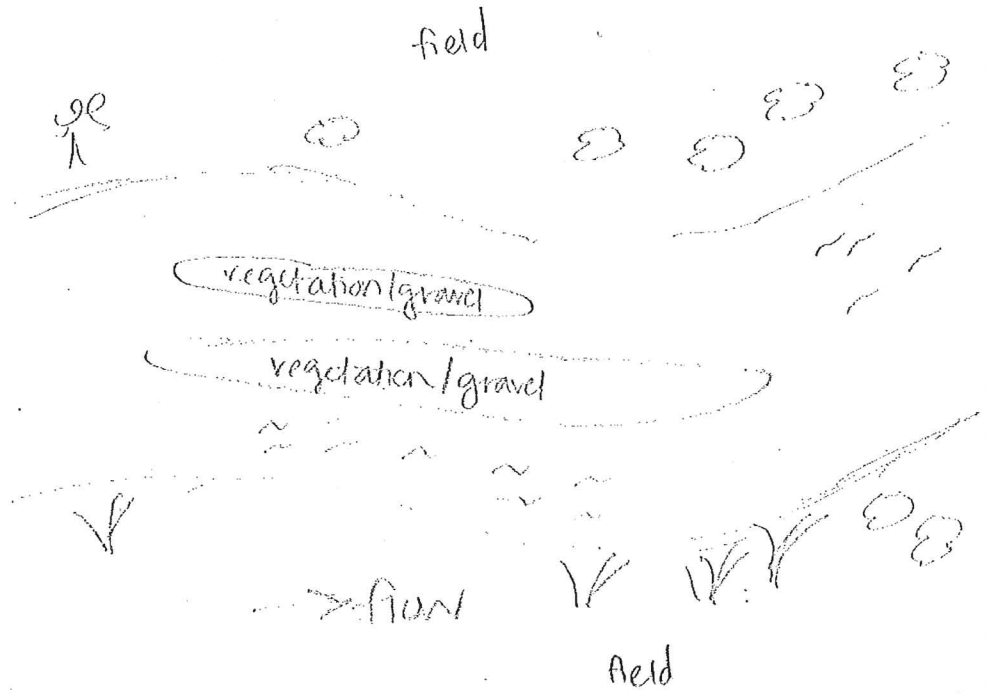
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME Walnut Brook	LOCATION	
STATION # WB3	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE 10/15/09 TIME 12:00 AM (PM)	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☒	
	☐	Showers (intermittent)	☐	Air Temperature ____ °C
	☒ ___%	% Cloud cover	☐ ___%	Other:
	☒	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi^2

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Branch	LOCATION	
STATION # W83 RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NTWSA	
INVESTIGATORS S. Skrzenski, H. Barrett, M. Kopec		LOT NUMBER
FORM COMPLETED BY S. Skrzenski	DATE 6/15/09 TIME 12:00 AM (PM)	REASON FOR SURVEY

HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ Cobble 20 % ☐ Snags 10 % ☒ Vegetated Banks 40 % ☐ Sand 10 % ☐ Submerged Macrophytes ____ % ☐ Other (gravel) 20 %
SAMPLE COLLECTION	**Gear used** ☒ D-frame ☐ kick-net ☐ Other _____ **How were the samples collected?** ☒ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

snags II cobble IIII
sand II veg HH IIII
gravel III

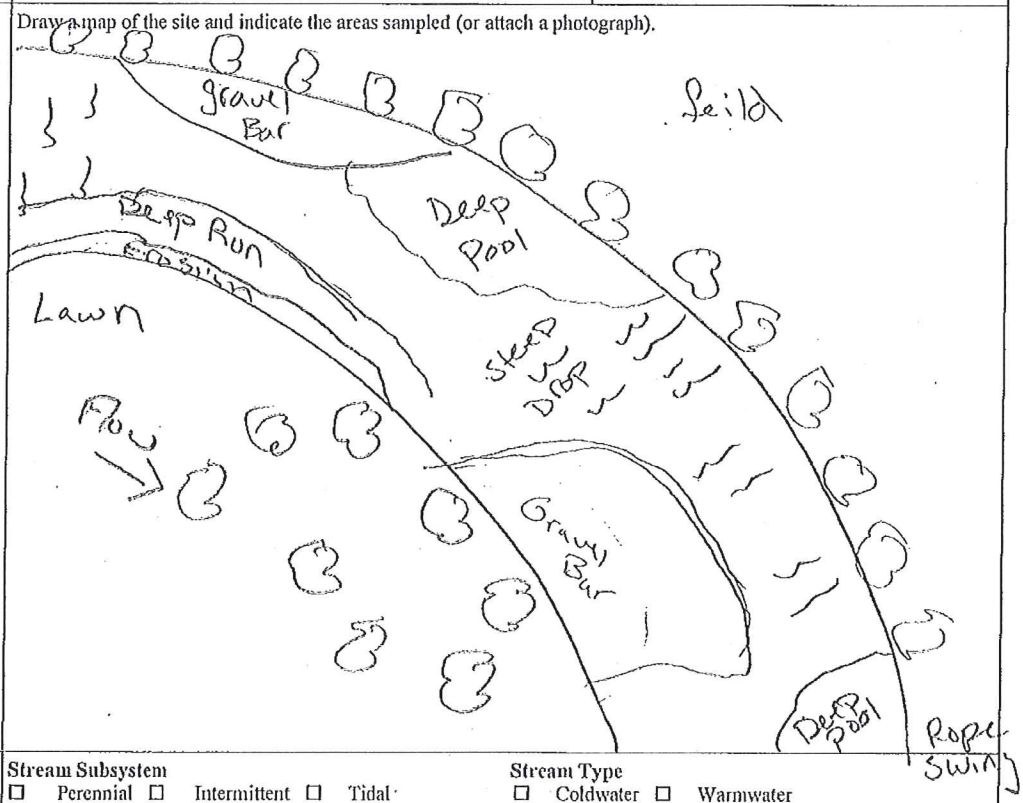
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME Walnut Brook	LOCATION	
STATION # WB2	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE 6/15/09 TIME 10:15 (AM) PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☒	
	☐	Showers (intermittent)	☐	Air Temperature _____ °C
	☒ 75%	% Cloud cover	☐ ___%	Other: lots of rain in past week 17°C water temp
	☒	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi²

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION Mill Brook Park	
STATION # WB2 RIVERMILE	STREAM CLASS	
LAT LONG	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS S. Skrzenski, H. Barvett, M. Kopec		LOT NUMBER
FORM COMPLETED BY	DATE 6/15/09 TIME 16:15 (AM) PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble 35 % ☐ Snags 5 % ☐ Vegetated Banks 10 % ☐ Sand 16 % ☐ Submerged Macrophytes ____ % ☐ Other (gravel) 40 %
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 10 ☒ Snags 2 ☒ Vegetated Banks 1 ☒ Sand 2 ☐ Submerged Macrophytes ____ ☒ Other (gravel) 5
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

cobble ||||| snags ||
veg | grav |||||
sand ||

9/30/09

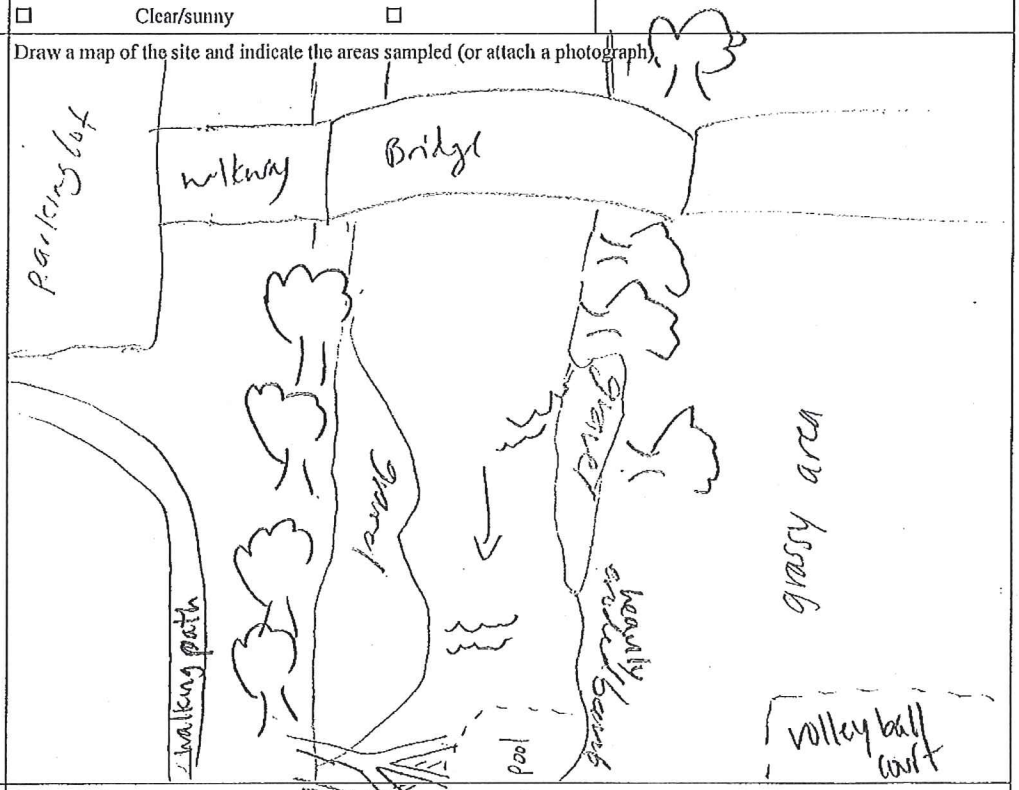
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB1	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anthes, H. Barrett		
FORM COMPLETED BY R. Anthes	DATE 9/30/09 TIME 1:30 AM (PM)	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☐ Yes ☒ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☒	Air Temperature 16 °C
	☒ 80%	% Cloud cover	☐ ___%	Other:
	☐	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION		
	Stream Subsystem ☒ Perennial ☐ Intermittent ☐ Tidal	Stream Type ☒ Coldwater ☐ Warmwater
	Stream Origin ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other _____	Watershed Area _____ mi²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☒ Agricultural ☒ Other park ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 10 m **Sampling Reach Area** 1000 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** .10 m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 15 % ☐ Run 75 % ☐ Pool 10 % **Channelized** ☒ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** ____ %
WATER QUALITY	**Temperature** 16.5 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	10%
Cobble	64-256 mm (2.5"-10")	70%
Gravel	2-64 mm (0.1"-2.5")	15%
Sand	0.06-2mm (gritty)	5%
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

cobble = HHT HHT III
veg bank = 1
leaf pack = 11
+4 gravel

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION Mine Brook Park, Raritan Twp. NJ	
STATION # WB1 RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anthes, H. Barrett		LOT NUMBER
FORM COMPLETED BY R. Anthes	DATE 9/30/09 TIME 1:30 AM (PM)	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 60 % ☐ Snags ____ % ☒ Vegetated Banks 5 % ☐ Sand ____ % ☐ Submerged Macrophytes ____ % ☒ Other (leaf pack) 5 % gravel = 30%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 13 ☐ Snags ____ ☒ Vegetated Banks 1 ☐ Sand ____ ☐ Submerged Macrophytes ____ ☒ Other (leaf pack) 2 gravel = 4
GENERAL COMMENTS	severe erosion on Left bank (look downstream) minimal riparian buffer

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	(4)
Macrophytes	0	1	2	3	4	Fish	0	1	(2)	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

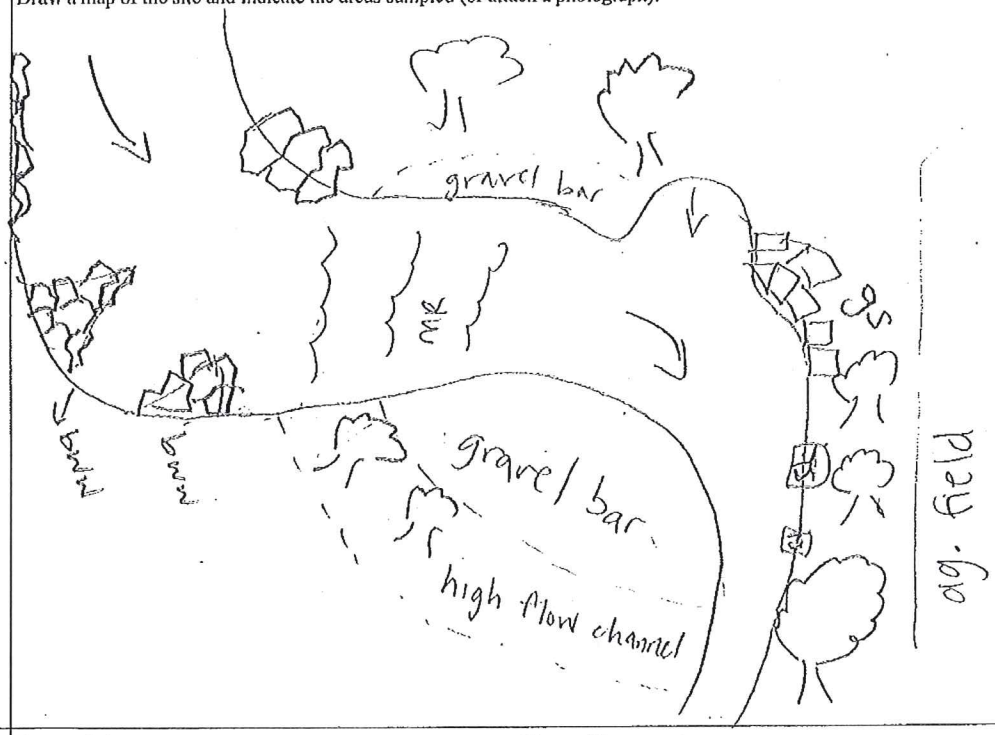
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB 2	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN Neshanic River	
STORET #	AGENCY NJNSA	
INVESTIGATORS R. Anthes, H. Barrett		
FORM COMPLETED BY R. Anthes	DATE 9/30/07 TIME 11:00 AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☐ Yes ☒ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☒	Air Temperature 15 °C
	☒ 100 %	% Cloud cover	☐ ___ %	Other:
	☐	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☐ Agricultural ☒ Other park ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☒ Grasses ☐ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 70 m **Estimated Stream Width** 6 m **Sampling Reach Area** 420 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** .15 m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☒ Riffle 40 % ☒ Run 50 % ☒ Pool 10 % **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** ____ %
WATER QUALITY	**Temperature** 16 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	30%
Cobble	64-256 mm (2.5"-10")	30%
Gravel	2-64 mm (0.1"-2.5")	30%
Sand	0.06-2mm (gritty)	10%
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	15%
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

gravel - 11 11
boulder - 11

cobble = 1HH 11
veg bank = 1
leaf pack = HHH 1

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION Mine Brook Park, Raritan Twp., NJ	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anthes, M. Barrett		LOT NUMBER
FORM COMPLETED BY R. Anthes	DATE 9/30/09 TIME 11:00 AM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 30 % ☐ Snags ____ % ☒ Vegetated Banks 5 % ☐ Sand 25 % ☐ Submerged Macrophytes ____ % ☒ Other (Boulder) 30 % leafpacks - 10
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble 7 ☐ Snags ____ ☒ Vegetated Banks 1 ☐ Sand ____ boulder = 2 ☐ Submerged Macrophytes ____ ☒ Other (leaf packs) 6 gravel = 4
GENERAL COMMENTS	recently constructed engineered rock riffle was difficult to sample in.

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

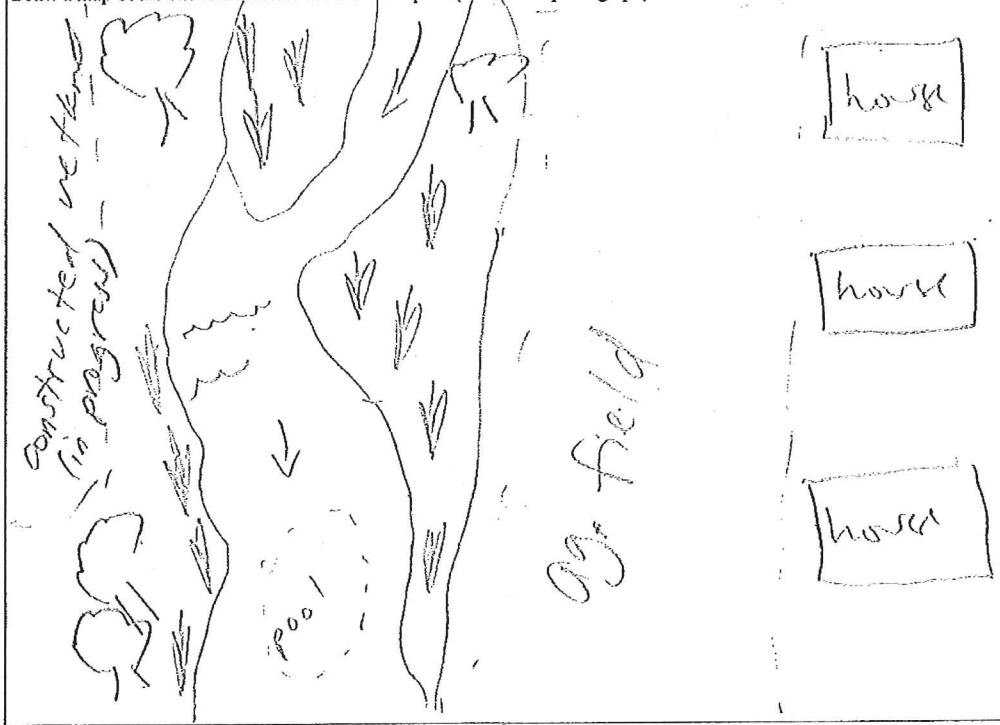
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB3	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anthes, H. Barrett		
FORM COMPLETED BY R. Anthes	DATE 9/30 TIME 8:30 (AM) PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☐ Yes ☒ No
	☐	Rain (steady rain)	☐	
	☒	Showers (intermittent)	☒	Air Temperature 12 °C
	☒ 100%	% Cloud cover	☐ ___%	Other:
	☐	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☒ Agricultural ☒ Other park ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☒ Grasses ☐ Herbaceous **Dominant species present** sycamore, willow
INSTREAM FEATURES	**Estimated Reach Length** 70 m **Estimated Stream Width** 5 m **Sampling Reach Area** 350 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** _____ m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 10 % ☐ Run 60 % ☐ Pool 30 % **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** 65 %
WATER QUALITY	**Temperature** 16 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	5
Cobble	64-256 mm (2.5"-10")	45
Gravel	2-64 mm (0.1"-2.5")	40
Sand	0.06-2mm (gritty)	5
Silt	0.004-0.06 mm	5
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

Sub. macrophyte = III gravel = IIII
veg = IIII
leaf pack = II
cobble = II

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

HABITAT TYPES	**Indicate the percentage of each habitat type present** ☒ Cobble 45 % ☐ Snags ____ % ☒ Vegetated Banks 30 % ☐ Sand ____ % ☒ Submerged Macrophytes 10 % ☒ Other (gravel) 15 %
SAMPLE COLLECTION	**Gear used** ☒ D-frame ☐ kick-net ☐ Other _____ **How were the samples collected?** ☐ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☒ Cobble 2 ☐ Snags ____ ☒ Vegetated Banks 7 ☐ Sand ____ ☒ Submerged Macrophytes 3 ☐ Other (gravel) 6 leaf pack = 2
GENERAL COMMENTS	constructed wetland in progress on RB

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

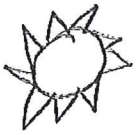
Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION FIELD DATA SHEET
(FRONT)

STREAM NAME Walnut Brook	LOCATION Mine Brook Park	
STATION # NB1	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS R. Anthes, H. Barrett		
FORM COMPLETED BY R. Anthes	DATE 6/25/10 TIME 1230 AM (PM)	REASON FOR SURVEY

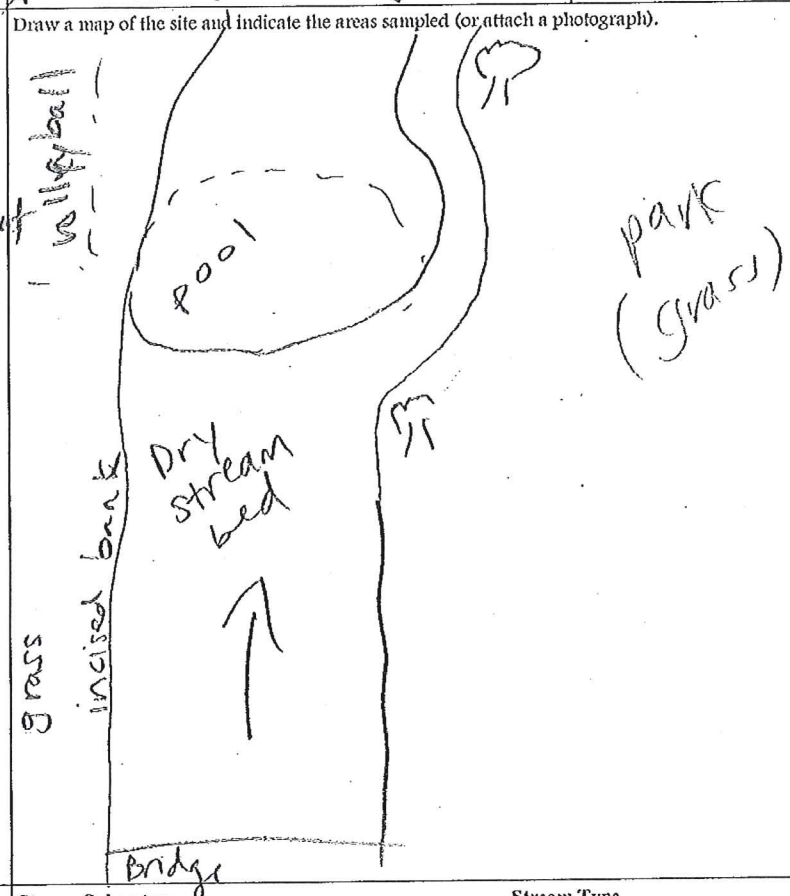
WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature 28 °C
	☐ ___%	% Cloud cover	☒ ___%	Other:
	☒	Clear/sunny	☒	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).

stream blocked by gravel/cobble @ end of segment

large dry section @ middle of segment



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Stream Type
☒ Coldwater ☐ Warmwater

Watershed Area _____ mi²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☒ Other park ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☒ Grasses ☒ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 300 m **Estimated Stream Width** 2 m **Sampling Reach Area** 600 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** .10 m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle _____ % ☒ Run 60 % ☒ Pool 40 % **Channelized** ☒ Yes ☐ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2/km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** _____ %
WATER QUALITY	**Temperature** 24 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	
Cobble	64-256 mm (2.5"-10")	45 %
Gravel	2-64 mm (0.1"-2.5")	55 %
Sand	0.06-2mm (gritty)	
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION Mine Brook Park	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN /	
STORET #	AGENCY NJWSA	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE 6/28/10 TIME 12:30 AM (PM)	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 65 % ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other (gravel) 35 %
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	dry stream bed

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	(3)	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	(4)

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION FIELD DATA SHEET
(FRONT)

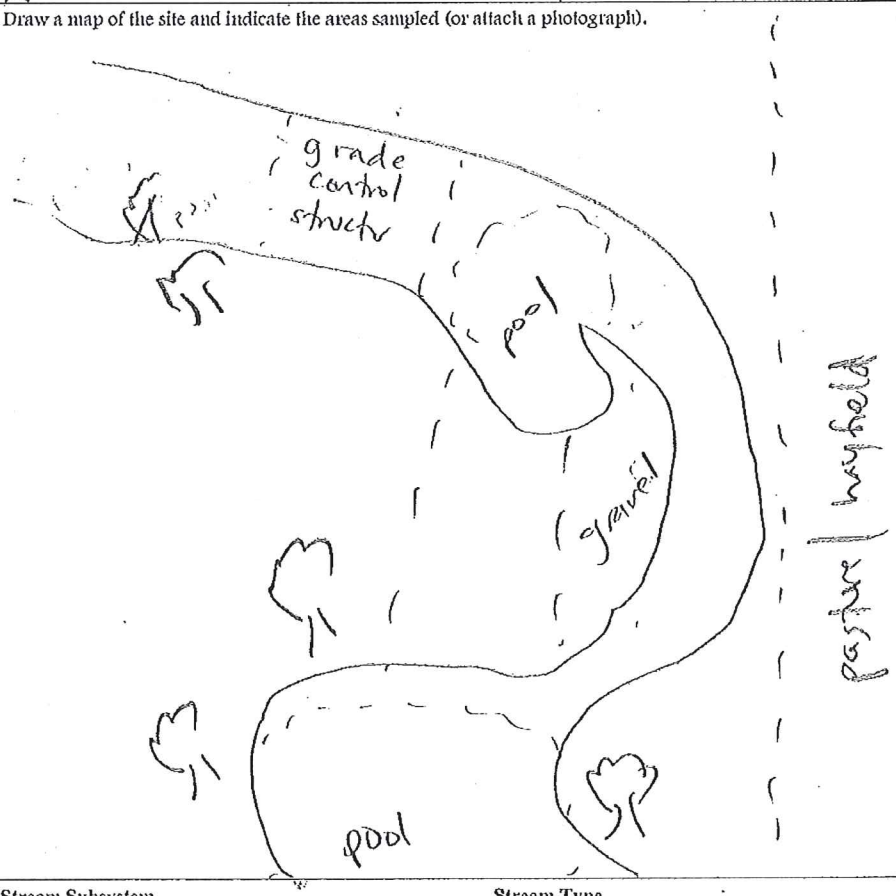
STREAM NAME Walnut Brook	LOCATION Mine Brook Park	
STATION # WB2	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN Neshanic River	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anther, H. Barrett		
FORM COMPLETED BY R. Anther	DATE 6/25/10 TIME 10:00 AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature 23 °C
	☐ ___%	% Cloud cover	☐ ___%	Other: Low flow due to restoration work
	☒	Clear/sunny	☐	

SITE LOCATION/MAP

no flow through grade control structure

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other _____ ☒ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☒ Shrubs ☒ Grasses ☒ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 2 m **Sampling Reach Area** 200 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** _____ m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☐ Partly shaded ☒ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle _____ % ☒ Run 75 % ☒ Pool 25 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2/km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** 65 %
WATER QUALITY	**Temperature** 22 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	40% → restoration
Cobble	64-256 mm (2.5"-10")	40%
Gravel	2-64 mm (0.1"-2.5")	20%
Sand	0.06-2mm (gritty)	
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	10%
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook		LOCATION Mine Brook Park	
STATION # WB2	RIVERMILE	STREAM CLASS	
LAT	LONG	RIVER BASIN Neshanic River	
STORET #		AGENCY NJWSA	
INVESTIGATORS R. Anthes, H. Barrett			LOT NUMBER
FORM COMPLETED BY R. Anthes		DATE 6/25/10 TIME 10:00 AM PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble____% ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	Low flow due to ongoing restoration work; lack of rain.

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Walnut Brook	LOCATION Mine Brook Park	
STATION # WB3 RIVERMILE	STREAM CLASS	
LAT LONG	RIVER BASIN	
STORET #	AGENCY NJDWSA	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY R. Arthur	DATE 6/25/10 TIME 7:30 AM PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble 60 % ☐ Snags ___ % ☐ Vegetated Banks ___ % ☐ Sand ___ % ☐ Submerged Macrophytes 5 % ☐ Other (gravel) 35 %
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other ___ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble 13 ☐ Snags ___ ☒ Vegetated Banks 2 ☐ Sand ___ ☐ Submerged Macrophytes ___ ☒ Other (gravel) 5
GENERAL COMMENTS	lack of flow due to ongoing restoration project; lack of rain

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

PHYSICAL CHARACTERIZATION FIELD DATA SHEET
(FRONT)

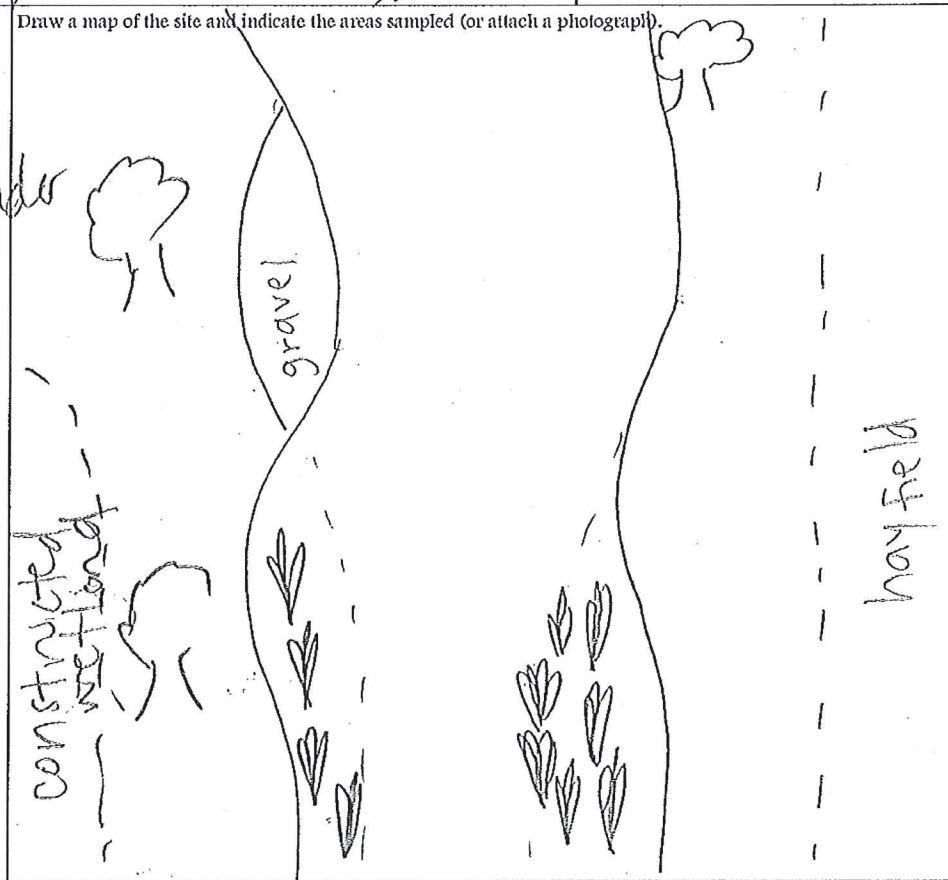
STREAM NAME Walnut Brook	LOCATION Mine Brook Park	
STATION # WB3	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN Neshanic	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. Anthes and H. Barrett		
FORM COMPLETED BY R. Anthes	DATE 6/25/10 TIME 9:30 AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature 24 °C
	☐ ___%	% Cloud cover	☒ ___%	Other:
	☒	Clear/sunny	☒	

SITE LOCATION/MAP

downstream of 2nd meander

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☒ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Watershed Area _____ mi^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other _____ ☒ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☒ Shrubs ☒ Grasses ☒ Herbaceous **Dominant species present** shiftgrass
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 2.5 m **Sampling Reach Area** 250 m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** .25 m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☒ Riffle 20 % ☒ Run 80 % ☐ Pool _____ % **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2/km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** 70 %
WATER QUALITY	**Temperature** 21 °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other _____ **Turbidity** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	
Boulder	> 256 mm (10")	
Cobble	64-256 mm (2.5"-10")	75
Gravel	2-64 mm (0.1"-2.5")	20
Sand	0.06-2mm (gritty)	5
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	<10%
Muck-Mud	black, very fine organic (FPOM)	
Marl	gray, shell fragments	

Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB1	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN RARITAN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. ANTHES, C. LIN		
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No
	☐	Storm (heavy rain)	☐	
	☐	Rain (steady rain)	☐	Air Temperature _____ °C
	☐	Showers (intermittent)	☐	Other:
	☐ ___%	% Cloud cover	☐ ___%	
	☐	Clear/sunny	☐	

SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph).

STREAM CHARACTERIZATION	Stream Subsystem ☐ Perennial ☐ Intermittent ☐ Tidal Stream Origin ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other _____	Stream Type ☐ Coldwater ☐ Warmwater Watershed Area _____ mi^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other _____ ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** _____m **Estimated Stream Width** _____m **Sampling Reach Area** _____m 2 **Area in km 2 (m 2 x1000)** _____km 2 **Estimated Stream Depth** _____m **Surface Velocity** _____m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** _____m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle_____% ☐ Run_____% ☐ Pool_____% **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** _____m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature** _____ °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other_____ **Turbidity** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☐ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other_____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	_____
Boulder	> 256 mm (10")	_____
Cobble	64-256 mm (2.5"-10")	_____
Gravel	2-64 mm (0.1"-2.5")	_____
Sand	0.06-2mm (gritty)	_____
Silt	0.004-0.06 mm	_____
Clay	< 0.004 mm (slick)	_____

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	_____
Muck-Mud	black, very fine organic (FPOM)	_____
Marl	gray, shell fragments	_____

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME WALNUT BROOK		LOCATION MINE BROOK PARK	
STATION # WB1	RIVERMILE	STREAM CLASS	
LAT	LONG	RIVER BASIN RARITAN	
STORET #		AGENCY NJWSA	
INVESTIGATORS R. ANTHES, C. LIN			LOT NUMBER
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME ____ AM PM		REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble____% ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☐ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB2	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN RARITAN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. ANTHES, C. LIN		
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☐ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature ____ °C
	☐ ___%	% Cloud cover	☐ ___%	Other:
	☐	Clear/sunny	☐	

SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph).

STREAM CHARACTERIZATION		
	Stream Subsystem ☐ Perennial ☐ Intermittent ☐ Tidal	Stream Type ☐ Coldwater ☐ Warmwater
	Stream Origin ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other _____	Watershed Area _____ mi^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other _____ ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** _____m **Estimated Stream Width** _____m **Sampling Reach Area** _____m 2 **Area in km 2 (m 2 x1000)** _____km 2 **Estimated Stream Depth** _____m **Surface Velocity** _____m/sec (at thalweg) **Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** _____m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle_____% ☐ Run_____% ☐ Pool_____% **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** _____m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature** _____ °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other_____ **Turbidity** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☐ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other_____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	_____
Boulder	> 256 mm (10")	_____
Cobble	64-256 mm (2.5"-10")	_____
Gravel	2-64 mm (0.1"-2.5")	_____
Sand	0.06-2mm (gritty)	_____
Silt	0.004-0.06 mm	_____
Clay	< 0.004 mm (slick)	_____

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	_____
Muck-Mud	black, very fine organic (FPOM)	_____
Marl	gray, shell fragments	_____

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK	
STATION # WB2 RIVERMILE_____	STREAM CLASS	
LAT_____ LONG_____	RIVER BASIN RARITAN	
STORET #	AGENCY	
INVESTIGATORS R. ANTHES, C. LIN		LOT NUMBER
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME _____ AM ☒ PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble____% ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☐ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

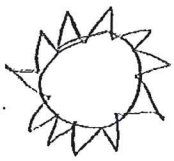
Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

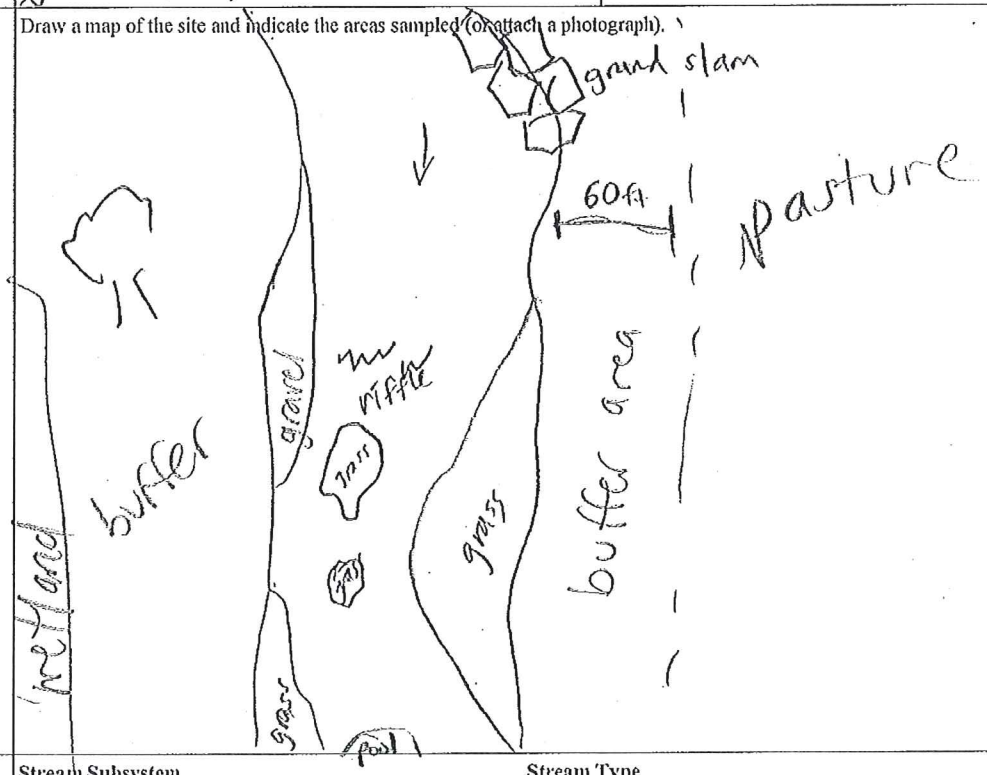
Appendix C-1: PHYSICAL CHARACTERIZATION FIELD DATA SHEET (FRONT)

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK, RARITAN TWP.	
STATION # WB3	RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN NESHANIC → RARITAN	
STORET #	AGENCY NJWSA	
INVESTIGATORS R. ANTHES, C. LIN		
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME 8:00 (AM) PM	REASON FOR SURVEY

WEATHER CONDITIONS	Now		Past 24 Hours	Has there been a heavy rain in the last 7 days?
	☐	Storm (heavy rain)	☐	☒ Yes ☐ No
	☐	Rain (steady rain)	☐	
	☐	Showers (intermittent)	☐	Air Temperature _____ °C
	☐ ___%	% Cloud cover	☐ ___%	Other:
	☒	Clear/sunny	☐	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph).



STREAM CHARACTERIZATION		
Stream Subsystem ☐ Perennial ☐ Intermittent ☐ Tidal	Stream Type ☒ Coldwater ☐ Warmwater	
Stream Origin ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other _____	Watershed Area _____ mi^2	

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other _____ ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☒ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☒ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **Dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 2 m **Sampling Reach Area** _____ m 2 **Area in km 2 (m 2 x1000)** _____ km 2 **Estimated Stream Depth** _____ m **Surface Velocity** _____ m/sec (at thalweg) **Canopy Cover** ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** _____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 10 % ☐ Run 75 % ☐ Pool 15 % **Channelized** ☒ Yes ☐ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** _____ m 2 **Density of LWD** _____ m 2 /km 2 (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☒ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **Dominant species present** _____ **Portion of the reach with aquatic vegetation** ____ %
WATER QUALITY	**Temperature** _____ °C **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other _____ **Turbidity** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other _____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other _____
SEDIMENT/SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other _____ **Oils** ☐ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other _____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS
(should add up to 100%)

Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock	N/A	_____
Boulder	> 256 mm (10")	_____
Cobble	64-256 mm (2.5"-10")	_____
Gravel	2-64 mm (0.1"-2.5")	_____
Sand	0.06-2mm (gritty)	_____
Silt	0.004-0.06 mm	_____
Clay	< 0.004 mm (slick)	_____

ORGANIC SUBSTRATE COMPONENTS
(does not necessarily add up to 100%)

Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	_____
Muck-Mud	black, very fine organic (FPOM)	_____
Marl	gray, shell fragments	_____

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME WALNUT BROOK	LOCATION MINE BROOK PARK
STATION # WB3 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN RARITAN
STORET #	AGENCY NJNSA
INVESTIGATORS R. ANTHES, C. LIN	LOT NUMBER
FORM COMPLETED BY R. ANTHES	DATE 10/22/10 TIME 8:00 (AM) PM / REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble____% ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other ( )____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☐ kick-net ☐ Other _____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☐ Vegetated Banks____ ☐ Sand____ ☐ Submerged Macrophytes____ ☐ Other ( )____
GENERAL COMMENTS	

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

FIELD OBSERVATIONS OF MACROBENTHOS

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare (1-3 organisms), 2 = Common (3-9 organisms), 3= Abundant (>10 organisms), 4 = Dominant (>50 organisms)

Porifera	0	1	2	3	4	Anisoptera	0	1	2	3	4	Chironomidae	0	1	2	3	4
Hydrozoa	0	1	2	3	4	Zygoptera	0	1	2	3	4	Ephemeroptera	0	1	2	3	4
Platyhelminthes	0	1	2	3	4	Hemiptera	0	1	2	3	4	Trichoptera	0	1	2	3	4
Turbellaria	0	1	2	3	4	Coleoptera	0	1	2	3	4	Other	0	1	2	3	4
Hirudinea	0	1	2	3	4	Lepidoptera	0	1	2	3	4						
Oligochaeta	0	1	2	3	4	Sialidae	0	1	2	3	4						
Isopoda	0	1	2	3	4	Corydalidae	0	1	2	3	4						
Amphipoda	0	1	2	3	4	Tipulidae	0	1	2	3	4						
Decapoda	0	1	2	3	4	Empididae	0	1	2	3	4						
Gastropoda	0	1	2	3	4	Simuliidae	0	1	2	3	4						
Bivalvia	0	1	2	3	4	Tabinidae	0	1	2	3	4						
						Culcidae	0	1	2	3	4						

Appendix C

South Branch Watershed Association Macroinvertebrate Sampling Results 2007-2008

Benthic Macroinvertebrates collected from Walnut Brook by the South Branch Watershed Association.

Location: **Dvoor Farm**
Sample Date: 11 May - 11 July - 8 November, 2007 and 10 June 2008
Sample Type: Travelling Kick (US EPA RBP III: 100-specimen subsample)

Taxon	Tol. Index (family)	Tol. Index (genus/sp.)	Common Name	2007 11 May Num. (fam)	2007 11 May Num. (gen./sp.)	2007 11 May Pct. (family)	2007 11 July* Num. (fam.)	2007 11 July* Num. (gen./sp.)	2007 11 July* Pct. (family)	2007 8 Nov. * Num. (fam.)	2007 8 Nov. * Num. (gen./sp.)	2007 8 Nov. * Pct. (family)	2008 10 June Num. (fam.)	2008 10 June Num. (gen./sp.)	2008 10 June Pct. (family)
Haplotaxida															
Lumbriculidae	8			2		2.0%				11		26.8%			
Stylodrilus heringianus		8	earthworm		2						11				
Tubificida															
Naididae	7									2		4.9%			
Nais sp.		8	naid worm								2				
Basommatophora															
Physidae	7						2		3.2%	1		2.4%			
Physa sp.		8	pouch snail					2			1				
Ephemeroptera															
Ameletidae				3		3.1%									
Ameletus sp.		0	mayfly		3										
Baetidae	4			1		1.0%	1		1.6%				8		8.0%
Baetis sp.		6	mayfly		1			1						8	
Ephemerellidae	1			12		12.2%									
Ephemerella sp.		1	mayfly		12										
Heptageniidae	4			4		4.1%									
Epeorus sp.		0	mayfly		2										
Stenonema sp.		3	mayfly		1										
Stenonema mediopunctatum		3	mayfly		1										
Leptophlebiidae	2												4		4.0%
Habrophlebia sp.		4	mayfly											4	
Odonata															
Aeshnidae	3						1		1.6%						
Boyeria vinosa		2	dragonfly					1							
Gomphidae	1						1		1.6%						
Stylogomphus albistylus		5	dragonfly					1							
Plecoptera															
Capniidae	1									12		29.3%			
Allocapnia sp.		3	stonefly								11				
Paracapnia sp.		1	stonefly								1				
Leuctridae	0												1		1.0%
Leuctra sp.		0	stonefly											1	
Nemouridae	2			31		31.6%							3		3.0%
Amphinemura sp.		3	stonefly		31									3	
Perlodidae	2			16		16.3%									
Isoperla sp.		2	stonefly		16										
Perlidae	1			1		1.0%									
Acroneuria carolinensis		0	stonefly		1								5		5.0%
Perlesta sp.		5	stonefly											5	
Trichoptera															
Hydropsychidae	4			7		7.1%	4		6.5%	3		7.3%	27		27.0%
Cheumatopsyche sp.		5	caddisfly		1			3			3			27	
Hydropsyche sp.		4	caddisfly		2								2		2.0%
Hydropsyche betteni		6	caddisfly		1									2	
Hydropsyche slossinae		4	caddisfly		3			1							
Hydroptilidae	4						1		1.6%						
Hydroptila sp.		6	caddisfly					1							
Polycentropodidae	6			2		2.0%									
Polycentropus sp.		6	caddisfly		2										
Rhyacophilidae	0												1		1.0%
Rhyacophila sp.		1	caddisfly											1	
Coleoptera															
Elmidae	4			2		2.0%	1		1.6%						
Oulimnius latiusculus		4	riffle beetle		1										
Stenelmis crenata gr.		5	riffle beetle		1			1							
Haliplidae	5						2		3.2%				1		1.0%
Peltodytes sp.		5	crawling beetle					2						1	

Benthic Macroinvertebrates collected from Walnut Brook by the South Branch Watershed Association.

Location: **Dvoor Farm**
Sample Date: 11 May - 11 July - 8 November, 2007 and 10 June 2008
Sample Type: Travelling Kick (US EPA RBP III: 100-specimen subsample)

Taxon	Tol. Index (family)	Tol. Index (genus/sp.)	Common Name	2007 11 May Num. (fam)	2007 11 May Num. (gen./sp.)	2007 11 May Pct. (family)	2007 11 July* Num. (fam.)	2007 11 July* Num. (gen./sp.)	2007 11 July* Pct. (family)	2007 8 Nov. * Num. (fam.)	2007 8 Nov. * Num. (gen./sp.)	2007 8 Nov. * Pct. (family)	2008 10 June Num. (fam.)	2008 10 June Num. (gen./sp.)	2008 10 June Pct. (family)
Hydrophilidae	5						7		11.3%						
Enochrus sp.		9	scavenger beetle					1					1		1.0%
Hydrobius sp.		5	scavenger beetle											1	
Paracymus sp.		5	scavenger beetle					6							
Psephenidae	4			2		2.0%	1		1.6%						
Psephenus herricki		4	riffle beetle		2			1							
Diptera															
Chironomidae	6			15		15.3%	40		64.5%	11		26.8%	42		42.0%
Cricotopus/Orthocladius sp.		6	midge		7			6			10			6	
Diamesa sp.		5	midge		7									13	
Dicrotendipes sp.		8	midge					12							
Eukiefferiella sp.		4	midge											2	
Paracladopelma sp. (tent.)		7	midge					1							
Polypedilum sp.		6	midge					1						1	
Pseudochironomus sp.		5	midge		1			4							
Tanytarsus sp.		6	midge					15						2	
Thienemanniella sp.		6	midge					1			1			3	
Thienemannimyia gr.		6	midge											2	
Tvetenia sp.		5	midge											13	
Empididae	6						1		1.6%						
Hemerodromia sp.		6	dance fly					1							
Similiidae	6												5		5.0%
Simulium sp.		5	black fly											5	
Diptera (cont.)															
Tipulidae	3									1		2.4%			
Tipula sp.		4	crane fly								1				
Total Taxa					21			20			9			19	
Total Specimens				98	98	100.0%	62	62	100.0%	41	41	100.0%	100	100	100.0%

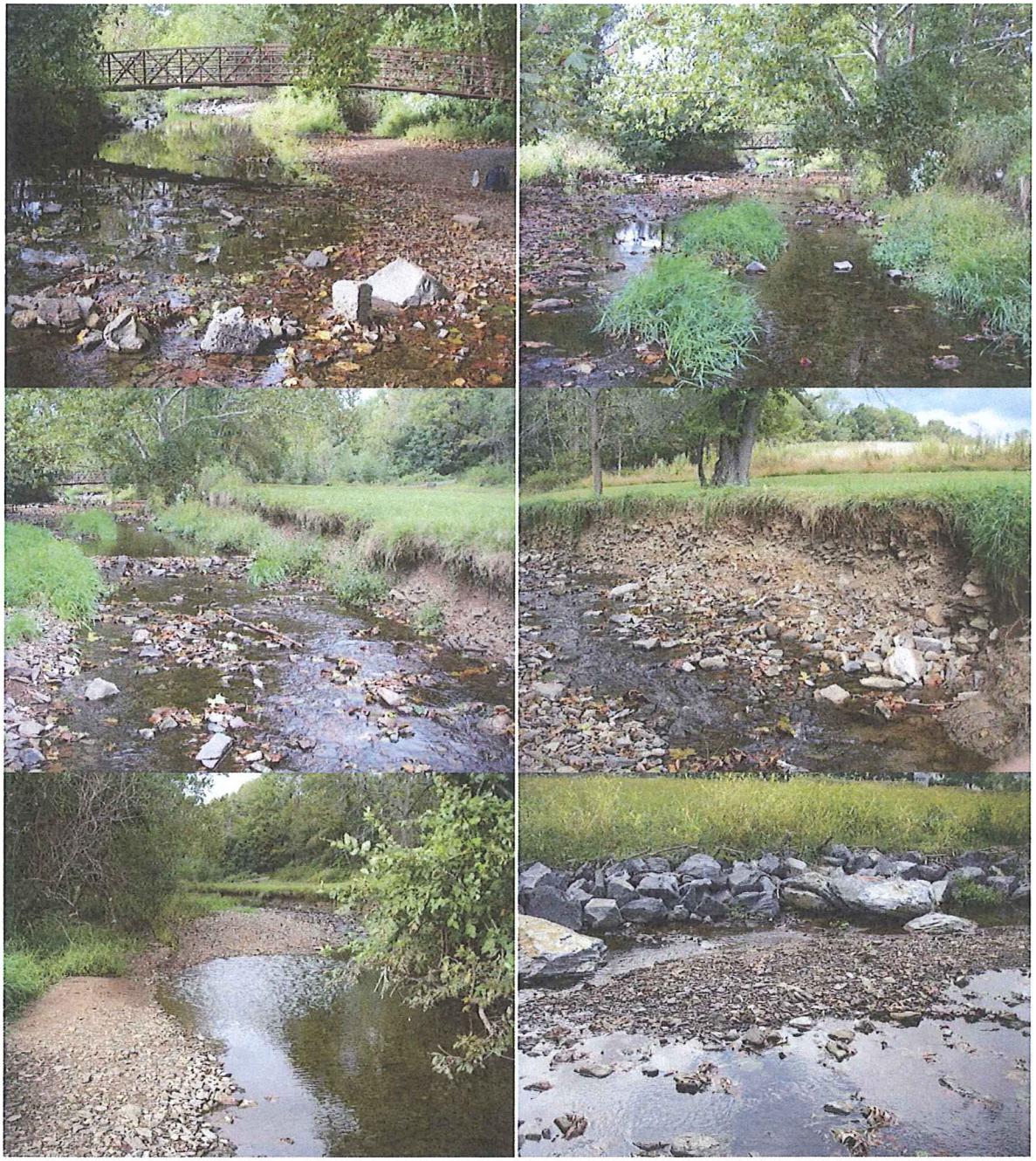
Rapid Bioassessment Protocol II Metrics:	11 May Metric Value	11 May Metric Score	11 May Water Quality	11 July* Metric Value	11 July* Metric Score	11 July* Water Quality	8 Nov. * Metric Value	8 Nov. * Metric Score	8 Nov. * Water Quality	10 June Metric Value	10 June Metric Score	10 June Water Quality
Taxa Richness (total number of families)	**13**	**6**		**12**	**6**		**N/A**	**-**		**12**	**6**	
EPT Families	**9**	**6**		**N/A**	**-**		**N/A**	**-**		**8**	**6**	
Percent Contribution Dominant Family	**31.6%**	**6**		**N/A**	**-**		**N/A**	**-**		**42.0%**	**3**	
Percent EPT Specimens	**78.6%**	**6**	**excel-**	**N/A**	**-**		**N/A**	**-**		**51.0%**	**6**	**very**
Family Biotic Index	**2.9**	**6**	**lent**	**5.5**	**3**	**good**	**4.9**	**-**	**good**	**4.4**	**6**	**good**
Total Score		**30**			**N/A**			**N/A**			**27**	
Biological Condition		**Non-impaired**			**N/A**			**N/A**			**Non-impaired**	
Dominant Family:		Nemouridae			-			-			Chironomiodae	
Hilsenhoff Biotic Index (based on genus/species identifications)	3.13		excellent	6.11		fair	5.63		fair	4.56		good

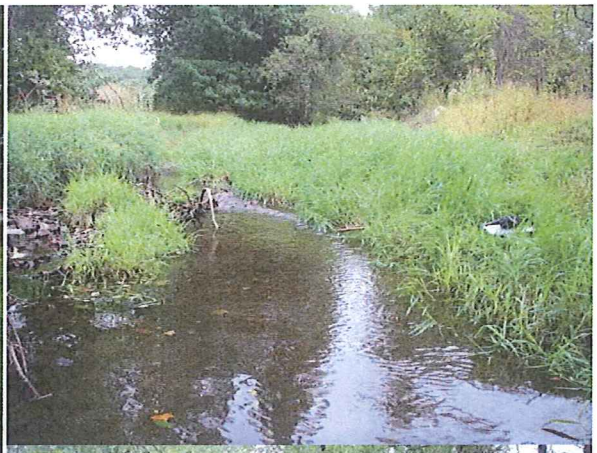
Note: *Sample matrices from the 11 July and 8 November 2007 collections were processed in entirety.

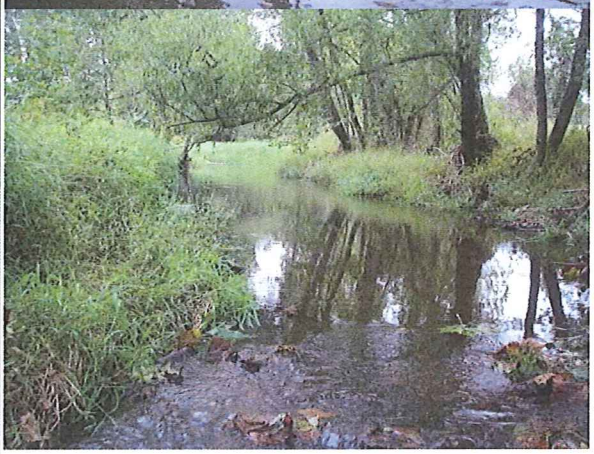
Appendix D

Photos

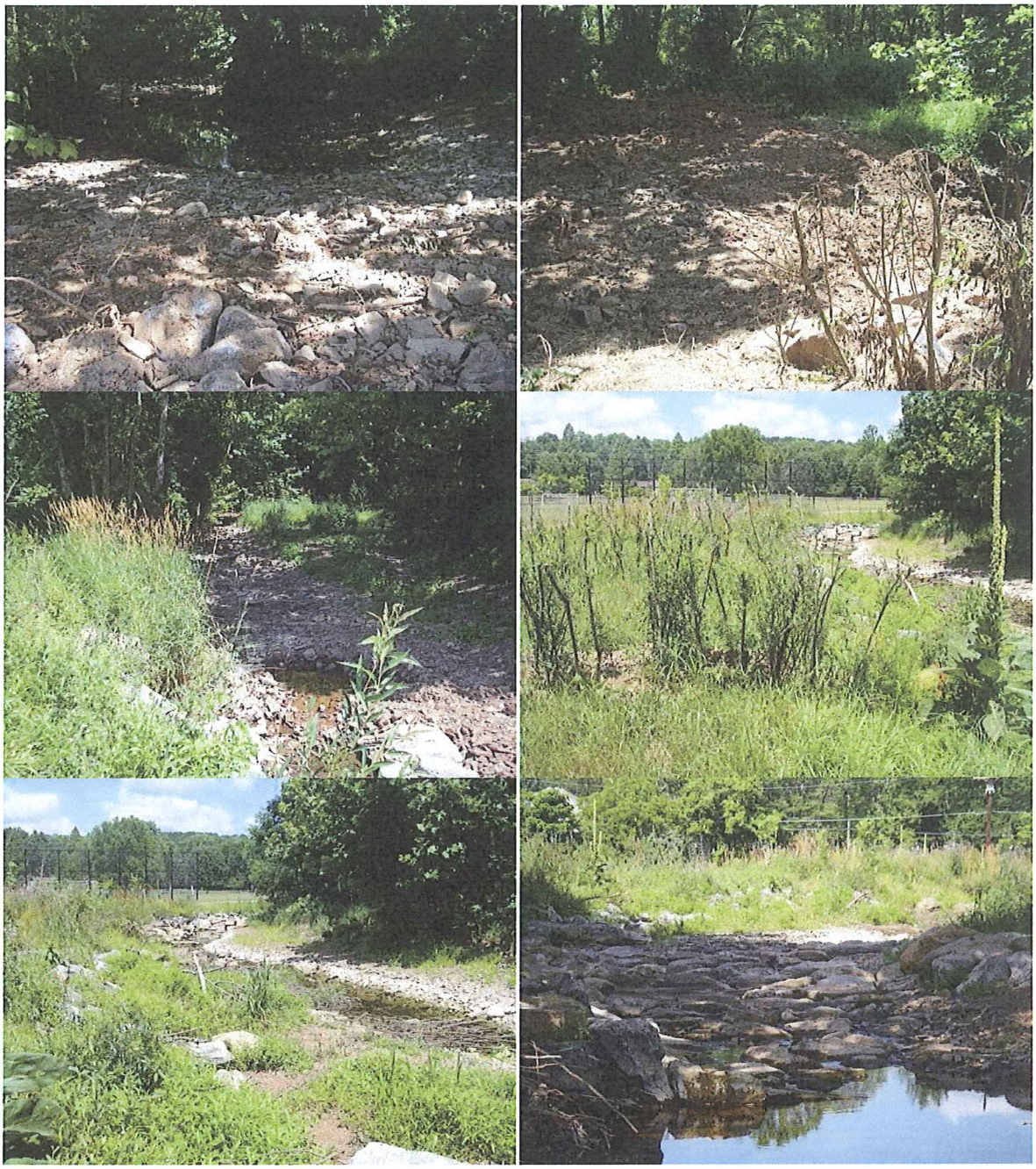
September 30, 2009 Sampling Event

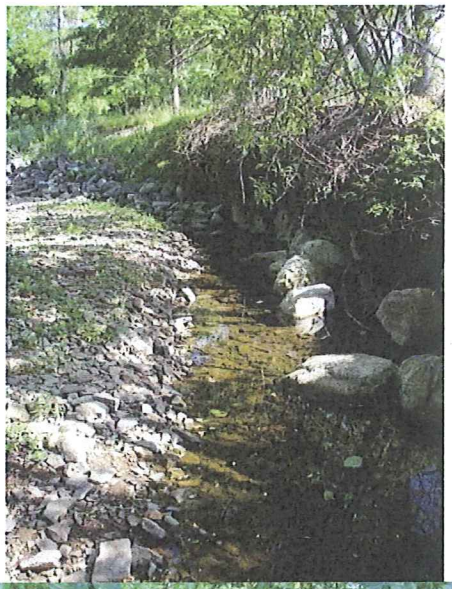






June 25, 2010 Sampling Event





October 22, 2010 Sampling Event