I-99 Environmental Research

Final Report

Executive Summaries

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March 2007

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-PA-2007-003-030207		

4. Title and Subtitle **I-99 Environmental Research**	**5. Report Date** March 5, 2007 **6. Performing Organization Code**
7. Author(s) R. G Quimpo, R. D. Neufeld, J. D. Monnell, D. Spaeder, and G. Reese	**8. Performing Organization Report No.** UPGH-CEE-EWR-2007-1
9. Performing Organization Name and Address Department of Civil and Environmental Engineering University of Pittsburgh Pittsburgh, PA 15211	**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** **030207**
12. Sponsoring Agency Name and Address The Pennsylvania Department of Transportation Bureau of Planning and Research Commonwealth Keystone Building 400 North Street, 6th Floor Harrisburg, PA 17120-0064	**13. Type of Report and Period Covered** Final Report, May 12, 2004 to March 5, 2007 **14. Sponsoring Agency Code**

15. Supplementary Notes

16. Abstract

Findings and recommendations are summarized from results of four tasks in the project. These covered the evaluation of erosion and sediment controls to determine Best Management Practice, the development of a runoff prediction model for watersheds engendered by highway construction, the assessment of hydro-biological indicators for land-use planning in highway corridors and the evaluation of the effectiveness of stream restoration, rehabilitation and relocation as part of the mitigation strategy.

17. Key Words E&S Best Management practice, runoff prediction for highway watersheds, Hydro-biological indicators for land-use planning for highway corridors, stream restoration, rehabilitation and relocation	**18. Distribution Statement** No restrictions. This document is available from the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	37	

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This is a compilation of the Executive Summaries for each of the four tasks in the I-99 Environmental Research project. It being submitted to provide a concise document which describes the scope of work, findings, conclusions and recommendations.

Introduction

The purpose of the research is to monitor and evaluate the effectiveness of various mitigation techniques that were implemented during the construction of a section of I-99. Highway construction causes changes in drainage patterns and disturbs the natural landscape. The project's objective is to conduct research during the construction phase to minimize and assess the impacts of highway construction by establishing best management practices for erosion and sedimentation, to monitor the hydrologic and biologic conditions in highway corridors and to assess the effectiveness of wetland mitigation and stream restoration strategies.

This project involves four specific tasks:

A. Evaluation of approved erosion and sediment controls to determine Best Management Practice
B. Hydrologic Monitoring and Modeling
C. Monitoring and assessment of wetland hydro-biological indicators for land-use planning in highway corridors
D. Evaluation of the effectiveness and sustainability of stream restoration, rehabilitation and relocation projects as part of mitigation for road construction

Because of the broad coverage of subjects treated under the project, detailed findings for each of the above tasks are documented in separately-bound reports. In each report, recommendations are also presented.

Only the executive summary for each of the above tasks are presented in this volume.

SECTION 1
EXECUTIVE SUMMARIES

Task A – Evaluation of Approved Erosion &Sediment Controls to Determine Best Management Practice – Leader: Ronald D. Neufeld

The Pennsylvania Department of Environmental Protection (PADEP) requires the implementation and maintenance of erosion and sediment control best management practices (BMPs) to minimize the potential for accelerated erosion and sedimentation, including for those activities (non-agricultural) which disturb less than 5,000 square feet (464.5 square meters). In this project, we have compared and evaluated the implementation of current BMPs at the I-99 construction sites to proposed BMPs in regards to their applicability for highway construction. The primary objective was to develop an evaluation of erosion and sediment controls existing at the I-99 site and to suggest a set of BMPs best suited for future highway construction projects. Best management practices for erosion and sediment control for highway construction sites are measures designed to reduce the amount of sediment leaving a construction site and to prevent them from entering nearby surface waters. Some of the BMPs commonly associated with land disturbance and construction activities are sediment basins, sediment traps, silt fence, vegetative filter strips, straw bale barriers, rock filters and erosion control blankets. In our assessment of these key issues, we conducted periodic monitoring of selected sedimentation ponds and silt fences for changes in condition and identified possible solutions to potential deficiencies or problems as they were observed.

Sedimentation Ponds Current BMPs for controlling construction site runoff focus primarily on reducing the quantity of runoff rather than the quality of runoff. Particle removal is an environmentally critical criterion that is a large component of runoff quality which is not considered in current designs. Sedimentation ponds were designed and installed along the I-99 corridor with two purposes in mind: (1) to initially contain sediment contained in run-off during the construction process, and (2) to attenuate rainfall runoff and contain potential spills from overturned tank trucks accidents during the longer-term operation of the highway. As a result of our assessments, we suggest BMPs that control both the quantity and quality of runoff. These BMPs are based on a more theory-based analytical procedure for arriving at SB volume, sediment storage zone volume, sediment dredging frequency and basin drainage time while taking into account rainfall intensity and frequency, and basin effluent suspended solids. Procedural details for design are included in the final report. Sampling and associated laboratory analysis showed a strong correlation of iron and aluminum with particulate effluent suspended solids. The suggested BMPs incorporating designed control of effluent suspended solids will concomitantly reduce metal loadings into receiving waters and down-slope game lands.

Silt Fences Super silt fences (*fabric fencing backed with metal support*) are employed along the I-99 right of way boundary down slope from sedimentation basins to help control runoff. The performance of these fences depends on several factors. For example it was observed that when the silt fence is anchored well, covered with fabric and the lower end of the silt fence is buried well into the ground, the silt fence has been observed to perform well and hold back up to 12 inches of sediment. Heavy vegetation that complements the performance of silt fences has been observed upslope and down slope in certain stretches of silt fence. However, silt fences were observed to be damaged by trees falling over the silt fence, blown out at the bottom, missing fabric or having damaged fabric. In some cases, they were missing over a small stretches. Photographs of the silt fence show breaches underneath the silt fence. The under cutting may be due to off contour installation resulting in channeling and the development of breaches at the toe of the silt fence. *From these observations we conclude that continuous maintenance of silt fences is critical to their performance.* It is recommended that for the prevention of undercutting of silt fences, on-contour installation and proper trenching in at the toe are essential. This will prevent channeling and forming of breeches at the toe. Portions of the silt fences that are subjected to higher overland water flows (particularly those in close proximity to sedimentation pond outlet discharges) should be provided with extra protection at the toe. They are particularly susceptible to increased damage due to the extra flow from the pond outlet that exists in addition to expected rainfall runoff.

Task B – Hydrologic Modeling and Monitoring – Leader: Rafael G. Quimpo

The primary objective of this task was to develop a hydrologic model that may be used as a tool for predicting the hydrologic impacts of highway construction. A survey of the existing models was conducted to ascertain their suitability for this purpose. It was determined that the special conditions engendered by the highway intersecting natural drainage patterns before construction required a formulation that is somewhat different from those of models what were then available.

Hydrological modeling requires large amounts of data, beginning with a delineation of a typical watershed from construction drawings of the project. A typical impacted watershed includes the roadway portion of a highway, its drainage ditches and inlet structures, the undisturbed area upstream which the roadway intercepts and the downstream area. These upper and lower areas together with the roadway contribute to the runoff at the outlet. The watershed outlet connects to a larger waterway or discharges into a wetland. Two test watersheds were instrumented to obtain calibration and validation data. Instruments included water level recorders at sedimentation ponds, monitoring wells to track deep and shallow groundwater fluctuations and a flow measuring gage at the outlet of each watershed. Precipitation data were obtained from a rain gage operated by Skelly & Loy, Inc. This was supplemented with data from a rain gage located at Tyrone, PA operated by the National Oceanic and Atmospheric Administration (NOAA). Using these data, a computational model that is able to predict the hydrograph at the outlet of this typical watershed was then developed and coded.

After calibration, the model was tested and found to perform very well. During the calibration and testing period which extended more than 12 months, 10 storms having significant rainfall amounts were analyzed to test model performance. For hydrologic models, the criteria for acceptance usually require good agreement between predicted and measured time-to-peak discharge. For these storms, the difference between predicted and measured peak flows differed by less than 15 percent. The same quality-of-fit criterion also was satisfied when comparing the measured and predicted time-to-peak discharges.

In addition to providing details of the model development and performance, the findings in this task also include recommendation on procedures that may be adopted in future projects. Also, included in the report are the instrumentation and monitoring requirements to carry out similar evaluations in the future. Data on the cost of instrumentation and monitoring are also provided. Finally, a Users Guide for using the developed software is also included.

Task C – Monitoring and Assessment of Wetland Hydro-Biological Indicators for Land-Use Planning in Highway Corridors – Leader: George Reese

The type and magnitude of potential impacts to wetlands were a source of considerable concern during analyses prepared for permitting of the construction and operation of the I-99 Project. Of particular concern were the hillside seep wetlands on the slopes of Bald Eagle Mountain. Post-construction monitoring was undertaken to evaluate the type and extent of impacts that occurred during construction and to evaluate the success of the mitigation designs that were incorporated into the project.

Field monitoring was conducted in 2005 and 2006 to evaluate the current conditions. In addition, pre-and post-construction monitoring data collected by PennDOT and the Pennsylvania State University were reviewed and incorporated as appropriate. Parameters examined during this investigation included water chemistry, hydrologic conditions, soil chemistry, soil condition, vegetation communities, avian communities, amphibian and reptile communities, mammalian communities, benthic macroinvertebrate populations, and adjacent land uses.

The regulatory agencies in Pennsylvania currently provide for the use of several wetland assessment methodologies in regulatory procedures. Forty-three methodologies were reviewed for their applicability for use in Pennsylvania. Three procedures were advanced for detailed consideration and assessed as part of this Project. Based on this evaluation, the Ohio Rapid Assessment Method (ORAM) appears to be the most comprehensive and effective assessment technique currently available to determine wetland functional capacity for the purpose of impact assessment. The Hydro-Geomorphic Methodology (HGM) would also fulfill this function, but operational models are not yet available. The ability to provide for mitigation planning parameters (i.e. design capabilities) was also reviewed. Methods were reviewed and several were evaluated in the field. Based on this review, the combination of ORAM for rapid functional assessment and Evaluation for Planned Wetlands (EPW) to address mitigation planning functions provides for the most comprehensive assessment. Key functions and values that were found to influence the success of the mitigation wetlands include hydroperiod, presence and extent of standing water, characteristics of vegetation communities, and overall wetland vegetation community size.

Pre- and post-construction wetland conditions were reviewed and assessed in relation to Erosion and Sedimentation (E&S) controls and stormwater/groundwater facilities. Key components of this system include infiltration galleries, sediment basins, and stormwater management channels. This review indicated that wetland hydrology has been maintained to date. Groundwater flows downslope of infiltration galleries have decreased but appear to remain sufficient to maintain wetland hydrology and plant communities based on the available data. No substantial E&S control failures or construction-related water quality problems were noted in the wetlands evaluated.

The design of the stormwater control facilities to discharge as sheet flow rather than point discharges has led to the unintended creation of additional ridgeside wetlands. While these "unplanned" wetlands appear to have surface water rather than groundwater as their primary hydrologic source, it is possible that they could replace some of the wildlife habitat functions of the ridge-side impacted wetlands. This suggests the possibility that flow from stormwater discharges could in the future be utilized to design replacement ridgeside wetlands that are capable of replacing a number of functions and values of natural communities. If this were to be the case, substantial cost savings could be incurred while at the same time providing for replacement of wetlands more similar to impacted seeps than is feasible with standard methods.

The results of the biological evaluations conducted for the mitigation wetland sites suggest that, since these sites were not designed to furnish in-kind replacement for impacted wetlands, these areas have at least temporarily increased native species diversity within the project area in comparison to pre-existing wetlands. This appears to be in part in response to the presence of substantial areas of standing water, which are not common in the project area. Performance standards were recommended for mitigation sites that incorporated, in addition to requirements imposed by regulatory agencies, standards for standing water and number and diversity of vegetation layers.

The development of a regional framework methodology for predicting construction impacts on ridgeside seep wetland species diversity was examined. This framework utilizes vegetation data, which was determined to be the most comprehensive and reliable data set for use by multiple observers. The framework assessment is based on the identification of correlations primarily through ordination analysis. The ordination analyses conducted for this study did not detect a statistically significant impact of construction on a myriad of response variables. The null results provided by the current ordination analysis could be interpreted as indicating that there was no effect (with implementation of appropriate mitigation measures). However, there are other possible explanations. These questions must be resolved by future investigation in order for a regional framework to be fully developed. A design appropriate for the development of a rigorous framework to allow for the critical evaluation and quantification of impacts of highway construction on not only wetland vegetation, but also on uncommon species and exotic invasive species, was developed for use on future projects.

Task D – Evaluation of the Effectiveness and Sustainability of Stream Restoration, Rehabilitation and Relocation Projects as Part of Mitigation for Road Construction
Leader: Don Spaeder

During the construction of I-99, streams were impacted along the highway route and mitigation for the impacts was required. Mitigation sites were provided in and around Bald Eagle Creek and a tributary, Reese Hollow Run, along the Route 220 corridor near Port Matilda, PA. This study was undertaken to assess the effectiveness of the stream enhancements for highway mitigation and to assess the ability of the enhancements to provide a stable, healthy stream over the long term. Throughout the study, detailed monitoring visits were taken to eight representative reaches at the six mitigation sites. At these monitoring reaches, detailed measurements were taken of the stream profile, designated riffle and pool cross sections, bank stability, riparian vegetation, macroinvertebrate population, stream bed composition, and water quality. In addition, several sediment sampling visits were performed to measure bedload and suspended sediment transport through the project area.

Six stream reaches were utilized to provide mitigation for the impacts, with four located on Bald Eagle Creek and two on Reese Hollow Run. Enhancement measures utilized at the various sites included fencing of the riparian corridor to prevent livestock damage, construction of designated livestock stream crossings, riparian plantings, rock toe protection of the stream banks, stream bank / bed regrading, and bank protection / habitat creation using rock structures such as J-hooks and cross vanes. From the detailed monitoring and analyses of the data, it was concluded that the construction of electric fencing around the riparian corridor has been a major contributor to improved stream conditions. The growth of riparian vegetation within the corridor has been mostly successful and it is expected that damage to the stream banks will be reduced. However, at several of the monitored sites, invasive vegetative species have become established. Multi-flora rose has been observed to be the predominant invasive species followed by Japanese knotweed.

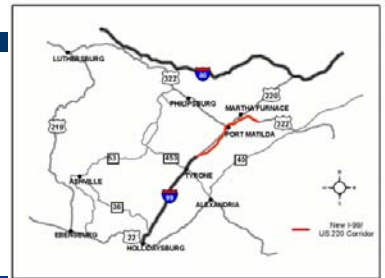
It was observed that much of the mitigation work on Bald Eagle Creek involved bank protection or redirection of flow away from the banks. As a result of the enhancements and stream plan and profile, the stream's energy is being redirected toward the stream bed, which was observed to convert riffle reaches into pools through bed scour. While this is not likely to cause further stream instability, an increase in pool lengths and occurrence may lead to a decrease in dissolved oxygen, an increase in siltation of the stream bed, and other less desirable habitat impacts. In contrast, erosion of the stream banks leading to overflow channel cuts has been observed meandering portions of Reese Hollow Run. This observation is typically nothing more than a natural propagation of meander patterns and as long as it is confined within the conservation easement and does not impact any stream structures, roads, buildings, etc., such propagation is not an adverse situation.

It was also observed that some installed rock structures did not function in quite the way they were intended. Pools downstream of cross vanes have typically filled in, and many of the structures have been buried by transported material. It was also learned through conversations with the property owners that the livestock, and thus the farmers, prefer concrete slat livestock crossings to the riprap and rock crossings. Additionally, one of the study mitigation reaches passes through Port Matilda Park and is accessible by the public. Part of the enhancements in this reach was the removal of artificial dams that had been used to create fishing pools, with the construction of natural pools intended to replace them. These previously installed artificial dams had caused siltation of the stream bed, covering the substrate and reducing the suitability of the bed as a habitat and were reversed in the mitigation construction. However, by the end of the monitoring period, rock and rubble dams had been reconstructed, presumably by the local populace.

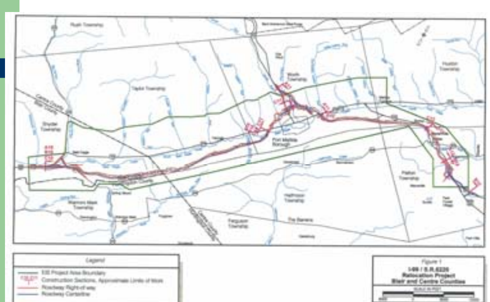
The techniques used for mitigation and enhancement at the I-99 sites have led to a significant improvement in stream conditions when compared to the pre-construction situation. While some mitigation measures are more successful than others, the data provided herein combined with the recommendations for further technique improvement will allow future projects to have substantial positive impacts on the environment. In addition, a monitoring methodology is proposed that utilizes a detailed visual technique to provide a series of snapshots of the stream system, enabling an assessment of enhancement effectiveness over time with a reduction in the amount of data and associated analysis time.

I-99 Environmental Research OVERVIEW

Project Location



Project Area



Management

Task A:
- **Team Leader: Ronald Neufeld, University of Pittsburgh**
- **Team includes personnel from:**
  - **University of Pittsburgh, GAI Consultants**
  - **Gwin, Dobson & Foreman, Inc., Unitec Consulting Engineers**

Task B:
- **Team Leader: Rafael G. Quimpo, University of Pittsburgh**
- **Team includes personnel from: University of Pittsburgh (CEE and Geological Sciences), AWK Engineers, Gwin Dobson & Foreman, Inc.**

Management (Continued)

Task C:
- **Team Leader: George Reese, GAI Consultants**
- **Team Includes personnel from:**
  - **GAI Consultants**
  - **University of Pittsburgh**

Task D:
- **Team Leader: Don Spaeder, GAI Consultants**
- **Team Includes personnel from: GAI Consultants, University of Pittsburgh (CEE and Biological Sciences), Western Pennsylvania Conservancy**

Objectives

- Verification and development of Best Management Practices for Pennsylvania Highways
- Develop of transferable models that can be used throughout Pennsylvania
- Develop enhanced capabilities to predict impact of construction
- Identify suitable mitigation measures for future projects
- Monitor and evaluate effectiveness of mitigation techniques implemented during construction of I-99 to provide improved management of corridor resources
- Reduce need for extensive and expensive field monitoring through use of models

Tasks

A. Evaluation of approved erosion and sediment controls to determine Best Management Practices
B. Hydrologic modeling and monitoring
C. Monitoring and assessment of wetland hydro-biological indicators for land-use planning in highway corridors
D. Evaluation of effectiveness and sustainability of stream restoration, rehabilitation and relocation as part of the mitigation program

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- Overall Project:
  Web Page Development

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I-99 Task A:
Summary and Conclusions
PennDOT Presentation
December, 2006

University of Pittsburgh
GAI

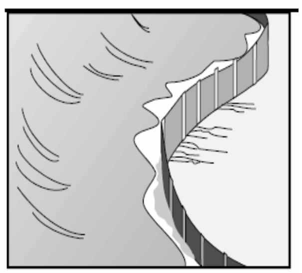
Task A Investigators

- Task Leader:
  - Dr. Ronald D. Neufeld, P.E., DEE
    Professor of Civil & Environmental Engineering
- Research Associate:
  - Dr. Jason Monnell
- Graduate Students:
  - Sujaya Kalainesan, Graduate Student
  - Emily Simms, Graduate Student
  - Kent Pu, Graduate Student
- GAI technical staff
- Uni-Tec Field Sampling Assistance

Silt Fence

Purpose:

•To intercept and slow or detain flow of storm water to allow sediment to settle and be trapped.



REF: CALTRANS Construction Site Best Management Practices Manual 2003

Silt Fences and Super Silt Fence

- A silt fence is made of a filter fabric that has been entrencher, attached to supporting poles, and sometimes backed by a plastic fence or wire mesh for support.
- A super silt fence has metal poles, supporting a chain link fence. The woven synthetic filtration fabric is stretched across its length. A super silt fence is sturdier and less likely to be breached than a regular silt fence.

1: Silt Fence Performance

- Data collected from Uni-Tec periodic on-site walking survey, detailed comments and photographs.
- A total of 10 walking surveys conducted through Summer 2005.

Silt Fence-Design Concepts

- Placed below the toe of exposed or erodible surfaces;
- Placed along the perimeter of the project;
- MUST be maintained
- Fabric Life generally limited to 5-8 months
  - Usually woven polypropylene or equivalent

REF: CALTRANS Construction Site Best Management Practices Manual 2003

I-99 Silt Fence Performance

Silt fences have been observed to hold back 12 inches of sediments for areas properly maintained. This means:

- Being well anchored, and
- Lower end of fabric buried well into the ground

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Silt Fence Design Performance

- Heavy vegetation is observed upslope and downslope in certain areas.
- Fences not needed when about 70% of the upslope area is well vegetated. This is present case in many areas.

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I-99 Silt Fence Performance

- Maintenance is still a problem. Fence damage, blow outs in silt fences and damages/missing fabric exist
  - Photographs of the silt fence show breaches underneath the silt fence. Channeling and the developments of breaches at the toe of the silt fence if installed off-contour.

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I-99 Silt Fence Performance

- Two major factors that will enhance silt fence performance would be,
  - on contour installation of silt fence, which may prevent channeling and development of breeches underneath the silt fence, and
  - regular maintenance of the silt fence.

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Silt Fence Performance

- Additionally portions of the silt fences that are close to the sedimentation pond outlet discharge may have to be provided with additional protection at the toes.

  This area is susceptible to more damage due to the increase flow from the pond outlet in addition to the rainfall runoff.

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Sediment Controls
Super Silt Fence (SSF)

SSF Blowout Repaired with Rock Check (Sep/22/04)

Tree fall on SSF (Sep/22/04)

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Supersilt Fence

Breach Underneath SSF (Sep/22/04)

12" Sediment Held Back by SSF (Oct/5/04)

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Supersilt Fence

SSF Removed (Oct/5/04)

Tree Damage on SSF (Oct/6/04)

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Heavy Vegetation
no fabric on fence

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Conclusions – Silt Fence

- Supersilt fencing by and large has served its purpose and its useful life.
- Maintenance has been a problem in the past, but it is questionable if fencing should continue to be maintained from here on out.
- Fencing does provide for a physical barrier during the length of the property (for people & large animals).

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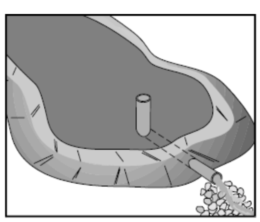
2 - Sedimentation Basins

Purpose:

A temporary basin formed by excavating or constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing the sediment to settle out before the runoff is discharged.



REF: CALTRANS Construction Site Best Management Practices Manual 2003

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Sedimentation Basins

- The purpose of sedimentation basins are to collect runoff from each well defined drainage area, and to control sediment runoff from highway construction.

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Sedimentation Basin Parameters

- **Large enough volume to capture flow for a given storm size and event frequency;**
  - ***Often designed based on "volume of storage per unit area draining into the basin"***
- **Should require a large surface area to permit settling and removal of sediments**
- **Should be able to drain within a short time (to avoid mosquito emergence);**

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I-99 Sedimentation Basins

- General Observations:
  - Some "*clean*" water upslope of the highway gets into sedimentation basins;
  - Seeding and fertilization for runoff control has lead to nutrient runoff & algae growth in ponds.
  - Acid Rock "seep water" enters basins

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Typical I-99 Sedimentation Basin

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I-99 Inlet Protection Structure

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Outlet Protection-Basin Discharge

- Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows (California Storm Water Quality Association, 2003).

I-99 Site
Basin Discharge

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Riprap: for erosion control

- Riprap is a permanent, erosion-resistant ground cover constructed of large, loose, angular or sub-angular (rounded) stone.

Riprap at I-99 Construction Site

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Erosion Control Mats

- Mattings of natural materials used to cover soil surfaces to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface.
- Matting may be used to stabilize soils until vegetation is established.

I-99 Vegetated Erosion Control Mat

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Other Erosion Control BMPs

- **Hydroseeding**: to temporarily protect exposed soils.
- **Vegetated Buffers:** vegetation strip to remove sediment by filtration; used as a "polishing step" from sedimentation traps and basins.
- **Straw-Bale Barriers:** placed to intercept sheet flows

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I-99 Sedimentation Basins

Four Sedimentation Basins selected for detailed analysis:

- **SB-11** (part of drainage basin for Task B)
- **SB-14** (highly turbid discharge)
- **SB-103** (receives acid mine constituents)
- **SB-111** (highly disturbed drainage area)

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Sedimentation Basins

- **Water chemistry data shows that acidic seeps affect sedimentation pond water quality. Analysis of seep sample shows that seeps have elevated concentrations of Al, Fe, Ca, and Mn.**
- **Correlation of rainfall data with water chemistry results shows that the concentration of pollutants in the sedimentation pond increase significantly with rainfall and the concentration peaks can be correlated to rainfall peaks.**

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Acid Rock Seeps

(Oct/5/04) Seep near SB14 (pH = 5.0)

(Oct/20/04) - Seep near SB111 Seep Draining into Crack

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Sedimentation Basins

- There is evidence of algae in the sedimentation ponds and the level of phosphate in the ponds supports the fact that eutrophication may result in the ponds in the future if existing conditions persist.

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Sedimentation Basins

- The level of aluminum in the ponds is elevated at times and may have adverse impacts on aquatic life.
- Analysis of water samples from the streams shows an aluminum concentration similar to that of the ponds, the concentration of aluminum in the wetland samples is in the range of 3mg/L to 29mg/L. This may be evidence of aluminum accumulating in the wetlands. However, the physical connection between basins and wetlands is still tenuous.

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Sedimentation Basins

- The design criteria of sedimentation ponds can be improved by using “overflow rate” as the design basis rather than using volume of sedimentation pond per unit acreage of drainage basin. This is the scientific basis for design of settling tanks for water treatment plants.

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Sedimentation Basins

- To improve sedimentation pond performance and control sediment release <u>during wet weather events,</u> addition of water soluble polymers to the sedimentation ponds may be considered. Such a system may improve settling during peak rainfall events and reduce the volume of sedimentation pond required for achieving a desired percentage removal.

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Sedimentation Basin Data (2004-2005)

- Field surveys and monitoring of basins
- Photographs and sampling conducted of influent & effluent on each date
- On-site analysis conducted for pH and color on each date
- Samples sent to the University for further analysis for each date.

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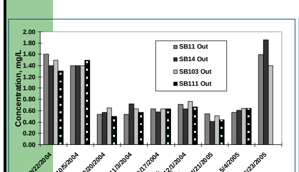
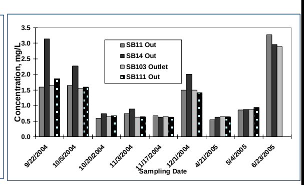
Focus on Aluminum

Dissolved Aluminum



Total Aluminum



Total and Dissolved Aluminum in Basin Effluent

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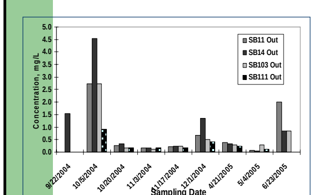
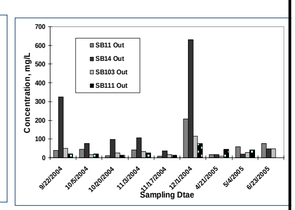
Focus on PO_4 & SS



Total Phosphate in the Basin Outlet



Suspended Solids in Basin Outlet

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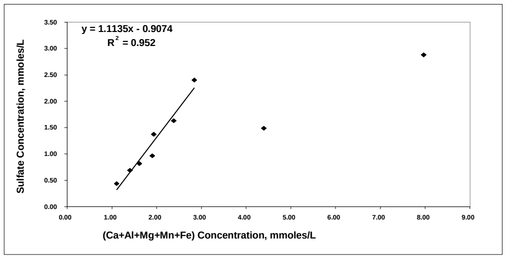
Other Correlations



Correlation of Total Sulfate Concentration with the
Sum of Total Ca, Fe, Mg, Mn & Al Concentrations for SB11 outlet

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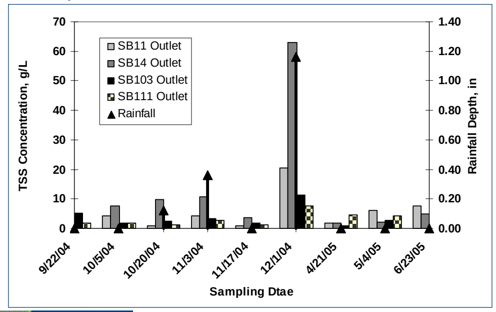
Rainfall correlation



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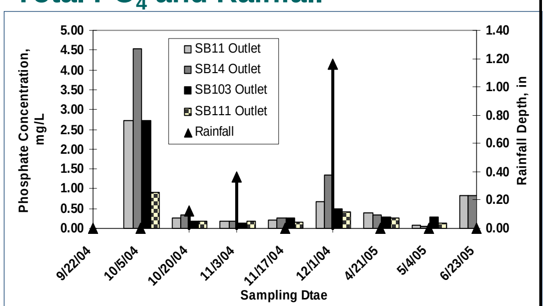
Total PO_4 and Rainfall



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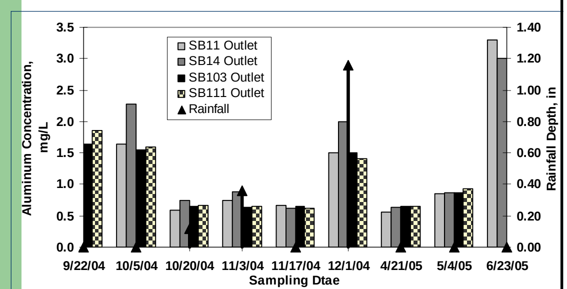
Total Al and Rainfall



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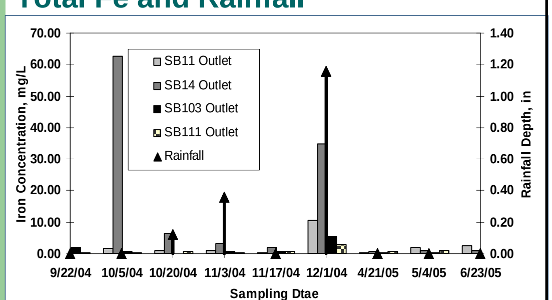
Total Fe and Rainfall



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24-hour Rainfall Correlations

- Peaks in total suspended solids can be directly correlated to the peaks in rainfall;
- Total aluminum appears to increase concentration corresponding to rainfall peaks with other later peaks evident;
- Components that are present mainly in the dissolved form do not show a clear correlation with rainfall data

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Basins: Observations

Leaking Pipe delivering up-slope excess clean water to SB11 (9/22/04)

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Basins - Observations

SB-14 showing green algae growth as a possible consequence of nutrient runoff from erosion control mats

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SB-11

May 2005

June 2005

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SB-111and Algae growth

5/05

6/05

Algae growth (7/26/05)

Algae growth (7/26/05)

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Additional Nutrient Addition

Trip 7 (4/21/2005) Picture of Duck Swimming in the Pond (Pond not Identified)

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Observations & Suggestions

1. What is the desired "outcome"? BMPs for highway application historically have been focused more on water quantity control rather than water quality control. (*Recent DEP discharge permits may re-focus needed outcomes.*)

2. Some states suggest the use of erosion & runoff BMPs for both quality and quantity management. *PA can move in that direction.*

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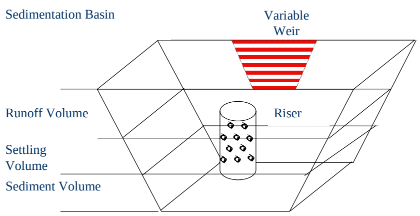
Sedimentation Controls for Wet Weather Events

- Rainfall events lead to a significant increase in the concentration of most of the pollutants leaving the sedimentation basins. Peaks in concentration match well with the rainfall peaks.
- According to conventional design practice, it may be necessary to construct sedimentation ponds of very large area to control SS release.

Wet weather pond design

- Since the construction of very large ponds involves very high costs, a better means of designing these sedimentation ponds is necessary so that ponds can be constructed with smaller area and higher efficiency to control sediment release during wet weather events.

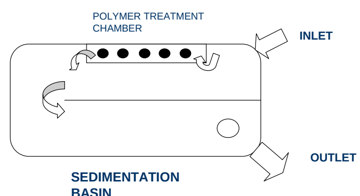
Alternative Sedimentation Basin



Sediment removal & storm water management achieved in same basin

Alternative Wet Weather Design

- To achieve good sediment removal during peak flows, a passive polymer flocculation system can be considered.



Questions & Comments

Task B- Hydrologic Modeling and Monitoring

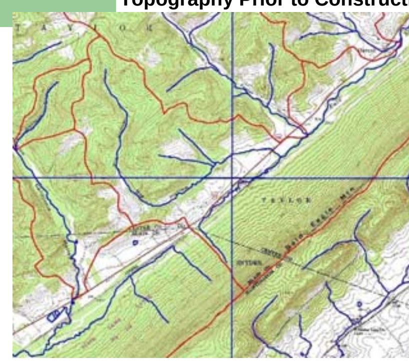
Dr. Rafael G. Quimpo
Professor of Civil Engineering
University of Pittsburgh
Task Leader

- Collaborators
  - **Dr. William Harbert, Professor, Geology and Planetary Sciences**
- Graduate Students
  - **Adam Scheller**
  - **Weizhe An**
  - **Majid Khazaei, AWK Engineers**

Tasks

- **Review of models**
- **Model selection and modification**
- **Instrumentation**
- **Calibration and Testing**
- **Model Implementation**
- **Impact Evaluation**

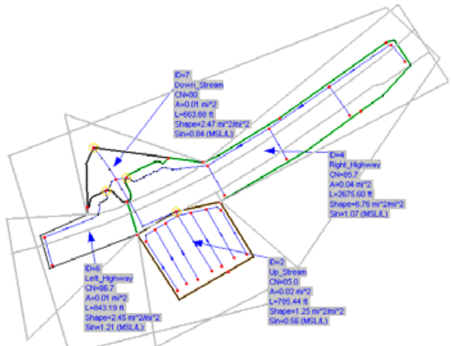
Topography Prior to Construction



Location of Test Watersheds

Surface Water Instrumentation

Model Schematic of Watershed A



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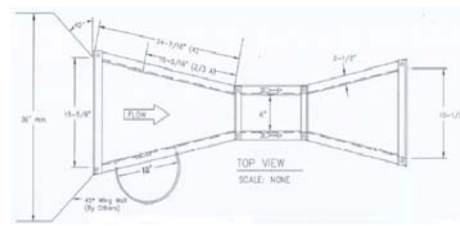
Flow Measuring Flume



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Flow Measuring Flume Installed

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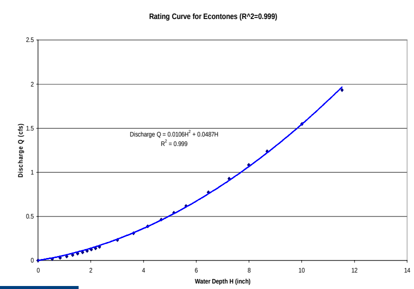
Rating Curve for Flume



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Groundwater Instrumentation

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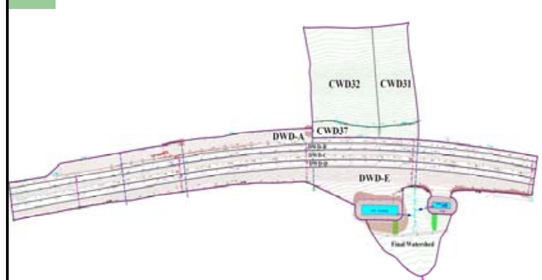
Watershed 1 clipped from construction drawings



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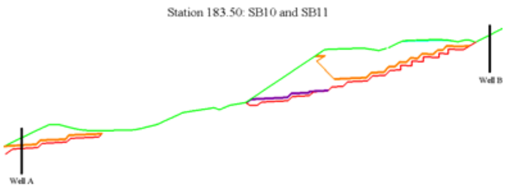
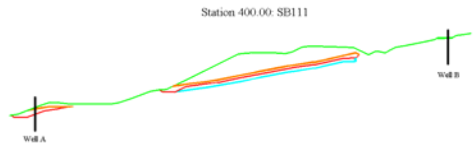
Section at Station 183+50

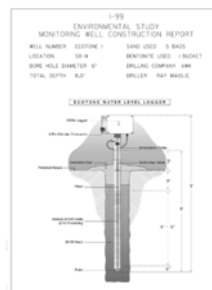


Section at Station 400 + 00



Monitoring Well

Ecotone Water Stage Recorder

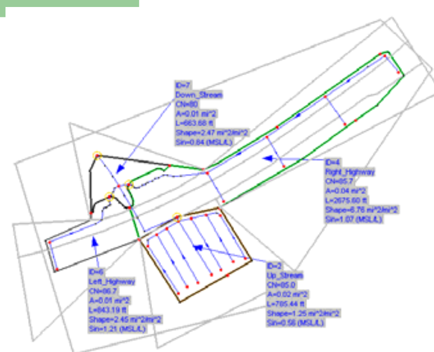

I-99
ENVIRONMENTAL STUDY
MONITORING WELL CONSTRUCTION REPORT

WELL NUMBER ECOTONE I
LOCATION SB-III
BORE HOLE DIAMETER 6"
TOTAL DEPTH 8.0'
SAND USED 5 BAGS
BENTONITE USED 1 BUCKET
DRILLING COMPANY AMK
DRILLER RAY MAGLIE

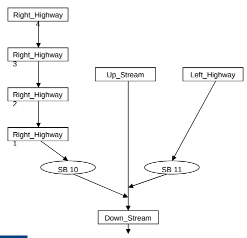
ECOTONE WATER LEVEL LOGGER

Computer Modeling

Model Schematic of Watershed A



Model Flow Schematic
Watershed A



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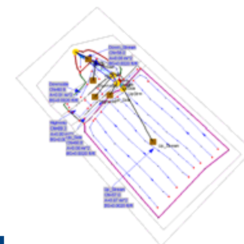
Model Schematic
Watershed B



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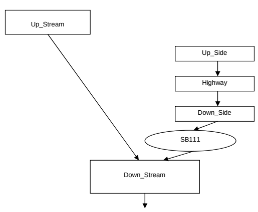
Flow Chart – Watershed B



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Data Collection and Processing

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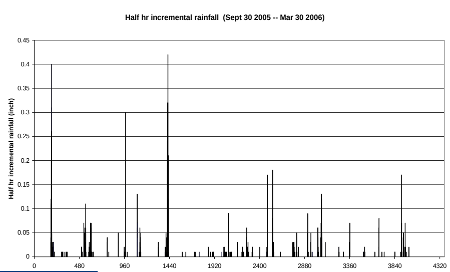
Rainfall Data



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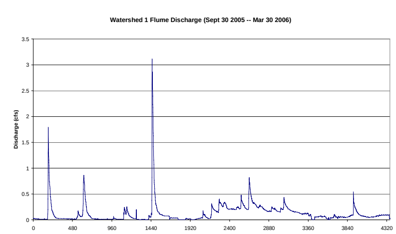
Runoff Data



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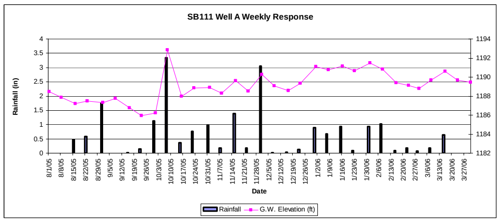
Groundwater Data



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Analysis

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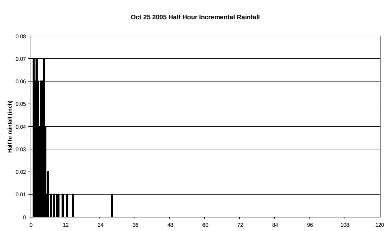
Precipitation for Storm Event



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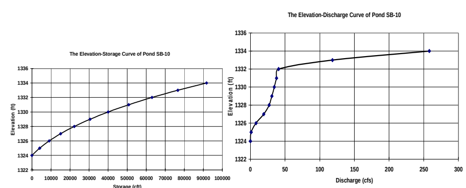
Storage-Discharge Characteristics Sedimentation Pond



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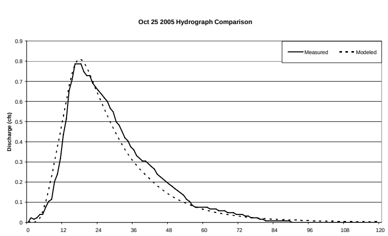
Measured and Predicted Hydrographs



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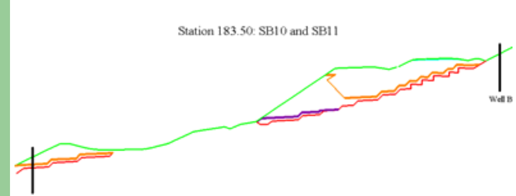
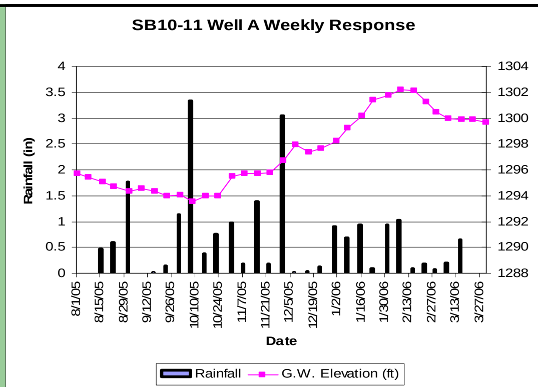
Section at Station 183+50



I-99 Environmental Research



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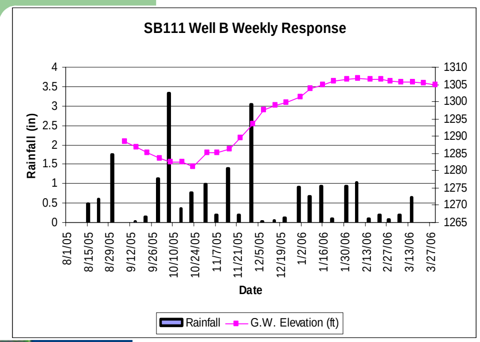

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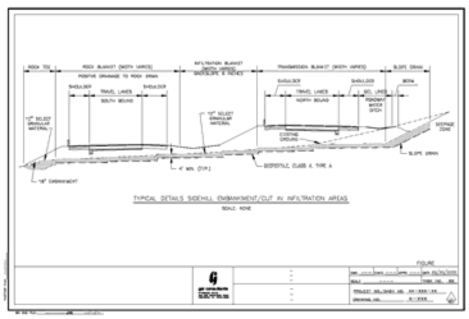
Infiltration Gallery



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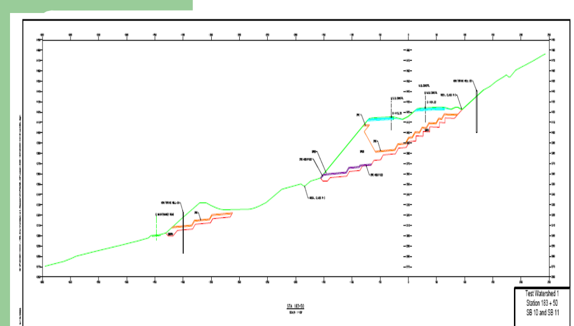
Relative Locations of Gallery and Wells



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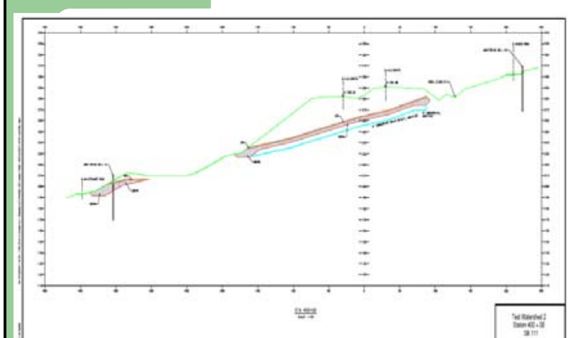
Section at Station 400+00



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Effectiveness of Infiltration Gallery

	pH	Con ductivity	Mg (mg/L)	Ca (mg/L)	Mn (mg/L)	Iron (mg/L)
SB-10	6.7	503	24	59	0.03	0.03
SB-11	6.6	715	29	110	0.08	0.03
Deep Well	6.7	314	15	47	0.07	0.03

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Results and Conclusions

- A model for predicting runoff from watersheds engendered by highway construction has been developed.
- The model has been tested using more than six months of rainfall-runoff data and found to perform satisfactorily. It may be used for environmental impact assessments.
- The computer code for the model can be adopted to other sites after adjustment for site-specificity.
- A Users' Guide has been prepared for future use by PennDOT personnel.

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RECOMMENDATIONS

1. For a quantitative impact analysis it is necessary that measurements of water quantity and quality parameters be undertaken on a watershed basis so as to deduce cause-effect relationships between adopted Best Management Practices and water quality.

2. As soon as the final alignment of the highway is decided upon, test watersheds should be identified so that they can be monitored. Only a few test watersheds can be instrumented for practical reasons.

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3. Instrumentation should provide for the measurement of hydro-meteorologic as well as hydro-geologic variables. These include deep wells and shallow water level recorders to measure deep groundwater and sub-surface moisture levels.

4. The installation of a local meteorological station to track precipitation, temperature and evapo-transpiration is also recommended. This local station should be close to the test watershed. For facility in data acquisition, provision must be made for automatic downloading.

5. After the test watershed has been delineated, a runoff gauging station should be installed at its outlet. Because the watershed is small, this requires a special flow measuring gage. Weirs or Venturi flumes would serve this purpose effectively.

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6. Regular inspection of the gages and their recording devices should be undertaken. Loss and interruption of power can affect the synchronization of rainfall-runoff events and make the calibration difficult. Power sources must be replaced regularly to minimize interruptions and erroneous readings.

7. Instrumentation may be staged to correspond with the progress of highway planning and construction. At the planning stage, both surface and groundwater flow measurements should be taken to provide the basis for preparing the Environmental Impact Analysis. The scope of instrumentation and data collection at this stage may not sufficient to carry out a quantitative analysis.

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8. After features such as sedimentation ponds, sub-surface drainage and flow routing junctions are identified, flow measuring devices should be installed. This are needed to collect benchmark data for use in flow prediction. For groundwater flow, monitoring wells must also be installed as soon as possible. A detailed record of the drilling log should be kept for subsequent subsurface flow analysis.

9. During construction, periodic checks must be made to determine if instruments are functioning as intended.

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Thank You

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Task C

WETLAND HYDRO-BIOLOGICAL INDICATORS

TEAM:

- GAI, Data Collection and Analysis
- Univ. of Pittsburgh, Dept. of Biological Sciences - Data Collection and Analysis
- Univ. of Pittsburgh, Dept. of Civil & Environmental Engineering – Project Management, Data Analysis
- Western PA Conservancy – Data Collection
- Gwin, Dobson, Foreman – Data Collection

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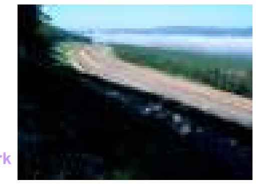
Task List

- Assessment of Wetland Methodologies
- Assessment of Baseline Data
- Site Selection/ Field Plan
- Data Collection
- **Data Analysis**
- **Impact Assessment and Corridor Planning Framework**



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Report Tasks

- **Assessment of key functions and characteristics** that should be included in considering mitigation efforts, including **review of existing methodologies** for function/ value assessment.
- Identification of **key functions/ values influencing success** of mitigation wetlands and development of performance standards.
- An assessment of **influence of design and construction elements** on wetlands and recommendations for modifications to current procedures.
- A **regional framework for predicting construction impacts** on wetlands by type and setting based upon key indicators.

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Assessment Methodologies

- Forty-three methodologies reviewed for function/value assessment:
- Ohio Rapid Assessment Method (ORAM) most comprehensive currently available
- Hydro-Geomorphic Methodology (HGM) - operational models not yet available.

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Assessment Methodologies

- Ability to provide mitigation planning/ design capabilities also reviewed.
- ORAM for rapid functional assessment and Evaluation for Planned Wetlands (EPW) to address mitigation planning functions provides most comprehensive assessment of key functions and characteristics.
- HGM - operational models not yet available.

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Key Functions/Values

- Factors influencing success of **mitigation wetlands** - evaluated with EPW and statistical analyses.
- Key factors:
  - Hydroperiod;
  - Presence and extent of standing water;
  - Spatial patterns of vegetation, and;
  - Overall wetland vegetation community size.

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Bird Populations

- Determine whether mitigation wetlands influenced overall wetland bird species diversity in the Bald Eagle valley.
- Species scored based on relative wetland dependency, based on values developed by Croonquist and Brooks (1991).
- When compared to reference sites, mitigation wetlands had significantly higher dependency scores and numbers of dependent species than pre-existing sites when two man-made ponds excluded.
- When ponds are included, mitigation sites have significantly higher numbers of dependent species, but there is no significant difference in dependency scores.

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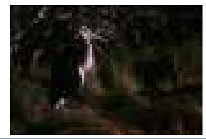
Bird Populations

- Suggests that the **extensive presence of open water** in the recently-constructed mitigation sites and the two man-made ponds is **increasing occurrence of wetland obligate birds**.
- Overall dependency score was found to be significantly related to the extent of water area in the wetland.



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Amphibians

- Six species in mitigation sites: Red-spotted Newt, Bullfrog, Green Frog, Wood Frog, Spring Peeper, and American Toad
- Only 1 pre-existing natural wetland contained water during sampling, potentially attributable to the drought . This site contained 3 of 6 species found in the mitigation sites.

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Amphibians

- **Permanent water** contained within the mitigation sites appears to have **served as a population source** during these drought years when pre-existing wetlands were dry.
- **Permanence of water may depress species diversity**. Longer hydroperiods allow establishment of predators including newts, bullfrogs, and invertebrates .

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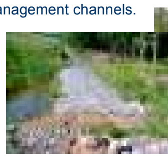
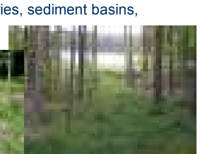
Design and Construction Elements

- Assessed for Section C10 - had the most intensive pre-construction background data.
- Key components include infiltration galleries, sediment basins, and stormwater management channels.





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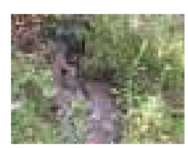
Design and Construction Elements

- There appear to be downward trends in several monitoring wells below the infiltration blankets. However, hydrology appears to be sufficient to maintain hydric conditions as evidenced by plant communities.



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Design and Construction Elements

- Amphibian populations in seeps appear **limited by hydroperiods** rather than by water quality.
- Short term water level trend downward - occurred in both seep sites as well as in wetlands on west side of Bald Eagle Creek not directly affected by construction impacts to hydrology.
- 2005-2006 drought conditions substantially inhibit assessment of potential construction impacts.
- Bird species diversity has declined in remaining forest interior areas during construction. Seep wetlands appear to **continue to have a positive influence** on the occurrence of wetland dependent birds on the ridgeside.

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Design and Construction Elements

- No substantial E&S control issues or water quality problems were noted in the wetlands evaluated. Some evidence of elevated sediments immediately downslope of discharges.

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Design and Construction Elements

- Point discharges from several stormwater management facilities increase sustained soil saturation in wetland and upland areas, resulting in a long-term increase in wetland area on the slope of the Bald Eagle ridge.

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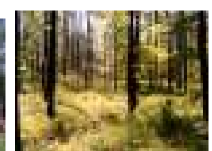
Design and Construction Elements

- At least 12 areas of dead trees have been observed. Seven delineated - range in size from 0.034 to 2.12 acres.



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Design and Construction Elements

- While the "unplanned" wetlands appear to have surface rather than groundwater as hydrologic source, they possibly replace some wildlife habitat functions of the impacted seep wetlands.
- EPW was conducted at unplanned Site 7 to compare with the existing ridgeside seep wetland WAA.
- The Sediment Stabilization FCI and Water Quality FCI for the WAA and Site 7 were exactly the same.
- There was a difference in the Wildlife FCI, with Site 7 having a **higher FCI** based primarily on the increased number of vegetation strata and cover types present.

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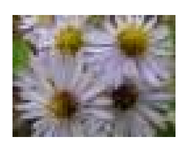
Regional Framework

- Framework utilizes **vegetation data**, which was determined to be the most comprehensive and reliable data set for use by multiple observers.
- Goal is determining if and to what extent construction impacts wetland vegetation and associated animal communities.
- Vegetation census of 62 wetland sites was conducted in 2005. Data collected for approximately 150 plant species.



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Regional Framework

- Framework is based on **ordination analysis**.
- Ordination used to show change in species composition through time.
- Sites that have little change through time will have multiple points that are very close to one another on the ordination graph; sites that change a lot will have points widely separated.

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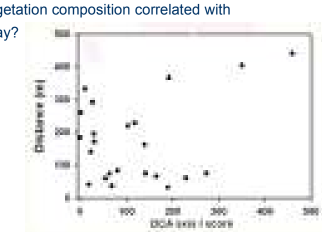
Regional Framework

- Is plant species or vegetation composition correlated with distance to the highway?



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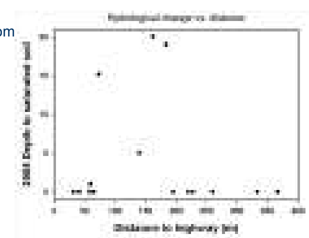
Regional Framework

- Is depth to saturated soil associated with distance from highway?



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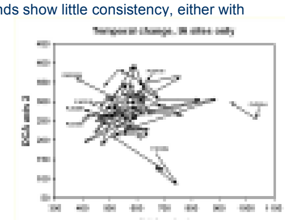
Regional Framework

- Changes for individual wetlands show little consistency, either with one another, or through time.



I-99 Environmental Research

Regional Framework

- Application of the ordination analysis framework found no discernable effect of highway on downslope plant communities.

<u>Interpretation:</u>
  - Actually is no effect in this situation;
  - Insufficient timeframe for changes to occur from construction;
  - No operational impacts occurred as yet; and/or
  - Insufficient pre-construction data to detect changes.

I-99 Environmental Research

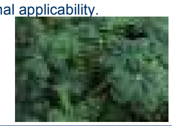
Regional Framework

Key Elements:
- For rigorous analysis of the impact of construction, major modifications of standard NEPA and Permitting sampling approaches/ methodology needed.
- Sites should be selected and sampling initiated during the NEPA process. Preferably 3 or more years prior to construction sites need to be selected and sampled.
- Important to have a similar number of reference and impact sites that are stratified by size, type, and surrounding habitat.
- The 50/20-rule recommended by USACE is **not** a viable approach to quantify the impact of construction.

I-99 Environmental Research

Regional Framework

- Provide framework to conduct future ordination analysis. Methodology provided to do this.
- Continue monitoring of I-99 through operation to refine and calibrate would be of benefit.
- Framework needs to be implemented **prior to construction of another project** and tracked through the project to refine, calibrate, and verify to develop regional applicability.



I-99 Environmental Research

I-99 ENVIRONMENTAL RESEARCH

TASK D

EVALUATING THE EFFECTIVENESS AND SUSTAINABILITY OF STREAM RESTORATION, REHABILITATION, AND RELOCATION

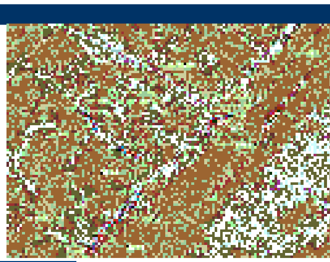
I-99 Environmental Research

Background

- 20,916 feet of impacted stream length requiring mitigation
- 17,383 feet of stream mitigation (restoration, stabilization, and relocation) at six completed mitigation sites
- 4,054 feet of stream mitigation proposed at two additional sites

I-99 Environmental Research

Mitigation area locations



I-99 Environmental Research

Project Goals

- Assess the effectiveness of stream restoration, stabilization, and relocation practices for highway mitigation
- Assess the ability of these practices to provide a stable, healthy stream system that is sustainable over the long term
- Identify key factors for rapid assessment of future mitigation projects

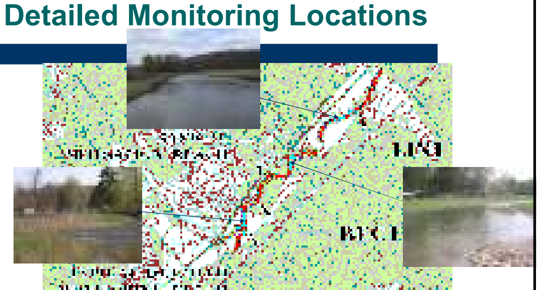
I-99 Environmental Research

Task List

- Site Selection
- Parameter Selection
- Baseline Data Collection
- Post-Construction Monitoring
- Sediment Supply Rating Curve Development
- Project Sediment Transport Capacity Calculation
- Data Analysis and Report

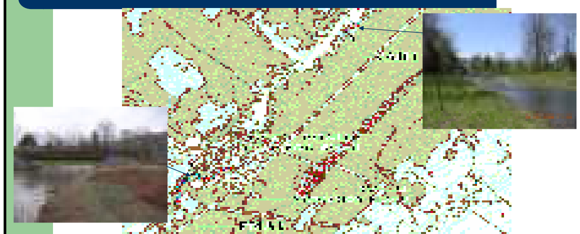
I-99 Environmental Research

Detailed Monitoring Locations



I-99 Environmental Research

Detailed Monitoring Locations



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Detailed Monitoring Locations

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Monitoring Parameters

Uniform list of data to be collected at each detailed monitoring location:

- General Site Overview
- Photographs
- Cross Section Survey
- Profile Survey
- Stream Pattern Assessment
- Substrate Composition

I-99 Environmental Research

Monitoring Parameters

- Bedload and Suspended Sediment Transport
- Water Chemistry and Quality (pH, dissolved oxygen, turbidity, nitrogen, phosphorus, color, total organic carbon)
- Riparian Vegetation
- Channel Stability Rating
- Bank Erosion Assessment
- Habitat Survey and Bioassessment

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Post-Construction Monitoring

Six detailed monitoring trips have been completed in 2005 and 2006.

Five event-based sediment sampling trips have been completed in 2006.

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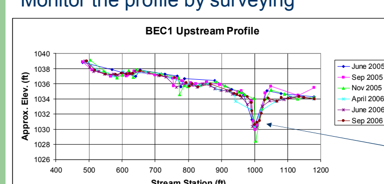
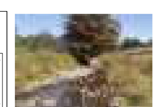
Post-Construction Monitoring

Monitor the profile by surveying





Pool at undercut bank by tree

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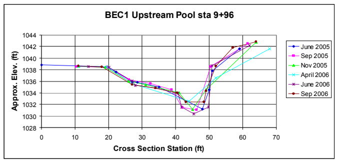
Post-Construction Monitoring

Monitor cross sections by surveying



Cross section just upstream of deepest part

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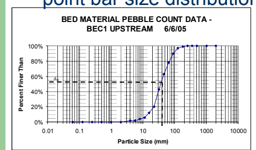
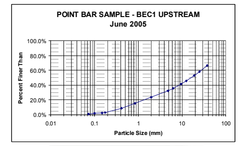
Post-Construction Monitoring

Analyze stream bed and point bar size distribution





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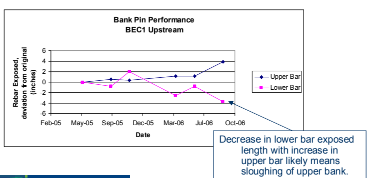
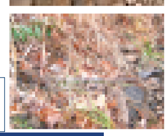
Post-Construction Monitoring

Monitor erosion and deposition with bank pins



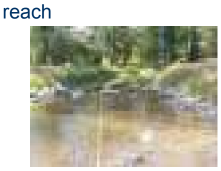


I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective: BEC1 downstream monitoring reach

December 2004



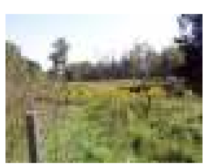
September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective: BEC1 reach

December 2004



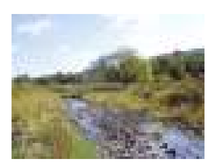
September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective: BEC1 upstream reach

December 2004



September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective:
LIN1 reach


June 2005


September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective:
PMA1 reach

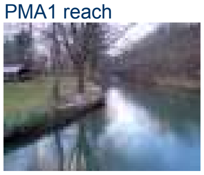

December 2004

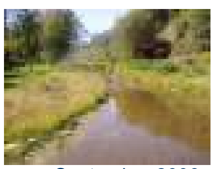

September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective:
PMA1 reach

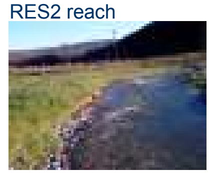

December 2004

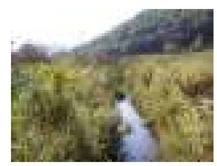

September 2006

I-99 Environmental Research

Post-Construction Monitoring

Many mitigation measures were very effective:
RES2 reach


December 2004


September 2006

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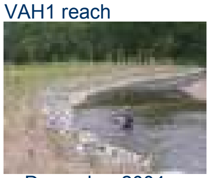
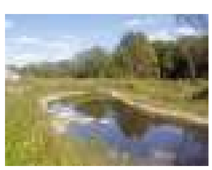
Post-Construction Monitoring

Many mitigation measures were very effective:
VAH1 reach

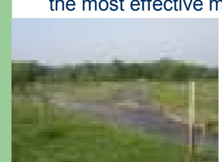

December 2004


September 2006

I-99 Environmental Research

Post-Construction Monitoring

Fencing to prevent livestock impacts was likely the most effective mitigation measure:


June 2005

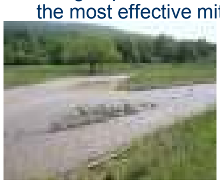
BEC1 upstream


September 2006

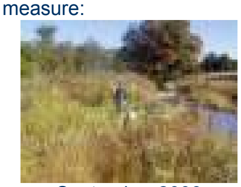
I-99 Environmental Research

Post-Construction Monitoring

Fencing to prevent livestock impacts was likely the most effective mitigation measure:



June 2005



September 2006

BEC1 upstream

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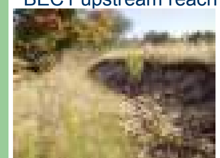
Post-Construction Monitoring

Some mitigation measures were marginally effective:

BEC1 upstream reach



September 2006

There are some areas where vegetation never established.

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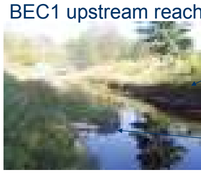
Post-Construction Monitoring

Some mitigation measures were marginally effective:

BEC1 upstream reach



September 2006

The channel is trying to meander to the right

with associated deposition on the left bank.

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Post-Construction Monitoring

Some mitigation measures were marginally effective:

BEC1 downstream reach

September 2006

Deposition has covered the edge of a J-hook vane located at the apex of a curve.

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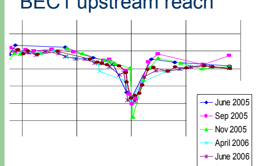
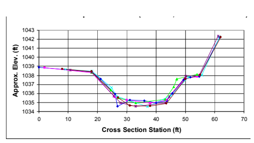
Post-Construction Monitoring

Some mitigation measures were marginally effective:

BEC1 upstream reach



The stream bed has been scouring, changing riffles to pools.



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Post-Construction Monitoring

Invasive vegetation has appeared:

Knotweed, PMA1 reach

September 2006

Multi-flora rose and garlic mustard, RES1 reach

April 2006

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Post-Construction Monitoring

The stream is not immune to human impacts: PMA1 reach

A constructed dam, presumably to provide for a fishing pool.

September 2006

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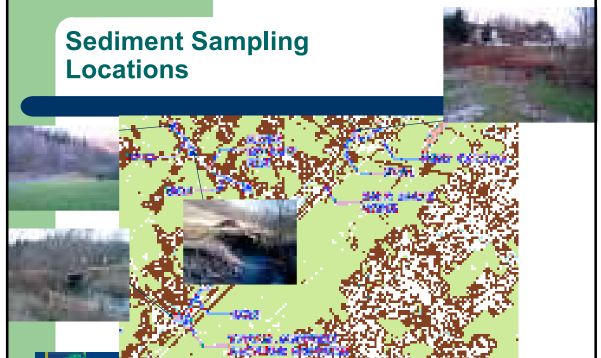
Sediment Sampling Locations



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Sediment Sampling

Sediment Sampling 1/18/06

SUMMARY OF ANALYSES

Location	Flow (cfs)	Sediment Load (tons/day)
Bald Eagle Creek at Hannah Lane	190	25.3
Bell Hollow Run at Hannah Lane	62	4.6
Bald Eagle Creek at Port Matilda Park	241	30.0
Reese Hollow Run at Adams Lane	43	3.9
Reese Hollow Run at Hillside Drive	69	4.6
Reese Hollow Run at Stine Lane	98	7.4

Sediment Sampling 10/18/06

SUMMARY OF ANALYSES

Location	Flow (cfs)	Sediment Load (tons/day)
Bald Eagle Creek at Hannah Lane	17	0.4
Bell Hollow Run at Hannah Lane	24	0.3
Bald Eagle Creek at Port Matilda Park	53	2.5
Reese Hollow Run at Adams Lane	11.5	0.1
Reese Hollow Run at Hillside Drive	11	0.1
Reese Hollow Run at Stine Lane	8	0.1

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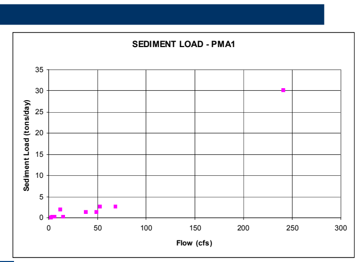
Sediment Sampling

Sediment Supply Curve

PMA1 Site



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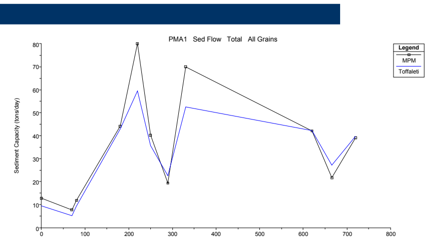
Sediment Transport Capacity

Sediment Transport Capacity Profile

PMA1 Site, based on 242 cfs flow



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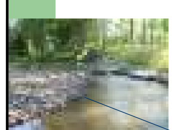
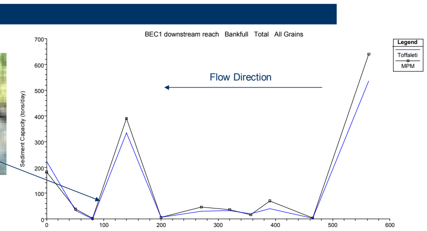
Sediment Transport Analysis



Deposition at lower transport capacity location



Sediment Transport Capacity Profile BEC1 Downstream Site, based on 160 cfs flow

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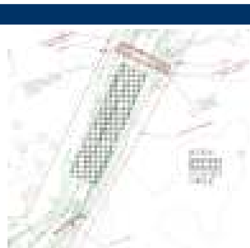
Proposed Monitoring Technique



After construction, using a visual assessment establish the location of riffle and pool reaches.

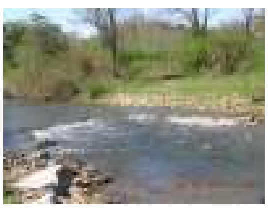
BEC1 Upstream Monitoring Reach

Proposed Monitoring Technique

At subsequent monitoring visits, document changes to the riffle/pool distribution as well as any other concerns.

BEC1 Upstream Monitoring Reach

Any Questions?



Thank You!