

NJDOT Bureau of Research  
 QUARTERLY PROGRESS REPORT  
**Date of report: June 26, 2009**  
**Reporting period: January 1 to June 30, 2009**

Project Title:	Portable Work Zone Barrier- Mobile Barriers		
RFP NUMBER: 2007-14	NJDOT RESEARCH PROJECT MANAGER: Edward Kondrath		
TASK ORDER NUMBER: RFCUNY 29 – Mod.#2	PRINCIPAL INVESTIGATOR: Robert Paaswell		
Project Starting Date: 1/1/ 2009 Project Ending Date: 12/31/2009	Period Starting Date: January 1, 2009 Period Ending Date: June 30, 2009		

<b>Tasks for Phase I – Fabrication</b>	<b>% of Total</b>	<b>% of Task this quarter</b>	<b>% of Task to date</b>	<b>% of Total Complete</b>
Task 2.1. Contracting with Mobile Barriers LLC	44.8%	100%	100%	44.8%
Task 2.2. Fabrication and Inspection of the Equipment	44.8%	100%	100%	44.8%
Task 2.3. Selection of Implementation Sites	2.6%	0%	0%	0%
Task 2.4 Equipment and Application Training	2.6%	0%	0%	0%
Task 2.5 Implementation, Monitoring & Cost Savings	2.6%	0%	0%	0%
Task 2.6 Final Document	2.6%	0%	0%	0%
<b>TOTAL</b>	100%			89.6%

**Project Objective:**

The objectives of this project are the fabrication, implementation, and evaluation of the Mobile Barrier Trailer (MBT-1) of Mobile Barriers, LLC as a portable protection device for the safety of New Jersey Department of Transportation workers in short duration highway work operations. This two-phase project will build on the results of the previous study, “Identification of Traffic Control Devices for Mobile and Short Duration Work Operations,” which identified the potential for a Mobile Barrier equipment to protect exposed highway workers along the shoulder and in the traveled lanes of high traffic, high speed areas.

**Project Abstract:**

This work will focus on the fabrication and implementation of the MBT-1 Beam which is a truck mounted, moveable, expandable beam that provides positive work zone protection comparable to a fixed concrete barrier. It is specifically intended to enhance worker safety when carrying out shoulder repair in work zones adjacent to guardrails, inlet repair, bridge rails, bridge deck repair, sound walls and other work where workers are normally exposed to traffic or behind cones in limited work areas for several hours. Usually the shadow vehicle or the truck mounted attenuator provides protection from rear end collisions; the new device provides protection from adjacent lane traffic.

The MBT-1 is designed to provide positive, steel beam protection system for exposed workers who normally work behind temporary cones and barrels in limited work areas. The MBT-1 was developed by Mobile Barriers, LLC. The device is currently implemented by Colorado DOT in Denver, CO.

1. Progress these quarters by task:

- The MBT has been fabricated and delivered to NJDOT

2. Proposed activities for next quarter by task, and anticipated percentage complete by end of quarter.

- NJDOT and the research team is will select implementation sites.
- Equipment and Application Training
- Implementation, Monitoring & Cost Savings

3. List of deliverables provided in this quarter by task (product date)

MBT -1 Trailer was delivered to NJDOT.

4. Progress on Implementation and Training Activities

NA

5. Problems/Proposed Solutions

NA

### **BUDGET EXPENDED AND REMAINING**

Total Project Budget	\$257,297
<b>Modified Contract Amount:</b>	<b>\$234,127</b>
Total Project Expenditure to date	\$225,000
% of Total Project Budget Expended	87.5%

NJDOT Bureau of Research  
 QUARTERLY PROGRESS REPORT  
**Date of report: June 26, 2009**  
**Reporting period: April 1 to June 30, 2009**

Project Title:	Technology Transfer Year 21		
RFP NUMBER: NA	NJDOT RESEARCH PROJECT MANAGER: Wladislau (Lad) Szalaj		
TASK ORDER NUMBER: RFCUNY 37	PRINCIPAL INVESTIGATOR: Robert Paaswell		
Project Starting Date: 1/1/ 2009 Project Ending Date: 12/31/2009	Period Starting Date: April. 1, 2009 Period Ending Date: June. 30, 2009		

Activities	% of Total	% of Task this period	% of Task to date	% of Total Complete
In House Lecture Series/Workshops	30%	50%	50%	15%
Visiting Scholar Seminar Series	30%	30%	100%	30%
UTRC Research Newsletter	25%	40%	50%	12.5%
Other - General Activities	15%	20%	40%	6%
TOTAL	100%			63.5%

**Project Objective:**

The objectives of the Technology Transfer program are:

- To increase the awareness and level of information concerning transportation issues facing US DOT Region 2 for all within the region;
- To improve the knowledge base and approach to problem solving of the region's transportation workforce, from those operating the systems to those at the most senior levels of managing the system; by doing so, to improve the overall professional capability of the transportation workforce;
- To stimulate discussion and debate concerning the integration of new technologies into our culture, our work and our transportation systems;
- To provide the more traditional but extremely important job of dissemination of research and project reports, studies, analysis and use of tools to the education, research and practicing community;
- To provide unbiased information and testimony to decision-makers concerning regional transportation issues consistent with the UTRC theme.

The goal of the Technology Transfer Program for the New Jersey Department of Transportation is to provide research results to potential users in a form that can be directly implemented, utilized and applied to transportation operations.

## 1. Progress this period by activities:

- **Visiting Scholar Seminars:** On May 1st Prof. Randall Crane, Director of the Institute of Transportation Studies at the UCLA School of Public Affairs presented “Sex Changes Everything: On the Demographic Determinants of the U.S. Commute, 1985-2007.” The average U.S. male historically commutes further and longer than his female counterpart. Yet pivotal changes at home, as younger women especially increase their influence on household location and work decisions, and in the labor market, and as women’s participation rates and profiles approach men’s, both strongly suggest that gender’s influence on travel might be changing as well. Further, the independent and interactive influence of other demographic factors, not least age and race, remain unclear. However, gendered elements of travel demand are indeed evolving, if not always in predictable directions.
- **Workshop at PANYNJ:** On May 13<sup>th</sup>, UTRC hosted the workshop at the PANYNJ Offices on the topic of “The Wider Economic Benefits of Transportation Investment: Theory and Practical Guidance” The workshop was prepared and presented by Dr. Robert Paaswell, Harold Stolper and Dr. Joseph Berechman for the Department of Planning of the Port Authority of NY and NJ. The workshop aims to review wider economic benefits theory and its implications for project evaluation, both in general and for the specific purposes of the Port Authority.
- **Visiting Scholar Seminars:** On June 12th, 2009: Prof. Daniel Sperling, Director of the Institute of Transportation Studies at the University of California, Davis presented “Two billion cars and the transformation of transportation.” The world is headed toward two billion vehicles. Is this sustainable? Not without transforming vehicles, fuels, and transportation—not only in the U.S., but virtually everywhere. Professor Sperling examined the roots of the problem: the resistant auto industry, dysfunctional oil markets, shortsighted government policies, and unmotivated consumers. He focused on the role of innovation and policy in bringing about low carbon fuels, electric-drive vehicles, socially-responsible behavior, enhanced mobility services, and low-carbon cities
- **Reindustrialization Workshop:** On June 17th, UTRC hosted the Workshop on Mass Transit Reindustrialization. This meeting, spearheaded by Jonathan Feldman, Michael Locker, Robert Paaswell and Jon Rynn, brought together some 20 experts from around the country, the region and overseas. Participants spent the day debating the potential for and impediments to subway car manufacturing in and for America. Issues explored included demand, supply, policy and finance.
- **UTRC Research News:** The Spring 2009 newsletter has been completed and disseminated on June 29, 2009.
- **Other - General Activities:** On May 13 and 14, UTRC has participated at the 2009 NJ TransAction Conference and Exposition held at Atlantic City, NJ
- Two final reports for recently completed projects (“Dynamic Analysis of Subway Structures under Blast Loading” by Dr. Huabei Liu of The City College of NY and “Light isn’t just for vision anymore: implications for transportation safety - Part II”

by Dr. Mariana Figueiro of RPI) have been sent to national transportation libraries. The UTRC website is under constant improvement.

- UTRC has received candidate topics for presentation at the NJDOT Offices.

## 2. Proposed activities for next quarter

- More visiting scholar seminars will be planned.
- The Fall 2009 Newsletter will be completed and disseminated
- UTRC will continue to schedule more seminars at NYC and in-house seminars at NJDOT
- Other - General Activities: UTRC will continue preparation of reporting documents for submission to USDOT. The UTRC website will still be under improvement. UTRC expect to continue to make improvements on the online system for submission and review of proposals. UTRC staff and P.I. will continue to participate at conferences and technical meetings. UTRC's P.I.s will continue to contribute in news articles.

## 3. List of deliverables provided in this quarter by task (product date)

Spring 2009 Research News

## 4. Progress on Implementation and Training Activities

NA

## 5. Problems/Proposed Solutions

NA

## BUDGET EXPENDED AND REMAINING

Total Project Budget	\$55,000
<b>Modified Contract Amount:</b>	
Total Project Expenditure to date	\$45,000
% of Total Project Budget Expended	82%

## QUARTERLY PROGRESS REPORT

Project Title:	<b>Water Quality Mitigation and Banking</b>		
RFP NUMBER: <b>2007-11</b>	NJDOT RESEARCH PROJECT MANAGER: <b>Nazhat Aboobaker</b>		
TASK ORDER NUMBER/Study Number: <b>Task Order #30</b>	PRINCIPAL INVESTIGATOR: <b>Anil K. Agrawal</b>		
Period Starting: <b>January 1, 2007</b>	Period Ending:		
Ending Date: <b>December 31, 2009</b>	<b>June 30, 2009</b>		

Task	% of Total	% of Task this quarter	% of Task to date	% of Total Complete
<i><b>Phase I - Literature Search</b></i>	5		100	5
<i><b>Task 1: Literature Search</b></i>	12		100	12
<i><b>Task 2: Assemble a technical panel composed of representatives from various agencies</b></i>	12		100	12
<i><b>Task 3: Make an inventory of future projects and determining the impact to impervious surface within watersheds</b></i>	12		100	12
<i><b>Task 4: Investigate water quality mitigation/banking/retrofit sites along State owned roadways within local watershed area</b></i>	8	20	100	8
<i><b>Task 5: Identifying potential mitigation areas and retrofitting those with stormwater enhancements. Propose a methodology to plan, analyze and track improvements and banking credits</b></i>	8	50	50	4
<i><b>Task 6: Select a specific mitigation/Bank location for the study. The feasibility evaluation will consider ROW, environmental constraints, watershed characteristics, and drainage data. List all environmental constraints, recommend BMP solution and cost estimates</b></i>	12	50	50	6
<i><b>Task 7: Propose a tracking mitigation program to offset future program needs</b></i>	8			
<i><b>Task 8: Prepare Final Report documenting the finding of the research</b></i>	18			
<i><b>Implementation</b></i>	5			
<b>TOTAL</b>	<b>100%</b>	<b>120%</b>	<b>600%</b>	<b>59%</b>

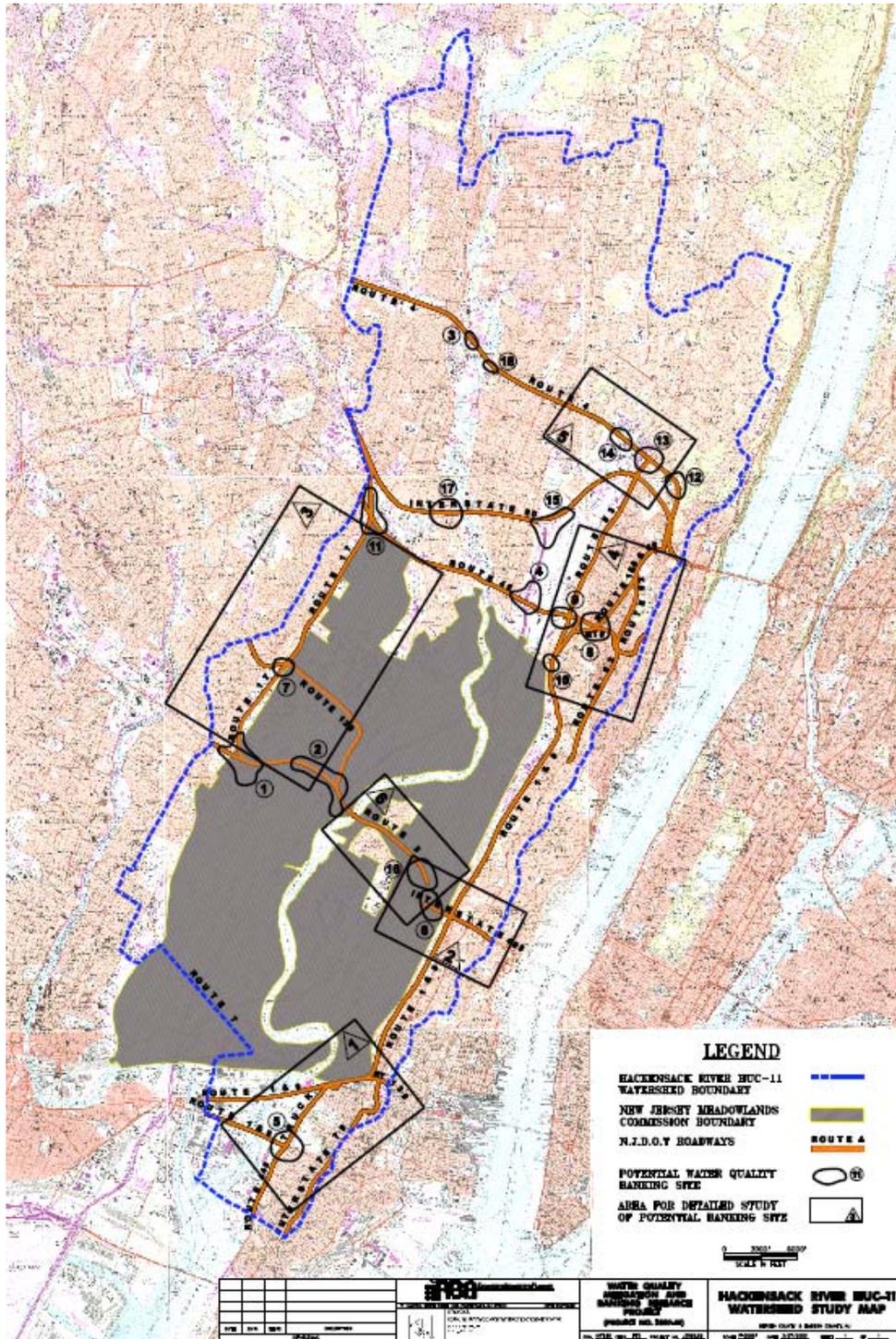
### 1. Progress this quarter by task:

The research team has made significant progress on Tasks 4, 5 and 6 this quarter and submitted a combined Technical Memorandum on Tasks 4 to 6 to the Project Manager, Dr. Aboobaker. Further progress on these tasks depends on the feedback from NJDOT. The research team hasn't received this feedback yet.

In these tasks, the research team carried out work on the selection of a retrofit stormwater mitigation site for treatment of existing untreated runoff from NJDOT highways within the Hackensack HUC 11 Watershed. Task 3 recommended the Hackensack Watershed as the most feasible with regard to banking for future project needs. Within this watershed, there is a need to treat runoff from approximately 23 Acres of new impervious surface associated with four NJDOT projects currently under Feasibility Assessment.

### Methodology

Using aerial photography and USGS quadrangle maps, an initial screening sequence was established to locate potential mitigation sites. The goal was to utilize existing right of way, especially associated with interchanges. The screening identified eighteen potential sites shown on the following Figure, which were discussed with NJDOT at the March 27, 2009 quarterly status meeting.



Following this effort, a detailed screening of the eighteen sites was done to determine the drainage area to each of the eighteen potential sites. To achieve this, USGS mapping was supplemented with New Jersey Meadowlands Commission mapping, I-Map wetlands mapping and the F.E.M.A. 100 year flood hazard information. Sites with small drainage areas and those that fell within the wetlands boundaries were excluded from further investigation. As a result, the eighteen potential sites were narrowed down to six. The remaining sites were numbered 5, 6, 7, 8, 14 and 16.

NJDOT As-Built plans and aerial imagery was evaluated as a second level of screening. Finally, a field visit to the final list of feasible sites was conducted to supplement mapping results and to identify the most promising location.

## **Results**

### **SITE 5**

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

### **SITE 6**

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

### **SITE 7**

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

### **SITE 8**

Site eight is located at the intersection of Routes 1, 9, 46 and Route 5, Borough of Palisades Park and Borough of Ridgefield. Initial investigation of the site concluded that runoff generated from 25 acres of roadway could potentially be captured and treated at the site. After examining As-Built plans, it was determined that the banking site could capture and treat much less than 25

acres of drainage area since a portion of the pavement runoff is diverted off-site. The plans also revealed frequent high and low points along the various contributing roadways. As a result it is estimated that the potential banking site could capture only a few acres of pavement. Areal imagery revealed that the potential banking site is fully developed. Therefore, R.O.W. would need to be purchased to construct the banking site in the surrounding urbanized area. *As a result, site number eight was determined to be unsuitable for banking.*

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

#### **SITE 14**

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

#### **SITE 16**

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

#### **Sites evaluated in the field**

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

#### **SITE 6**

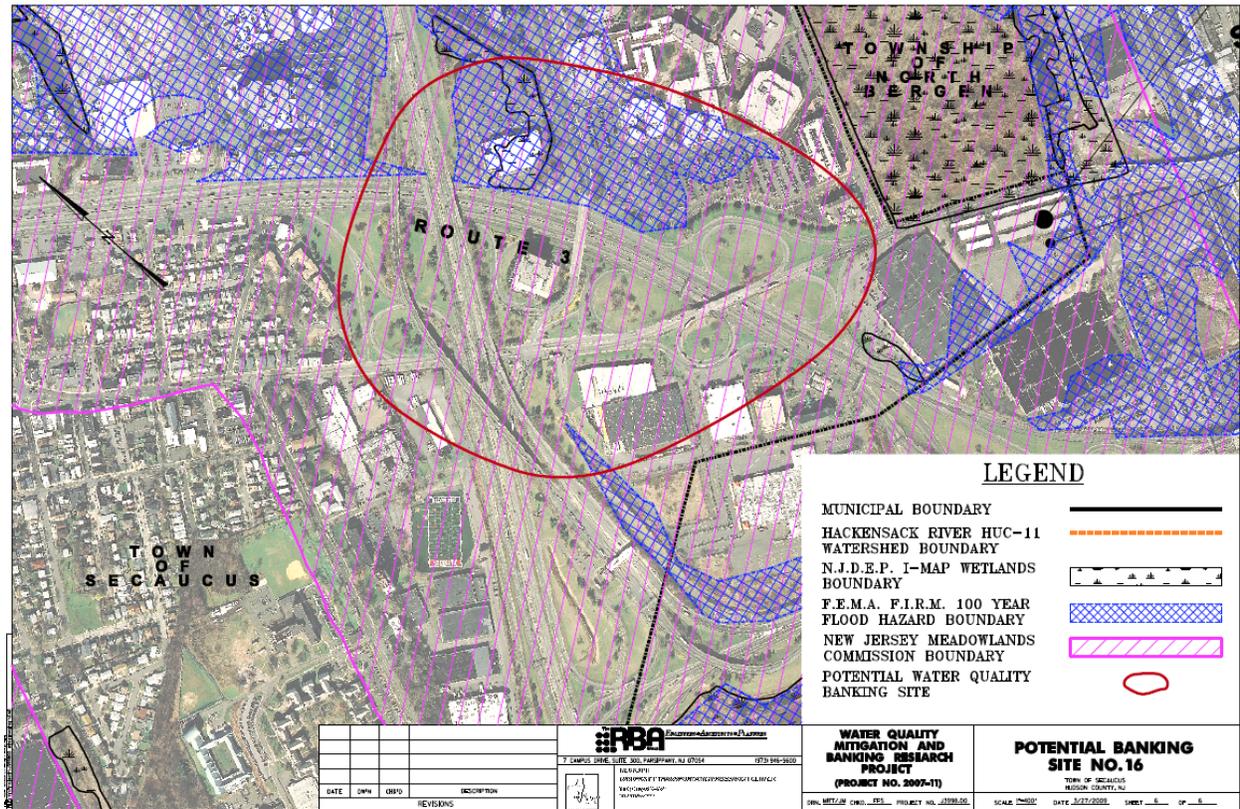
Runoff from I-495 is diverted off site, upstream of the point where the interstate crosses over Paterson Plank Road. The bridged section of the roadway is drained through scupper or joint inlets. The inlet piping was observed to be plastic and to discharge at the ground level. Since most of the runoff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

#### **SITE 9**

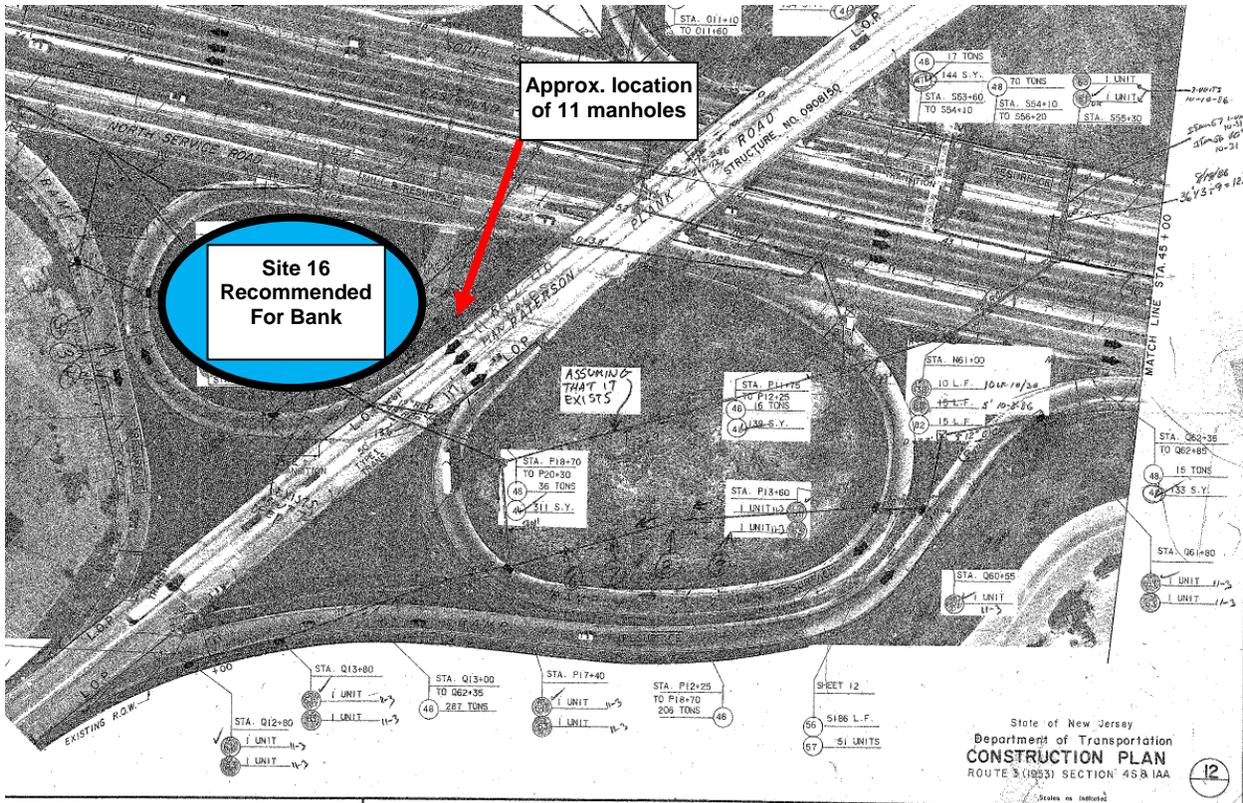
Using As-Built plans, the configuration of drainage structures were verified. As a result of this, in combination with field observations, it was determined that the site could capture approximately 7.4 acres of roadway runoff. However, there is no open space available for the construction of a bank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

#### **SITE 16**

The field conditions matched conditions identified in the As-Built plans. Field observations verified that the interchange infield area is suitable for banking construction. The impervious



area that could be captured by this facility is at least 6.6 acres. Depending on the results of more detailed investigation, the potential paved drainage area could be as much as 7.6 acres. Further evaluation is needed to identify the location and potential impact on existing communication utilities, including eleven manholes located adjacent to Route 3, on a banking facility at this site.



**CONCLUSION**

Subject to the results of an evaluation of utility relocation issues, site sixteen is the most suitable location for construction of a banking facility. A minimum of 6.6 acres (potentially 7.6 acres) of pavement runoff can be treated at this location, constructed entirely within existing R.O.W. within an infield area of the Paterson Plank Road ramp to Route 3.

Prior to proceeding with further evaluation for banking at this site, concurrence is requested from NJDOT.

**Views of Site 16, interchange infield**





**Views of manholes adjacent to Rt.**



**2. The results obtained this quarter includes:**

Subject to the results of an evaluation of utility relocation issues, site sixteen is the most suitable location for construction of a banking facility. A minimum of 6.6 acres (potentially 7.6 acres) of pavement runoff can be treated at this location, constructed entirely within existing R.O.W. within an infield area of the Paterson Plank Road ramp to Route 3. Prior to proceeding with further evaluation for banking at this site, concurrence is requested from NJDOT.

**3. Proposed activities for next quarter by task:**

- Complete tasks 4, 5 and 6 by finalizing the site selection and evaluating potential banking credits.
- Finish Task 7 on a computer program to generate banking credits (already in progress and expected to finish by July 31, 2009)
- Organize a meeting with NJDOT on implementation aspects of banking credits.
- Start work on the final report.

**4. List of deliverables provided in this quarter by task (product date):**

- Technical memorandum on Tasks 4, 5 and 6

**5. Progress on Implementation and Training Activities: None**

**6. Problems/Proposed Solutions: None**

**7. Budget Summary:**

Total Project Budget(# of years)	<b><i>NJDOT: \$310,000</i></b> <b><i>UTRC: \$80,002</i></b> <b><i>CCNY: \$9,358</i></b> <b><i>No. of Years: 2</i></b>
Total Project Expenditure to date	<b>\$247,579</b>
% of Total Project Budget Expended	<b>62%%</b>
	(may not reflect recent work by RBA)
Task Order Number/Study Number:	<b>Task Order # 30</b>
Current Task Order Budget (# of years)	
Actual Expenditure to date against current task order	
% of current task order budget expended	

## QUARTERLY PROGRESS REPORT

Project Title:	<b>Seismic Design Considerations</b>		
RFP NUMBER: <b>2008-09</b>	NJDOT RESEARCH PROJECT MANAGER: <b>Nazhat Aboobaker</b>		
TASK ORDER NUMBER/Study Number: <b>Task Order # 32</b>	PRINCIPAL INVESTIGATOR: <b>Anil K. Agrawal</b>		
Period Starting: <b>January 1, 2008</b>	Period Ending:		
Ending Date: <b>July 31, 2010</b>	<b>June 30, 2009</b>		

Task	% of Total	% of Task this quarter	% of Task to date	% of Total Complete
<i>Phase I – Literature Search</i>				
<b>Task 9:</b> Seismic Soil Classification Map of NJ	32	<b>80</b>	<b>100</b>	<b>32</b>
<b>Task 3:</b> Importance Classification of New Jersey Bridges	3	<b>70</b>	<b>90</b>	<b>2.7</b>
<b>Task 2:</b> Development of Examples Illustrating Design Recommendations.	26			
<b>Task 1:</b> Design Guidelines for New Bridges (SDC Maps)	<b>9</b>	<b>30</b>	<b>30</b>	<b>2.7</b>
<b>Task 4:</b> Development of Design Recommendations for Seismic Retrofit of Existing Bridges	26			
<b>Task 8:</b> Final Report	4			
<b>Implementation</b>				
<b>TOTAL</b>	<b>100%</b>	<b>150</b>	<b>190</b>	<b>37.4</b>

### 1. Progress this quarter by task:

**Progress on Task 9:** The research team has finished this task. The final seismic soil map of NJDOT is enclosed with the report. We are currently carrying out quality control review of the map to make sure that the soil classification matches with other existing resources, e.g., NJGS data.

**Progress on Task 3:** The main objective of this task has been to develop criteria for importance classification of NJDOT bridges.

We have finished this task 90%. A presentation on this task was given to Mr. Dick Dunne on June 17, 2009. Following the discussion with Mr. Dick Dunne. The PI also had meetings with Lisa Webber of NJDOT Emergency Management and Mr. Joe Englot of HNTB. Using the data provided during these meetings, the PI has completed the technical portion of the task and is currently working on the memorandum of the Task, which is expected to be submitted to NJDOT during first week of August. A copy of the presentation given to Mr. Dick Dunne is enclosed with this report.

**Progress on Task 1:** Currently the research team is working on liquefaction analysis of soil data in soil classes D and E. Once quality control review of soil map is complete, seismic design category map will be created.

**2. Proposed activities for next quarter by task:** In next quarter, we plan to finish Tasks 1 and 3. For Task 2, we have received three bridge drawings. We plan to finish examples for these three bridges.

3. List of deliverables provided in this quarter by task (product date): Seismic Soil Maps of New Jersey.

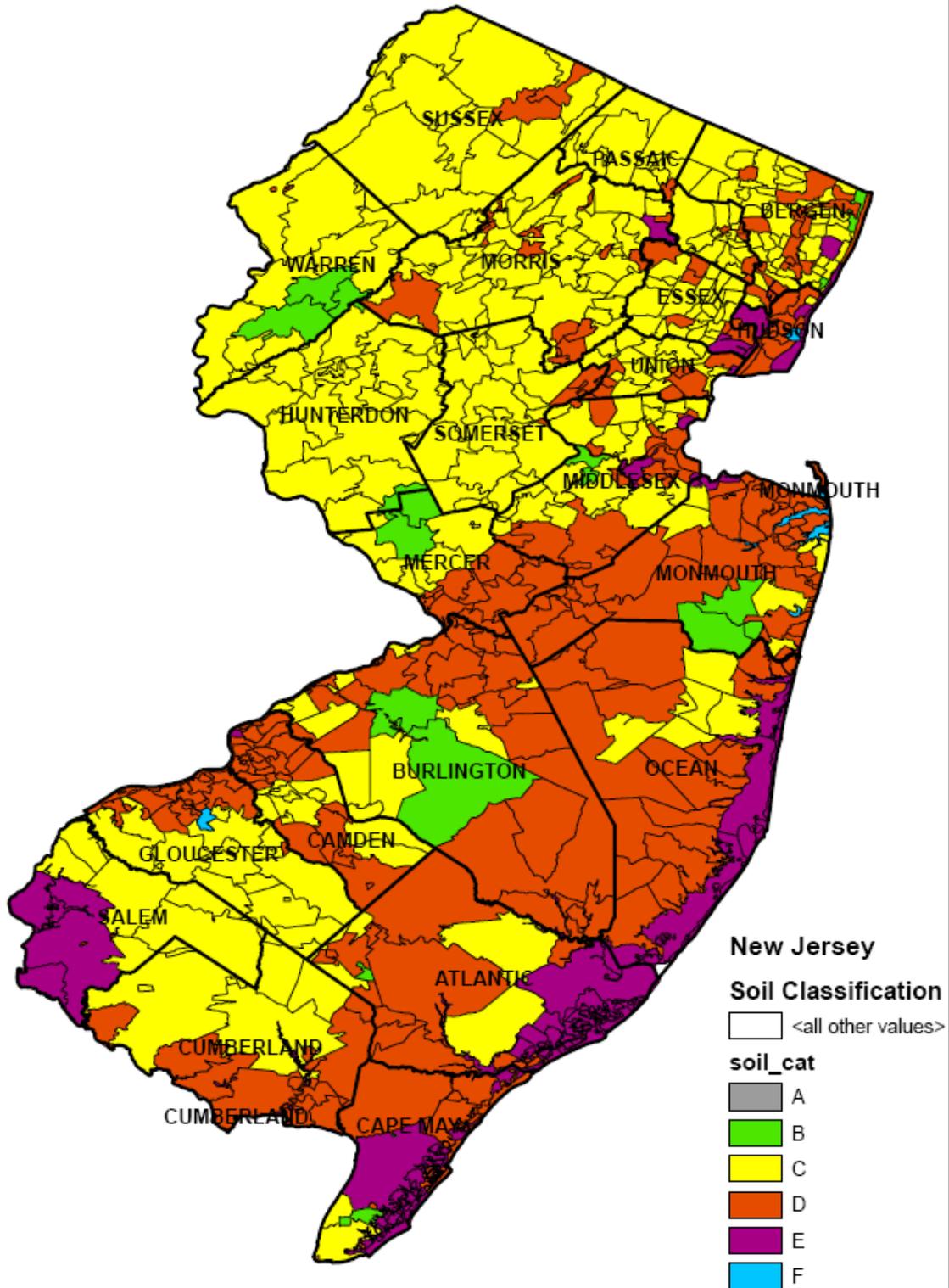
4. Progress on Implementation and Training Activities: **None**

5. Problems/Proposed Solutions: **None**

6. Budget Summary:

Total Project Budget(# of years)	<i>NJDOT: \$400,000 UTRC: \$50,000 CCNY: \$0 No. of Years:2.5 years</i>
Total Project Expenditure to date	\$153,557
% of Total Project Budget Expended	34%
Task Order Number/Study Number:	Task Order # 32
Current Task Order Budget (# of years)	
Actual Expenditure to date against current task order	
% of current task order budget expended	

Seismic Soil Map on NJ



# Seismic Design Hazard Considerations for New Jersey Department of Transportation



Anil K. Agrawal  
The City College of New York, NY 10031

Roy Imbsen  
Imbsen Consulting

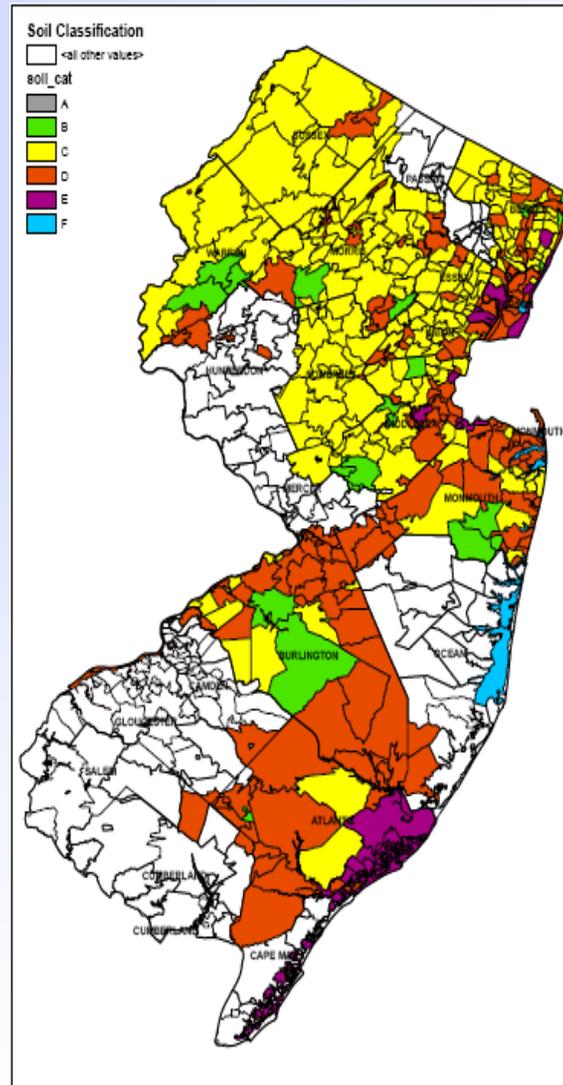
Arjuna Ranasinghe  
Michael Baker, Jr.



NJDOT



# Task 1 Status



# Task 3: Importance Classification

- ◆ Normal bridges: Conventional slab, beam, girder and box girder superstructure construction with spans not exceeding 500 ft (150 m).

# Task 3: Importance Classification

- ◆ **CRITICAL BRIDGES:** A Critical Bridge must not collapse and provide immediate access (once inspected within a few hours) to function as a critical link to the lifeline network to serve the social/survival network, civil defense, police, fire department, and/or public health agencies to respond to a disaster situation after the event.

# Task 3: Importance Classification

- ◆ The hazard level for the Critical Bridges shall be the 1000 year event (7% probability of being exceeded in 50 years) multiplied by a factor of 1.5. A Critical Bridge should have only minimal damage. The bridge should essentially behave elastically during the earthquake, although minor inelastic response could take place. Post earthquake damage should be limited to narrow flexural cracking in concrete and masonry elements. There should be no permanent deformations to structural members. Only minor damage or permanent deformations to non-structural members should take place.

# Task 3: Importance Classification

- ◆ **ESSENTIAL BRIDGE:** An Essential Bridge must not collapse and provide limited access (once inspected within a few hours) to serve as an important link for civil defense, police, fire department and/or public health agencies to respond to the disaster situation after the event.

# Task 3: Importance Classification

- ◆ The hazard level for the Essential Bridge shall be a 1000 year times 1.5, the same as that used for a Critical Bridge. An Essential Bridge may have repairable damage. The extent of damage should be limited so that the structure can be restored to its pre-earthquake condition without replacement of structural members. Inelastic response may occur resulting in: concrete cracking, minor cover spalling and reinforcement yielding; minor yielding of structural steel members; some damage to secondary members and non-structural components; some damage to masonry. Repair should not require complete closure of the bridge. Permanent offsets should be small and there should be no collapse.

# Task 3: Importance Classification

## CRITICAL BRIDGES:

- ◆ Bridges that are required to be open to all traffic once inspected an earthquake.
- ◆ Bridges that are on the Interstate Highway System.
- ◆ Bridges that provide access to the New Jersey Turnpike.
- ◆ Bridges on highways that lead up to major river crossings.
- ◆ Bridges that are required to be usable by emergency vehicles to provide secondary life safety to provide access to local emergency services such as hospitals immediately after a design level earthquake.
- ◆ Bridges that are on SHRAHNET: defense highway network providing connecting routes to military installations, industries, and resources and is part of the NHS.
- ◆ Bridges that are formally designated as critical for a defined local emergency plan.
- ◆ **Criticality based on ADT, Recovery time and Detour Length.**
  - Based on criteria developed by Joe Englot

# Task 3: Importance Classification

## ESSENTIAL BRIDGES

- ◆ Bridges that are required to be open to emergency traffic once inspected after the design level earthquake and open to all traffic within days after the design level earthquake to provide economic recovery to the affected region
- ◆ The bridge is formally designated as essential by a local emergency plan.
- ◆ The type of facilities crossed as pertinent to defense, emergency, and economical considerations.
- ◆ Existence of utilities carried by the bridge and their relative importance on life safety, depending on the discretion of NJDOT.
- ◆ Foundation and site characterization for a bridge that is a water crossing in terms of increased effort of post-earthquake investigation and response, depending on the discretion of NJDOT.
- ◆ **Criticality based on ADT, Bridge Length, Width, Recovery time and Detour Length.**
  - Based on criteria developed by Joe Englot.

# Performance Requirements

<u>Design Approach</u>	<u>Ductility Demand</u>	<u>Protection Systems</u>	<u>Repairability</u>
Minimal Plastic Action	Limited $\mu_D < 2$	May be Used	Not required to Maintain
Moderate Plastic Action	Limited $\mu_D < 4$	May be Used	May require closure or limited usage
Significant Plastic Action	$\mu_D$ May be higher	Not warranted	May require closure or removal

# Performance Requirements

Component	Essential	Critical
Ductile Column	Repairable	Minimal
Spread Footing	Minimal	Minimal
Pile Cap	Minimal	Minimal
Piles	Minimal*	Minimal*
Bent Cap	Minimal	Minimal
Pad Key	Minimal	Minimal
Diaphragm Cap	Minimal	Minimal
Seat Abutments	Minimal	Minimal
Stub Abutments	Minimal	Minimal
Wingwall	Minimal	Minimal
Piles At Abutment	Minimal*	Minimal*
Shear Keys At Abutment	Minimal	Minimal
Stem Wall	Minimal	Minimal
Ductile Steel Diaphragm	Repairable	Minimal
Girder Connection to Concrete	Minimal	Minimal
* Except for Liquefaction and lateral spreading		

# Seismic Design Categories

Value of $S_{DI} = 1.5F_v S_1$	SDC
$S_{DI} < 0.15$	<b>A</b>
$0.15 \leq S_{DI} < 0.30$	<b>B</b>
$0.30 \leq S_{DI} < 0.50$	<b>C</b>
$0.50 \leq S_{DI}$	<b>D</b>

# Seismic Design Categories

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
<i>Identification ERS</i>	-----	Recommended	Required	Required
<i>Demand Analysis</i>	-----	Required	Required	Required
<i>Implicit Capacity</i>	-----	Required	Required	Required
<i>Push Over Capacity</i>	-----	-----	-----	May be Required
<i>Support Width</i>	Required	Required	Required	Required
<i>Detailing - Ductility</i>	-----	SDC B	SDC C	SDC D
<i>Capacity Protection</i>	-----	Recommended	Required	Required
<i>Liquefaction</i>	-----	Recommended	Required	Required

# Conclusions and Recommendations

It is recommended to apply a 1.5 magnification factor on the 1000 year USGS-AASHTO Design Spectrum only for critical and essential bridges.

While critical bridges shall be design for minimal damages during such earthquakes, essential bridges shall be designed to undergo reparable damages.

Other bridges shall be designed for collapse prevention during 1000 yr event.

NJDOT approval and agreement is needed on these issues before proceeding to other tasks.

# Discussion and Resolutions

The meeting on June 17, 2009 at NJDOT was attended by Anil Agrawal, Richard Dunne and Eddy Germain. The proposed approach for classification and performance for critical and essential bridges was discussed extensively. It was agreed that the proposed approach will meet the needs of NJDOT. The research team will proceed with completion of Tasks 1 and 2 using the proposed approach.