Connecticut Department of Transportation

Route 9
Tunnel Feasibility Study Report

State Project No. 82-279

Prepared by:

URS

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I. EXECUTIVE SUMMARY

The intent of this report is to analyze the feasibility of designing and constructing a six-lane depressed highway tunnel for Connecticut State Route 9 in Middletown, Connecticut. The focus of this report is intended to describe the general design criteria, outline the existing geotechnical conditions, and present possible constructability obstacles and potential solutions associated with the construction of the tunnel using the cut and cover method. In addition, also presented is a preliminary construction cost estimate.

It is expected that the cost for this tunnel, projected to a construction start in year 2010, would be approximately $557 million including, engineering, construction administration, and contingencies. Annual operation and maintenance costs, beginning in 2013, would be in the range of $1.9 million per annum, which includes $700,000 in annual energy costs to power the tunnel and its facilities.

If this project is progressed into design, it is recommended that the initial phase include an extensive geotechnical data collection program. The collection of this additional data will allow designers to make better informed decisions regarding the constructability issues and allow for more precise estimation of construction and maintenance costs.

II. INTRODUCTION

The City of Middletown, population 45,000, is located along the Connecticut River, recently designated an American Heritage River. Prior to the construction of Route 9 there was unobstructed access and vistas of the Connecticut River from downtown Middletown. That connection was cut off when Route 9 was built in it present location. In an effort to reclaim the lost access to the waterfront, the citizens of Middletown have urged the Connecticut Department of Transportation (ConnDOT) to investigate a solution that reconnects the downtown commercial area with the waterfront. (See Study Area in Figure 1)

The Connecticut Department of Transportation has been studying Route 9 with the intent of providing a safer and more efficient Route 9. Various alternatives that address the deficiencies along Route 9 have been presented to ConnDOT and town officials in an effort to find a solution that meets the needs of both groups. Based on input received from the City, improving waterfront access is one of the primary concerns of the Middletown officials. In response, ConnDOT is investigating means to provide improved access to the riverfront, a more pedestrian friendly environment, and additional area for development.

One of the options being explored is to depress Route 9 in a tunnel to provide the direct pedestrian access to the riverfront desired by the City. It is envisioned that the area above the tunnel would be an expansion to the waterfront park. The tunneling of Route 9 would allow pedestrians to walk between the waterfront and the downtown.

It should be noted that the existing rail line running between Route 9 and deKoven Drive is an active line leased and used by Providence and Worchester Railroad (P&W). Pedestrian access across this rail line will be controlled and only specific crossing points will be designated.

This study will outline the design features associated with a roadway tunnel. The report will also present a discussion of the existing geotechincal conditions of the project area, based on limited subsurface data. The discussion of the subsurface conditions will lead to a recommendation of a construction method that allows for construction of the tunnel in two primary stages. Finally, a preliminary construction cost estimate is included. The cost estimate is provided using future dollar values projected to an assumed construction start in year 2010.

Route 9 mainline runs beneath the superstructure of the railroad bridge. Three southbound lanes of Route 9 pass between the western most abutment and a pier located in the median of Route 9. The existing three northbound lanes are west of the median pier on an embankment adjacent to the Connecticut River. Additionally, the railroad tracks also run between deKoven Drive and Route 9 and eventually pass under the highway via the Union Street Overpass. These tracks create a boundary between Route 9 and deKoven Drive.

4. Natural Resources

The tunnel and each project alternative would need to be analyzed for its potential impact to the estuary and its shoreland. In particular, potential impacts to regulated wetlands, water quality, significant coastal fish and wildlife habitats, and rare and endangered plant and animal species would need to be assessed. Habitat degradation and destruction is among the most serious threat to endangered and threatened species. In general, permission to fill or disturb a wetland can be granted if there is no feasible alternative to avoid such action and if appropriate mitigation, such as replacement wetlands in another location, can be agreed upon. Coordinated management of underwater lands is an essential element in assuring the long-term health and viability of plant and animal communities of the estuary.

5. Cultural Resources

Parkland, historic properties and archaeological resources are protected from potential adverse effects by Section 4(f) of the Department of Transportation Act of 1966. The Secretary of Transportation may approve a transportation project requiring the "use" of publicly owned land of a public park, recreation area, wildlife and waterfowl refuge, or historic or archaeological site only if there is no prudent and feasible alternative to using that land, and if all possible measures to minimize harm are included. A significant adverse impact constitutes a "use". This includes direct physical impacts, such as demolition or removal of part of a property. It also includes adverse contextual impacts or the "constructive use" of a property, which occurs when changes caused by the project creates a substantial impairment to the important qualities of the resource. Constructive use could occur from such changes as noise, visual intrusion, or other such elements that would significantly alter the setting of the resource.

Historic and archaeological resources are also protected by Section 106 of the National Historic Preservation Act of 1966, which require that Federal and State agencies consider the effect of their actions on properties listed on or determined to be eligible for listing on the National and State Register of Historic Places.

6. Environmental Permits and Approvals

The Connecticut River is New England's largest river ecosystem and one of the Nation's 14 American Heritage Rivers. The entire Connecticut River Watershed was designated a National Fish Wildlife Refuge by Congress in 1991. In addition, the portion of the River that extends from just north of Middletown south to the Long Island Sound is a designated estuary and tidal river complex that has received international recognition as "wetlands of international importance especially as waterfowl habitat" and is considered the most pristine in the Northeast.

If ConnDOT decides to proceed with project development, one of the first tasks would be to complete the environmental review process in accordance with the National Environmental Policy Act of 1969. NEPA requires that agencies contemplating an action (such as spending federal funds or issuing a federal permit) take a "hard look" at the environmental consequences of their actions. An environmental impact statement (EIS) would need to be prepared considering all reasonable and feasible alternatives to the proposed action. Field surveys, monitoring and modeling efforts would need to be completed to fully identify the potential environmental effects of each project alternative in accordance with Federal and State regulations.

The permits and approvals required for project implementation would entail coordination with numerous Federal and State resource and regulatory agencies. Consequently, it would be important to develop and address all reasonable and feasible alternatives in consultation with the regulatory agencies and the public early on, to obtain guidance on what is acceptable. During the environmental review process, consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Connecticut Department of Environmental Protection, among others, would occur. Other analyses required under NEPA such as Environmental Justice and noise impact assessments would also be completed.

Specific permits and approvals required to construct the project are typically identified during the EIS process based on specific construction methods that would be used and the preliminary engineering of the preferred alternative. Outlined below is a summary of some of the environmental permits that would likely be required for the Route 9 Tunnel project.

Federal Permits/Compliance Requirements:

- National Environmental Policy Act (NEPA)
- Clean Air Act Conformity Determination
- Air Quality Analysis Report
- Endangered Species Consideration
- Hazardous Materials Regulation
- US Army Corp of Engineers
  a) Section 404 Wetlands Permit
  b) Section 10 Rivers Permit

State Permits/Compliance Requirements:

- CT Department of Environmental Protection (DEP) Inland Water Resource Division
  a) Inland Wetlands & Watercourses Permit
  b) 401 Water Quality Certification
  c) Flood Management Certification
  d) Stream Channel Encroachment

- CT DEP Office of Long Island Sound Programs
  a) Structures, Dredging and Fill Permit
  b) Tidal Wetlands Permit

- National Pollution Discharge Elimination System (NPDES) Permit/State General Stormwater Discharge Permit

- CT DEP Indirect Source Air Permit

B. Design Criteria

Of particular importance to a project of this magnitude is an understanding amongst all parties involved of the criteria by which the planning and design phases will be controlled. Federal, state and local regulations must be followed and integrated early into the planning process in order to insure successful completion of the program. The following "Design Criteria" is suggested as a starting point for concept preparation. Each area should be examined carefully for its impact on the local environment, community and the safety of the users:

1. Tunnel Orientation, Length, and Limits

The design including the associated sketches, figures and drawings, will utilize conventional highway referencing, where the stationing increases from the south to the north. In referencing right or left of centerline, the orientation will be looking in the direction of increasing station.

- Tunnel Limit: Approximately 1,200 m [3,950 ft] (South Boat Section to North Boat Section)

- Tunnel Length: Approximately 470 m [1,540 ft] (South Portal to North Portal)

Note: URS designed the Atlantic City / Brigantine Connector in 1999. For comparison, the tunnel limit of the Atlantic City tunnel is 884m [2,898.75 ft] and tunnel length from portal to portal is 596 m [1,957 ft].

2. Highway Design Criteria

2.1 General

Route 9 is classified as a Multilane Urban Principal Arterial-Expressway. The tunnel and its approach structures will conform to the criteria outlined below

2.2 Applicable Standards

During design the depressed roadway will comply with the latest applicable codes, regulations and standards. The following publications were used in the development of the conceptual design used for determining the overall feasibility of this tunnel.

- Connecticut DOT Highway Design Manual, 1999.

- A Policy on Geometric Design of Highways and Street (2001); Fourth Edition AASHTO
- "Standard Specifications for Highway Bridges", 17th Edition-2002, American Association of State Highway and Transportation Officials (AASHTO); Seismic effects will be considered.

2.3 Base Mapping

The Connecticut Department of Transportation has provided the topographic and planimetric mapping that has been used in the development of this report. The following horizontal and vertical datum were used.

- The Horizontal control is based on NAD 27.
- The Vertical Datum is based on NGVD 29.
- Middletown Datum is 15.503 feet above the NGVD 29.

2.4 Excavation and Grading

For the purpose of this study it is assumed that the tunnel will be constructed by cut and cover methods. The materials adjacent to the excavation could be supported by sheeting or sheet piling. There is possibly a need for the excavation to be performed in segments both parallel and transversely to the direction of traffic. Due to the width of cut required the structure may be constructed in sections (say one half width at a time). Upon completion of the structure the area above the tunnel will be graded and sodded in accordance with local requirement to allow unimpeded access to the river. Portions of the depressed section at both the northern and southern end will be left open as tapered transition sections to existing Route 9.

2.5 Roadway Design Guidelines

2.5.1 Traffic

* Design years: 20
* Average Daily Traffic (ADT) (Year 2000): 65,000 vehicles /day
* Design Speed: 45mph (through tunnel)

2.5.2 Horizontal and Vertical Alignment

* Stopping Sight Distance	160 m-205 m
* Minimum Radius of Curve	440 m
* Maximum Grade	4.0%
* Minimum Grade	0.5%
* Superelevation (max)	6.0 %

2.5.3 Typical Section (Two Cell Tunnel Roadway)

* Number of Lanes (ultimate)	Six lanes with three lanes in each direction (3 per cell)
* Lane width	3.6m
* Right shoulder	1.2m-2.4m
* Left shoulder	1.2m-2.4m
* Vertical Clearance	16'-3"=16.25' (4.92 m)

Note: Inside overall vertical dimension is 16'-3" + 4'-0" = 20'-3".

2.6 Approach Drainage

Drainage will be developed for both the north and south approaches of the tunnel. A pump station will be necessary at the low point of the tunnel structure. Storm drains will be placed in the depressed sections and in the tunnel structure. Design of the drainage system will be in accordance with the Connecticut Department of Transportation Drainage Manual.

3. Geotechnical

3.1 General

A generalized geological profile was generated from available sources. These sources include a cross section from record construction plans of the Arrigoni Bridge, boring logs from the recently constructed State Courthouse located west of Route 9, and a set of three boring logs taken for the Route 9 overpass over Union St.

3.2 Groundwater Control Inside the Tunnel

It is anticipated that the exterior of the structure will be adequately waterproofed to prevent the infiltration of groundwater. Both longitudinal and transverse joints throughout the tunnel should be detailed to resist leakage. The entire structure will be proportioned to resist uplift pressures exerted by groundwater. No underdrains will be used for the structure.

4. Structural

4.1 General

The following sections establish the basic criteria for the design of the tunnel and its structural components.

4.2 Cross Passages

Cross passages per National Fire Protection Association (NFPA) requirements will be provided between the northbound and southbound tunnel cells. They will be spaced at intervals of not more than 300 feet to provide access to authorized personnel and emergency egress to evacuate the public to the adjacent cell.

4.3 Design Loads

The cut and cover structure is to be constructed of reinforced concrete. The size of its various elements (roof, walls, base slab, etc.) will be proportioned by either using Service Load Design method or alternatively the Load Factor Design method as defined in The American Association of State Highway and Transportation Officials (AASHTO) specifications. Some of the loads to be considered are as follows.

i) Live Load
- MS 22.5 (metric equivalent of HS25)

ii) Earth Pressure
- Use 19 kN/m3 (=120pcf) for the unit weight for earth pressure

iii) Buoyancy

Adequate resistance to flotation will be provided at all sections of the tunnel for full hydrostatic uplift pressure on the structure foundation based on the probable maximum height of the groundwater. The factor of safety against uplift under the above conditions, neglecting side wall soil friction effects, will not be less than 1.10.

iv) Flooding

Local flooding will add load to the structure. Design of the structure should make allowance for this loading. Flood level shall be based on 100-year flood (EL +7.0m).

v) Portals

Portals shall provide protection against flooding resulting from high water levels of the Connecticut River. The design top elevation of the portals shall be based on 500-year flood (EL +8.0m).

5. Tunnel Ventilation

The tunnels will be provided with a longitudinal ventilation system using jet fans. A discussion of alternate ventilation systems is included in section IV (System Wide Elemnts).

6. Tunnel Lighting

- Lighting calculation using "Lumen Micro" software to design tunnel lighting in accordance with requirements of American National Standard Institute (ANSI) / Illuminating Engineering Society of North America (IESNA) recommended practice for tunnel lighting RP-22-96

- Preparation of lighting plans (threshold zone, transition zone, and interior zone) will be based on calculation results.

  Note:
  a) Threshold Zone - The area inside the tunnel where a transition is made from the high natural lighting level outside the tunnel to the beginning of the transition zones.
  b) Transition Zone(s) - Areas which allow motorists to achieve appropriate eye adaptation by incrementally reducing the level of luminance required in the threshold zone to the luminance level of the interior zone.
  c) Interior Zone - Area within the tunnel after eye adaptation has been completed.

Note: Early emergency operational cost project to year 2013 will be approximately $717,590

7. Supervisory Control and Data Acquisition (SCADA)

The SCADA and data communications sub-system provides for the monitoring and control of electrical and mechanical systems equipment (linear heat detection system, tunnel fire alarm system, carbon monoxide (CO) monitors, ventilation fans, pumps, switchgear) and Traffic Surveillance and Control System (TSCS) equipment. There will be a communication area located in the electrical control room area, where all data will be collected. Ventilation fans normally will be operated from CO signal detectors.

C. Existing Conditions

1. Land Use

The Connecticut River waterfront area in and around the study area contains available land with the potential for further development and improved access to the downtown area. The land presently has on it a restaurant, boat house and Harbor Park (Photo No. 5 and 6). Access to the park is by the Harbor Park Pedestrian Tunnel (Photo No. 7) located beneath Route 9 at approximately station 1+750 or via Union Street (Photo No. 4). Additional access is by River Road located south and east of the project limits.

2. Arrigoni Bridge

The Arrigoni Bridge carries Connecticut State Routes 66 and 17 east and west between Portland and Middletown, over Route 9 and the Connecticut River. The bridge is located just north of the project limit. Design plans from 1935 provided clues to the soil stratification and foundation design approach for that time period.

3. Union Street Overpass

The Union Street Overpass carries Route 9 over both Union Street and the Providence and Worchester rail lines. Union Street is one of two vehicular access roadways to the Connecticut River waterfront. Boring logs for this structure, dated 1984, were available from ConnDOT.

4. Utilities

Generally, the utilities throughout the study area are not obstructive. There is the normal water supply, power supply, and communications to the waterfront area, which require relocation. It should be noted that a large reinforced concrete storm sewer exists adjacent to deKoven Drive. Storm water collected by this system appears to outlet into the river through extensions beneath the railroad and Route 9. Consideration should be given to redesigning the entire storm water system in the area of the tunnel construction to avoid conflicts.

5. Geotechnical

A detailed geotechnical investigation program was not included as part of this feasibility study, but should be a priority for any future studies for depressing Route 9. Such a study would seek to obtain the existing soil condition data necessary to adequately assess the strength characteristics of the soil as well as other information necessary to provide comprehensive design. For this study, geotechnical data was extracted from construction records of other projects. The information available consisted primarily of boring logs, test pit logs, and a general soil profile across the Connecticut River from the Arrigoni Bridge plans. This information was compiled and results in the Geologic Profile shown on Drawing Sheet 2 of 14.

The soils overlying bedrock in the project area appear to have been deposited in three distinct strata ranging from cohesionless glacial deposits in the upper layers (A), to clays with interbedded sand lenses (B), to layer (C) glacial tills, composed of dense sands, silts, cobbles, clays and some boulders. Each of these layers tend to increase in thickness from south to north along the alignment of Route 9. The generalized Geological Profile was overlaid on alternative alignments in order to assess the pros and cons of constructability in those particular environments. Subsequent investigations would delineate the locations and interfaces of these layers more definitively. It appears that foundation support for the railroad bridge and the Arrigoni Bridge was achieved by going through the clay areas (B) to the till (C) and rock.

It should be noted that the location of the water table over the alignment varies from elevation 0.00 m to + 6.0 m over the alignment. The water table location will have a significant impact on the constructability of the tunnel. Special measures may have to be taken to insure, the stability of the soils encountered resulting in an increase in cost.

IV. DESIGN FEATURES

Applying the criteria outlined in this study results in a two cell reinforced concrete structure over one hundred feet wide. The structure will provide three 3.6 meter lanes in each direction with shoulders and a center wall with passageway doors located along its length. The box structure will separate into two individual boat sections at the north tunnel limit prior to passing beneath the Providence and Worcester railroad bridge. In subsequent studies, the roof of the structure should be evaluated for alternative pre-cast construction or a combination of pre-cast and cast-in-place concrete construction.

V. SYSTEM WIDE ELEMENTS

A. Mechanical –Heating, Ventilation, and Air-conditioning

1. Applicable Codes and Standards

The Work of this Section shall conform to the latest applicable codes, standards, and references as follows:

- **AFMBA** Anti-Friction Bearing Manufacturers' Association
- **AISI** American Iron and Steel Institute
- **AMCA** Air Movement and Control Association
- **AWS** American Welding Society
- **ASHRAE** American Society of Heating, Refrigeration and Air-conditioning Engineers
- **ANSI** American National Standards Institute
- **ASME** American Society of Mechanical Engineers
- **ASTM** American Society for Testing and Materials
- **NEMA** National Electrical Manufacturers' Association
- **NFPA** National Fire Protection Association

2. Tunnel Ventilation System Requirements

The tunnel ventilation system shall provide proven and reliable means of smoke control in the event of a fire inside the tunnel such that a safe evacuation of stranded motorists can be carried out and the fire department and other emergency personnel can gain access to the fire site.

The longitudinal tunnel ventilation system shall be capable of moving air in the tunnel at sufficient volume and pressure to meet the critical air velocity requirements as defined in National Fire Protection Association (NFPA) 502. The maximum air velocity in the tunnel shall not exceed 220 ft/min the minimum air velocity within a tunnel should be sufficient to prevent backlayering of smoke.

The required ventilation capacity for the longitudinal ventilation system shall be based on assumption that a group of vehicles, traveling downgrade has stopped and the first vehicle is on fire.

Tunnel ventilation fans that are to be used during fire emergencies, their motors, dampers, actuators and accessories that are exposed to the exhaust air stream from the roadway fire shall be designed to remain operational for a minimum of one hour in an airstream temperature of 482 Deg. F. The emergency ventilation capacity required to maintain the critical velocity past the vehicles and thus preventing smoke traveling toward the trapped vehicles is the capacity recommend for the system. See page three and page four details.

3. Tunnel Ventilation - Longitudinal Ventilation with One Vent Shaft

a) The vehicle-induced piston-action ventilation during a free-flowing traffic is anticipated to be sufficient to provide adequate ventilation through the tunnel. To facilitate this effect, an emergency ventilation shaft, located in the middle of the tunnel could be constructed to operate like passive air exchange shaft during non-emergency operation and low CO value in the tunnel.

The Carbon monoxide monitoring system shall start a fan in the cell affected with a critical value of carbon monoxide.

The vent shaft structure could be combined with the pump station, and/or electrical station.

b) Emergency Condition Longitudinal Ventilation

For this option the emergency fan shaft is to be located in the middle of the tunnel. The total emergency ventilation capacity at vent shaft is 1,000,000 cfm, with four fans. Each fan should provide at least 250,000 cfm in exhaust mode and 225,000 cfm minimum in supply mode. Any one of these four fans can provide ventilation for any of the tunnel's tube.

c) Commonality

Fans, sound attenuators, dampers, motor starters and other like components of each category of the tunnel ventilation system equipment, shall be of a single manufacturer and supplied by a single supplier. All like parts shall be interchangeable where practical.

d) Fan Performance

Fans shall be capable of delivering air in both the forward and reverse directions of airflow. The fans shall be capable of reversing the direction of airflow by reversing the motor rotation. Fans for longitudinal ventilation system shall be multi-speed. Fans shall be capable of reversing airflow in sixty seconds or less, from full speed forward to full speed reverse or vice versa with a maximum deenergized period of 30 seconds between reversals. Fans shall be capable of reversing airflow at least three times during any one hour.

e) Sound Attenuators Requirements

Sound attenuators shall be of such design that when all fan assemblies are operating together, the ventilation system noise does not exceed the maximum acceptable sound power levels of 85 dBA at five feet above the road surface.

f) Motor Control Centers

Three-phase starters (controllers) shall be provided for all motors rated 1/2 horsepower and above unless a specific item of motor-driven equipment is normally supplied with single phase motor rated 1/2 horsepower.

Starters shall be grouped in floor mounted NEMA 12 assemblies of one or more metal enclosed vertical sections having a horizontal common power bus and principally containing combination motor control units (starters), identified by the industry and NEMA Standards as "Motor Control Centers." Motor control centers, which are required to contain electrical interlocking between starter units, shall be specified as Class IIC type. When a fan is installed `out of sight' from its motor starter, a local disconnect switch of appropriate rating shall be provided.

g) Emergency Operating Conditions

During an emergency operating mode, the fans will be operated to move air in the normal direction of traffic flow forcing smoke and hot gases from the fire towards the empty portion of the tunnel and maintain a clean air supply upstream of the fire. This mode of ventilation system operation will generate airflow pattern to protect emergency personnel and vehicles stopped behind the accident, by maintaining clean air supply in the upstream of the roadway to serve as an evacuation path for patrons and access for firefighters and other emergency personnel.

The ventilation system operation in emergency mode shall be activated manually by the operator at the Operations Control Center after receiving an alarm from the fire alarm pull station, the traffic surveillance, and from the control system.

4. Tunnel Ventilation– Longitudinal Ventilation with Jet Fans

a) Vehicle fire size: 50 megawatt (MW)

Number of jet fans: 36 (three jet fans transversely per tube in 6 areas longitudinally throughout the tunnel).

Jet fans size: 630mm diameter and 2 diameter sound attenuators at both ends to reduce fan noise to acceptable level.

Jet fans capacity: Static thrust of 473 Newton with discharge air velocity of 36.9 meters per second.

b) CO monitoring system: consist of MultiGard control panel with signal averaging hardware located in an electrical station and 8 sampling points for each tunnel (tube). When average carbon monoxide levels in the tunnel reach a critical value of 120ppm the monitoring system will activate the tunnel ventilation system.

Jet fan operation - normal and emergency:

c) Normal operating conditions. When CO level in any tunnel cell approaches the high set point of the acceptable limit, the fans shall be activated automatically to induce airflow through the respective tunnel cell. The direction of airflow shall mimic the traffic direction. As CO levels increase, additional fans shall be energized. During congested or stopped traffic, when CO levels approach the maximum allowable limit of 120ppm for a 15min exposure in spite of all fans operating, the ventilation control system shall generate alarms to warn the operating personnel so that steps can be taken to restrict the traffic through the tunnel.

d) Emergency operating conditions. During an emergency operating mode, the fans will be operated to move air in the normal direction of traffic flow forcing smoke and hot gasses from the fire towards the empty portion of the tunnel and maintain a clean air supply upstream of the fire. This mode of ventilation system operation will generate an airflow pattern to protect emergency personnel and vehicles stopped behind the accident, by maintaining a clean air supply upstream of the roadway to serve as an evacuation path for patrons and access for firefighters and other emergency personnel. The ventilation system operation in emergency mode shall be activated manually by the operator at the operation control center after receiving an alarm from either a pull station or the traffic surveillance and control system.

After verifying that the vehicles downwind of the fire have cleared out of the tunnel, fans shall be activated to produce a high velocity air stream to push the tunnel air toward the exit portal. The most appropriate operating mode for ventilation system shall be selected using a pre-programmed sequence to activate fans and associated equipment. The ventilation system for the non-incident tunnel cell shall also operate to maintain a supply of fresh air.

5. Air Distribution System Design for Pump Room and Electrical Room

All air-distribution duct systems shall be designed based on recommendations and in accordance with information contained in the latest edition of the Handbook of Fundamentals (ASHRAE). Supply duct sizes shall be selected for an equal pressure drop or static regain method as appropriate.

In general, the ductwork fabrication shall be in accordance with Low Pressure or Medium Pressure Duct Construction Standards (Sheet Metal and air-conditioning Contractors National Association, Inc. (SMACNA)) as appropriate.

Supply Air Registers and Diffusers

All supply air registers and diffusers shall be selected to provide the required throw and spread with the least amount of draft and noise. All registers shall be provided with opposed-blade adjustable volume dampers. The volume dampers shall be key operable through the face of the diffusers and registers.

Exhaust / Return Air Grilles and Registers

Either all exhaust/return air grilles and registers shall be equipped with fixed, non-see-through blades or louvers, or the duct behind them shall be painted matte black. Registers shall be equipped with key operable opposed blade volume dampers that are adjustable through the face the grille.

Fire Dampers

Fire dampers shall be provided where air ducts pass through fire rated walls and partitions. Fire dampers shall be UL listed.

Access Doors

Access doors shall be provided in ducts and plenums to service fans, dampers, fire dampers, turning vanes, coils, filters, etc. Access doors in insulated ducts and plenums shall be insulated using sheet metal insulation.

Flexible Duct Connectors

Flexible duct connectors shall be used on all fan units to connect units to ductwork. The length of each joint shall be selected to adequately accommodate both horizontal and vertical deflections of the fan units.

Insulation

Insulation shall be provided for the following:

- Heating and A/C supply and return ducts [UPS (Uninterruptible Power Supply) Room]
- Outside Air Intake Ducts subject to condensation (Sweating)

6. Electrical and Mechanical Equipment Rooms

System Concept

A supply and exhaust ventilation system shall be provided to remove and discharge to the outdoors heat produced by transformers, switchgear, the uninterruptible power supply unit, lights, etc. Ventilation air shall be obtained from the outdoors. Air filtration shall be provided at the air intake to the space and a positive pressure shall be maintained when the system is in operation. Where required, heating shall be provided with the use of electric unit heaters.

The ventilation systems shall be automatically shut down in the event of fire or smoke detection within the room.

7. Pump Room

Exhaust ventilation shall be provided in pump rooms. The ventilation system shall continuously operate to maintain the space under negative pressure. One fan shall be on stand by. Fans shall be connected to stand by power supply, and hydrocarbon/smoke control panel.

Low point pump stations shall be ventilated with a minimum of six air changes per hour. The heating system shall be provided by electrical heaters.

B. Electrical

All work of this section shall conform to the latest applicable codes, standards, and references as follows:

NFPA-70: National Electric Code
UL: Underwriters Laboratory
NEMA: National Electrical Manufacturers' Association

1. Tunnel lighting system will consist of three major components:

a. Normal lighting in tunnel interior zone and portals. It would be designed for urban tunnel with the speed of 45 mph. Lighting level would be 9 cd/m² for daytime and 2.5 cd/m² for nighttime operation.

b. Tunnel entrance zone lighting will be designed for threshold zone and two transition zones- 230 cd/m², 80 cd/m², and 25 cd/m² respectively.

c. Emergency lighting will be provided to permit egress from tunnel during the loss of power it will provide illumination of at least 10 lux average measured at floor level (NFPA101)

2. Electrical service and power distribution will consist of :

a. Dual incoming utility power from two independent sources. It will utilize two service feeders, ductbank, dual-ended unit substation with primary and secondary switchgear, protection and metering scheme.

b. Standby 2000kw generator with fuel supply for 12 hours of operation of emergency lighting, ventilation and communication, alarm and control loads.

c. 225 kva UPS system with minimum 15 minutes duration will be provided to prevent lost of data during transition from utility to generator operation and will serve communication, Closed Circuit Television (CCTV), SCADA, Fire Detection and Alarm System.

d. Electrical substation room, motor control center room, battery and UPS and generator rooms are required to house all necessary equipment and shall be located in the tunnel.

e. Electrical power distribution system shall be designed to provide power in coordination with the two alternatives of the ventilation system design: one alternative having one ventilation shaft with four 200 hp (250,000CFM/ea) ventilation fans, reversible with Variable Frequency Panel (VFD) controllers and another alternative with thirty six (six rows of six)50 hp jet fans suspended from ceiling in each cell, reversible with VFD controllers.

f. Electrical service building lighting, small convenience and motor loads smaller than ½ hp will be served at 120/208V; motor loads above ½ hp and tunnel lighting will be served at 480V.

3. Communication system will consist of :

a. Motorist aid phones located in north and south bound tunnels no more than 150 ft apart with blue indicating light above. The phone activation shall send a signal to communication room and to remote control station.

b. Fire alarm pull stations located in north and south bound tunnels no more than 150 ft apart with red indicating light above. Activation of fire alarm pull station shall send a signal to communication room and to remote control station.

c. Linear heat/fire detection wire running exposed in north and south bound tunnels. Activation of fire detection shall send a signal to communication room Fire Alarm Control Panel (FACP) and to remote control station.

d. Radio system will accommodate Police and Fire department operations. Transmitters/receivers, Radio Frequency (RF) combiners and power splitters will be installed in communication room. Radio transmission will be facilitated through the coaxial cable (radiax) on both sides of north and south bound tunnels.

e. Communication room is required to house all necessary equipment and shall be located in the tunnel.

f. Communication room shall have emergency phone line

4. Control equipment will include:

a. Closed Circuit Television (CCTV)

b. Carbon monoxide system

c. Ventilation control system

d. SCADA system: Supervisory Control and Data Acquisition System (SCADA) programmable logic controller base (PLC based) will be provided to pick all the points for local and remote alarms, control and annunciation of electrical, ventilation, pumping and communication systems at tunnel and tunnel service building. Interface module for conversion of all data signals to fiber optic signals shall be provided. All signals from interface module will be sent via fiber optic cable to remote control location.

C. Roadway Drainage System

The basic components of the tunnel drainage system will consist of drain inlets with grates, longitudinal gravity drain lines, underground pump station at the tunnel low point with three (3) submersible pumps, and a 20-inch discharge line from the pump station to a water quality basin at the south portal, prior to discharge to the Connecticut River.

The portal storm water runoff criteria used for the design of the drainage system will be based on a storm frequency of 50 years with a duration of five minutes, plus 500gpm for fire fighting. Both the Lindberg Boulevard Runway Bridge/Tunnel in St. Louis and the Atlantic City-Brigantine Connector adopted this criteria.

Roadway inlets will be spaced no more than 100 feet apart in the tunnel and boat sections, and will be located entirely off the travelway. Inlet gratings are designed for HS-25 truck loading and will be securely fastened to the frames.

The underground pump station will have three distinct levels: screen, treatment and sump pit level; pump access room level; heating and ventilation, and the control room level. The top of the underground pump station will be flush with grade with access covers.

The screen, treatment and wet well level will consists of the following: stainless steel bar screens with 2" by 2" openings at the entrance to the pump station to contain debris and floatables which may be carried into the inlet chamber; two storm water treatment units, manufactured by Stormceptor, after the screens to remove hydrocarbon pollutants and sediment from the incoming storm flow; and three (3) submersible pumps in the sump pit area with a redundant water level pump control system.

Each submersible pump will be capable of handling 50% of the design storm flow, which is approximately 7000 gpm. In an extreme flood condition, it would be possible to bring the three(3) pumps on-line. The pump access room floor area will be used by maintenance personnel to service, clean, and remove debris and floatables from the trash rack screen pit, to remove captured oil and sediment from the oil/water separators, to remove, service and replace the three (3) submersible pumps and the two (2) water level control assemblies in the sump pit.
This area will also have the three (3) main pump control panels, one (1) instrumentation control panel, and an overhead monorail with hoist.

The HVAC floor area will have heating and ventilating equipment required to heat and ventilate the pump station, as well as maintain a negative pressure, at all times, in the pump access room area and in the lower screen, treatment and sump level area. The ventilation system design will include two units, with one unit in continuous operation and the other on full standby. Equipment will be selected with two speed operating mode, low and high speed. Normally, one unit will operate at low speed, with a minimum of six (6) air changes per hour, 24 hours a day.

A hydrocarbon detection system will be provided in the lower level of the pump station and in the pump access room to detect any hydrocarbon in the area. If this system should be activated on detection of hydrocarbon in the area, it will signal an alarm condition at the Remote Control Center, will activate a horn/strobe light at grade outside the pump station, and will start the ventilation equipment in the high speed mode to increase the exhaust air flow to remove all traces of hydrocarbon.

A smoke detection system will also be provided in all rooms and areas in the pump station, and in the heating and ventilating duct system. If this system is activated, it will signal an alarm condition at the Remote Control Center, and will activate the horn/strobe light at grade outside the pump station.

D. Fire Protection System

The fire standpipe system will consists of two (2) 4-inch standpipe mains, one in each tunnel, with fire hose valve cabinet stations recessed into the center wall of the roadway tunnel and the exterior walls of the boat sections. The standpipe system will remain dry (without water) during normal operations. When required, the dry fire standpipe system will be charged by the City Fire Department using fire department pumpers hooked up to street fire hydrants and to system inlet connections at grade.

The fire standpipe system will be capable of providing two hose streams, each with a capacity of 250gpm at 100psi at the most remote hose outlet, and a total flow of 500gpm at 65psi residual pressure in accordance with the requirements of NFPA 502.

Combined vacuum and air relief valves will be installed on the fire standpipe mains to insure that the delivery time of water to any hose connection on the system will be less than 10 minutes as stipulated in NFPA 502. This equipment will also facilitate draining the system, in winter, after a fire incident use.

Stainless steel fire hose valve cabinets with two (2) 2-1/2 inch angle hose valve outlets and a stainless steel fire extinguisher will be provided every 150 feet maximum in the tunnel and boat sections. Fire extinguishers will be of the multipurpose (ABC) type in NFPA 10, twenty pound capacity.

All fire standpipe system cabinets will be provided with a waterproof tamper switch that will indicate an alarm condition at the Remote Control Center to alert the operator when the cabinet door is opened during a fire incident or due to an act of vandalism.

VI. CONSTRUCTABILITY

The following section will discuss some of the requirements and challenges that must be addressed during construction. The Maintenance and Protection of Traffic (M&PT) will discuss the changes that could be made to traffic patterns to maintain at least two travel lanes in each direction along Route 9. The discussion of construction staging will look at some of the construction techniques and activities that will take place during the various stages of construction.

A. Maintenance and Protection of Traffic (M&PT)

It should be noted that construction of the tunnel could not progress until the Route 66 / Route 9 interchange improvements, currently under study, were implemented to remove the signalized intersections along Route 9. As currently proposed, the tunnel boat section extends beyond the existing Hartford Avenue intersection, thus prohibiting any access to Middletown from Route 9 in this area.

The traffic staging sequence will closely follow the construction staging plan and will consist of three primary stages (See Drawing Sheets 7 thru 10). During construction, two lanes will be maintained in each direction along Route 9 throughout the project limits, and the posted construction zone speeds will be 35 mph. A temporary construction easement would be established limiting staging impacts on the river.

Stage 1: Early construction will be required to widen the northbound lanes eastward towards the river bank. Once this is completed, all Southbound Route 9 traffic will cross over the median to the northbound lanes immediately after passing under the Arrigoni Bridge. Two lanes will be provided in each direction separated by concrete barrier. Traffic will travel along the northbound side of the existing highway for the length of the tunnel section.

Once southbound traffic has been shifted, the southbound cell of the cut and cover tunnel can be excavated and built to completion. In addition, most of the deep boat section, as well as the southbound split boat section under the existing railroad bridge can also be constructed during Stage 1.

Beyond the limits of the newly constructed tunnel section, southbound traffic will again cross over the median and return to the existing alignment before the approach to the Union Street Overpass. Southbound access points at Hartford Avenue and deKoven Drive will be maintained. Washington Street access will be closed permanently.

Stage 2: Once the southbound tunnel and deep boat sections are completed, southbound traffic will be placed within the newly constructed tunnel, northbound traffic will remain with two lanes at-grade along the outside of the widened existing northbound roadway. At this time, the median boat section and inside boat section running northbound under the Railroad Bridge will be excavated and built.

Stage 3: During the final stage of major construction, the two northbound lanes will cross over to the southbound side of the highway through the median immediately after crossing the Union Street Overpass. Two travel lanes will be provided in each direction through the completed southbound tunnel cell. The travel lanes will be separated by a concrete median barrier. Once all traffic has been shifted into the tunnel, the northbound tunnel and deep boat section can be excavated and built.

As northbound traffic exits the tunnel, the two lanes will be split as one lane will cross the median back to the northbound side of the highway. The lane crossing the median will cross over the median constructed in Stage 2 and travel in the constructed boat section under the Railroad Bridge. The other northbound lane will continue within the southbound boat section under the Railroad Bridge. Beyond the Railroad Bridge, the left northbound lane will then cross over the median and return to the existing northbound alignment before passing under the Arrigoni Bridge. Final shallow boat section construction will be done on both ends of the project using single lane closures and typical M&PT standards and details.

B. Construction Staging

Given the information available, the Cut and Cover method will probably be the more conservative method to complete the project with the least amount of risk under the given conditions. Driving sheet piles along with a controlled dewatering program, worked well in Atlantic City, New Jersey (See Appendix C). A typical construction staging sequence is shown on Drawing Sheet 6 that would allow for the various structural elements to be placed. Due to the width of the structure and need to minimize traffic disruption, the tunnel will be constructed one half at a time. The Southbound tunnel cell would be constructed first while two lanes of traffic are maintained in each direction on the northbound side of the existing highway. Once construction of the southbound side of the tunnel is completed, traffic will be routed inside the completed southbound tunnel cell. The completed tunnel should have all tunnel lighting, ventilation and other safety features installed prior to allowing vehicular traffic even on a temporary basis. The northbound tunnel cell could then be constructed. The typical construction staging sequence and corresponding Traffic Staging Sequences are shown on Drawing Sheet 6 through 10. The landside substructures for the Railroad Bridge are assumed to be founded on piles or a very deep spread foundation. For the purpose of this study no load from the new construction will be imposed on the existing substructure.

Supporting excavations adjacent to waterways always impose a challenging set of circumstances. Providing lateral support and stability of the subgrade materials during construction is of extreme importance. For the Atlantic City Tunnel, jet grouting was used to assist in improving subgrade soils as necessary. Overlapping jet grout columns were used running perpendicular to the sheet pile walls, adding stability to the base of the excavation and temporary sheet pile wall. Given the similar conditions expected on this project and the state of the art of ground modification techniques available, we believe that a contractor would take advantage of such tools and have included ground modification as part of our estimate.

VII. CONSTRUCTION AND MAINTENANCE COST ESTIMATES

A construction estimate has been prepared utilizing the following assumptions:

1) The base year for the estimate is 2002.

2) Escalation is assumed at 2.75% per year.

3) The construction period is assumed to be three (3) years beginning around April 2010.

4) A contingency of 50% has been added to allow for the unknowns associated with preparing a conceptual stage design with limited information.

5) Both Engineering and Management Costs have been included at 10% each. ConnDOT administrative costs have been left open for inclusion by ConnDOT.

For the purposes of an approximate annual Operation and Maintenance (O&M) we have prepared an approximate cost for a crew undertaking normal maintenance functions in a highway tunnel. Those items are included in the description of the O&M estimate. In addition, a recent bid for O&M cost on the Lindbergh Boulevard Runway Bridge/Tunnel in St. Louis, also cut and cover (yet to be constructed), was around one million for two years.

IX.1 ORDER OF MAGNITUDE CONCEPTUAL ESTIMATE

Cons. Sequence	Description	Quantity	Unit	Unit Cost	Total Cost	OH & Profit 10%	Gen Cond. - 6%	Total Price	Comments
1	Utility Investigation prior to Cutoff Wall Construction	3,300	LF	$50.00	$165,000.00	$16,500.00	$9,900.00	$191,400.00	
2	Relocate Utilities prior to Cutoff Wall Construction	3,300	LF	$100.00	$330,000.00	$33,000.00	$19,800.00	$382,800.00	
3	Widen northbound lanes eastward to River Bank 15' x 4300'	64,500	SF	$12.00	$774,000.00	$77,400.00	$46,440.00	$897,840.00	
4	Construct Crossover from southbound to widened roadway - 2 Ends	25,000	SF	$12.00	$300,000.00	$30,000.00	$18,000.00	$348,000.00	50' x 250' x 2 Each
5	Provide Median Barrier, Signage and Traffic Markings for Crossover	500	LF	$100.00	$50,000.00	$5,000.00	$3,000.00	$58,000.00	
6	Traffic Management for Crossover	500	LF	$100.00	$50,000.00	$5,000.00	$3,000.00	$58,000.00	
7	Demolish Pedestrian Tunnel @ Sheetpile Cutoff Wall	2	Locations	$25,000.00	$50,000.00	$5,000.00	$3,000.00	$58,000.00	
8	F&I Sheetpile Cutoff Wall w/ Tiebacks west side S.B. Lane	3,300	LF	$1,750.00	$5,775,000.00	$577,500.00	$346,500.00	$6,699,000.00	
9	F&I Sheetpile Cutoff Wall w/ Tiebacks east side S.B. Lane	3,300	LF	$1,750.00	$5,775,000.00	$577,500.00	$346,500.00	$6,699,000.00	
10	Excavate for Retaining Wall - Southbound 495'L x 16.5'D x15'W	4,500	CY	$10.00	$45,000.00	$4,500.00	$2,700.00	$52,200.00	STA 1+300 to 1+450
11	Excavate for Boat Section - Southbound 575'L x 40'D x 82'W	69,850	CY	$10.00	$698,500.00	$69,850.00	$41,910.00	$810,260.00	STA 1+450 to 1+625
12	Excavate for Tunnel - Southbound 1560'L x 64'D x 82'W	303,220	CY	$10.00	$3,032,200.00	$303,220.00	$181,932.00	$3,517,352.00	STA 1+625 to 2+100
13	SB -Soil Removal to Landfill - Inc. Testing, Re-Load, Tipping Fee	566,355	Ton	$40.00	$22,654,200.00	$2,265,420.00	$1,359,252.00	$26,278,872.00	
14	SB -Boat and Tunnel Underground Utility Installation	3,300	LF	$50.00	$165,000.00	$16,500.00	$9,900.00	$191,400.00	
15	Dewatering	36	Months	$50,000.00	$1,800,000.00	$180,000.00	$108,000.00	$2,088,000.00	
16	Grouted Mud Slab - 2' x 82' x 2950	27,500	SY	$25.00	$687,500.00	$68,750.00	$41,250.00	$797,500.00	
17	SB - Form and Pour Retaining Wall (S) - 495'L x 16.5'D	8,200	SF	$40.00	$328,000.00	$32,800.00	$19,680.00	$380,480.00	STA 1+300 to 1+450
18	SB - Form and Pour Retaining Wall (N) - 328'L x 10.3'D	3,400	SF	$40.00	$136,000.00	$13,600.00	$8,160.00	$157,760.00	STA 2+370 to 2+470
19	SB - Form, Pour, Finish Boat Section (S)- Full Width 575'L x 26'D x 82'W	1,320,200	CF	$6.70	$8,845,340.00	$884,534.00	$530,720.40	$10,260,594.40	STA 1+450 to 1+625
20	SB - Form, Pour, Finish Boat Section (N)- Full Width 164'L x 26'D x 82' W	349,648	CF	$6.70	$2,342,641.60	$234,264.16	$140,558.50	$2,717,464.26	STA 2+100 to 2+150
21	SB - Form, Pour, Finish Boat Section (N)- AT Pier 722'L x 26'D x 46'W	863,512	CF	$6.70	$5,785,530.40	$578,553.04	$347,131.82	$6,711,215.26	STA 2+150 to 2+370
22	SB -Form, Pour, Finish Cut and Cover Tunnel 1558'L x 30'D x 64'W	2,991,360	CF	$9.75	$29,165,760.00	$2,916,576.00	$1,749,945.60	$33,832,281.60	STA 1+625 to 2+100
23	Backfill with Impervious Material 3300' x 25'D x 4' Wide	12,250	CY	$125.00	$1,531,250.00	$153,125.00	$91,875.00	$1,776,250.00	
24	F&I Sheetpile Cutoff Wall w/ Tiebacks River Side N.B. Lane	3,300	LF	$1,750.00	$5,775,000.00	$577,500.00	$346,500.00	$6,699,000.00	
25	Excavate for Retaining Wall - Northbound 495'L x 16.5'D x15'W	4,500	CY	$10.00	$45,000.00	$4,500.00	$2,700.00	$52,200.00	
26	Excavate for Boat Section - Northbound 575'L x 40'D x 82'W	69,850	CY	$10.00	$698,500.00	$69,850.00	$41,910.00	$810,260.00	

Cons. Sequence	Description	Quantity	Unit	Unit Cost	Total Cost	OH & Profit 10%	Gen Cond. - 6%	Total Price	Comments
27	Excavate for Tunnel - Northbound 1560'L x 64'D x 82'W	303,220	CY	$10.00	$3,032,200.00	$303,220.00	$181,932.00	$3,517,352.00	
28	NB -Soil Removal to Landfill - Inc. Testing, Re-Load, Tipping Fee	566,355	Ton	$40.00	$22,654,200.00	$2,265,420.00	$1,359,252.00	$26,278,872.00	
29	NB -Boat and Tunnel Underground Utility Installation	3,300	LF	$50.00	$165,000.00	$16,500.00	$9,900.00	$191,400.00	
30	Grouted Mud Slab - 2' x 82' x 2950	27,500	SY	$25.00	$687,500.00	$68,750.00	$41,250.00	$797,500.00	
31	NB - Form and Pour Retaining Wall (S) - 495'L x 16.5'D	8,200	SF	$40.00	$328,000.00	$32,800.00	$19,680.00	$380,480.00	
32	NB - Form and Pour Retaining Wall (N) - 328'L x 10.3'D	3,400	SF	$40.00	$136,000.00	$13,600.00	$8,160.00	$157,760.00	
33	NB - Form, Pour, Finish Boat Section (S)- Full Width 575'L x 26'D x 82'W	1,320,200	CF	$6.70	$8,845,340.00	$884,534.00	$530,720.40	$10,260,594.40	
34	NB - Form, Pour, Finish Boat Section (N)- Full Width 164'L x 26'D x 82' W	349,648	CF	$6.70	$2,342,641.60	$234,264.16	$140,558.50	$2,717,464.26	
35	NB - Form, Pour, Finish Boat Section (N)- AT Pier 722'L x 26'D x 62'W	1,163,864	CF	$6.70	$7,797,888.80	$779,788.88	$467,873.33	$9,045,551.01	
36	NB -Form, Pour, Finish Cut and Cover Tunnel 1558'L x 30'D x 64'W	2,991,360	CF	$9.75	$29,165,760.00	$2,916,576.00	$1,749,945.60	$33,832,281.60	
37	Backfill with Impervious Material 3300' x 25'D x 4' Wide	12,250	CY	$125.00	$1,531,250.00	$153,125.00	$91,875.00	$1,776,250.00	
38	F&I Vent Bldg,Pump Station w/ Electric Substation	1	LS	$5,000,000.00	$5,000,000.00	$500,000.00	$300,000.00	$5,800,000.00	
39	Tunnel Power, Lighting, Mechanical	1,600	LF	$6,000.00	$9,600,000.00	$960,000.00	$576,000.00	$11,136,000.00	
40	Restore Site to Grade 140' x 4000'	560,000	SF	$7.50	$4,200,000.00	$420,000.00	$252,000.00	$4,872,000.00	
							Subtotal	$223,288,634.78	
	Escalation to Midpoint of Construction 2011 – 2.75% at 9 1/2 Years = 1.294							$65,668,964.20	
							Subtotal	$288,957,598.78	
							Design Contingency - 50%	$154,794,846.06	
							Total Construction Cost	**$443,752,445.00**	
							Engineering Design Costs - 10%	**$44,375,244.00**	
							Engineering Construction Management Costs - 10%	**$44,375,244.00**	
							TOTAL PROJECT COST	**$532,503,000**	

IX.2 MAINTENANCE - ANNUAL ESTIMATED COSTS

Description	Number	Quantity	Unit	Material Price	Total Material	Labor Price	Labor Total	Equipment Price	Equipment Total	Total
Crew Cost										
Heavy Equipment	1	40	Hrs					$50.00	$2,000.00	$2,000.00
Operators	1	40	Hrs			$38.77	$1,550.80			$1,550.80
Labor Foreman	1	40	Hrs			$32.50	$1,300.00			$1,300.00
Laborers	4	40	Hrs			$29.00	$4,640.00			$4,640.00
Truck Drivers	1	40	Hrs			$29.74	$1,189.60	$25.00	$1,000.00	$2,189.60
Misc. – Materials	1	1	LS	$1,000.00	$1,000.00					$1,000.00
				Subtotal	**$1,000.00**		**$8,680.40**		**$3,000.00**	**$12,680.40**
				Shift Differential - 1.15%	**$1,000.00**		**$9,982.46**		**$3,000.00**	**$13,982.46**

Description	Quantity	Unit	Unit Cost	Total Cost	OH & Profit 10%	Gen Cond. 6%	Total Price			
Lighting	2	Weeks	$14,000.00	$28,000.00	$2,800.00	$1,680.00	$32,480.00			
Power Washing – Cleaning	8	Weeks	$14,000.00	$112,000.00	$11,200.00	$6,720.00	$129,920.00			
Cleaning Catch Basins	4	Weeks	$14,000.00	$56,000.00	$5,600.00	$3,360.00	$64,960.00			
Substation Maintenance	1	LS	$100,000.00	$100,000.00	$10,000.00	$6,000.00	$116,000.00			
Pump Station Maintenance	1	LS	$100,000.00	$100,000.00	$10,000.00	$6,000.00	$116,000.00			
Jet Fan Cleaning and Maintenance	4	Weeks	$14,000.00	$56,000.00	$5,600.00	$3,360.00	$64,960.00			
Paving Upgrade - 2 " Resurfacing	2,500	Ton	$40.00	$100,000.00	$10,000.00	$6,000.00	$116,000.00			
Pavement Re –Markings	1	LS	20,000.00	20,000.00	2,000.00	1,200.00	23,200.00			
						Subtotal	**$663,520.00**			
						Escalation to Completion of Construction 2013 - 3.5% at 11 Years = .460	$305,219.20			
						Contingency (on total) - 25%	$242,184.80			
						Total Estimated Annual Maintenance Costs	**$1,210,924.00**			
						Estimated Operational Energy Costs	$717,590.00			
						Total Estimated Annual Cost to Operate Tunnel	**1,928,514.00**			

VIII. FINAL CONCLUSIONS AND RECOMMENDATIONS

The intent of this report is to investigate and document the feasibility of constructing a roadway tunnel along Route 9 in Middletown. For the purpose of this study, the feasibility of constructing a cut and cover tunnel was investigated. Based on limited existing condition information and conservative assumptions, it is determined that at an estimated price of $550 million plus $1.9 million per year in maintenance of a roadway tunnel, approximately 1,200 feet in length can be constructed.

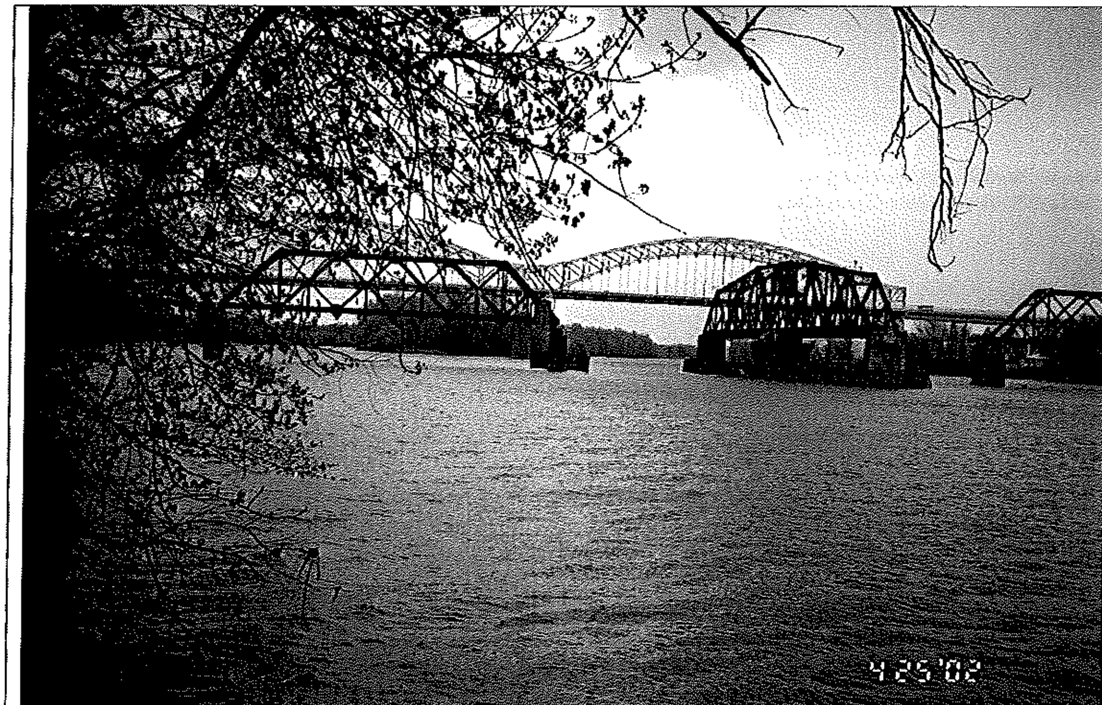
The benefit of improved access to the waterfront would be provided to the City of Middletown through the implementation of the tunnel. However, waterfront access would be limited by a fence along both sides of an active rail line. Pedestrian access would be restricted to gate controlled pedestrian crossings. Based on the costs and limitations on pedestrian traffic, the overall benefit of the tunnel appears to be disproportionate with the anticipated costs. Therefore, we recommend the pursuit of supplementary alternatives to provide improved waterfront access.

Throughout the Preliminary Engineering phase of the Route 9 Study an alternative concept for enhancing pedestrian access to the riverfront was considered by the Route 9 Corridor Advisory Committee (CAC). This alternative to a tunnel provides a pedestrian platform over deKoven Drive, the railroad tracks and Route 9. This pedestrian promenade could be connected to the existing pedestrian platform built as a part of the new police station. In addition to the benefit of direct pedestrian access from the Main Street area, the new platform could lead into the availability of air rights for development over Route 9. This potential dual use provides the access that the City desires and provides potential for development right along the waterfront.

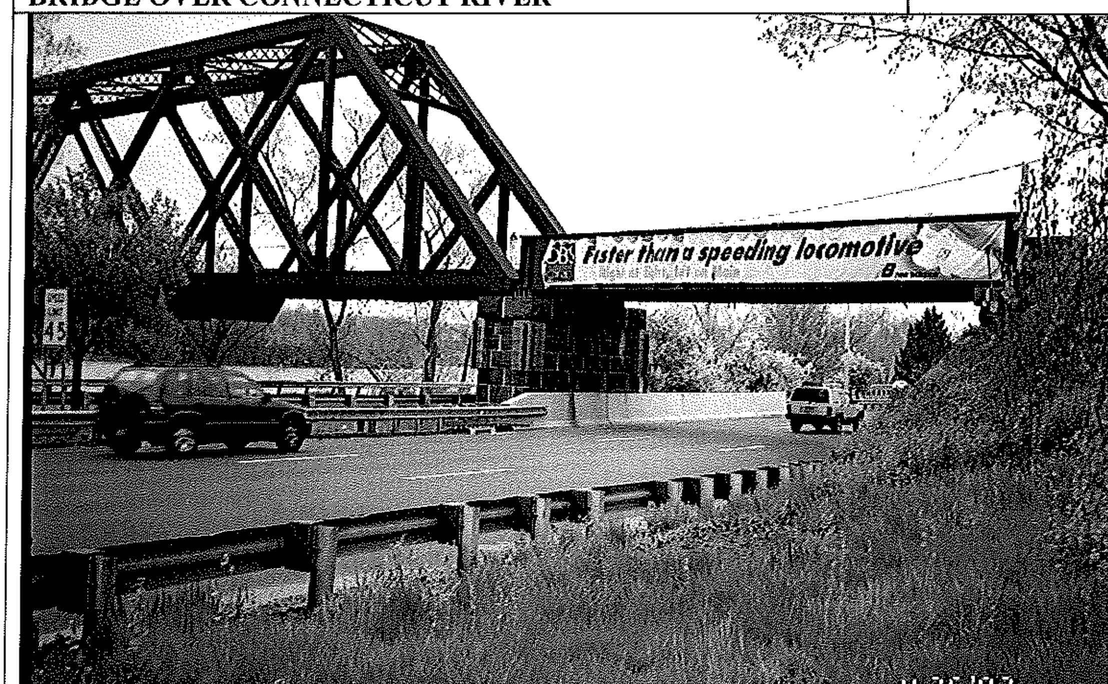
It is our recommendation that the City and the State enter into a discussion over the potential funding of a pedestrian platform over Route 9. The platform would address the City's desire to enhance their access to the riverfront and would provide a more economical alternative for the Department of Transportation. Additionally, the platform would have a minimal impact on existing traffic operations, while the construction of the tunnel would have a major impact on traffic during construction activities. During our discussions with the Middletown merchants and residents, limiting the adverse impacts of construction was a priority.

APPENDIX-A

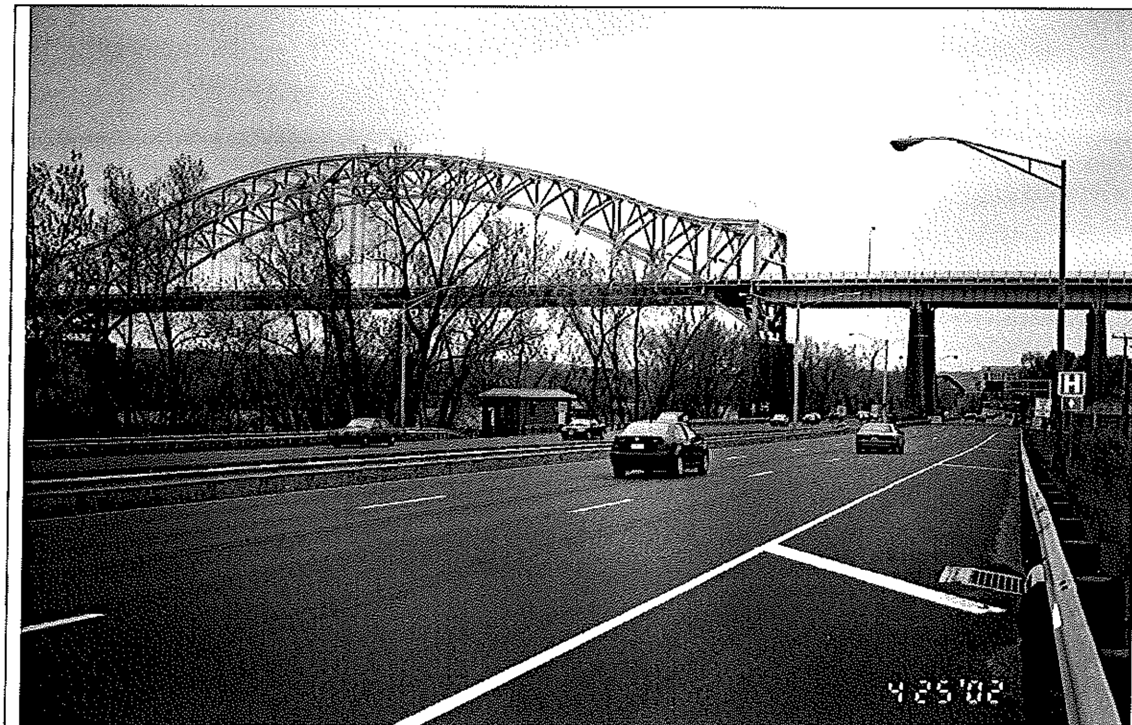
Photographs



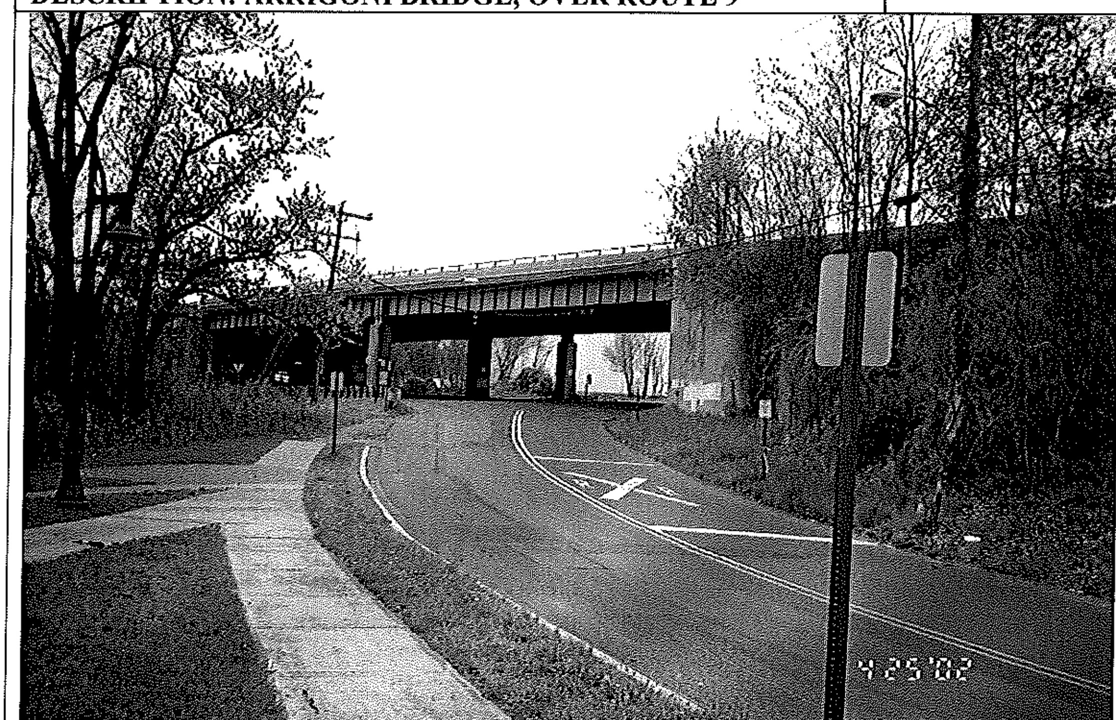
VIEW LOOKING: NORTH DESCRIPTION: PROVINCE & WORCHESTER RAIL ROAD BRIDGE OVER CONNECTICUT RIVER	PHOTO NO. 1



VIEW LOOKING: SOUTH DESCRIPTION: PROVINCE & WORCHESTER RAIL ROAD BRIDGE OVER ROUTE 9 SOUTHBOUND	PHOTO NO. 2

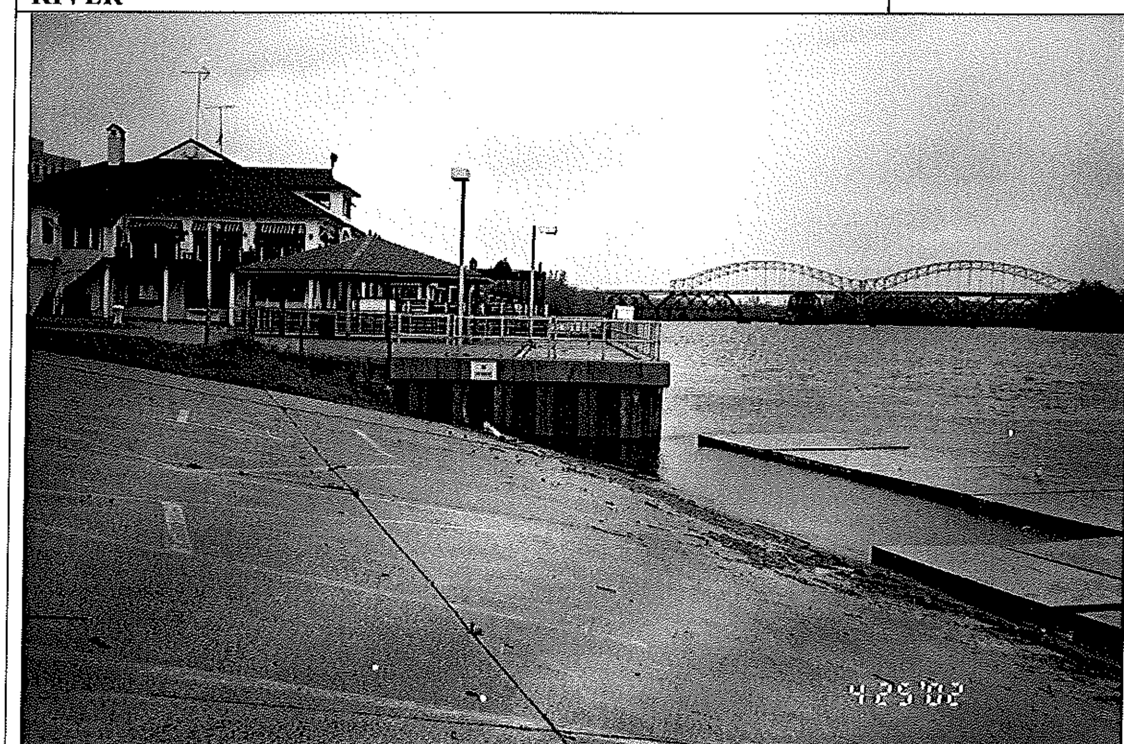


VIEW LOOKING: SOUTH DESCRIPTION: ARRIGONI BRIDGE, OVER ROUTE 9	PHOTO NO. 3

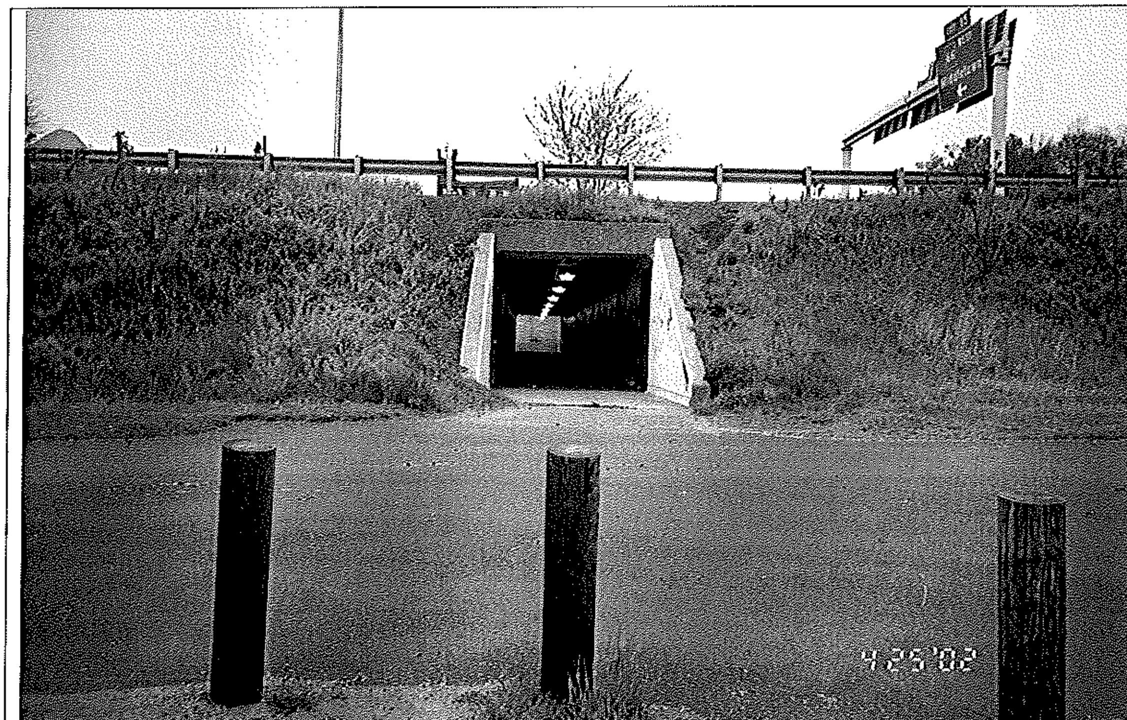


VIEW LOOKING: WEST DESCRIPTION: UNION STREET ROUTE 9 OVERPASS	PHOTO NO. 4

VIEW LOOKING: NORTH DESCRIPTION: HARBOR PARK ALONG CONNECTICUT RIVER	PHOTO NO. 5



VIEW LOOKING: NORTH DESCRIPTION: EXISTING RESTAURANT ALONG CONNECTICUT RIVER	PHOTO NO. 6



VIEW LOOKING: WEST DESCRIPTION: HARBOR PARK PEDESTRIAN TUNNEL UNDER ROUTE 9	PHOTO NO. 7

VIEW LOOKING: NORTH DESCRIPTION: ACCESS TO ROUTE 9 FROM UNION STREET UNDERPASS	PHOTO NO. 8

VIEW LOOKING: SOUTH DESCRIPTION: WASHINGTON STREET INTERSECTION WITH ROUTE 9 SOUTHBOUND	PHOTO NO. 9

VIEW LOOKING: NORTH DESCRIPTION: WASHINGTON STREET INTERSECTION WITH ROUTE 9 SOUTHBOUND	PHOTO NO. 10

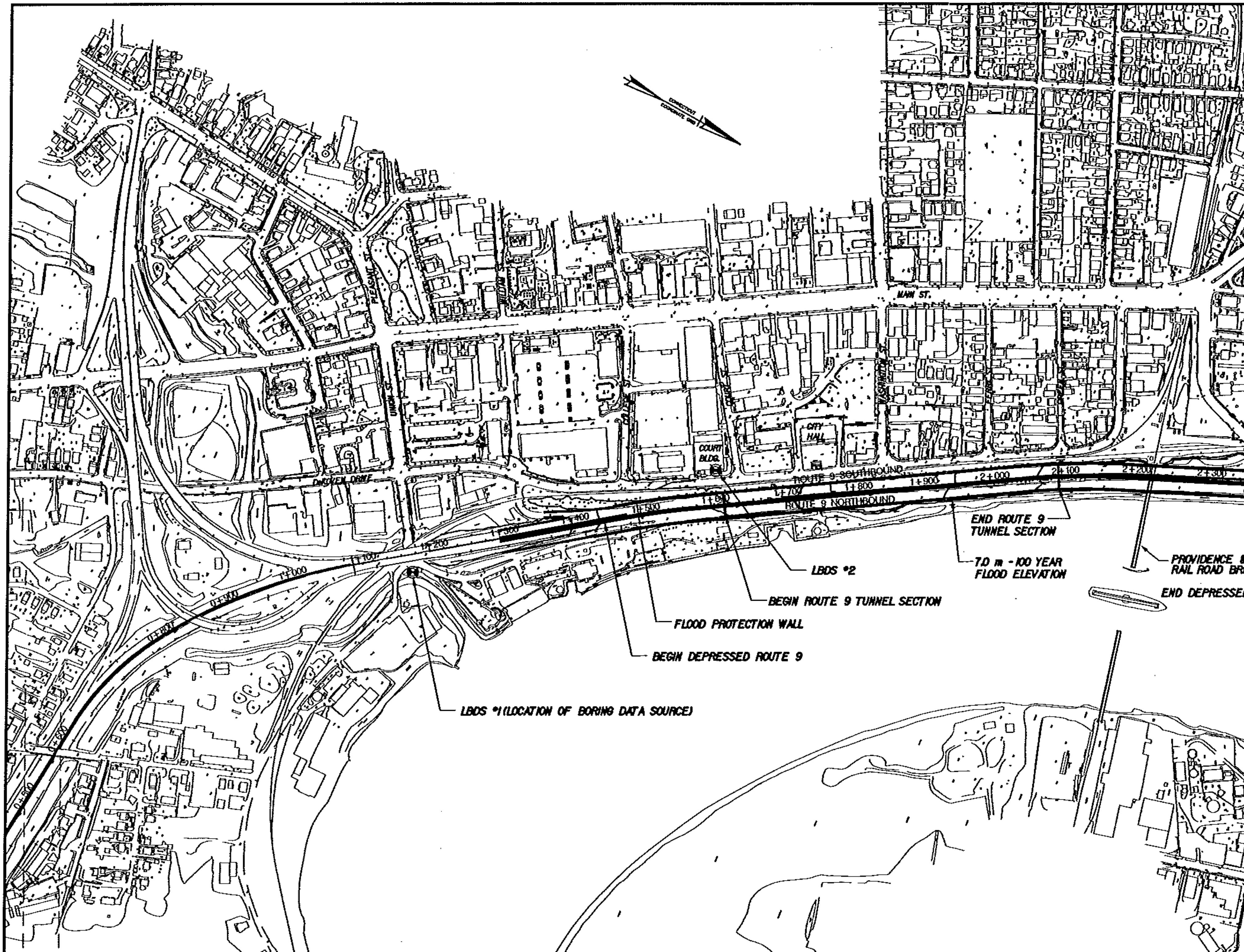
VIEW LOOKING: SOUTH DESCRIPTION: DEKOVEN DRIVE AT WASHINGTON STREET	PHOTO NO. 11

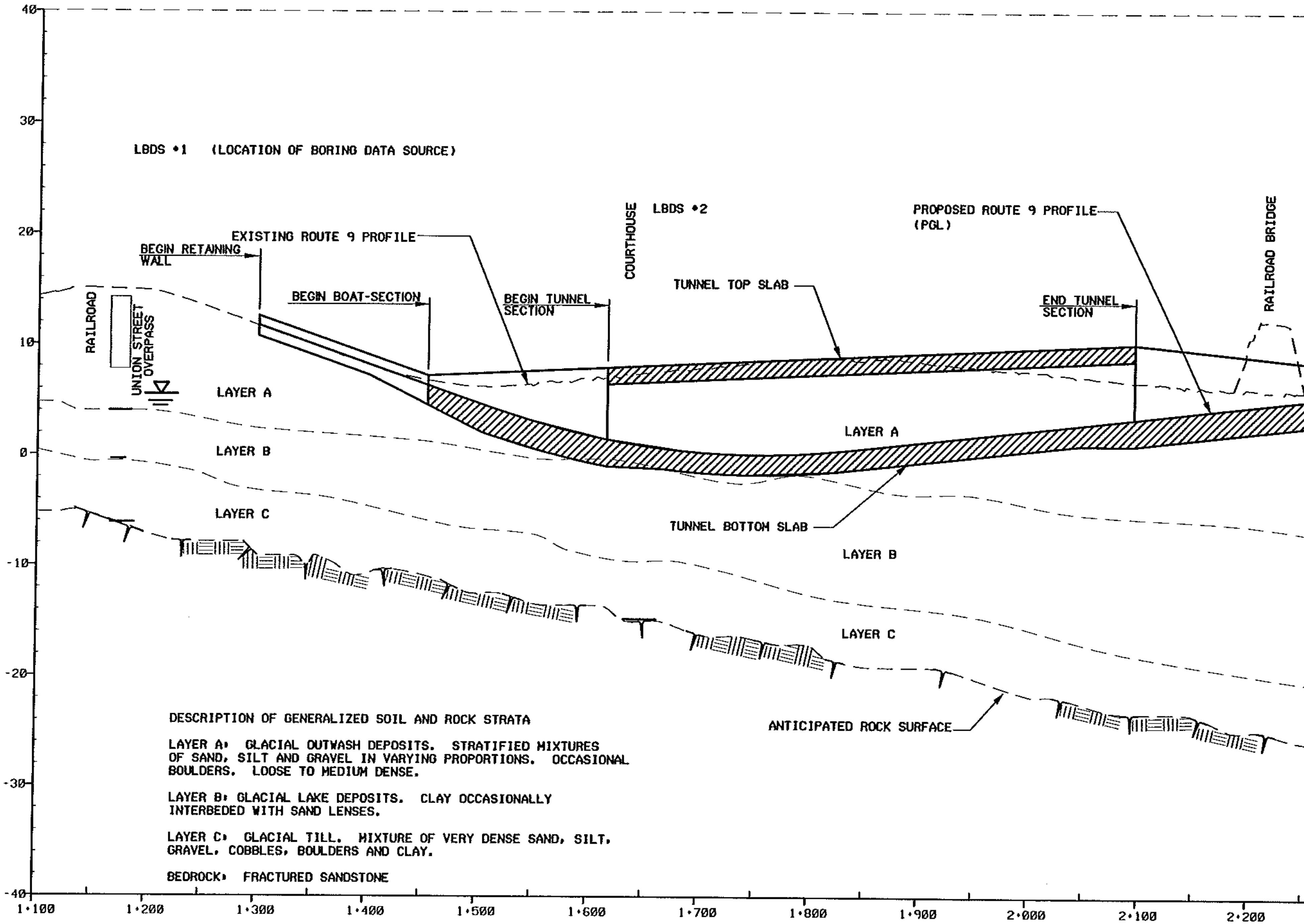
VIEW LOOKING: SOUTH DESCRIPTION: ROUTE 9 DEKOVAN EXIT	PHOTO NO. 12

APPENDIX-B

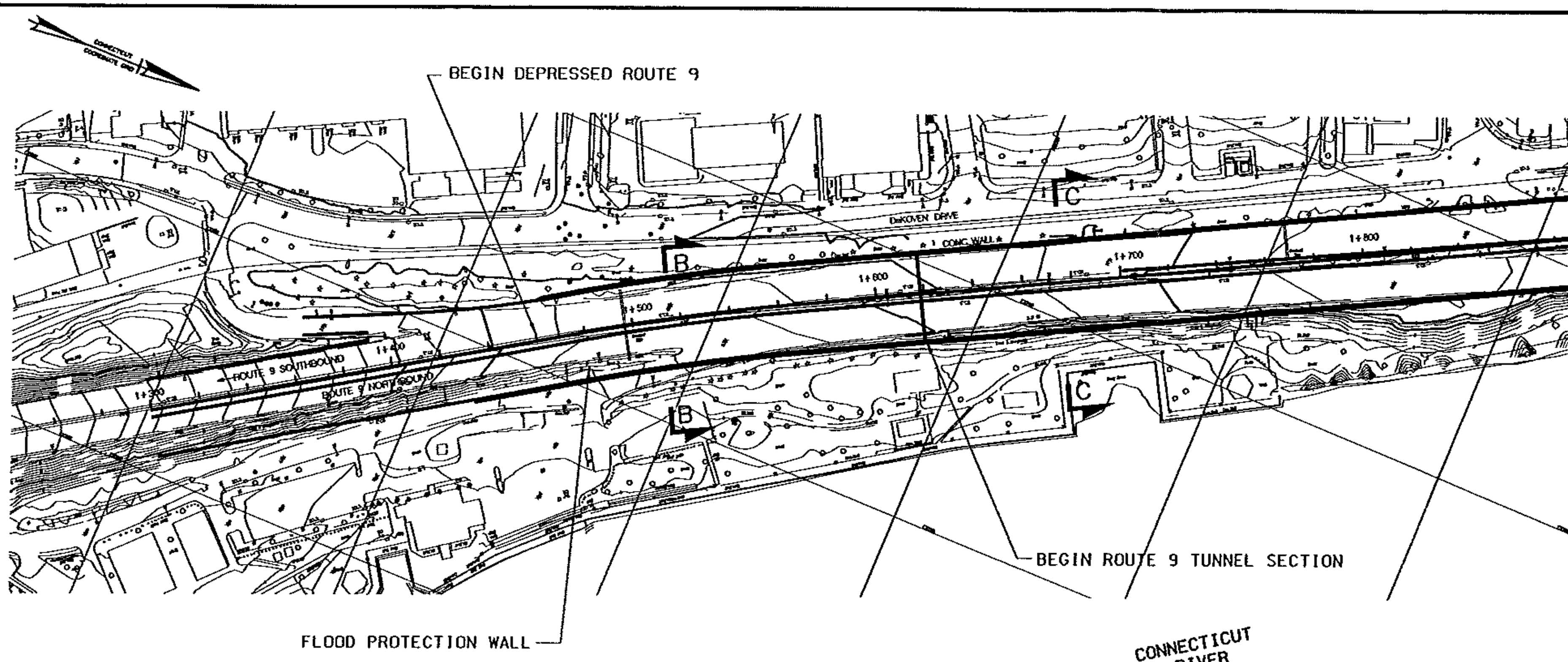
Schematic Drawings

List of Drawings

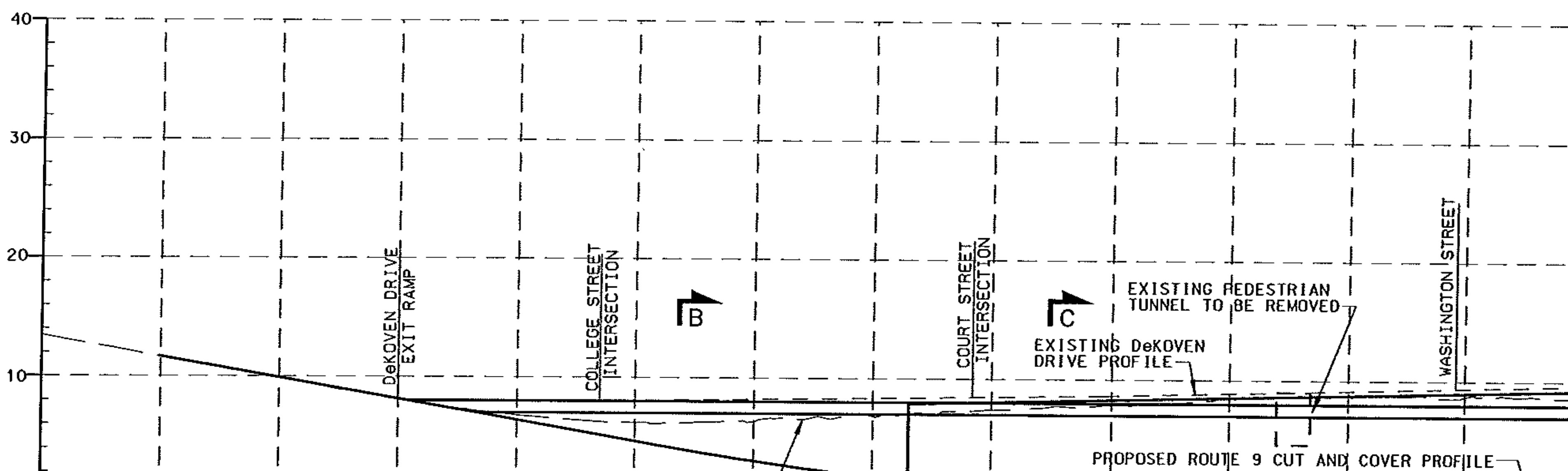

MAIN ST.
PLEASANT ST.
UNION ST.
DeKOVEN DRIVE
WASHINGTON ST.
CITY HALL
COURT BLDG.
ROUTE 9 SOUTHBOUND
ROUTE 9 NORTHBOUND
END ROUTE 9 TUNNEL SECTION
7.0 m - 100 YEAR FLOOD ELEVATION
PROVIDENCE &
RAIL ROAD BR
END DEPRESSE
LBDS #2
BEGIN ROUTE 9 TUNNEL SECTION
FLOOD PROTECTION WALL
BEGIN DEPRESSED ROUTE 9
LBDS #1 (LOCATION OF BORING DATA SOURCE)
CONNECTICUT COORDINATE GRID

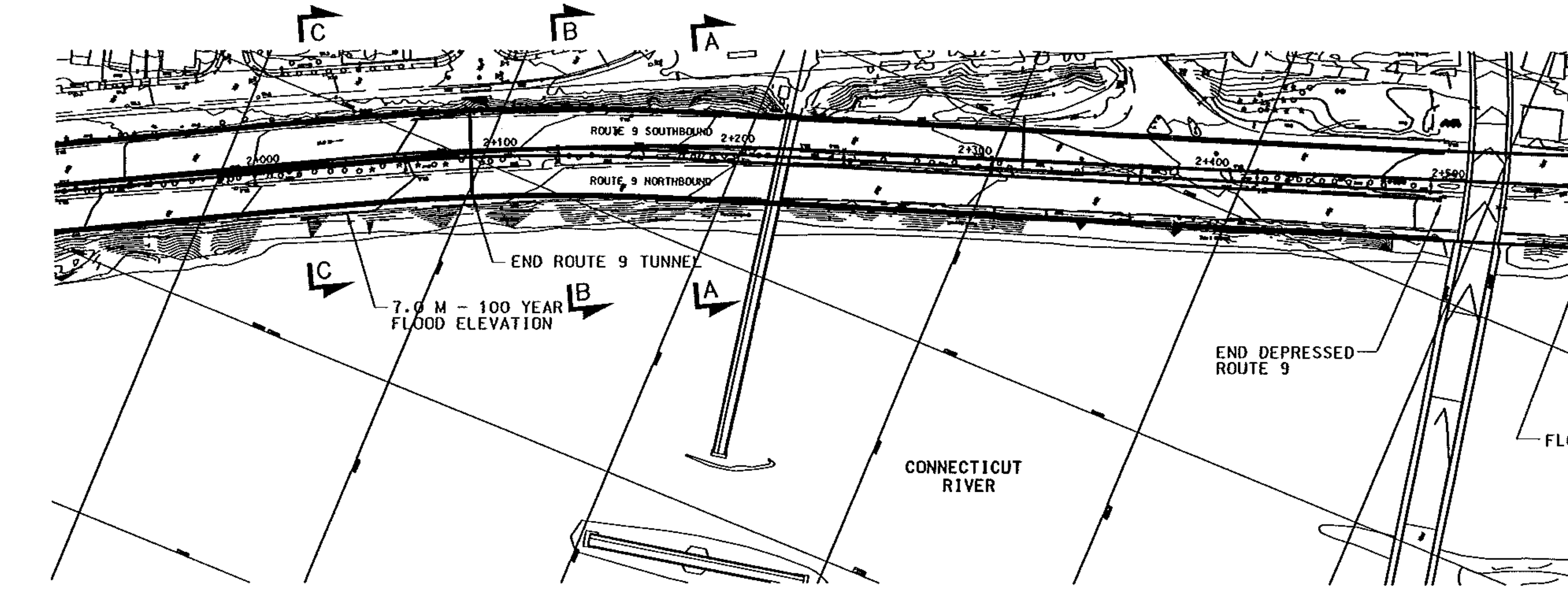

LBDS •1 (LOCATION OF BORING DATA SOURCE)
LBDS •2
COURTHOUSE
EXISTING ROUTE 9 PROFILE
BEGIN RETAINING WALL
BEGIN BOAT-SECTION
BEGIN TUNNEL SECTION
TUNNEL TOP SLAB
END TUNNEL SECTION
PROPOSED ROUTE 9 PROFILE (PGL)
RAILROAD BRIDGE
RAILROAD
UNION STREET OVERPASS
LAYER A
LAYER B
LAYER C
TUNNEL BOTTOM SLAB
ANTICIPATED ROCK SURFACE
DESCRIPTION OF GENERALIZED SOIL AND ROCK STRATA
LAYER A: GLACIAL OUTWASH DEPOSITS. STRATIFIED MIXTURES OF SAND, SILT AND GRAVEL IN VARYING PROPORTIONS. OCCASIONAL BOULDERS. LOOSE TO MEDIUM DENSE.
LAYER B: GLACIAL LAKE DEPOSITS. CLAY OCCASIONALLY INTERBEDED WITH SAND LENSES.
LAYER C: GLACIAL TILL. MIXTURE OF VERY DENSE SAND, SILT, GRAVEL, COBBLES, BOULDERS AND CLAY.
BEDROCK: FRACTURED SANDSTONE
40
30
20
10
0
-10
-20
-30
-40
1+100
1+200
1+300
1+400
1+500
1+600
1+700
1+800
1+900
2+000
2+100
2+200

NOTES:

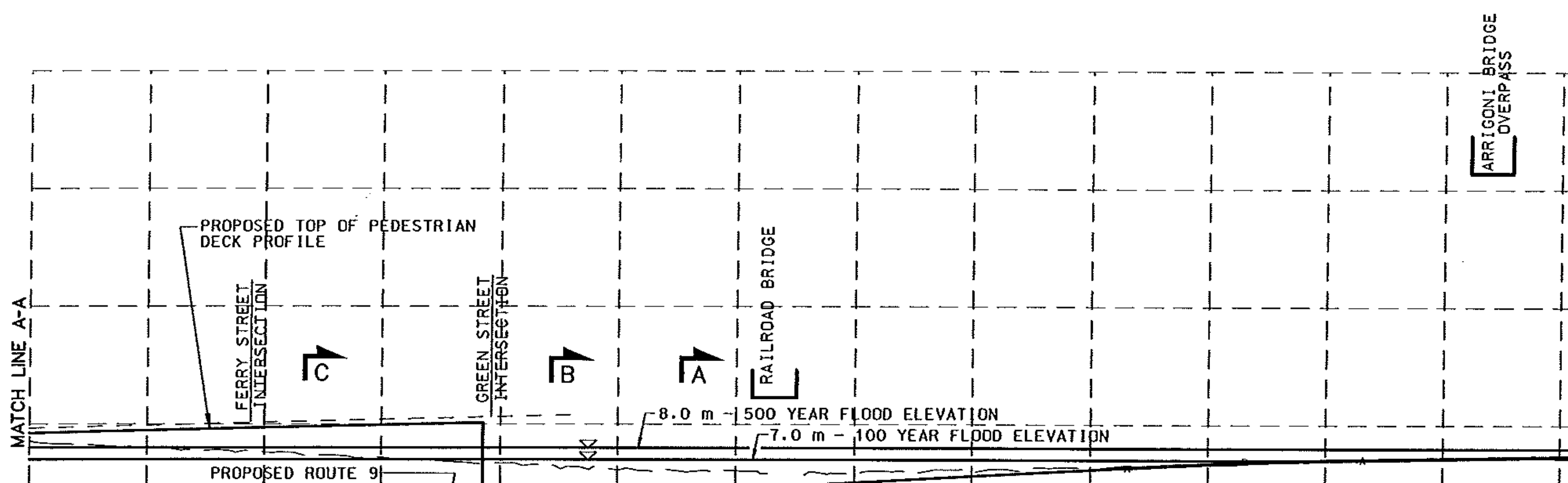


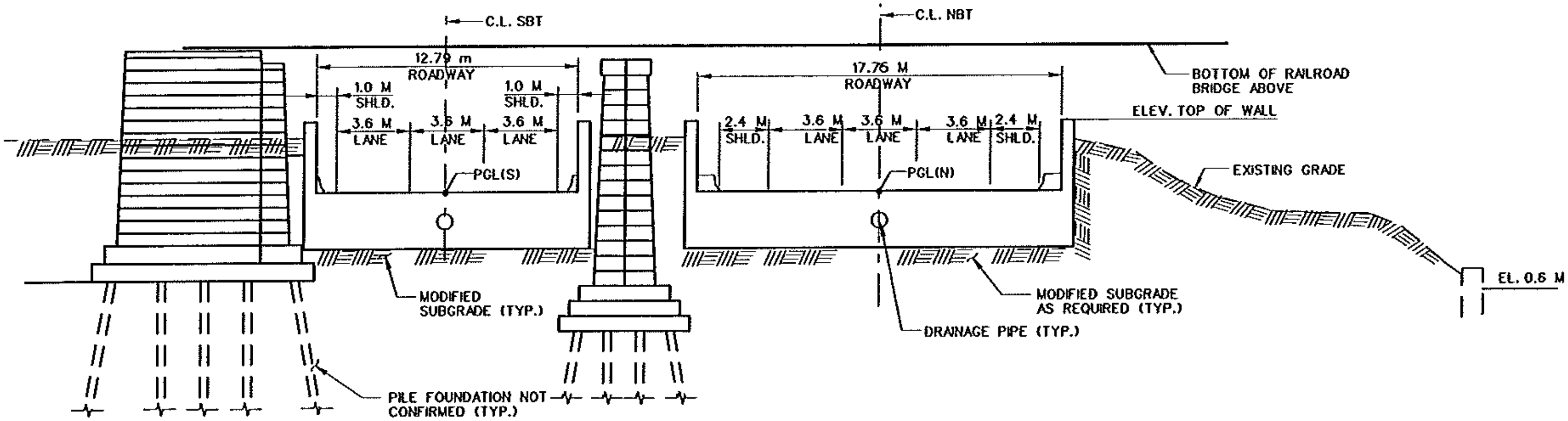
GENERAL PLAN - PART I





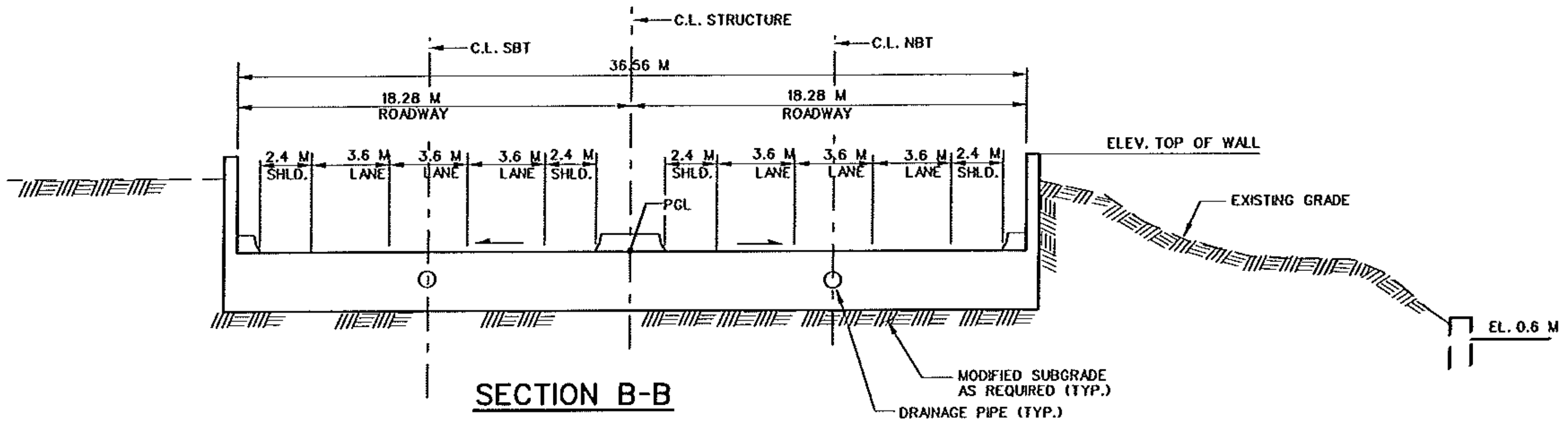
GENERAL PLAN - PART II





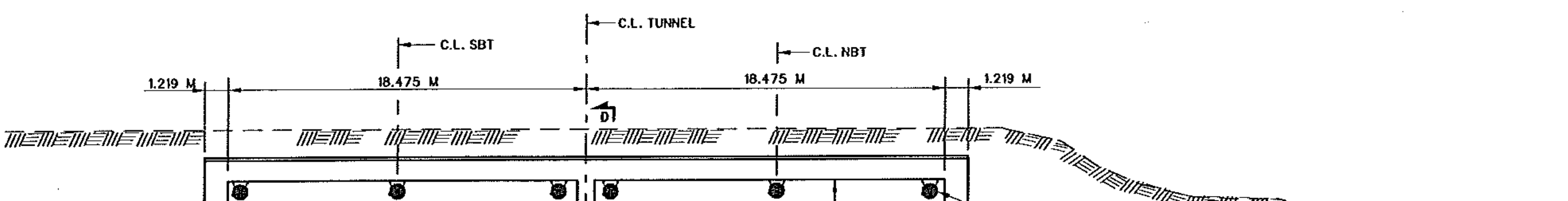
SECTION A-A

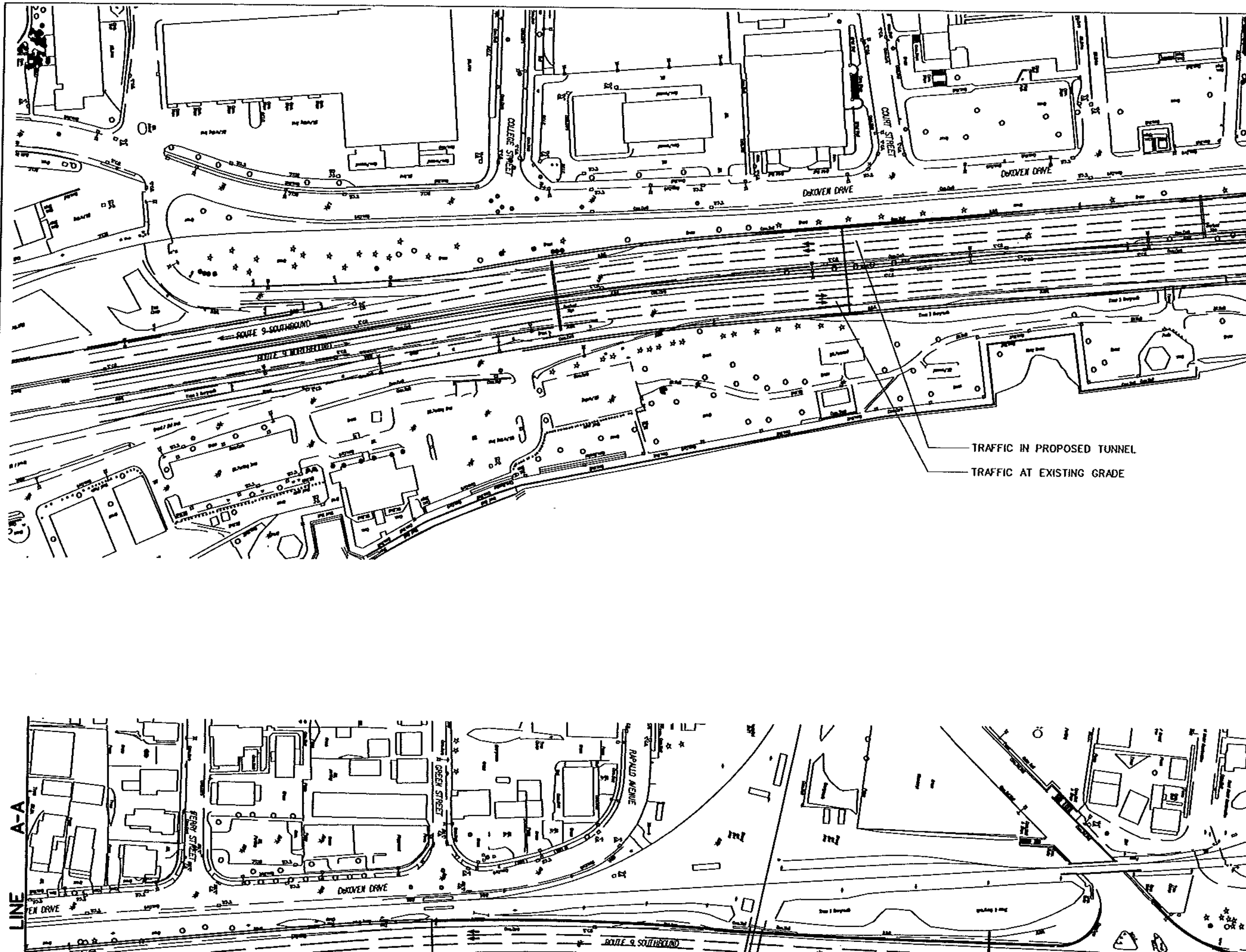
TYPICAL SECTION (DUAL BOAT-SECTIONS)
DEPRESSED ROUTE 9 TUNNEL
LOOKING NORTH

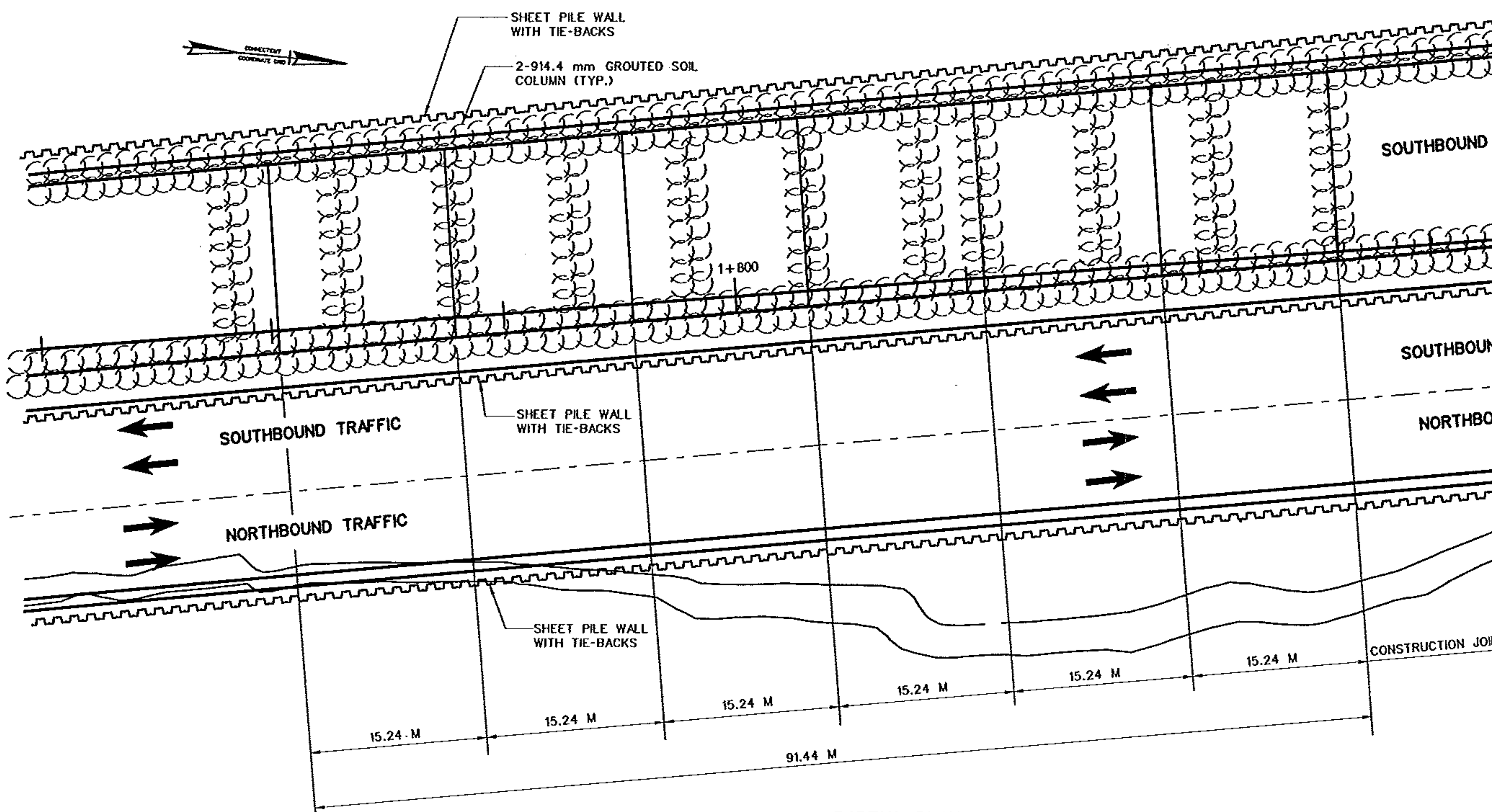


SECTION B-B

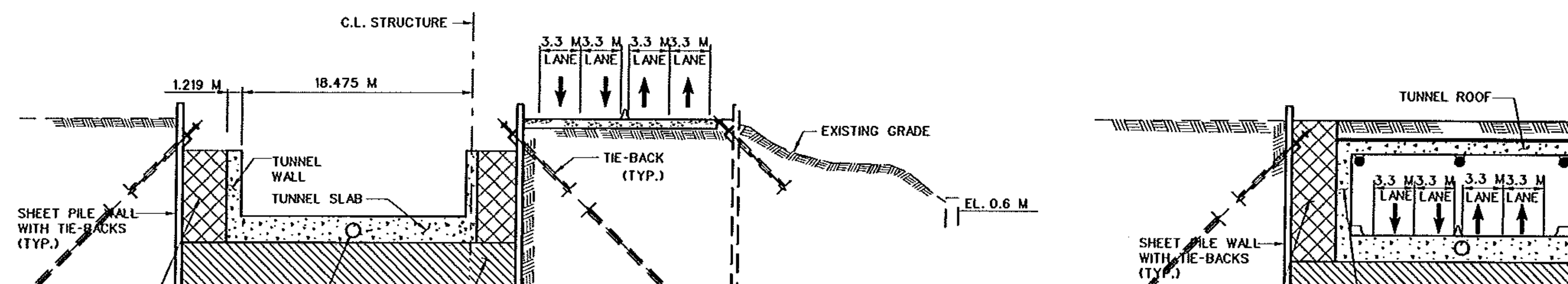
TYPICAL SECTION (BOAT-SECTION)
DEPRESSED ROUTE 9 TUNNEL
LOOKING NORTH

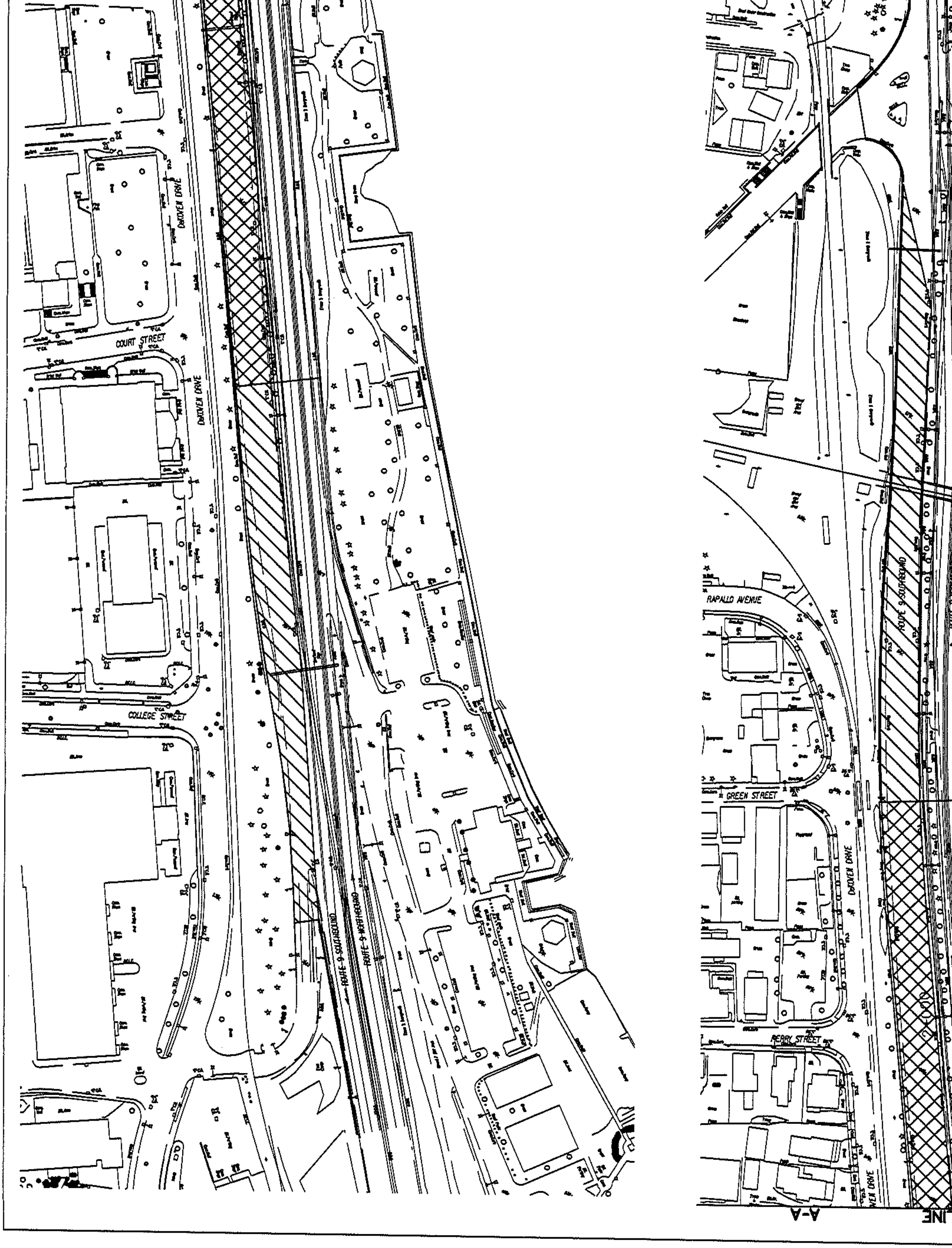



TRAFFIC IN PROPOSED TUNNEL
TRAFFIC AT EXISTING GRADE
COURT STREET
DeKOVEN DRIVE
COLLEGE STREET
ROUTE 9 SOUTHBOUND
ROUTE 9 NORTHBOUND
RAPALLO AVENUE
GREEN STREET
FERRY STREET
A-A
LINE



PARTIAL PLAN -TUNNEL SECTION





COURT STREET
DeKOVEN DRIVE
COLLEGE STREET
ROUTE 9-SOUTHBOUND
ROUTE 9-NORTHBOUND
RAPALLO AVENUE
GREEN STREET
PERRY STREET
A-A


TRAFFIC IN PROPOSED TUNNEL
DeKOVEN DRIVE
COURT STREET
COLLEGE STREET
ROUTE 9 SOUTHBOUND
ROUTE 9 NORTHBOUND
RAPALLO AVENUE
GREEN STREET
PERRY STREET
MATCH LINE A—A

1+700
1+600
1+500
1+400
1+300
COURT STREET
DeKOVEN DRIVE
COLLEGE STREET
ROUTE 9 SOUTHBOUND
ROUTE 9 NORTHBOUND
2+400
2+300
2+200
2+100
2+000
RAPALLO AVENUE
GREEN STREET
BERRY STREET
LINE A-A

APPENDIX-C

Magazine Article

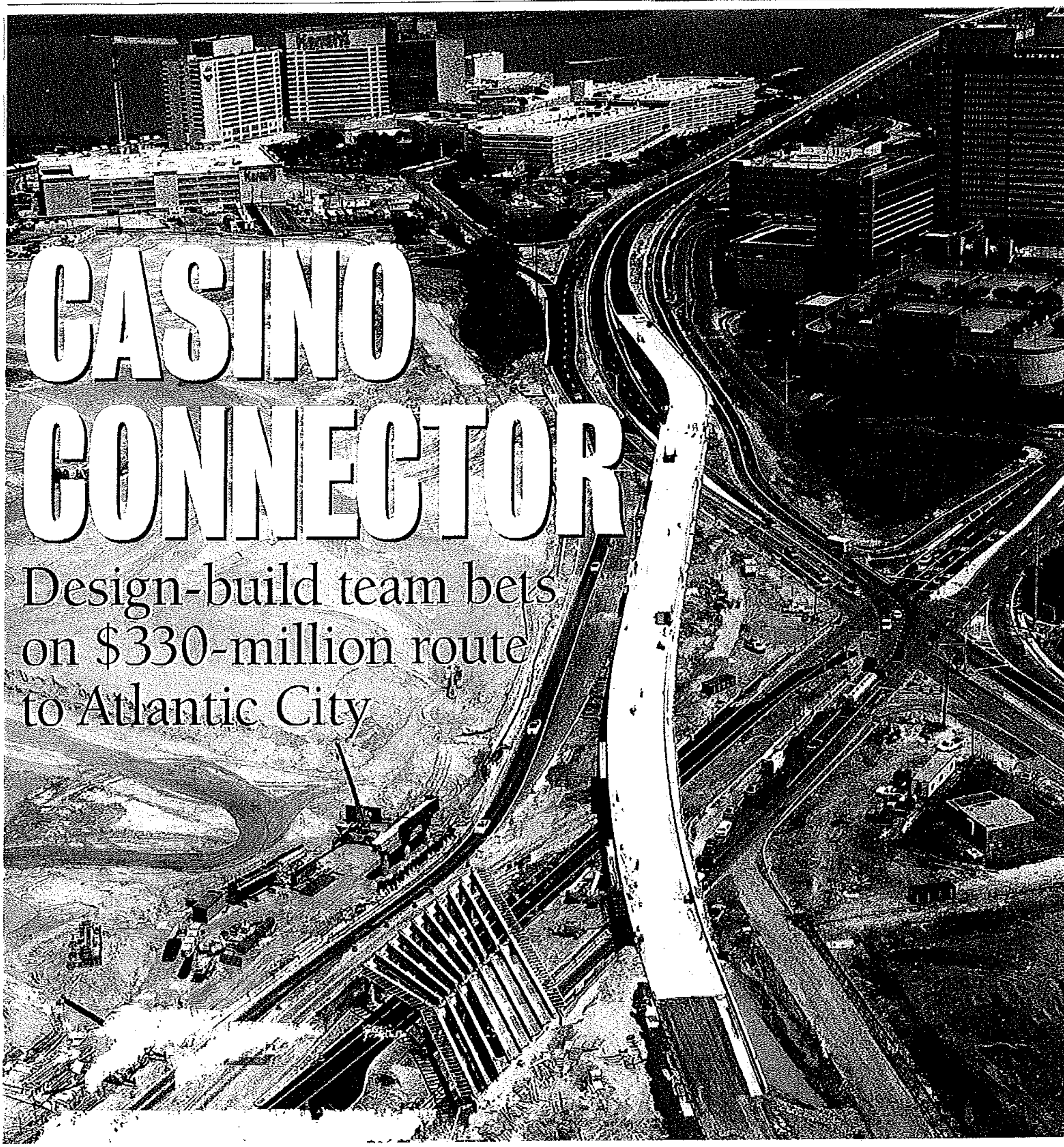
ENR (June 18, 2001), pp. 42-44

Making the Right Cut on Atlantic City Route

ENR
Engineering News-Record

THE TOP 100
- DESIGN-BUILDERS
- CONSTRUCTION MANAGERS

enr.com | A Publication of The McGraw-Hill Companies | June 18, 2001 $5

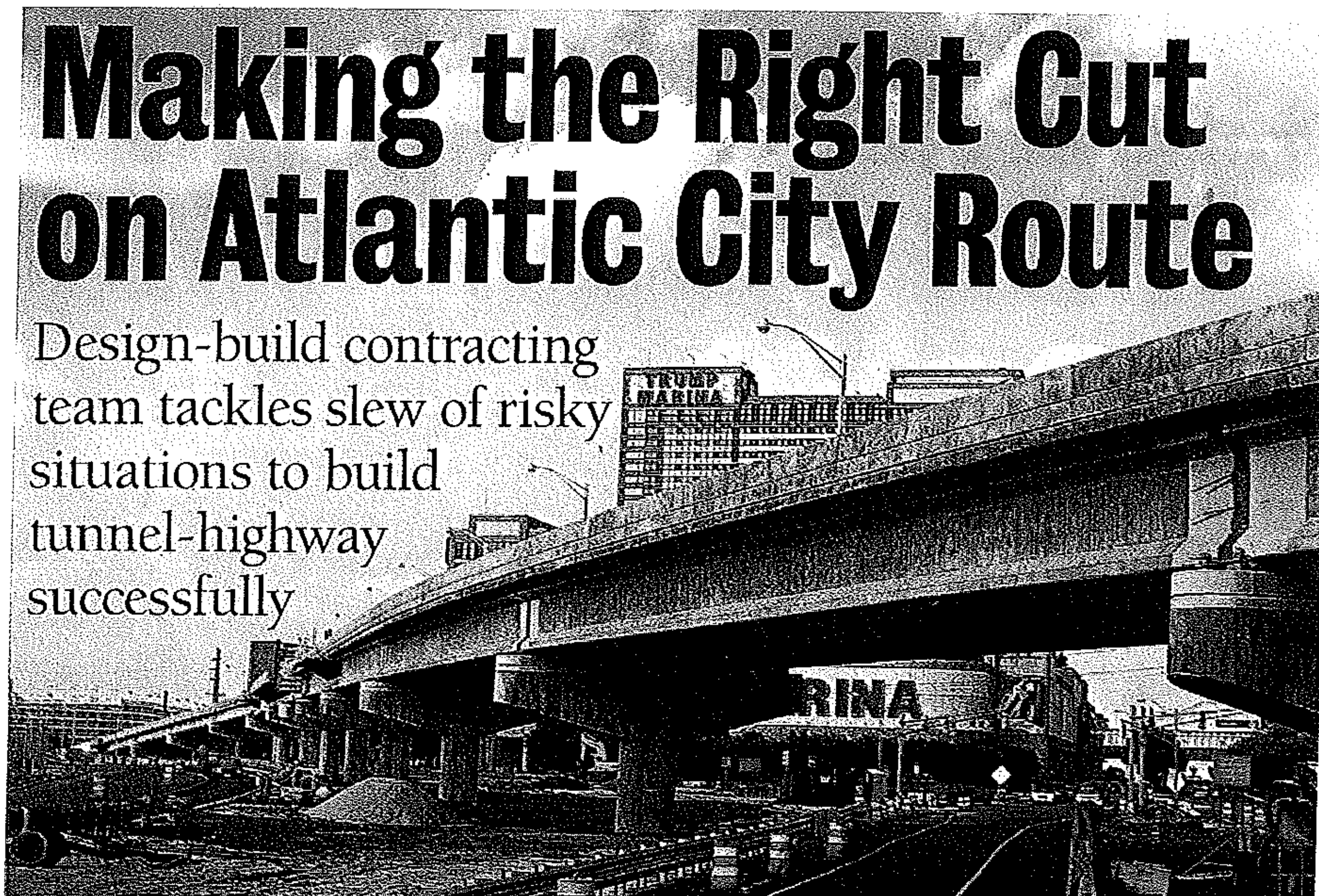


CASINO CONNECTOR

Design-build team bets on $330-million route to Atlantic City

Making the Right Cut on Atlantic City Route

Design-build contracting team tackles slew of risky situations to build tunnel-highway successfully



HIGH STAKES Tunnel-highway connector will provide flood evacuation for the city as well as faster casino access.

PHOTO COURTESY GRANITE JOINT VENTURE/GREGG KOHL

In a city of gamblers, no high-stakes undertaking has more significant risks and rewards than that of the $330-million Atlantic City-Brigantine Connector. Dealt a design-build card, the joint venture team building the 2.5-mile route is playing to win—nearing completion of a 2,000-ft cut-and-cover tunnel, 10 new bridges and 2.3 miles of new highway in extremely tight conditions with many challenges.

Yonkers Contracting Co., Yonkers, N.Y., with Granite Construction, Watsonville, Calif., tackled the New Jersey project's 30-month schedule, difficult geology and a range of other challenges from wetlands to relocating powerplants. Since work began after 5 to 10% of design in late 1998, the team has incorporated a number of innovative methods into the project—usually, but not always, successfully. "You see the people coming here to gamble," notes Lawrence W. Klein, Yonkers vice president for construction. "We're contractors. We gamble every day. We don't need to go to the casinos."

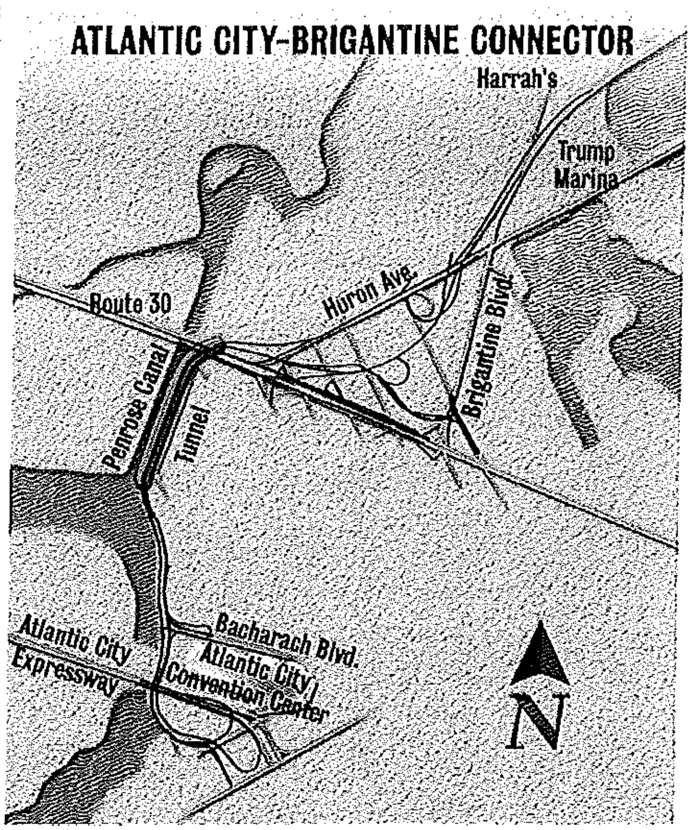
The team negotiated with the South Jersey Transportation Authority (SJTA), which will own and operate the connector, to push back an original completion date of May 1 several times to July 16. In the interim, there have been lawsuits by residents and casino mogul Donald Trump, investigations by environmental agencies, a protest over a New Jersey Transit rail crossing and an endless technical obstacle course. "There are controversial topics," says Randy Merrill, senior engineer for Parsons Brinckerhoff and Goodkind & O'Dea, program managers for the authority. "But the bottom line is that the tunnel will be open by mid-July."

Flanked by Penrose Canal just 15 ft on one side and houses on the other, the four-lane connector dips under U.S. Highway 30 and links to the Atlantic City Expressway. It will be a seamless route connecting some 17,000 vehicles a day from the expressway to the resort's marina district—and provide a flood evacuation route for the island of Brigantine.

ROLL OF THE DICE. Hotelier Steve Wynn, planning a Mirage Resort in Atlantic City, financed $110 million of the project as part of a partnership with the SJTA and the state Casino Reinvestment Development Authority. The transportation agency itself provided an additional $125 million, and another $95 million came from the state transportation trust fund. "We in turn will get back parking fees plus tolls," says James A. Crawford, SJTA's executive director. The three owners agreed to use design-build, which is not uncommon in casino construction, notes Joseph Iorio, Yonkers vice president. The project would have taken another three or four years with design-bid-build, estimates Carl Petrillo, founder of Yonkers.

Design began under the lead of URS Corp.'s New York City office. Then, the Yonkers-Granite team edged out competing teams led by Slattery Skanska, Whitestone, N.Y., and Schiavone Construction, Secaucus, N.J. For a while, "Yonkers had three engineers sitting in the URS office daily," recalls Klein. Now, "we have biweekly coordination meetings" with representatives from PB, the three owners and Frederic R. Harris, New York City, as the construction inspector." The project team is also one of the few nationwide in heavy construction that is operating under the U.S. Occupational Safety & Health Administration's Voluntary Protection Program, says Tom Smith, Yonkers safety program director. OSHA inspected the project intensively after the first year and has exempted it from further regular inspections.

MAKE WAY. Utilities of every type, including a 69,000-kv power line, 36-in. sewer pipes and 48-in. water lines, had to be relocated, says Bruce Carnovale, Yonkers project engineer. The team also demolished or moved 20,000-sq-ft of powerplant facilities to make room, shifted 2,000 ft of rail tracks and rebuilt 3,680 ft of marina bulkhead, plus a small park. Building the grade crossing at New Jersey Transit tracks caused some upset, but "we determined it was more important to have a full interchange for the back of the convention center than to try to go over or under [the tracks]," says Crawford. "We couldn't do both."



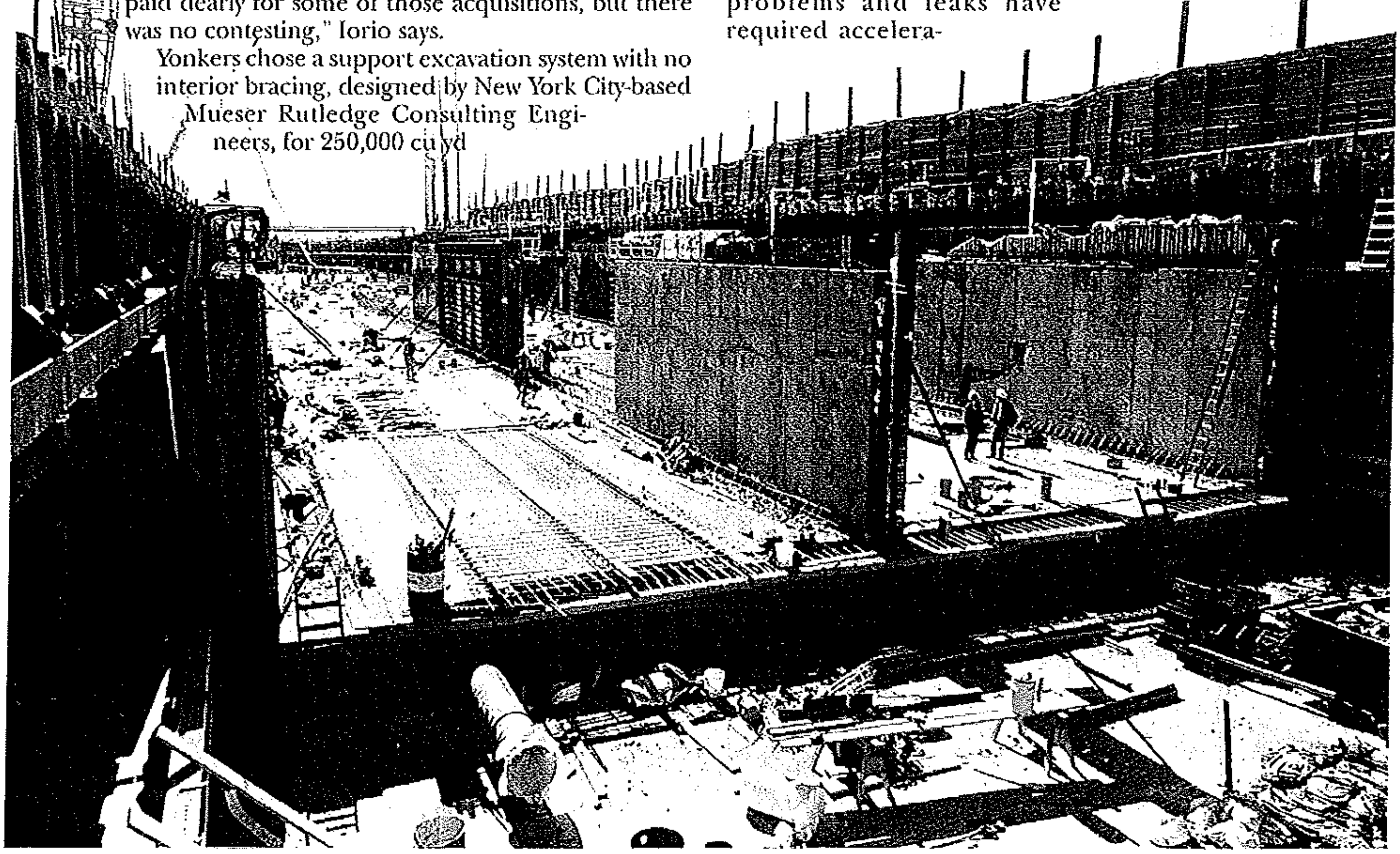
Site access is restricted to existing right of way, so equipment and workers—245 at peak for the contractor and 150 for subcontractors—navigate past each other. Nine homes were acquired. "The owners paid dearly for some of those acquisitions, but there was no contesting," Iorio says.

Yonkers chose a support excavation system with no interior bracing, designed by New York City-based Mueser Rutledge Consulting Engineers, for 250,000 cu yd of tunnel excavation. When the team proposed the method, an alternative to the designers' preferred top-down design, "we evaluated the request and agreed," says PB's Merrill.

Hayward Baker Inc., Odenton, Md., designed giant jet grout columns to be drilled perpendicular to the alignment, forming a subgrade brace. "This is the first time we've used jet grout columns to support a cofferdam this way," says Dave Cacoilo, Mueser Rutledge partner. "The system is unique in that it's not a solid mat of grout."

The subgrade cones are typically 13 ft in dia., 7 ft deep, and sealed with steel sheeting. As workers excavated down, they installed a top row of tiebacks. Once tiebacks were in, they could excavate down to the bottom. The system allowed for almost half the typical weight of steel sheets and only one row of tiebacks, notes Cacoilo.

The tunnel required construction of a 30-ft-dia., 65-ft deep pump station system supported by cement columns. Soil mix problems and leaks have required accelera-



BUOYANT Four-lane, 2,000-ft tunnel below canal level is anchored down by the weight of concrete slabs rather than piles.

MAP BY NANCY SOULLIARD FOR ENR; PHOTO COURTESY OF YONKERS GRANITE JOINT VENTURE/GREGG KOHL tion of scheduling to six 10-hour days to pressure-grout voids, says Michael Bianchini, Yonkers project manager.

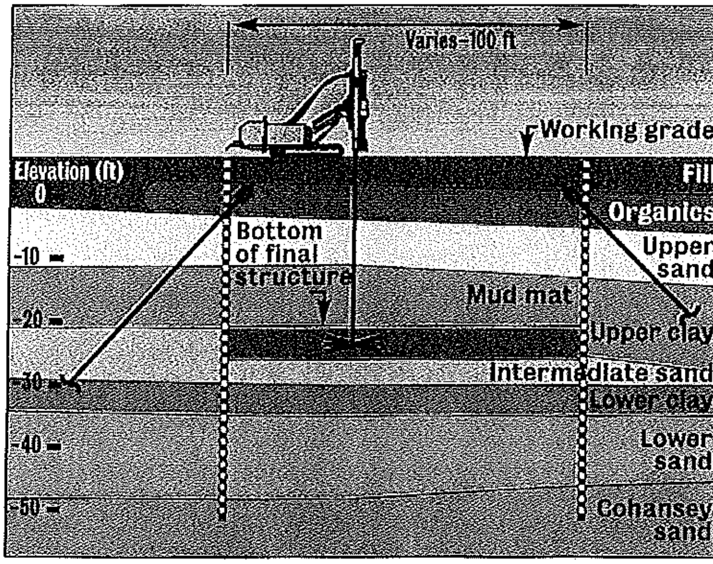
The tunnel, 90 ft wide and 20 ft below canal level, avoids buoyancy in the wet soil by the extra weight of the bottom slabs, up to 7 ft thick and placed in 50-ft sections. Precast roof slabs for the tunnel are reinforced with cast-in-place slabs on top. Twenty-four jet fans provide ventilation, and three pumps with capacity of 4,900 gal per minute protect against a 250-year flood.

BRIDGES. The bridges typically have cast-in-place stub abutments wrapped with special mechanically stabilized retaining walls, supplied by Reinforced Earth Co., Vienna, Va. The embankments required 300,000 cu yd of earth, mostly transported from tunnel excavation. The 30-ft elevated roadway required 130,000 cu yd of surcharge, up to 18 ft. Settlement reached 4.5 ft at its worst, says Carnovale. Galvanized wire baskets with fabric were interlocked on the 23 retaining walls. "The fabric allowed us to preload the abutments areas to settle," says Bianchini. Amid swarms of gnats, workers hung precast panels on the galvanized straps after settlement. The surcharging process provided a good lesson learned from the contractor, says Robert Fulton, inspection team head for Harris.

An ambitious design for cutting back on piles was successful, but it took some trial and error. The bridges rest on 16-in.-dia. steel shell piles filled with concrete, up to 90 ft deep, says Bianchini. The original design called for 969 piles, and the URS design called for 468. "We thought early on that there would be large savings, but that dwindled down," he adds.

The piles, based on existing piles for the nearby convention center, were designed for 450-ton capacities. "We rarely attained that," he says. Adds Klein: "We pushed [URS] to be as optimistic as it could." Piles were extended with splices to achieve load capacity, and seismic loads as well. Actual construction included 512 piles, still less than the original design.

CONTINGENCIES. "The key here was that there was a large enough contingency for the contractor," says Crawford, though Klein notes that "the owners sometimes wanted us to address issues without using those funds." In addition to the $28-million fund are $12 million in contractor change orders and $8 million in owner-paid changes. The team will get 85% of whatever is left of the contingency fund upon completion by July 16. Every subsequent week, that percentage would be reduced by 5%, plus $64,000 a day would be assessed in fines. Crawford says there is some $20 million left.

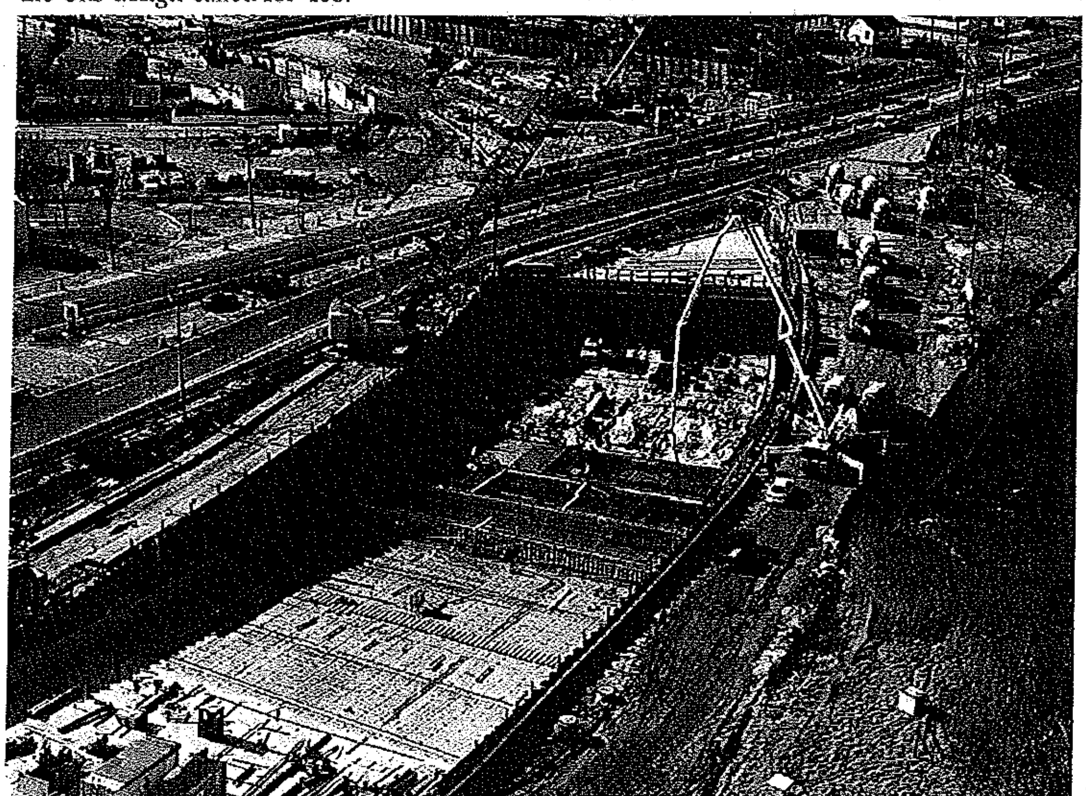


The owners added $4 million in contingencies, mostly relating to remediation of contaminated soils. "We found benzene, industrial wastes, and underground tanks with leaks," says Klein. Last year, the U.S. Environmental Protection Agency investigated complaints that contaminated soil was being pumped into the canal, tinting the banks orange.

But the state Dept. of Environmental Protection found contaminants were within acceptable levels. "They found only that with the dewatering system, we were pulling up iron, which is naturally occurring," says Klein. The team agreed to reconstruct wetlands where discoloration occurred and instituted a weekly monitoring system. Now the pumping operation of 5.5 million gal per day is completed.

The SJTA last month awarded a $1-million contract to Parsons Brinckerhoff for design work on a turn-around ramp that will allow traffic on the connector to head toward Trump's casino—thus ending that mogul's lawsuits. Yonkers completed a $20-million job to compact a landfill, called the H-Tract, and cap it with 2 million tons of soil for the Mirage. It is now working on a $17-million contract for the casino foundation work. But after all the challenges tackled on the connector, Carnovale says half-jokingly: "Unless our next job is $500 million, we won't know what to do with ourselves." ☐

By Aileen Cho in Atlantic City



FOUNDATIONS Jet grout columns and steel sheeting eliminated need for elaborate bracing.

PHOTO COURTESY S GRANITE JOINT VENTURE/GREGG KOHL

APPENDIX-D

Boring Logs and Data

GZA GEOENVIRONMENTAL, INC.
Consulting Engineers/Geologists/Environmental Scientists

27 Naek Road
Vernon, Connecticut 06066
(203) 875-7655

PROPOSED COURTHOUSE
MIDDLETOWN, CONNECTICUT

Boring No. GZ-7
Page 1 of 3
File No. 40808
Chkd. By RMD

Boring Co.	GZA GEOENVIRONMENTAL, INC.
Foreman	AL AUGUSTINE
GZA GeoEnvironmental Rep.	JIM WHITE
Date Start	12/9/91 End 12/10/91
Location	SEE PLAN
GS.Elev.	57' +/- Datum City of Middletown

	Casing	Sampler
Type	HSA	S.S.
I.D./O.D.	4-1/4"	2" O.D.
Hammer Wt.		140 LB.
Hammer Fall		30"
Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
12/9	1100	18.8'	20'	5 Minutes

DEPTH	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	RMKS	Equipment Installed
	S-1	24/12	0-2	3-2 / 3-5	ND	Loose, brown, fine SAND and SILT, trace (+) Roots, Grass. Last 2": Red-brown, fine to medium SAND, trace Silt	10" TOPSOIL	1.	NO EQUIPMENT INSTALLED
5	S-2	24/8	5-7	3-2 / 3-3	ND	Loose, red-brown, fine to coarse SAND, some (-) fine Gravel, trace (+) Silt, trace (-) Roots, Brick Chip	FINE TO MEDIUM SAND (FILL) 10.5'		
10	S-3	24/18	10-12	2-2 / 2-2	ND	Top 4": Red-brown, fine to coarse SAND, little (-) fine Gravel, trace (-) Silt. Last 14": Soft, red-brown, Clayey SILT	CLAYEY SILT 14'		
15	S-4	24/20	15-17	12-17 / 29-21	ND	Dense, red-brown, fine to medium SAND, some (+) Silt, little, fine to coarse Gravel	GRAVELLY SILTY SAND		
20	S-5	24/15	20-22	13-21 / 28-35	ND	Dense, red-brown, fine (+) to coarse SAND, little (+) Gravel, little Silt		2.	
25	S-6	24/15	25-27	22-68 / 66-35	ND	Very dense, red-brown, fine (+) to coarse SAND, little (+) fine Gravel, little (+) Silt			

Remarks
1. Samples screened in the field using a T.E.I. 580B OVM. ND = None Detected.
2. Auger chatter, hard drilling at approximately 23 feet.

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

Boring No. GZ-7

GZA GEOENVIRONMENTAL, INC. Consulting Engineers/Geologists/Environmental Scientists 27 Naek Road Vernon, Connecticut 06066 (203) 875-7655	PROPOSED COURTHOUSE MIDDLETOWN, CONNECTICUT	Boring No. GZ-7 Page 2 of 3 File No. 40808 Chkd. By: RMD

Boring Co.	GZA GEOENVIRONMENTAL, INC.		Casing	Sampler
Foreman	AL AUGUSTINE	Type	HSA	S.S.
GZA GeoEnvironmental Rep.	JIM WHITE	I.D./O.D.	4-1/4"	2" O.D.
Date Start	12/9/91 End 12/9/91	Hammer Wt.		140 LB.
Location	SEE PLAN	Hammer Fall		30"
GS.Elev.	57 +/- Datum City of Middletown	Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
12/9	11:00	18.8'	20'	5 Minutes

DEPTH	CSNG	BLWS	Sample No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	RMKS	Equipment Installed
			S-7	24/12	30-32	16-30 95-105	ND	Very dense, red-brown, fine (+) to medium SAND, some Silt, little (+) fine to medium Gravel	30'	3.	NO EQUIPMENT INSTALLED
35			S-8	15/12	35-36.3	44-83 100/3"	ND	Very dense, red-brown, fine to medium SAND, some (-) Silt, trace (+) fine Gravel			
40			S-9	12/11	40-41	52-90	ND	Very dense, red-brown, fine to medium SAND, little fine to coarse Gravel, little Silt, trace (-) coarse Sand, one fragment of decomposed Rock	GLACIAL TILL	4.	
45			S-10	17/10	45-46.4	41-60 100/5"	ND	Very dense, red-brown, fine to medium SAND, some fine to coarse Gravel (includes fragments of red-brown and grey shale), little Silt, trace coarse Sand		5. 6.	
50			S-11	13/11	50-51.1	29-82 100/1"	ND	Very dense, red-brown, fine to medium SAND, some fine to coarse Gravel, some (-) Silt, trace (-) coarse Sand with fragments of red-brown and decomposed shale in tip of spoon		7.	
55			S-12	8/8	55-55.7	105- 100/2"	ND	Very dense, red-brown, fine (+) to coarse SAND, some (+) Silt, fragment decomposed shale			

Remarks

3. Very difficult augering.
4. Difficult augering, auger chatter 42 to 43 feet, suspected boulder(s).
5. Fragment of grey shale in tip of spoon.
6. Difficult augering, auger chatter 46 to 47 feet, suspected boulder(s).
7. Difficult augering 51 to 54 feet.

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

GZA GEOENVIRONMENTAL, INC.
Consulting Engineers/Geologists/Environmental Scientists

27 Nack Road
Vernon, Connecticut 06066
(203) 875-7655

PROPOSED COURTHOUSE
MIDDLETOWN, CONNECTICUT

File No. 40808
Chkd. By: RMD

Boring Co.	GZA GEOENVIRONMENTAL, INC.		Casing	Sampler
Foreman	AL AUGUSTINE	Type	HSA	S.S.
GZA GeoEnvironmental Rep.	JIM WHITE	I.D./O.D.	4-1/4"	2" O.D.
Date Start	12/9/91 End 12/10/91	Hammer Wt.		140 LB.
Location	SEE PLAN	Hammer Fall		30"
GS.Elev.	57' +/- Datum City of Middletown	Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
12/9	11:00	18.8'	20'	5 Minutes

DEPTH	CSNG	BLWS	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	RMKS	Equipment Installed
			S-13	4/4	60-60.3	200/4"	ND	Very dense, red-brown, fine to medium SAND, some (-) Silt, little fine to coarse Gravel, fragments of decomposed shale	GLACIAL TILL		NO EQUIPMENT INSTALLED
65			S-14	3/2	65-65.2	200/3"	ND	Very dense, red-brown, fine to medium SAND, some (-) Silt, little fine to coarse Gravel, fragments of decomposed shale		8. 9.	
70											
75											
80											
85			S-15	2/2	85-85.2	256/2"	ND	Very dense, red-brown SANDSTONE fragments, some (-) fine Sand, some (-) Silt	85.2' END OF EXPLORATION		

Remarks

8. Difficult augering, average 7,000 psi down pressure with CME 55.
9. Very difficult augering from 65 to 85 feet with some less difficult zones.

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

SOIL SAMPLING LOG — CONNECTICUT TEST BORINGS, INC.

Sub-Surface Specialists · P.O. Box 88 · Seymour, Connecticut

Date Start: 5-21-84 · Date Finish: 5-21-84 · Sheet 1 of 2

Location: Bridge #0638, Rt. 9 · Middletown, Ct. · Ground Elevation: 21.8 · Hole No.: B-1

Especially Compiled For: Greiner Engineering Sciences, Inc., One Village Square, Village of Cross Keys, Baltimore, Maryland 21210

Ground Water Observations: 5-21-84, 0 hrs., 11'±

Casing: NSA, 2" · Sampler: SS, 1 3/8" · Type of Rig: Hydraulic Rotary

Sample Depths	Type	Blows			Density or Consistency, Moisture	Strata Change Depth	Field Identification of Soils / Remarks	No.	Pen	Rec
0' to 2'	SS	4	7	16/11	M.Comp damp	0"	Blk br. silty topsoil, gravel. Red br. & br. silty sand, some gravel, asphalt (fill).	1	24	20
5' to 6'6"	SS	5	4	4	Loose moist	4'6"	Red br. silt, tr. clay, tr. roots.	2	18	16
10' to 11'6"	SS	4	5	5	M.Comp moist		Red br. silt, lit. clay, tr. f-gravel.	3	15	14
15' to 16'6"	SS	5	5	8	M.Comp moist		Red br. silt, tr. clay.	4	10	17
20' to 21'6"	SS	4	5	7	M.Comp wet		Red br. silt, lit. clay.	5	16	16
25' to 26'6"	SS	4	4	4	Stiff wet	26'0"	Red br. silt, lit/some clay.	6	15	18
30' to 31'6"	SS	23	27	24	V.Dense damp		Red br. f-m sand, some silt, some c-f gravel (till).	7	12	[illegible]
35' to 36'	SS	72	50/		V.Dense damp	34'	Red br. weathered ledge or (till).	8	12	12
40' to 41'6"	SS	21			V.Dense damp		Red br. weathered ledge or (till).	9	6	2

Driller: J.D. · Helper: J.K. · Boring Inspector: H.A.S.

SOIL SAMPLING LOG — CONNECTICUT TEST BORINGS, INC.

Date Start: 5-21-84 · Date Finish: 5-21-84 · Sheet 2 of 2

Location: Bridge #0638, Rt. 9 · Middletown, Ct. · Ground Elevation: 21.8 · Hole No.: B-1

Greiner Engineering Sciences, Inc., One Village Square, Village of Cross Keys, Baltimore, Maryland 21210

Ground Water Observations: 5-21-84, 0 hrs., 11'±

Casing: NSA, 2" · Sampler: SS, 1 3/8" · Type of Rig: Hydraulic Rotary

Sample Depths	Type	Blows	Density or Consistency, Moisture	Strata Change Depth	Field Identification of Soils / Remarks	No.	Pen	Rec
					Red br. weathered ledge or (till).			
45' to 45'3"	SS	50/3"	V.Dense damp	45'±	Red br. siltstone.	10	3	3
50' to 50'	SS	50/0"		50'	Refusal on NSA & SS. Cored from 50' to 55', recovered 60" of red br. siltstone and f-sandstone.	11	0	0
Coring time: 8.0 mins., 2.0, 5.0, 8.5, 4.5				55'	Bottom of boring 55'.			

Driller: J.D. · Helper: J.K. · Boring Inspector: H.A.S.

SOIL SAMPLING LOG — CONNECTICUT TEST BORINGS, INC.

Date Start: 5-21-84 · Date Finish: 5-21-84

Greiner Engineering Sciences, Inc., One Village Square, Village of Cross Keys, Baltimore, Maryland 21210

Ground Water Observations: 0 hrs., 39'

Casing: 2" · Sampler: 1 3/8" · Type of Rig: Hydraulic Rotary

Sample Depths	Type	Blows			Density or Consistency, Moisture	Strata Change Depth	Field Identification of Soils / Remarks
0' to 1'6"	SS	23	37	32	V.Dense damp	0"	Concrete. Br. & red br. c-f sand, so[me] ... tr. silt.
5' to 6'6"	SS	7	15	12	M.Comp dry	4'±	Red br. f-m sand, lit. c-f ... silt.
10' to 11'6"	SS	7	10	11	M.Comp dry		Red br. f-m sand, lit. c-f ... c-sand, tr. silt.
15' to 16'6"	SS	6	5	11	M.Comp dry		Red br. f-m sand, lit/tr. c... tr. silt.
20' to 21'6"	SS	8	6	12	M.Comp dry		Red br. m-f sand, lit. c-f ... c-sand.
25' to 26'6"	SS	11	9	8	M.Comp dry		Red br. m-f sand, lit. c-f ...
30' to 31'6"	SS	9	11	12	M.Comp damp		Red br. m-f sand, lit. c-f ... silt.
					Loose damp	32'	Dk br. silty sand, ashes.
35' to 36'6"	SS	3	5	7	M.Comp damp	34'	Dk br. silty sand, ashes, c... (fill).
40' to 41'6"	SS	1	2	7	Loose moist	38'±	Dk br. silt, some f-c sand, ... gravel, tr. clay.

Driller: J.D. · Helper: J.D. · Boring Inspector: H.A.S.

SOIL SAMPLING LOG — CONNECTICUT TEST BORINGS, INC.

Date Start: 5-18-84 · Date Finish: 5-18-84 · Sheet 1 of 2

Location: Bridge #0638 - Rt. 9 · Middletown, Ct. · Offset: Noted on plan · Ground Elevation: 22.5 · Hole No.: B-3

Greiner Engineering Sciences, Inc., One Village Square, Village of Cross Keys, Baltimore, Maryland 21210

Ground Water Observations: 5-18-84, 0 hrs., 9'; + 72 hrs., 12'6"

Casing: NSA, 2" · Sampler: SS, 1 3/8" · Type of Rig: Hydraulic Rotary

Sample Depths	Type	Blows			Density or Consistency, Moisture	Strata Change Depth	Field Identification of Soils / Remarks	No.	Pen	Rec
	SS	1	4	3/3	Loose dry	3'±	Blk oily sand, gravel (fill).	1	24	13
5' to 6'6"	SS	6	6	4	M.Comp dry		Red br. c-f sand, lit. c-f gravel.	2	18	14
	SS	6	6	4	Loose moist		Red br. silt, some f-m sand, lit. f-gravel, tr. coal.	3	18	16
	SS	2	3	4	Loose moist		Red br. silty c-f sand layered w/red br. clayey silt, tr. roots.	4	18	18

SOIL SAMPLING LOG — CONNECTICUT TEST BORINGS, INC.

Date Start: 5-18-84 · Date Finish: 5-18-84 · Sheet 2 of 2

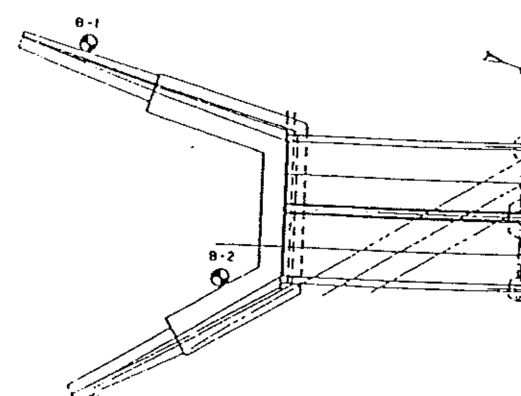
Location: Bridge #0638, Rt. 9 · Middletown, Ct. · Offset: Noted on plan · Ground Elevation: 22.5 · Hole No.: B-3

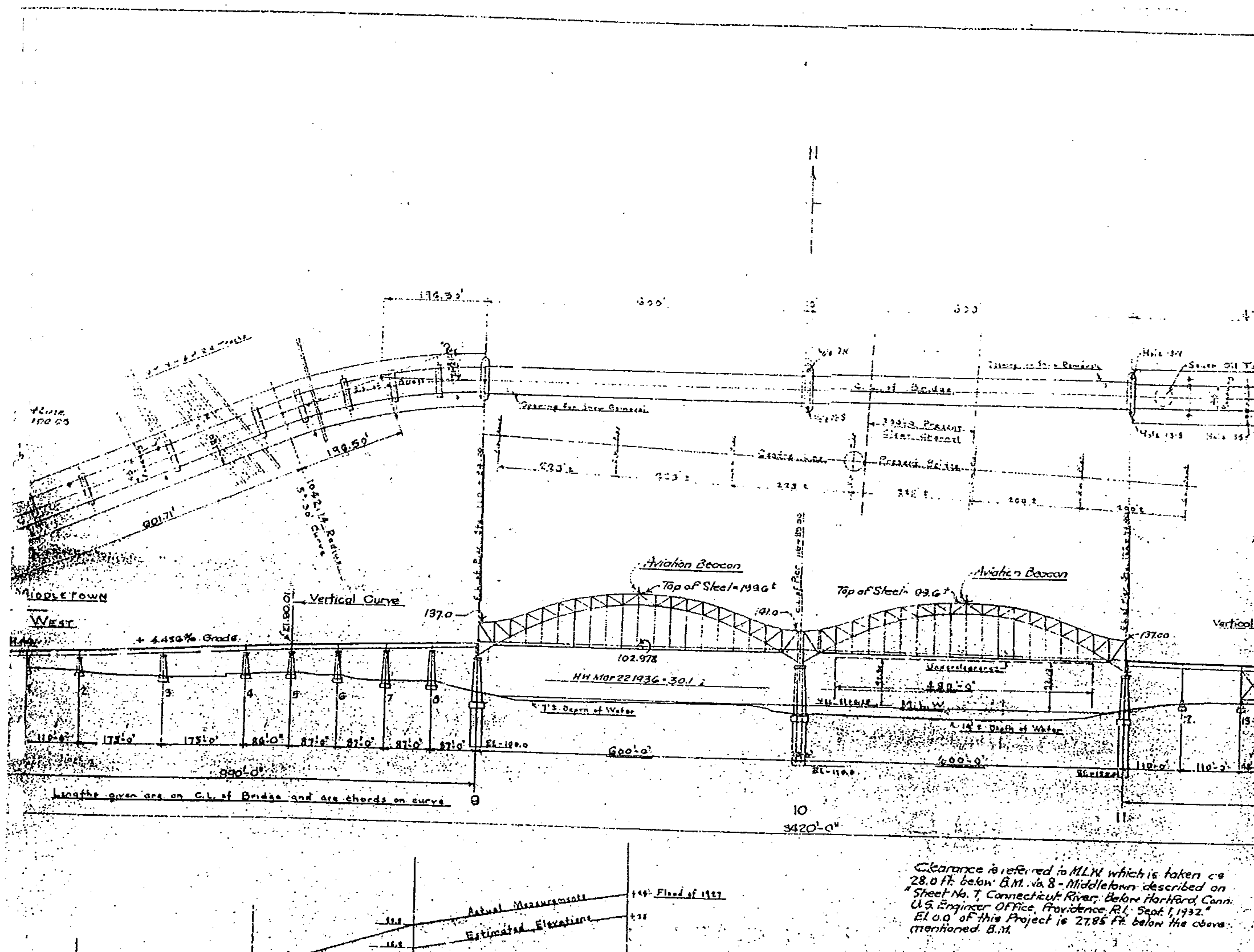
Greiner Engineering Sciences, Inc., One Village Square, Village of Cross Keys, Baltimore, Maryland 21210

Ground Water Observations: 5-18-84, 0 hrs., 9'; + 72 hrs., 12'6"

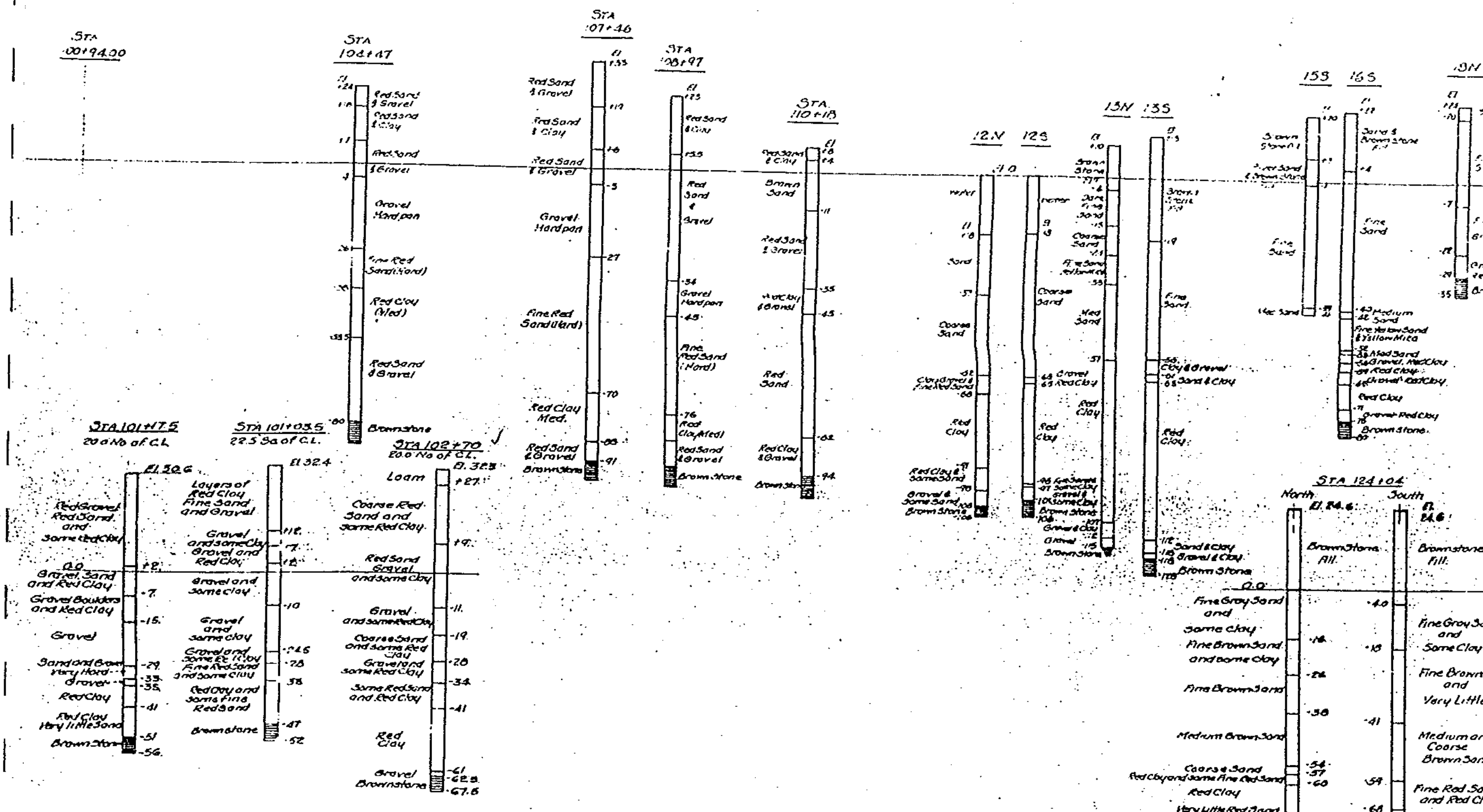
Casing: NSA, 2" · Sampler: SS, 1 3/8" · Type of Rig: Hydraulic Rotary

Sample Depths	Type	Blows			Density or Consistency, Moisture	Strata Change Depth	Field Identification of Soils / Remarks	No.	Pen	Rec
						42'±	Br. or gry sand.			
45' to 46'6"	SS	5	6	11	M.Comp wet	48'	Br. & gry organic sandy silt, some organic matter (leaves), some f-sand seams.	10	18	17
50' to 51'6"	SS	8	8	13	M.Comp wet	51'6"	Red br. & gry c-f sand, lit. silt, lit. c-f gravel, lit. organic matter (wood).	11	18	15

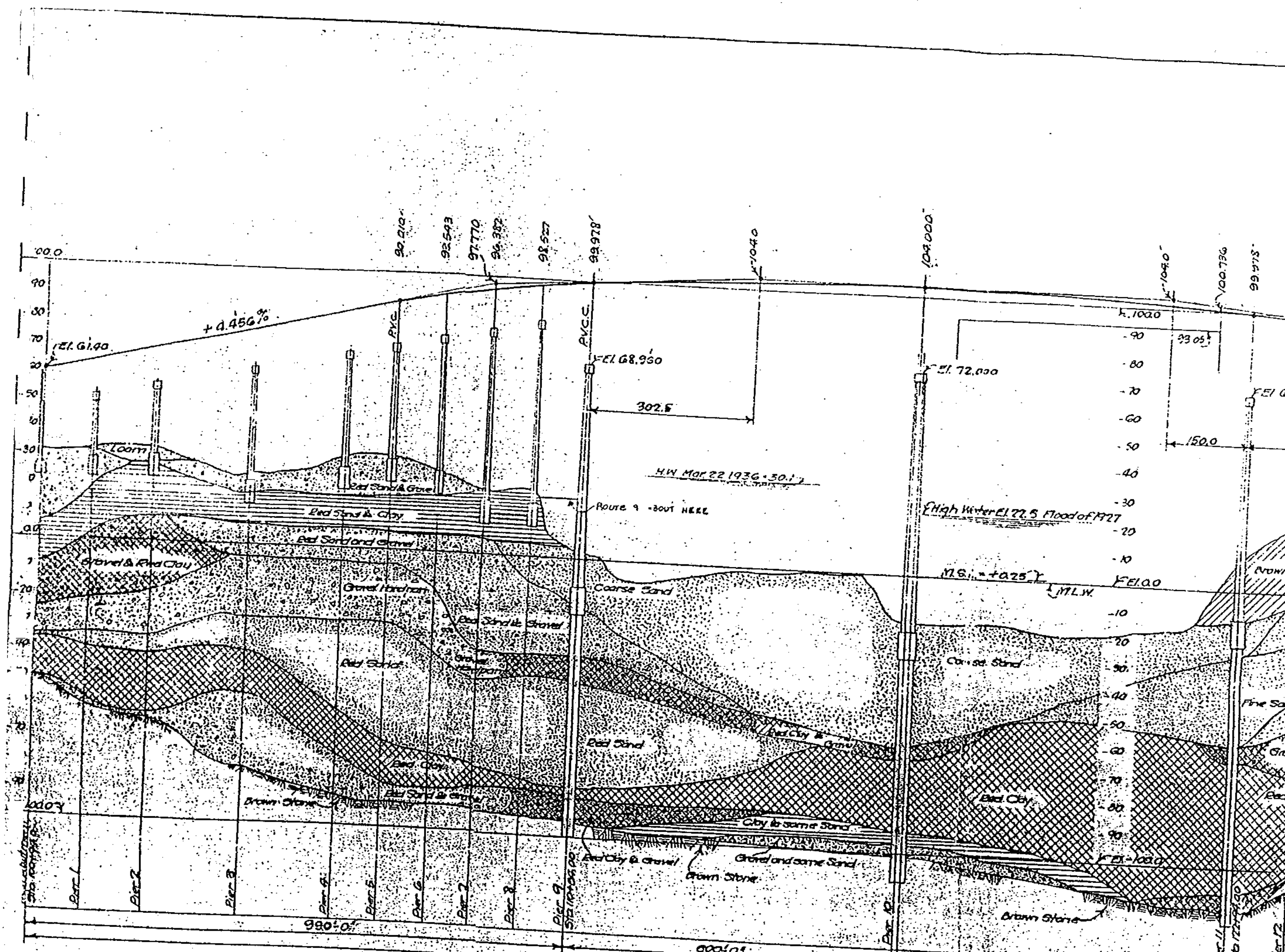




Middletown
West
+ 4.456% Grade
El. 90.01
Vertical Curve
137.0
1042.14 Radius
5°30' Curve
901.71'
196.59'
176.53'
600'
Aviation Beacon
Top of Steel = 199.6±
102.978
HW Mar 22 1936 = 30.1
7'± Depth of Water
600'-0"
141.0
Top of Steel = 193.6±
Underclearance
480'-0"
M.L.W.
14'± Depth of Water
600'-0"
137.00
Vertical
EL-100.0
110'-0"
175'-0"
175'-0"
86'-0"
87'-0"
87'-0"
87'-0"
87'-0"
890'-0"
Lengths given are on C.L. of Bridge and are chords on curve
9
10
11
3420'-0"
C. L. of Bridge
Bearing for Span Removal
Present Bridge
Actual Measurements
Estimated Elevations
Flood of 1927
Clearance is referred to M.L.W. which is taken as 28.0 ft. below B.M. No. 8 - Middletown described on "Sheet No. 7, Connecticut River, Below Hartford, Conn. U.S. Engineer Office, Providence, R.I., Sept. 1, 1932." El. 0.0 of this Project is 27.85 ft. below the above mentioned B.M.



STA 100+94.00
STA 104+47
STA 107+46
STA 108+97
STA 110+18
12N
12S
13N
13S
15S
16S
STA 101+17.5
20.0 No of C.L.
El. 50.6
STA 101+03.5
22.5 So of C.L.
El. 32.4
STA 102+70
20.0 No of C.L.
El. 32.8
STA 124+04
North
South
Loam
Brownstone
Red Clay
Gravel
Hardpan
Red Sand & Gravel
Brown Stone Fill
Fine Gray Sand and Some Clay
Fine Brown Sand and Some Clay
Fine Brown Sand
Medium Brown Sand



+0.456%
El. 61.90
P.V.C.
P.V.C.
El. 68.950
302.5
El. 72.000
150.0
33.05
90.010
92.543
97.770
96.382
98.527
99.978
104.0
104.000
104.0
100.736
99.975
Loam
Red Sand & Gravel
Red Sand & Clay
Red Sand and Gravel
Gravel & Red Clay
Gravel Hardpan
Red Sand & Gravel
Red Sand
Red Clay
Red Sand & Gravel
Brown Stone
Coarse Sand
Red Clay & Gravel
Clay & some Sand
Red Clay & Gravel
Gravel and some Sand
Brown Stone
Brown Stone
Fine Sand
H.W. Mar. 22 1936 - 30.1
Route 9 - about here
High Water El. 77.5 Flood of 1927
M.S.L. = +0.25
M.L.W.
El. 0.0
El. -100.0
Pier 1
Pier 2
Pier 3
Pier 4
Pier 5
Pier 6
Pier 7
Pier 8
Pier 9
Pier 10
Sta. 110+06.00
990'-0"