Federal Highway Administration
Pennsylvania Department of Transportation
New Jersey Department of Transportation

# Biological Assessment

**for**

# I-95/Scudder Falls Bridge Improvement Project

Bucks County, PA and Mercer County, NJ

Prepared by the:

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# 1. BACKGROUND

## 1.1 INTRODUCTION

The I-95/Scudder Falls Bridge, which was constructed in 1959, carries Interstate 95 (I-95) over the Delaware River between Lower Makefield Township in Bucks County, Pennsylvania (PA) and Ewing Township, a suburb of Trenton, in Mercer County, New Jersey (NJ) (see Figure 1, Project Location Map). This segment of I-95 has not been substantially improved since it was constructed in 1959 and is operating well over available highway capacity during peak travel periods. The Delaware River Joint Toll Bridge Commission (DRJTBC), in cooperation with the Federal Highway Administration (FHWA), the Pennsylvania Department of Transportation (PennDOT), and the New Jersey Department of Transportation (NJDOT), is proposing improvements to the I-95/Scudder Falls Bridge and 4.4 miles of I-95.

An Environmental Assessment (EA) is currently being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969. To support the preparation of the EA, federal, state and local agencies were initially contacted in October and November 2003 in order to obtain information concerning terrestrial and aquatic habitat and species present within the study area. The National Marine Fisheries Service (NMFS) responded on February 24, 2004 that the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) was known to spawn in the project area. NMFS stated that any discretionary federal action that may affect the shortnose sturgeon must undergo Section 7 consultation, under the Endangered Species Act (ESA). This Biological Assessment (BA) is being prepared in support of Section 7 consultation.

In supplemental correspondence with the NMFS dated November 15, 2007, the NMFS stated that the Atlantic sturgeon (*Acipenser oxyrhynchus*) is also known to occur in the project area. The Atlantic sturgeon is currently a candidate species. The NMFS recommended conferencing for the Atlantic sturgeon, under Section 7(a)(4) of the ESA, since this species may be listed prior to implementation of the project.

## 1.2 PROJECT PURPOSE

The purpose of the project is to alleviate recurring current and future traffic congestion and upgrade safety and traffic operational conditions on the I-95/Scudder Falls Bridge and adjoining highway segments in Pennsylvania and New Jersey. The project area extends 4.4 miles between the PA Route 332 (Newtown-Yardley Road) Interchange in Pennsylvania and the Bear Tavern Road (County Route 579) Interchange in New Jersey. The overarching goal of the project is to improve mobility and to provide a safe and reliable river crossing on this segment of I-95. The Scudder Falls Bridge provides critical access for community facilities and emergency services between Pennsylvania and New Jersey; it also is essential to continued economic development and interstate commerce, by accommodating the movement of people and goods.

From west to east, I-95 in the project area consists of two lanes in each direction between PA Route 332 and NJ Route 29 and three lanes in each direction east of NJ Route 29 to Bear Tavern Road. This highway segment is operating over capacity during peak periods under existing conditions and is projected to operate well over capacity in 2030. The goal for the improvements in this segment of I-95 is to achieve a traffic level of service of LOS D, considered to represent an acceptable traffic operating level in an urban environment, in the future year 2030. The project involves adding a travel lane in each direction where there are currently two lanes in each direction, and providing adequate outside and inside shoulders in each direction to meet this LOS goal. On the Scudder Falls Bridge, in addition to the new lanes, two auxiliary lanes[1] in the northbound direction and one auxiliary lane in the southbound direction are proposed to allow for safe merging of traffic getting on and getting off of I-95 from the interchanges at Taylorsville Road and NJ Route 29. Additional transitional engineering necessary to achieve the LOS D goal will be made along the approximately 1.5-mile section of I-95 extending east from NJ Route 29 to the Bear Tavern Road (County Route 579) Interchange.

The project includes improvements to the Taylorsville Road Interchange in Pennsylvania and the NJ Route 29 Interchange in New Jersey to meet current highway and geometric design standards. Interchange improvements include reconfiguration, the addition/modification of acceleration and deceleration lanes and providing adequate spacing of ramp merges.

# 2. PROPOSED ACTION

## 2.1 PERMANENT STRUCTURES IN THE DELAWARE RIVER ASSOCIATED WITH THIS PROJECT

### 2.1.1 Description of Bridge Piers

The existing bridge is supported by nine piers. Seven of these piers are founded within the river bed and supported by spread footings on rock.

Based on the preliminary design, the proposed bridge is anticipated to be an eight span multi-girder bridge supported on seven reinforced concrete hammerhead piers supported on spread footing foundations on rock (see Figure 2, Plan View). Of the seven piers, five will be directly founded within the river bed, and two will be upland of the Ordinary High Water (OHW) mark. The spread footings, estimated to be 20 ft wide by 160 ft long and 8 feet deep, will be topped with large rock (30 inch diameter nominal) for scour protection (see Figures 3 and 4). During final design, the bridge span arrangements and foundation units will be refined. An alternative foundation system which may be employed would consist of drilled shafts foundations rather than spread footing foundations. This would entail multiple, equally-spaced six foot drilled shafts supporting a pile cap. This method would require heavy equipment which would create vibrations during the construction of the shafts. The drilled shaft option is generally utilized in areas where spread footings do not provide adequate strength for the bridge. The pier stems for both options would be similar and the drilled shaft option also would require scour protection similar to that for the spread footings. Therefore, the square foot impact to river bottom of drilled shaft foundations would not exceed the impacts of the spread footing foundations.

During the final design phase, approximately ten soil borings (two per river pier) will be taken from the river bed to help determine the capacity of the river bottom to support either spread footings or drilled shafts for the piers. The boring operation will be performed outside of the

[1] An auxiliary lane is defined as the portion of the roadway adjoining the traveled way for purposes supplementary to through-traffic movement such as speed change, weaving, and positioning drivers for entry or exit.

moratorium period and consists of 4-inch diameter augers drilled to about 50 feet into the river beds to assess the material types. The soil boring operations will be performed from small portable work platforms in the river. There would be little or no impact to the river and its resources from this operation. The soil borings are required by PennDOT and NJDOT as part of the final design of the pier foundations.

### 2.1.2 Bridge Drainage System

The bridge deck section within the center third of the river will capture runoff and outlet through downspouts to the river below. The runoff from the outer thirds of the deck area of the bridge will be captured by scuppers on the bridge and piped back to the abutments where they will be connected to existing stormwater facilities off the bridge. The bridge deck area will be nearly double the existing as the proposed typical section will be comprised of nine lanes versus the existing bridge carrying four lanes. The existing bridge also free drops the runoff to the river below.

During final design, a Spill Prevention and Countermeasure Plan (SPCP) will be developed to prevent spills from entering the river during construction. Additionally, an SPCP will be prepared to address spills from vehicles using the bridge when construction is completed.

## 2.2 CONSTRUCTION METHODS

### 2.2.1 Construction Equipment Used for Bridge Construction

A variety of construction equipment is anticipated to be used in the construction of the bridge foundations, including but not limited to bulldozers, pile drivers, augers for possible drilled shaft construction, excavators, cranes, dump trucks, hydraulic rams, and de-watering pumps and hoses.

### 2.2.2 Description of Cofferdams

There will be temporary cofferdams at each pier foundation composed of interlocking steel sheeting driven to rock (see Figures 5 and 6). The sheeting will be vibrated in to reduce noise when the substrate permits. As the excavation progresses within the internal area of the cofferdam, lateral supports will be installed to support the sheeting. The interlocking sheet piles will provide a water tight working enclosure for the construction activities. Therefore, it is not anticipated that drifting fish eggs or swimming fish larvae will enter the enclosed cofferdam area. There will be small amounts of groundwater leakage which will be evacuated with a sump pump so that construction can be conducted in dry conditions. This is a standard construction method for in water type construction. The cofferdams will encompass an area of about two feet wider, all around, than the size of the footing to allow for formwork. We anticipate a cofferdam area of about 26 feet x 166 feet. From study of the existing bridge borings, the level where the footings would most likely be placed will be either a competent sand and gravel layer or competent rock. This footing level will be anywhere from 10 to 15 feet below the existing river bed. Blasting operations are not anticipated in the placement of the cofferdams or the footings. In areas where the rock is shallow, the upper weathered layers of the rock will be removed with excavating type equipment.

Demolition of the existing bridge piers also will be accomplished within cofferdams, as described in Section 2.5.

### 2.2.3 Description of Causeway

#### 2.2.3.1 Size/Type/Materials Used/Installation

Four stages of temporary causeway would be employed to construct the Scudder Falls Bridge. Each stage would include a main causeway, extending approximately 400 to 600 feet from either the Pennsylvania or New Jersey shore, approximately to mid-river. In order to access each proposed bridge pier location, perpendicular extensions (causeway fingers) from the main causeway would be used. The causeway fingers also would be used to access the existing piers for demolition, in cases where the proposed piers do not overlap with the existing piers. Stage I (from the PA side) and Stage II (from the NJ side) would construct a portion of the new bridge upstream of the existing bridge. When traffic is moved to the newly constructed upstream portion of the new bridge, Stage III (from the PA side) and Stage IV (from the NJ side) would be used to demolish the existing bridge and construct the downstream portion of the new bridge. Each causeway would obstruct approximately half of the river width, and additional hydraulic openings (temporary bridges) would be provided through each causeway to provide adequate flow of water and to provide for fish passage. The hydraulic openings (temporary bridges) would have a 50 foot span on the Pennsylvania side and a 100 foot span over the deeper channel on the New Jersey side and would reduce the overall effects on the substrate. Each causeway segment would have a working width of approximately 30 feet with sideslopes shaped at approximately a 1:1 ratio (see Figure 7, Earthen Causeway Plan). Upon removal of each causeway stage, the river bottom would be restored to its pre-construction condition.

The causeways will be constructed of clean rock, 6 to 12 inches in size, (PennDOT R-7 size) dumped from the riverbank and spread by bulldozers to create the causeway. Back-hoes will be used to shape the causeway sideslopes. Once the finished causeway elevation is reached, a 6 inch layer of 2-inch diameter stone will be added to form a working platform for equipment, deliveries and storage of materials.

#### 2.2.3.2 Effects of Causeways on Upstream and Downstream Flows

The causeway will be constructed in four stages – two upstream (Stages I and II) and two downstream (Stages III and IV). The causeway length will be about one half of the river width for each of the four stages. The preliminary Hydrological and Hydraulic (H&H) studies analyzed Stage III as the worst case condition since it creates the most constriction in channel flow due to: Stage I New Bridge piers completed, existing bridge remains and Stage III Causeway within the river cross section. Based on the HEC-RAS modeling a 1.4 Year Design Storm is used to design the causeway. A more detailed analysis will be performed during the final design to fine tune the causeway elevation once the exact shapes of the piers are established. In selecting 1.4 Year Design Storm, the following key issues were studied:

- River flow volumes for past 10 years
- Lowest causeway height that would provide the highest practical number of working days during the year without over-topping

- Highest causeway height that would create the lowest practical backwater elevation increase

This results in a modest 2 foot increase in elevation immediately upstream which gradually reduces to no impact approximately 1,500 feet upstream. With this elevation rise, the water elevation remains below River Road PA-32 and NJ Route 29 and does not impact structures.

In order to provide a comparison and general order of magnitude of potential flooding impacts, the causeway was modeled for several flood events. It should be noted that the 1.4 Year Design Storm event yields flows of approximately 62,000 CFS for the entire river. This is fairly conservative when compared to the mean annual high flow of the Delaware River between 1997 and 2006 which was calculated as 25,000 CFS from a USGS gage located at Trenton, just downstream of the Scudder Falls Bridge.

In addition, an H&H analysis of the earthen causeway Stage III was performed to assess the flooding of the PA 32 roadway which serves as the natural buffer to the adjoining, upstream properties and serves as an upper boundary of flood conditions outside of the larger storm events. With the Stage III earthen causeway in place, the storm event which causes the overtopping of PA 32 corresponds to 174,000 CFS or nearly three times the causeway design event. The probability of this occurring over a two year construction window is ~16% or a 12 year flood frequency. Moreover, with this specific causeway stage and condition expected to be in place for no more than one year, the probability is reduced even further.

In summary, the worst case causeway staging condition Stage III as developed, strikes a reasonable balance of providing a working platform in the ‘dry’ for the maximum duration during the construction season against the overtopping of PA 32 and the potential for flooding of adjoining, upstream properties.

#### 2.2.3.3 Types of Work that will be done from the Causeway

The new bridge construction will be constructed from the causeway and causeway fingers. Demolition of the existing bridge piers also will be accomplished from the causeway and causeway fingers. The causeway and cofferdams will be scheduled to be constructed outside of the seasonal moratoriums for the shortnose sturgeon from approximately mid-March to late-June. Extension of this moratorium to mid-July to account for time restrictions for other fish species of special concern including alewife, blueback herring, and American shad will be considered during final design and implemented if feasible. It is anticipated that once the causeways and cofferdams are completed, all work can be accomplished throughout the year from the causeway, inside the cofferdams and from the partially constructed bridge. For example, once the cofferdams are constructed, all pier construction can be accomplished inside the cofferdams and from the causeway. The steel erection for the bridge superstructure will be performed by delivering the beams via the existing I-95 bridge (there will be partial closure of the bridge at night) with the cranes placed on the causeway.

Once the steel beams are erected, the remaining portions of the bridge, such as the deck, can be constructed from the new structure. Timber shielding will be placed between the erected beams and the edges to protect the workers and prevent debris from falling into the river.

#### 2.2.3.4 Potential for Causeway Wash-Out

As with any work in and around the river environment, severe flood events can adversely affect the construction area. The causeways are constructed of rock and where washouts occur, can be easily repaired by reclaiming lost rock and/or placement of new rock. It is expected that washouts will only occur during the most extreme flood events and that the majority of the construction period will be free of washouts.

Although the Delaware River has experienced severe flooding events in the past several years, the mean annual high flow from 1997 to 2006, as calculated from the USGS gage at Trenton, is significantly lower than causeway design flow. As stated in 2.2.3.2, the preliminary causeway elevation has been set for a 1.4 year storm event as a balanced approach. A more robust causeway size would result in unacceptable backwater elevation increase. The area north of the bridge along the river is low and flat and excessive backwater elevation increase would impact the home owners beyond an acceptable level.

## 2.3 EROSION AND SEDIMENTATION CONTROL MEASURES

An Erosion and Sedimentation Control Plan (E&S) as well as an National Pollutant Discharge Elimination System (NPDES) will be prepared for the project outlining Best Management Practices to be implemented during and after construction. A combination of stone and grass lined ditches will flank the majority of the mainline in PA to promote water quality and infiltration. Sediment basins are proposed for the interchange infield areas in both states, and will be converted to permanent bio-retention facilities to control additional stormwater runoff generated by the project. Straw bales will prevent sedimentation from entering the existing and proposed stormwater collection system along the mainline in NJ, and anywhere inlets may collect construction runoff.

Once the silt fence barrier is placed along river banks and embankment toe of slopes, the causeway construction activities will begin. Groundwater that may seep into the cofferdams will be de-watered through pumps and hoses. The hoses will outlet into sediment filter bags and traps before re-entering the river environment.

Because the river bed in the project area consists of clean coarse and granular type material, significant turbidity problems are not expected. However, the contract documents will include turbidity barriers as necessary to mitigate this potential issue.

## 2.4 RESTORATION (OF COFFERDAMS, CAUSEWAYS)

Once the piers have been constructed and the steel beams have been erected, the cofferdams will be removed either by pulling the sheets out of the river bed or by removing the portion of the sheets above the river bed. The causeway can then be removed in a retreating manner. In two of the stages, the causeway will also be used for part of the demolition of the existing bridge.

If desired and through consultations with the appropriate agencies, certain portion or certain material of the causeway could be left in place to enhance aquatic environment in the project area.

## 2.5 DEMOLITION OF EXISTING BRIDGE

It is anticipated that the existing bridge will be demolished using various methods. As a first step, timber shielding will be placed between the existing girders, beams, and the edges to protect the workers and prevent debris from falling into the river.

The bridge deck will then be removed by saw cutting the concrete into manageable pieces for loading onto dump trucks. The deck will be removed from the existing bridge in a retreating manner. The beams and girders will be cut into pieces and loaded onto trucks with cranes placed on the existing bridge and on the causeway. The steel will be trucked off to a recycling center.

For the demolition of the existing piers, cofferdams will be installed and demolition will occur from within. These cofferdams will be approximately 15 feet wide by 70 feet long. Access to the existing piers will be via the causeways as shown on Figure 7. The existing piers are clad with stones with a reinforced concrete core. So, the stones will have to be removed first. The concrete core will be demolished by hydraulic ram equipment, which creates a pulsing sensation that causes the existing concrete to crumble. The larger sections will be broken into smaller pieces and perhaps recycled on-site for use by the contractor for embankment and/or backfill material. The existing pier stems will be removed to a depth of two to three feet below the river bed elevation. The existing bridge has seven piers in the river. With the removal of these piers, 4,285 square feet (0.10 acre) of restored river bottom will be gained.

## 2.6 MUSSEL MITIGATION

A survey of the freshwater mussels present in the study area was conducted in October 2004. The objective of the mussel survey was to determine if the tidewater mucket (*Leptodea ochracae*) and the yellow lampmussel (*Lampsilis cariosa*) are present in the bridge's immediate vicinity. The tidewater mucket and the yellow lampmussel are listed by the State of New Jersey as Threatened species. The yellow lampmussel is listed by the Pennsylvania Fish and Boat Commission (PFBC) as rare. Of the two target species, no live tidewater mucket or spent shell of this species were encountered. However, 64 live yellow lampmussel, the second target species, were found. They were widely distributed, with individuals found in nearly every search area.

Conversations with NJDEP have indicated that they would like the development of a mussel mitigation plan which would include relocation of yellow lampmussel from direct impact locations (i.e. locations of construction causeways and cofferdams and proposed piers). A mussel mitigation plan is currently being prepared. Mussel relocation efforts will be proposed to occur after June 30 to avoid impacts from increased sedimentation to the shortnose sturgeon during relocation efforts.

There is concern that adult shortnose sturgeon may use yellow lampmussel as a food resource during the short period of time when these fish are present in the project area spawning grounds. Therefore, relocating yellow lampmussel may reduce the shortnose sturgeon's food supply. However, there are many other macroinvertebrates present in the project area in much greater numbers than yellow lampmussel that also would be used as a shortnose sturgeon food resource. Additionally, it is expected that yellow lampmussel will recolonize any areas that are temporarily affected (riverbed under the construction causeways and cofferdams) (Villella 2005).

## 2.7 PROJECT TIMING

### 2.7.1 Anticipated Start and Duration/Construction Seasons

This project will require two primary phases to construct the new bridge and demolish the existing; the first phase would construct the upstream, or northern side of the bridge while the second phase would demolish the existing bridge and construct the downstream, or southern side of the bridge. Based on the length of the structure, and type of construction, it is anticipated that a three to four year construction period will be required. The actual completion of final design and the DRJTBC letting schedule will determine the start of construction. However, it can be suggested that a July bid opening will allow for a September Notice to Proceed (NTP). The contractor will then mobilize operations in October just before the first construction season. Once the E&S measures are installed and traffic control established the first causeway stage can be constructed. The causeway and cofferdams will be constructed before mid-March and after the end of June. Extension of this moratorium to mid-July to account for time restrictions for other fish species of special concern including alewife, blueback herring, and American shad will be considered during final design and implemented if feasible. Once causeways and cofferdams are in place, it is expected that the pier foundations, abutment foundations and superstructure erection will last through the calendar year. Once the deck is completed for the northern (upstream) side of the bridge, the traffic can be shifted to it and the existing bridge demolished. This is anticipated for Spring of Year 2. Figure 8, Conceptual Scudder Falls Bridge Construction Sequencing, provides details regarding the construction sequencing.

### 2.7.2 Duration of Work in Cofferdams

The cofferdams will be in use for several months each. It will take approximately four months to build the foundations and the piers. Each cofferdam will require approximately three to four weeks to construct.

# 3. ALTERNATIVES ANALYSIS

## 3.1 STRUCTURAL OPTIONS – BRIDGE REHABILITATION VERSUS BRIDGE REPLACEMENT

Both full and partial rehabilitation options that would also involve widening of the structure to meet the project purpose and need (LOS D goal) were considered for the existing I-95/Scudder Falls Bridge in addition to the option of full bridge replacement.

• **Full Bridge Rehabilitation** would involve total replacement of the existing bridge superstructure and construction of a new parallel bridge to meet the proposed number of lanes and shoulders,

• **Partial Bridge Rehabilitation** would involve deck replacement and strengthening of the existing bridge superstructure and construction of a new parallel bridge to meet the proposed number of lanes and shoulders.

However, full or partial bridge rehabilitation to meet current AASHTO, PennDOT, and NJDOT criteria would result in costs that approach (or even exceed) those for bridge replacement. Under the PennDOT policies and guidelines, if life cycle costs for bridge rehabilitation are within 30% of the life cycle costs for bridge replacement, bridge replacement is recommended. Moreover, although the bridge can be strengthened, rehabilitation does not eliminate concerns associated with the age and previous loading history of the bridge (currently exceeding 48 years in service and expected to remain in service for at least 75 more years) and its "non-redundant" configuration. A non-redundant bridge is defined as a structure where there are generally only two primary load carrying members and where the failure of one of the primary members results in the catastrophic collapse of the bridge. A "catch" system has been added to the existing bridge to prevent this situation. The FHWA and the DOTs around the nation no longer allow design of non-redundant structures.

The complete bridge replacement would allow greater flexibility and efficiency and longer spans, thus reducing the number of piers in the Delaware River. The two options evaluated for rehabilitation of the I-95/Scudder Falls Bridge are not considered fiscally prudent and were dismissed from further consideration, and full replacement of the bridge is proposed as part of the Preferred Alternative.

## 3.2 PIER-LESS CONSTRUCTION

The feasibility of a long span bridge type which could possibly eliminate all of the river piers was studied. The long span bridge types studied included truss, concrete segmental, deep steel girders, suspension, and cable stayed. The limiting factors for the long span bridge types for this project are the following:

- The close proximity of NJ 29 and Taylorsville Road interchanges to the bridge which would not allow for proper transition of the on and off ramps
- Some of the long span types such as the truss, suspension, and cable stayed can not be constructed in stages, which would mean the entire width of the new bridge will have to be constructed upstream. This would have a much greater footprint impact on the two canals, and the residences in NJ and PA.
- Some of the long span bridge types, namely concrete segmental and deep steel girders, will have a much deeper superstructure depth and will have more impact on the hydraulics of the river cross section by intruding into the 100 year flood elevation.

Therefore the option of a long span bridge (i.e. pier-less) was determined to be not feasible for this project.

## 3.3 LANE CONFIGURATION OPTIONS

Three lane configuration options were considered to provide the number of lanes required to achieve LOS D in the design year.

### 3.3.1 Double-Deck Bridge

A double-deck bridge across the Delaware River was considered that would carry local traffic from the adjoining interchanges on a lower level and I-95 through traffic on an upper level. The upper level for through traffic would consist of three 12-foot travel lanes, a 12-foot outside shoulder, and a 14-foot inside shoulder in each direction. The lower level would consist of three 12-foot travel lanes and two 12-foot shoulders in the northbound direction and two 12-foot travel lanes and two 12-foot shoulders in the southbound direction.

The permanent foot print impact in the river will be less than the standard one level type bridge. However, this option would require the entire bridge to be constructed either on the upstream or downstream of the existing bridge and would have significantly more impact to the properties on both sides of the river. One of the other requirements of the double-deck bridge option is the need for approach structures, on both ends of the bridge, to elevate the through traffic roadway and separate it from the local traffic. The approach structures would extend approximately 800 feet beyond the abutments of the main bridge. The approach structures width, in combination with the local approach roadway, would require a wider footprint than the Standard Lane Addition Design Option and consequently greater environmental impacts. A double-deck bridge would pose a higher security risk than a single level bridge. In addition, a double-deck bridge would be more visually intrusive in the environment, as well as to bridge users, than a single level bridge due to its height. This option would cost approximately $18 million (in 2005 dollars) more than the Standard Lane Addition Design Option (see Section 3.4). For these reasons, the option for a doubledeck I-95/Scudder Falls Bridge was dismissed from further consideration.

### 3.3.2 Contra-Flow Lane

Incorporation of a contra-flow lane on I-95 would employ a movable barrier, which would provide an additional lane in the peak flow direction and one less travel lane in the off-peak flow direction. Use of a contra-flow lane would allow one less travel lane to be constructed on the I-95/Scudder Falls Bridge. For the A.M. peak traffic, the lane configurations would be five lanes northbound and three lanes southbound. For the P.M. peak traffic, the lane configurations would be four lanes northbound and four lanes southbound.

The footprint of the piers in the river will be slightly smaller than the standard lane piers, about 8 feet less in length. The width of the pier will be the same.

A movable barrier operating system would require the barrier machines, operators, lane delineation system, spare barriers, shelter for the machine and other miscellaneous items.
The contra-flow lane option would cost an additional $8,500,000 (in 2005 dollars) over standard lane additions. In addition to the cost differential, a contra-flow lane over such a short length of roadway would not be efficient. Safety would be at issue at the end treatments of the moveable barrier and in the transition areas into and out of the contra-flow lane. For these reasons, the contra-flow lane option was dismissed from further consideration.

### 3.3.3 Collector/Distributor Roadway

A collector/distributor roadway (CD Roadway) on a centerline alignment was considered that would segregate northbound I-95 mainline traffic from traffic entering and exiting at Taylorsville Road or at NJ Route 29. The northbound I-95 travel lanes and the CD Roadway would be separated by a 6-foot wide raised divider. This CD Roadway would only be provided in the northbound direction, over a total length of about 2.4 miles. The northbound CD Roadway ramp would begin, on its western end, approximately 0.8 mile west of Taylorsville Road (across from the rest area in Pennsylvania) and would merge back into the I-95 mainline roughly 1.5 miles east of NJ Route 29.

The I-95/Scudder Falls Bridge would be 24 feet wider with the CD Roadway alternative (186 feet) than it would be with standard lane additions (162 feet). Hence, the river bed impact would also be proportionally greater than the standard lane option. The CD Roadway alternative would involve greater impacts on adjoining properties. Approximately 5.37 acres of public land would be affected by the CD Roadway alternative, which is roughly 2.73 acres more than that required by standard lane additions. Of this, approximately 1.92 acres of land owned or occupied by the New Jersey State Police would be affected with the CD Roadway alternative. The property affected on the New Jersey State Police Headquarters includes construction trailers, electrical service facility, and a portion of a parking area and site access road. In Pennsylvania, both alternatives would affect approximately 1.37 acres of Lower Makefield Township preserved farmland. In addition, the CD Roadway alternative would affect approximately 1.69 acres of Commonwealth and Township property, approximately ½ acre more than the standard lane additions.

The CD Roadway alternative would span a greater area of the Delaware Canal in Pennsylvania (increase of 400 square feet) and the Delaware and Raritan Canal in New Jersey (increase of 800 square feet) than standard lane additions. The traffic levels of service for the CD Roadway alternative would be comparable to that for standard lane additions. Because the CD Roadway alternative would not produce substantially greater traffic benefits or sufficient operational benefits to justify the additional $13 million in cost (in 2005 dollars) and would increase property/environmental impact, the CD Roadway alternative was dismissed from further consideration.

## 3.4 ALIGNMENT OPTIONS

Three alignment options for the new bridge were considered, each overlapping the footprint of the existing bridge. One option would be built about the existing centerline (Centerline Alignment), while the other two would be built slightly upstream (Upstream Alignment) or downstream (Downstream Alignment) of the existing bridge. Since the roadway cross-section would be the same for each of these options (five lanes northbound and four lanes southbound on the Scudder Falls Bridge) the number and size of bridge piers in the river would be the same regardless of which option is selected. Therefore, the permanent impacts to the river bed would be the same as well.

### 3.4.1 Centerline Alignment

The new bridge would be centered on the centerline of the existing bridge. The centerline alignment option would displace a total of two residences, one on each side of the existing bridge, compared to displacement of only one residence under each of the other alignment options. Compared to the other alignment options, the centerline alignment would involve greater property impacts than an upstream alignment, but less than the downstream alignment. The centerline alignment would affect approximately 2.61 acres of public land and roughly 1.0 acre of private property. For floodplains, the centerline alignment would have the greatest impacts (roughly 0.77 acre more than the upstream alignment and roughly 0.47 acre more than the downstream alignment). The centerline alignment would also impact the USACOE flood control structure on the Delaware Canal, which is south of I-95. A new bridge on a centerline alignment would have greater property impacts, without presenting any clear advantages over other alignment options. From a constructability standpoint the centerline alignment would be the least favorable, as it would involve the greatest overlap with the existing bridge. For these reasons, this option was dismissed from further consideration.

### 3.4.2 Downstream Alignment

Under the downstream alignment option, the bridge alignment over the Delaware River and the mainline approaches would be shifted, with the new bridge overlapping the footprint of the existing bridge. The new, wider bridge would be constructed downstream of, or south of, the existing bridge, with the new bridge extending south from the northern edge of the existing bridge. From a constructability standpoint, the downstream alignment option would provide more travel lanes and flexibility than the centerline alignment during the various phases of construction because a large portion of the new bridge's width could be constructed parallel to the existing bridge without interfering with traffic flow on the existing bridge.

The downstream alignment would displace one residence. The downstream alignment would involve the greatest property impacts, affecting approximately 2.96 acres of public land and roughly 1.6 acres of private property. Although the natural resource impacts are comparable for all three alignment options, the downstream alignment would involve the greatest impacts on streams (by approximately 4,600 to 6,750 square feet), but the least amount of wetlands fill (by approximately 0.07 to 0.16 acre). The downstream alignment would also have the greatest impact on the USACOE flood overflow structure on the canal south of I-95. For these reasons, the downstream alignment was dismissed from further consideration, and a new bridge on an upstream alignment was selected as part of the Preferred Alternative.

### 3.4.3 Upstream Alignment (Preferred Alternative)

A new, wider bridge will be constructed upstream of, or north of, the existing I-95/Scudder Falls Bridge over the Delaware River, with the new bridge extending north from the southern edge of the existing bridge.

The Upstream Alignment Design Option would involve lesser impacts to public and private properties than the Centerline or Downstream Alignment options. With the Upstream Alignment Design Option, 2.22 acres of public land would be affected, compared to 2.61 and 2.96 acres of public land affected by the Centerline and Downstream Alignments, respectively. Excluding residential displacement, the Upstream Alignment would affect 0.81 acres of private property, compared to 1.0 acres and 1.6 acres affected by the Centerline and Downstream Alignments. Impacts to natural resources are comparable for all three alignment options. However, distinctions are noted in impact to wetlands, where the Upstream Alignment would impact slightly more wetlands (up 0.15 acre more) than the Centerline or Downstream Alignments. Conversely, the Upstream Alignment would have lesser effects on streams and drainages than the other options. Additionally, the upstream alignment would have no impact on the USACOE flood overflow structure on the canal south of I-95.

## 3.5 TEMPORARY ACCESS METHODOLOGIES CONSIDERED

### 3.5.1 Barges

Construction from shallow barges was considered and dismissed as not feasible due to the limited water depth available and due to the variation in the river bottom at the site of the bridge. Normal water depth can be as shallow as four feet deep on the Pennsylvania side, and seven feet on the New Jersey side according to normal water elevations recorded at the bridge. Barges, which would be weighed down with crane equipment as well as other materials required for the construction of bridge piers, foundations and erection of structural members, would require a minimum draft of five feet. The limited normal water depths render the shallow barge method infeasible.

### 3.5.2 Construction from Existing Bridge

"Topside" construction, meaning construction from the existing bridge, was considered and dismissed as not feasible because the limited width of the existing bridge must be used to maintain traffic flow and there would be no available space for work areas and construction equipment. There are no existing shoulders for use, and closing lanes during peak periods would result in severe congestion. In addition, the width of the proposed bridge would require an extended reach that would preclude effective use of cranes from the existing bridge.

### 3.5.3 Trestle Causeway

Construction from a temporary trestle causeway would involve construction of short spans of approximately 25 feet with pile bents and progressive construction from shoreline. A conceptual plan view and elevation of the temporary trestle causeway is shown on Figure 9.

The trestle would be constructed in four stages. Each stage would include a main trestle, extending approximately 400 to 600 feet from either the Pennsylvania or New Jersey shore, approximately to mid-river. Perpendicular extensions (causeway fingers) of the main trestle would be needed for access to the existing and proposed bridge piers. Stage I (from the PA side) and Stage II (from the NJ side) would construct a portion of the new bridge upstream of the existing bridge. When traffic is moved to the newly constructed upstream portion of the new bridge, Stage III (from the PA side) and Stage IV (from the NJ side) would be used to demolish the existing bridge and construct the downstream portion of the new bridge.

Approximately 22 to 36 pile bents would be required for each causeway stage. Each pile bent would be driven into the river bottom, and would disturb approximately 10 square feet of river bottom. The 22 to 36 bents installed for each causeway stage correspond to approximately 210 and 340 square feet of river bottom disturbance at any one time. Upon removal of each trestle causeway stage, the bents would be removed to a depth of 3 feet and the river bottom restored to its pre-construction condition. Because the piles would not be removed entirely, a trestle causeway permanently impacts the river bottom.

The trestle causeway is, in effect, a narrow bridge. Construction equipment on the trestle will normally cause vibration during operation or movement. Due to the slender nature of the trestle, equipment operators must exercise considerably more care in their operations on a trestle versus earthen causeway. This limits the contractor's ability to maneuver his construction equipment and thus reduces productivity and increases construction duration. Further, there would a greater chance of equipment toppling into the river with the trestle causeway than with the earthen causeway.

### 3.5.4 Earthen Causeway

Like the trestle causeway, four stages of causeway would be employed to construct the Scudder Falls Bridge. Each stage would include a main causeway, extending approximately 400 to 600 feet from either the Pennsylvania or New Jersey shore, approximately to mid-river. Perpendicular extensions (causeway fingers) of the main causeway would be needed for access to the existing and proposed bridge piers. Stage I (from the PA side) and Stage II (from the NJ side) would construct a portion of the new bridge upstream of the existing bridge. When traffic is moved to the newly constructed upstream portion of the new bridge, Stage III (from the PA side) and Stage IV (from the NJ side) would be used to demolish the existing bridge and construct the downstream portion of the new bridge.

Each causeway would obstruct approximately half of the river width, but additional hydraulic openings (temporary bridges that would reduce impact to the substrate) would be provided through each causeway to provide adequate flow of water and to provide for fish passage. Each causeway stage would have a width of approximately 58 feet. Considering the varied lengths and number of fingers of each causeway stage, the temporary disturbance to river bottom of each causeway stage would range from approximately 35,000 and 47,000 square feet. Upon removal of each causeway stage, the river bottom would be restored to its pre-construction condition.

A hydrologic and hydraulic analysis of the two causeway options, trestle causeway and earthen causeway, was performed to estimate the flooding impact. Using aerial mapping for a distance 1,500 upstream from the existing Scudder Falls Bridge and limited available stream bathymetry, a 1.4 year storm event was utilized for the purpose of this analysis. This storm event yields flows of approximately 62,000 CFS which is considered very conservative given that the mean annual high of the Delaware River between 1997 and 2006 was calculated as 25,000 CFS from a USGS gage located at Trenton, just downstream of the Scudder Falls Bridge. Using a worst case condition where the existing bridge piers and new piers for the new bridge are in place along with the Stage III causeway, the greatest rise in water elevation within the first 1,500 feet upstream is 2.08 feet for the earthen causeway and 0.51 feet for the trestle. These are located approximately 80 feet from the upstream face of the proposed bridge. The elevation difference decreases from there. With these elevation rises, the water elevation remains below River Road PA-32 and NJ Route 29 and does not impact property.

## 4. DESCRIPTION OF AFFECTED ENVIRONMENT

The project is located within the Delaware River Valley and the Piedmont Physiographic Province, and topography in the project area is flat to gently rolling. Major water resources along the project include the Delaware River, the Delaware Canal in Pennsylvania, the Delaware and Raritan Canal in New Jersey, and their tributaries. Other waterways in the project area include unnamed tributaries and Reeders Creek in New Jersey. These waterways and their adjoining floodplains and wetlands provide a variety of functions that include drinking water supply, recreation, flood control, and habitat for aquatic species and wildlife. The I-95/Scudder

Falls Bridge crosses the Delaware River upstream of the head of tide in Trenton. In the project area, the Delaware River is a freshwater, non-tidal river that does not accommodate interstate commerce under the U.S. Rivers and Harbors Act. The river accommodates recreational navigation, including whitewater uses approximately 2,000 feet upstream at the Scudder Falls Recreation Area. The I-95/Scudder Falls Bridge spans the Delaware River and a privately owned island, located within the Pennsylvania portion of the river, known as Park Island or generally referred to as part of the Scudder Falls Islands. North of the project area, at Washington Crossing, the Lower Delaware River is designated as a National Wild and Scenic River, but this designation does not extend south to the project area. The Delaware River serves as a primary source of drinking water supply for project area communities, and the Delaware and Raritan Canal is also operated as a drinking water supply by the New Jersey Water Supply Authority (NJWSA). The groundwaters in the project area also serve as a source of drinking water supply. The project area is underlain by the Lockatong Argillite (in New Jersey) and the Stockton Formation, comprised of arkoses and shales. The secondary porosity in these bedrock formations provides a source of groundwater supply for drinking water wells.

The Scudder Falls (I-95) Bridge (the Bridge) crosses the Delaware River approximately seven miles above the head-of-tide, a river reach that is free-flowing (non-tidal). The New Jersey Division of Fish and Wildlife indicated in its November 17, 2003 letter to STV, Inc. that fisheries in this freshwater river reach are quite diverse, with more than 50 species present. These species include many that live there year-round and several others that live part of their lives downstream in tidal freshwater, in Delaware Bay, or in the Atlantic Ocean. The Delaware River is a passageway for both anadromous species that migrate upstream to spawn, such as the American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and striped bass (*Morone saxatilis*), and catadromous species of fish, such as the American eel (*Anguilla rostrata*) that migrates downstream to spawn in the ocean. The river hosts both warmwater and coolwater assemblages of fish. The river also supports yellow lampmussels (*Lampsilis cariosa),* which are considered threatened in New Jersey and rare in Pennsylvania.

Most of the substrate in the study area is a coarse mixture of gravel, cobbles, and boulders containing interstitial sand and small deposits of sand located downstream of larger cobbles and boulders. One exception is a small band of silt and sand located along the east shoreline of Park Island, which grades to include gravel and some cobble under the bridge. Current velocity is low only in this particular area, also. The other area of differing substrate conditions is located along the river's west shoreline downstream of the bridge where occasional outcrops of bedrock are present.

# 5. SPECIES BIOLOGY

## 5.1 SHORTNOSE STURGEON

The shortnose sturgeon is migratory but spends the greatest part of its life in the estuary and moves into the lower part of the non-tidal Delaware River to spawn. Pre-spawning adult fish overwinter in the tidal freshwater reach below Trenton between river miles 118 and 131 (the upper end of this reach is eight miles downstream of the Scudder Falls Bridge) (see Figure 10 Delaware River –River Mile Location Map).

The pre-spawning sturgeon move upstream into the principal spawning grounds, which are located between the head of tide (river mile 133) and Scudder Falls (river mile 140), when water temperature reaches 8°C. Some late arrivals may be present when water temperature is as high as 18°C. However, the majority of spawning is expected to take place in the Scudder Falls reach when water temperature is 10-14°C (Brundage 1986, Environmental Research and Consulting, Inc. 1999 and 2001). The longer temperature range (8-18°C) commonly is observed from late March into mid-May. However, adult shortnose sturgeon typically have returned to the tidal river by early May (Brundage 1986).

Shortnose sturgeon spawn over gravel, rubble (cobble), and boulder substrate (Dadswell *et. al.* 1984, Buckley and Kynard 1985, and Kieffer and Kynard 1996) in rapidly flowing and turbulent water. The eggs sink in the water column, and because they are adhesive, stick to substrate particles on the river bottom. Eggs that sink onto silt or fine sand substrate risk suffocation. Those that adhere to coarser particles or bedrock hatch after approximately 13 days into larvae that are photonegative and which are believed to remain hidden interstitially in the river bottom substrate. Larvae are expected to begin swimming up into the water column and, therefore, drift downstream at 9-14 days old (Richmond and Kynard 1995) and studies (Kynard and Horgan 2002) suggest that the sturgeon larvae move approximately 7.5 km/day (4.7 miles/day). At this rate, the sturgeon larvae would reach the tidal river during a two to three day period and, therefore, be out of the Scudder Falls Bridge area. Based on the length of time reported for egg hatching and development of swimming behavior, it should be expected that sturgeon eggs and larvae may be present in the Scudder Falls Bridge area for as long as 28 days after spawning is expected to end. Typically, this would extend into mid-June.

On 24 and 25 April 2006, 26 shortnose sturgeon larvae were identified in entrainment samples collected for Exelon Corporation's Fairless Hills Generating Station (FHGS) (Waterfield*, et. al.* 2008). The collection of these larvae at this location is likely a rare event, produced by rapidly increasing river flow (from less than 6,000 cfs to over 30,000 cfs in three days), which carried the larvae, which were in the "swim-up" phase of development (13 to 16 mm) identified by Richmond and Kynard (1995), to this downriver location. The Delaware River intake from which the samples were collected is located at river mile 127, approximately 12 miles downstream of the Scudder Falls Bridge project area. This intake is located within the Keystone Industrial Port Complex (the former U.S. Steel Fairless Works), a property owned by U.S. Steel (USS). Cooling and service water for FHGS and other facilities located on this property is obtained from a cooling water intake system and distribution infrastructure that is owned and operated by USS. Examination of the larvae and application of development time estimates from the previous paragraph indicated that they likely spawned around 2 April. These data fit well with the typical late March into mid-May spawning interval, also noted above.

It should be noted that the extent of shortnose sturgeon spawning within the immediate vicinity of the Scudder Falls Bridge is uncertain, according to John C. O'Herron, II, a researcher who has studied this species in the Delaware River for over 20 years. However, Mr. O'Herron and his research partner Harold M. Brundage are studying early life stages of shortnose sturgeon in the lower non-tidal reach of the Delaware River under a two-year grant from the National Marine Fisheries Service to Mr. Brundage's firm, Environmental Research and Consulting, Inc. through the New Jersey Division of Fish and Wildlife's Endangered and Non-Game Species Program. The study reach extends from Blaugard Island, located at river mile 135 (approximately 2 miles upstream of the head of tide), upstream to the head of the Titusville Pool near Washington

Crossing (river mile 142). The Scudder Falls Bridge is located in this reach at river mile 139. The work involves 1) tracking acoustically-tagged adult shortnose sturgeon, 2) collection of settling eggs using floor buffing pads attached to concrete pavers, and 3) collection of drifting eggs and swimming larvae (ichthyoplankton) using D-frame nets.

Preliminary results of this study of shortnose sturgeon early life stages are reported in three progress reports (Environmental Research and Consulting, Inc. 2007, 2008a, and 2008b). In addition, Mr. O'Herron was interviewed and he indicated that a final report on both years' findings (2007 and 2008) would not be available until December 1, 2008. Preliminary findings are as follows:

1. Field sampling did not begin until May 1 in 2007, which is late in the typical shortnose sturgeon spawning period in the Delaware River. Field sampling began on March 27 in 2008.

2. Two acoustically-tagged adult shortnose sturgeon were detected in the study reach on May 1, 2007. An unstated number of acoustically-tagged adult shortnose sturgeon were detected in the study reach on April 14, 18, and 22 and on May 2 in 2008.

3. Floor buffing pads were deployed for collection of settling shortnose sturgeon eggs from May 1 to May 14, 2007. One non-viable egg was collected immediately downstream of Scudder Falls on the Pennsylvania side of the river on May 7. The pads were deployed from March 27 to May 19 in 2008. Shortnose sturgeon eggs were observed on the pads in 2008 as follows:

   - At the head of the Titusville Pool – 1 egg on April 30 and 4 eggs on May 6;

   - Downstream of the Scudder Falls Bridge – 2 eggs on April 14, 1 egg on April 18, and 1 egg on April 22; and

   - In the Yardley Pool – 2 eggs on April 14 and 1 egg on April 18.

4. Thirty-two ichthyoplankton collections totaling approximately 113 net hours were made during the period May 4 to 23, 2007. Ichthyoplankton were collected as follows:

   - Approximately 150 feet downstream of the Scudder Falls Bridge – 1 unfertilized egg and 3 larvae on May 4; and

   - Downstream of Blaugard Island on the Pennsylvania side – 1 confirmed and 1 probable larvae on May 11.

   Sixty-eight ichthyoplankton collections were made during the period April 18 to May 22, 2008. The results of the sample analyses are not yet available.

Although the final results of the work of Mr. O'Herron and Mr. Brundage are not available, it is clear from the preliminary findings that adult shortnose sturgeon were present in the lower non-tidal reach of the Delaware River, which includes the Scudder Falls Bridge, during the spawning season in 2007 and 2008. Secondly, eggs and larvae were present near the Scudder Falls Bridge, but apparently in small numbers.

### 5.2 ATLANTIC STURGEON

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment (Atlantic Sturgeon Status Review Team 2007). The Delaware River spawning grounds are largely unknown, but, based on known locations in other rivers, spawning probably occurs over hard substrate upstream of Wilmington, Delaware (O'Herron *et. al.* 1995). Recent work by researchers at Delaware State University using ultrasonic transmitters suggests that spawning may occur from approximately Tinicum Island at river mile 85 to near the head of tide at Trenton, New Jersey at river mile 131 (Simpson and Fox undated).

Spawning typically occurs in late April through early June, after which the adults may move throughout the tidal river and upstream in search of feeding opportunities. However, they move toward the Atlantic Ocean as water temperature decreases in fall. The juvenile fish remain in tidal waters for several years, moving downstream into and upstream out of Delaware Bay annually in response to changing water temperature.

The Atlantic sturgeon is found in greatest numbers in tidal waters of the Delaware River and upper Bay, but has been recorded as far upstream as Port Jervis, New York at river mile 254, historically (Mihursky 1962). More recently, an Atlantic sturgeon was observed moving downstream near the I-78 Bridge near Easton, PA by a PA Fish and Boat Commission field crew in October 1997 or 1998 (Michael Kaufmann personal communication). Therefore, the occasional adult Atlantic sturgeon may move through the Scudder Falls reach of the Delaware River. Noting that Atlantic sturgeon are large fish, i.e., males are about five feet long and females about six feet long when they are first able to reproduce, any of them in the Scudder Falls reach would be expected to be found in the deeper water located toward the New Jersey side of the river. Juveniles are unlikely to be present in the Scudder Falls reach because they remain in tidal waters.

## 6. CURRENT CONDITIONS FOR SPECIES

### 6.1 SHORTNOSE STURGEON

#### 6.1.1 Rangewide Conditions

Much of the following passage is reprinted from the NMFS's Biological Opinion issued 19 April 2004 for Emergency Repairs to the Morrisville Levy, Morrisville, Pennsylvania (National Marine Fisheries Service 2004). The repairs were made at river mile 133.7, approximately 5 miles downstream of the Scudder Falls Bridge.

Shortnose sturgeon was listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the Endangered Species Act (ESA) in 1973. A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (NOAA Fisheries 1998). NOAA Fisheries Service initiated status review for shortnose sturgeon on November 30, 2007 and extended the comment period on January 28, 2008. The review is expected to be completed in 2009.

Although shortnose sturgeon is listed as endangered range-wide, in the final recovery plan NOAA Fisheries recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick, Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NOAA Fisheries has not formally recognized distinct population segments (DPS) of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. While genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NOAA Fisheries 1998). Consequently, this Biological Assessment will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the Scudder Falls Bridge area) for the purposes of this analysis.

Shortnose sturgeon occur in large rivers along the western Atlantic coast from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long-lived fish species. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NOAA Fisheries 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000: Bain et. al. 1998). No reliable estimate of the size of either the total species or the shortnose sturgeon population in the northeastern United States exists.

### 6.1.2 Conditions in Project Area

There are several estimates of the size of the population of adult shortnose sturgeon in the Delaware River available in the literature. The Final Recovery Plan (NOAA Fisheries 1998) lists three:

| Estimate | Precision (95% Confidence Interval) | | |
|---|---|---|---|
| 6,408 | N/A | - | N/A |
| 12,796 | 10,288 | - | 16,267 |
| 14,080 | 10,079 | - | 20,378 |

These estimates, prepared using three different computation methods and data collected in 1981 through 1984, were published in Hastings, *et. al.* (1987). However, the Final Recovery Plan stated (page 18):

> "These estimates are useful but, because recruitment and migration rates between the population segment studied and the total population in the river are unknown, model

assumptions may have been violated. With the limited scope of the tagging experiment, it is difficult to assess the status of the Delaware River shortnose sturgeon population."

Subsequent to the Final Recovery Plan, Environmental Research and Consulting, Inc. in association with O'Herron Biological and Environmental Consulting, Inc. (2006) reported a fourth estimate of the population size of adult shortnose sturgeon in the Delaware River, based on mark-recapture data collected during January 1999 through March 2003. This estimate (12,047 adults, with a 95% confidence interval of 10,757 to 13,589) is very similar to one of the population estimates listed above.

### 6.1.3 Cumulative Effects of State and Private Actions in Project Area

The following passage is reprinted, with some editing for clarification, from the NMFS's Biological Opinion issued 19 April 2004 for Emergency Repairs to the Morrisville Levy, Morrisville, Pennsylvania (National Marine Fisheries Service 2004).

Impacts to shortnose sturgeon from non-federal activities are unknown in the Delaware River. It is possible that occasional recreational and commercial fishing for anadromous fish species may result in incidental takes of shortnose sturgeon. However, positive identification and distinction between Atlantic sturgeon and shortnose sturgeon are difficult and therefore, historically, takes have not been quantified. Pollution from point and non-point sources has been a major problem in the Delaware River, which continues to receive discharges from sewage treatment facilities and industrial facilities. Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom-dwelling species like shortnose sturgeon are particularly vulnerable.

### 6.1.4 Other Consultations of Federal Action Agency in Area to Date

The National Marine Fisheries Service consulted on emergency repairs to the Morrisville Levy, Morrisville, Pennsylvania with respect to shortnose sturgeon. The NMFS issued its Biological Opinion on April 19, 2004. Prior to this action, NOAA Fisheries Biological Opinions were issued on October 25, 1996 on dredging in the Philadelphia District of the US Army Corps of Engineers, a May 25, 1999 supplement to the previous Biological Opinion, and on February 2, 2001 on the Delaware River Main Channel Blasting Project.

## 6.2 ATLANTIC STURGEON

### 6.2.1 Rangewide Conditions

Atlantic sturgeon presently is not listed under the Endangered Species Act (ESA). However, a review of the status of this species prepared on February 23, 2007 and updated with corrections on July 27, 2007 recommended that three of the five distinct population segments (DPSs) should be listed as threatened under the ESA (Atlantic Sturgeon Status Review Team 2007). A listing recommendation for the remaining two DPSs was not made because the available science was considered insufficient to allow a full assessment of these populations.

The status review reported that Atlantic sturgeon populations should be divided into five distinct DPSs. They were named: 1) Gulf of Maine, 2) New York Bight, 3) Chesapeake Bay, 4)

Carolina, and 5) South Atlantic. These populations are markedly separated, based on genetic, physical, and physiological facts. They have unique genetic characteristics, are located in unique ecological settings, and would represent a significant gap in the range of the species if one of them were to become extinct.

### 6.2.2 Conditions in Project Area

Historically, the Delaware River may have supported the largest stock of Atlantic sturgeon of any Atlantic coastal river system (Kahnle *et. al.* 1998, Secor and Waldman 1999, and Secor 2002). A population estimate made in 1995 using mark-and-recapture methodology indicated a population of less than 1,000 individuals, although it is noted that this and other population estimates violated most tagging study assumptions and, therefore, should not be used as unequivocal evidence that the population has declined dramatically in recent years (Atlantic Sturgeon Status Review Team 2007).

The Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife has documented large reduction in the number of Atlantic sturgeon captured by directed gill netting efforts in the lower tidal Delaware River from 1991 to 1998. The following passage is reprinted from the Division's synopsis to the Atlantic States Marine Fisheries Commission (Delaware Division of Fish and Wildlife undated):

> "Research conducted by the Delaware Division of Fish and Wildlife throughout the 1990's documented an abundance of large (80 to 120 cm TL) sub-adult Atlantic sturgeon in the lower Delaware River. Over 1,000 fish were captured by directed gill netting efforts throughout the summer and early fall in 1991 and 1992 alone which were tagged for determination of abundance, growth and migration. However, continued sampling throughout the remainder of the 90's, showed a precipitous decline in total catch and catch rates. At the same time, the mean size continued to increase and the proportion of previously tagged individuals continued to rise. Not only did these studies provide some valuable insight into growth rates and migratory patterns, they also indicated a sudden decline in reproduction and recruitment. By 1998 when these studies were terminated, the annual total catch had declined to only 14 individuals despite increased sampling efforts in other areas of the lower River."

Data supporting the paragraph above, plus data collected after 1998, are shown in the table below, reprinted from the Division's Atlantic Sturgeon Progress Report State Wildlife Grant Project T-4-1 (Fisher and Jacobini 2007). It is clear that numbers of Atlantic sturgeon appeared to stabilize in the late 1990s forward, but remaining quite low.

TABLE 1.—Annual catch rates of Atlantic sturgeon taken in the lower Delaware River from 1991 to 2007 by the Delaware Division of Fish and Wildlife. In 2007, six additional Atlantic Sturgeon were caught in experimental nets but were not included in the n/hr due to the difference in gear type.

| Year | No. Taken | Days Sampled | Net Hours | N/hr |
|---|---|---|---|---|
| 1991 | 565 | 26 | 17.5 | 32.2 |
| 1992 | 501 | 26 | 29.5 | 17.0 |
| 1993 | 222 | 24 | 26.2 | 8.0 |
| 1994 | 220 | 26 | 21.6 | 10.2 |
| 1995 | 111 | 18 | 21.6 | 5.1 |
| 1996 | 43 | 14 | 17.5 | 2.5 |
| 1997 | 57 | 17 | 17.2 | 3.2 |
| 1998 | 14 | 13 | 10.3 | 1.4 |
| 2001 | 27 | 14 | 15.5 | 1.7 |
| 2004 | 31 | 21 | 19.1 | 1.6 |
| 2007 | 42 | 22 | 22.6 | 1.9 |

The Delaware River Atlantic sturgeon subpopulation and the Hudson River subpopulation constitute the New York Bight DPS. The status review reported that the Delaware River subpopulation has a moderately high risk (>50% chance) of becoming endangered in the next 20 years due to the loss of adults from ship strikes and moderate risk (<50% chance) from dredging, water quality, and commercial bycatch. Such risk to the Delaware River subpopulation, in addition to moderate risk of the Hudson River subpopulation, was sufficient to recommend that the New York Bight DPS be listed as threatened under the Endangered Species Act.

### 6.2.3 Cumulative Effects of State and Private Actions in Project Area

Ship strikes in the Delaware River/Bay shipping channel and dredging associated with the shipping channel and access channels to nearby docks are threats to Atlantic sturgeon. Dredging may be considered an indirect impact because this activity destroys the benthic macroinvertebrate community associated with the river bottom and which comprises the Atlantic sturgeon's food supply. Other threats to this species in the Delaware River/Bay include water pollution and commercial bycatch in the Delaware Bay gillnet fishery, although bycatch mortality of Atlantic sturgeon is typically low (Atlantic Sturgeon Status Review Team 2007).

### 6.2.4 Other Consultations of Federal Action Agency in Area to Date

The National Marine Fisheries Service consulted on Emergency Repairs to the Morrisville Levy, Morrisville, Pennsylvania with respect to shortnose sturgeon. The NMFS issued its Biological Opinion on April 19, 2004. Prior to this action, NOAA Fisheries Biological Opinions were issued on October 25, 1996 on dredging in the Philadelphia District of the US Army Corps of Engineers, a May 25, 1999 supplement to the previous Biological Opinion, and on February 2, 2001 on the Delaware River Main Channel Blasting Project.

There have been no consultations on Atlantic sturgeon because it is currently not a listed species under the Endangered Species Act.

# 7. CRITICAL HABITAT

Although shortnose sturgeon is listed under the Endangered Species Act, critical habitat is not defined for this species. Critical habitat is not defined for Atlantic sturgeon because it is not a listed species.

# 8. PROJECT EFFECTS

## 8.1 SHORTNOSE STURGEON

Adult shortnose sturgeon are expected to be in the project area only during the spawning season, which typically lasts from late March into mid-May when river water temperature is in the range of 8-18°C. Sturgeon eggs and larvae are expected to be in the project area from late April through mid-June, including approximately four weeks for the eggs to hatch on the bottom and the larvae to swim up and downstream into tidal waters.

### 8.1.1 Direct Effects (noise, vibration, sedimentation, etc.)

Direct effects to shortnose sturgeon include temporary loss of spawning habitat in the footprint of causeways and cofferdams used in bridge construction and permanent loss of spawning habitat in the footprint of new bridge piers. Four causeways will be constructed through the life of the project, but each causeway will be removed before the next is built. It is anticipated that a three to four year construction period will be required and it is likely that one causeway will be in place throughout most of this period.

Each causeway stage will extend approximately to mid-river, and will include 100 feet of hydraulic opening (temporary bridges) to allow river flow through it. The hydraulic openings will reduce the causeway effects on the substrate. Each of the two New Jersey-side causeways will contain one hydraulic opening (temporary bridge) extending 100 feet across the deepest part of the river. Each of the two Pennsylvania-side causeways will contain two hydraulic openings (temporary bridges), each 50 feet wide.

Each causeway will include “causeway fingers” constructed perpendicular to the main causeway to allow construction access to the existing and new pier locations.

Each causeway will have a typical width of 58 feet including work area and sideslopes. Causeway lengths, number of hydraulic openings (temporary bridges) and number of fingers will vary. The area of river bottom that will be temporarily lost as spawning and nursery habitat will range from approximately 33,000 square feet to approximately 47,000 square feet per causeway. Although only one causeway will be in place at any one time, the total temporary loss of river bottom as spawning and nursery habitat of the four causeways and causeway fingers will be approximately 153,000 square feet (3.52 acres).

Five new bridge piers with scour protection will be constructed in the riverbed, each footprint estimated to be 20 feet wide and 160 feet long. Each new bridge pier will cover approximately 3,200 square feet (=0.07 acres). Therefore, five new bridge piers will cause the permanent loss of approximately 16,000 square feet (= 0.37 acres) of river bottom as spawning and nursery habitat.

Construction of the new bridge will include removal of the seven existing piers that are located in the Delaware River. Removal of these piers to a depth of two to three feet below the river bed elevation will result in restoration of approximately 4,285 square feet (0.10 acres) of river bottom. This restoration will reduce the permanent loss of river bottom spawning and nursery habitat due to the new bridge piers to approximately 11,715 square feet (0.27 acres).

In order to build each pier, a cofferdam will be constructed of interlocking steel sheeting vibrated or driven to rock. As the excavation progresses, lateral supports will be installed to strengthen the steel sheeting. Each cofferdam's footprint is anticipated to be 26 feet wide and 166 feet long, covering a river bottom surface area of 4,316 square feet (0.10 acres) that will be dewatered to allow pier construction. Therefore, when considering the permanent impact of 3,200 square feet from each pier within each cofferdam, the net temporary impact of each cofferdam is 1,116 square feet (0.026 acres). There will be a maximum of three cofferdams in place for Stages I and III. The total net temporary loss of spawning and nursery habitat at any one time during these stages due to cofferdams will be about 3,348 square feet (0.077 acre).

In order to demolish the existing bridge piers, a cofferdam will be constructed similar in type to those constructed for the proposed bridge piers except these cofferdams will be smaller. Each of these cofferdams is anticipated to be approximately 15 feet wide and 70 feet long covering a river bottom surface area of approximately 1,050 square feet that will be dewatered to allow demolition. In total, the cofferdams for pier demolition will temporarily impact 7,350 square feet of river bottom. There will be a maximum of six cofferdams (three for proposed piers and three for demolition of existing piers) in place for Stages II and IV. The total net temporary loss of spawning and nursery habitat at any one time during these stages due to cofferdams will be about 5,200 square feet (0.12 acre).

Because the cofferdam steel sheeting will be driven to bedrock and all joints will be tightly sealed, it is anticipated that shortnose sturgeon eggs and larvae will not enter the enclosed cofferdam areas.

It is anticipated that it will take approximately three weeks to construct each cofferdam and that each will be in use for approximately four months in order to construct the bridge pier foundations and shafts. Because all of the piers will not be constructed simultaneously, there will be at least one cofferdam in place during much of construction.

Other direct effects of the project include noise, vibration, and sedimentation. Noise will be generated by heavy and other equipment used in bridge construction and demolition, including, but not limited to, bulldozers, pile drivers, hydraulic rams, excavators, dump trucks, and dewatering pumps. Vibration will be generated by steel sheet vibrated or driven into the riverbed as part of cofferdam construction, and from the hydraulic ram during demolition of the existing bridge. Vibration may also be expected from drilling for river bottom samples conducted as part of the final design of the pier foundations and drilling for construction of drilled shaft pier foundations if river bottom subsurface conditions do not favor spread-footing pier foundations. Downstream sedimentation can be expected as rock is dumped onto the riverbed during causeway construction and as it is removed during causeway removal. Since construction will occur within the cofferdams and causeways during the moratorium, noise and vibration effects may occur during that time.

No blasting is included in the project. Therefore, there will be no noise, vibration, concussion, or sedimentation impacts from blasting.

Yellow lampmussel is expected to be relocated from the footprint of the causeways and proposed new piers to a river reach located upstream of the bridge project. Limited sedimentation can be expected from hand-excavation of the river bottom surface in search of mussels.

### 8.1.2 Indirect Effects (upstream and downstream flow impacts, etc)

The only indirect effects to shortnose sturgeon that are anticipated from the project are related to causeway impacts on river flow. Each causeway will extend only approximately one-half of the width of the river, allowing unimpeded water flow around it. Furthermore, each causeway will contain 100 feet of hydraulic opening (temporary bridge) for water flow and passage of spawning adults, eggs, and larvae. Lastly, each causeway will contain one pipe 5 feet in diameter to facilitate river flow through the structure between adjacent fingers where hydraulic openings (temporary bridges) are not located. However, the causeways can be expected to reduce river flow immediately downstream of them, but only at points between the hydraulic openings and pipes. Such flow reduction may make these locations less attractive as spawning habitat.

It is unlikely that washout of a causeway would make much difference in survival of larval shortnose sturgeon during a severe storm event. First, it should be noted that the volume of material used to construct one of the causeways probably would represent a tiny fraction of the total bedload that would move during a severe storm event. With or without the causeway in place, shortnose sturgeon larvae would be present interstitially in the river bottom substrate. Some larvae likely would be sufficiently deep in the substrate that they would not be disturbed by bedload movement. Other larvae undoubtedly would be washed away. It is difficult to estimate what percentage might be killed because there is no known data available in the literature on this subject.

### 8.1.3 Incidental Take

Section 9 of the Endangered Species Act (ESA) and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. NOAA Fisheries interprets the term “harm” as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CRS §222.102). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement.

Application of the conservation measures outlined in Section 9, including the seasonal restrictions, should ensure that incidental take should not occur or would be negligible. In place of an estimate of incidental take, effect to the riverbed (important as spawning and nursery habitat) is presented in this section as a surrogate for incidental take, understanding that it is not possible to measure the decrease in shortnose spawning success due to effects to the riverbed.

A total of approximately 153,000 square feet (3.52 acres) of river bottom will be temporarily occupied by the four causeways. A total of approximately 16,000 square feet (0.37 acres) of river bottom will be occupied by five new bridge piers, less approximately 4,285 square feet (0.10 acres) of river bottom that will be gained after removal of seven existing piers, for a permanent loss of approximately 11,715 square feet (0.27 acres) of river bottom. Five cofferdams for new bridge piers and six cofferdams for demolition of existing bridge piers will temporarily affect an additional area of approximately 11,880 square feet (0.27 acres) of river bottom.

Most of the substrate in the study area is a coarse mixture of gravel, cobbles, and boulders containing interstitial sand and small deposits of sand located downstream of larger cobbles and boulders, which is considered suitable habitat for shortnose sturgeon. In order to determine what percentage of the bottom in the seven mile long river reach extending from the head of tide to Scudder Falls might be temporarily lost to causeway and cofferdam construction and permanently lost to replacement of the seven smaller existing piers with five larger proposed piers, the area of this river reach was computed using an average river width of 1,000 feet. This area is approximately 848.5 acres. The river bottom areas temporarily or permanently lost are small:

Temporary Effects

| Effect | River Bottom Area (Acres) | Percent of Total River Reach |
|---|---|---|
| Causeways[2] | | |
| Stage I | 0.81 | 0.10 |
| Stage II | 0.76 | 0.09 |
| Stage III | 1.07 | 0.13 |
| Stage IV | 0.87 | 0.10 |
| Total | 3.52 | 0.41 |
| Cofferdams –new bridge piers | | |
| One | 0.026 | 0.003 |
| Five | 0.130 | 0.015 |
| Cofferdams – existing pier demolition | | |
| One | 0.024 | 0.003 |
| Six | 0.145 | 0.017 |

Permanent Effects

| Effect | River Bottom Area (Acres) | Percent of Total River Reach |
|---|---|---|
| Replacement of seven existing piers with five proposed piers | 0.27 | 0.032 |

Although these actions represent temporary or permanent loss of spawning and nursery habitat, the loss should not be considered significant because it will represent only a minute percentage of the seven miles of river in which shortnose sturgeon are expected to spawn.

## 8.2 ATLANTIC STURGEON

Although the Delaware River spawning grounds of Atlantic sturgeon are largely unknown, spawning occurs in tidal waters, perhaps as far upstream as the head of tide. Juvenile Atlantic sturgeon remain in tidal waters. Therefore, the project will not affect spawning adults, eggs, larvae, or juveniles.

The Atlantic sturgeon is found in greatest numbers in tidal waters of the Delaware River and upper Bay, but has been recorded as far upstream as Port Jervis, New York. Therefore, the occasional adult Atlantic sturgeon may move upstream through the project area after spawning in June and downstream to tidal waters in the fall.

[2] Causeway calculations include causeway fingers

### 8.2.1 Direct Effects

Direct effects to Atlantic sturgeon, which are bottom feeders, include temporary loss of feeding habitat in the footprint of causeways and cofferdams used in bridge construction and permanent loss of spawning habitat in the footprint of new bridge piers. See Section 8.1.1, above, for discussion of the amount of river bottom affected by these project components and their timing.

Other direct effects of the project include noise, vibration, and sedimentation. These effects also are discussed in Section 8.1.1, above.

### 8.2.2 Indirect Effects

The only indirect effects to Atlantic sturgeon that are anticipated from the project are related to causeway impacts on river flow. Each causeway will extend only approximately one-half of the width of the river, allowing unimpeded water flow around it. Furthermore, each causeway will contain hydraulic openings for water flow and fish passage.

### 8.2.3 Conferencing Analysis/Conclusion

In place of an estimate of incidental take for shortnose sturgeon, impact to the riverbed is presented as a surrogate in Section 8.1.3. This effect estimate would be consistent for Atlantic sturgeon, should the species be listed prior to project implementation.

# 9. CONSERVATION MEASURES

## 9.1 CONSTRUCTION MEASURES

The following conservation measures will be incorporated into the project to minimize effects on aquatic resources, including shortnose sturgeon and Atlantic sturgeon, in the Delaware River:

- In-river construction and removal of the four causeways and cofferdams will be scheduled outside the period March 15 through June 30 in order to prevent disruption of shortnose sturgeon spawning and effects on this species' eggs and larvae. A determination will be made during the final design phase of the feasibility of extending this moratorium to July 15 to protect river herring (alewife and blueback herring), which are important as prey for predatory fish species, during the end of their spawning period.

- The causeways will be constructed of clean, washed rock to minimize in-river sedimentation.

- Each causeway will contain at least one hydraulic opening (temporary bridge that would not affect the substrate) and large pipe (5 feet diameter) to allow water passage.

- The steel sheeting that will be used to construct the cofferdams will be vibrated into the river bottom where physical conditions allow. Otherwise, it must be driven.

- Five cofferdams will allow construction of the new bridge piers "in the dry". Similarly, six cofferdams will allow demolition of the existing bridge piers "in the dry". This will prevent any fish, including Atlantic and shortnose sturgeon, and their eggs and larvae from entering river bottom areas where they may be injured or killed.

- Turbidity barriers and other erosion/sedimentation controls will reduce in-river sedimentation.

- Water quality will be monitored downstream of the causeways and cofferdams during their construction and removal to measure sedimentation.

- Some scuppers will be eliminated in construction of the new bridge, with the majority of the stormwater directed to land-based passive treatment. This will be an improvement from the existing bridge drainage system.

- An SPCP will be developed to prevent spills from entering the river during construction. Additionally, an SPCP will be prepared to address spills from vehicles using the bridge when construction is completed.

- Large particle crushed rock used to construct the causeways will be used to restore the river bottom in the footprint of the seven existing bridge piers after they are removed. This rock also will be available to enhance habitat in other areas of river bottom near the proposed new bridge.

- The riverbed in the project area will be monitored to ensure timely removal of all construction debris.

### 9.2 PROACTIVE MEASURES TO PROMOTE RECOVERY OF THE SPECIES

The project will also incorporate the following measures to proactively promote the recovery of the shortnose sturgeon.

- An acoustic receiver will be provided to researchers for use in the project area to record the possible presence of acoustically-tagged shortnose sturgeon.

## 10. CONCLUSIONS

The Scudder Falls Bridge Improvement Project will impact the river bottom habitat of shortnose sturgeon and Atlantic sturgeon in the project area, not the fish directly. None of these fish will be killed or injured, including eggs and larval shortnose sturgeon, because they will be excluded from areas of the riverbed where construction will take place.

Some river bottom habitat will be temporarily lost to use by shortnose sturgeon and Atlantic sturgeon when temporary causeways and cofferdams are in place. A smaller amount of river bottom habitat in the footprint of the proposed piers will be permanently lost to use by both species. However, the surface areas that will be temporarily or permanently lost are quite small, compared to the total surface area of river bottom available to these species in the non-tidal Delaware River.

This project may affect, and it is likely to adversely affect, shortnose sturgeon or Atlantic sturgeon because river bottom habitat will be temporarily or permanently lost. However, the effect to both species should be considered insignificant because the losses will be only a very small percentage of the habitat that is available to them.

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## 12. LIST OF CONTACTS

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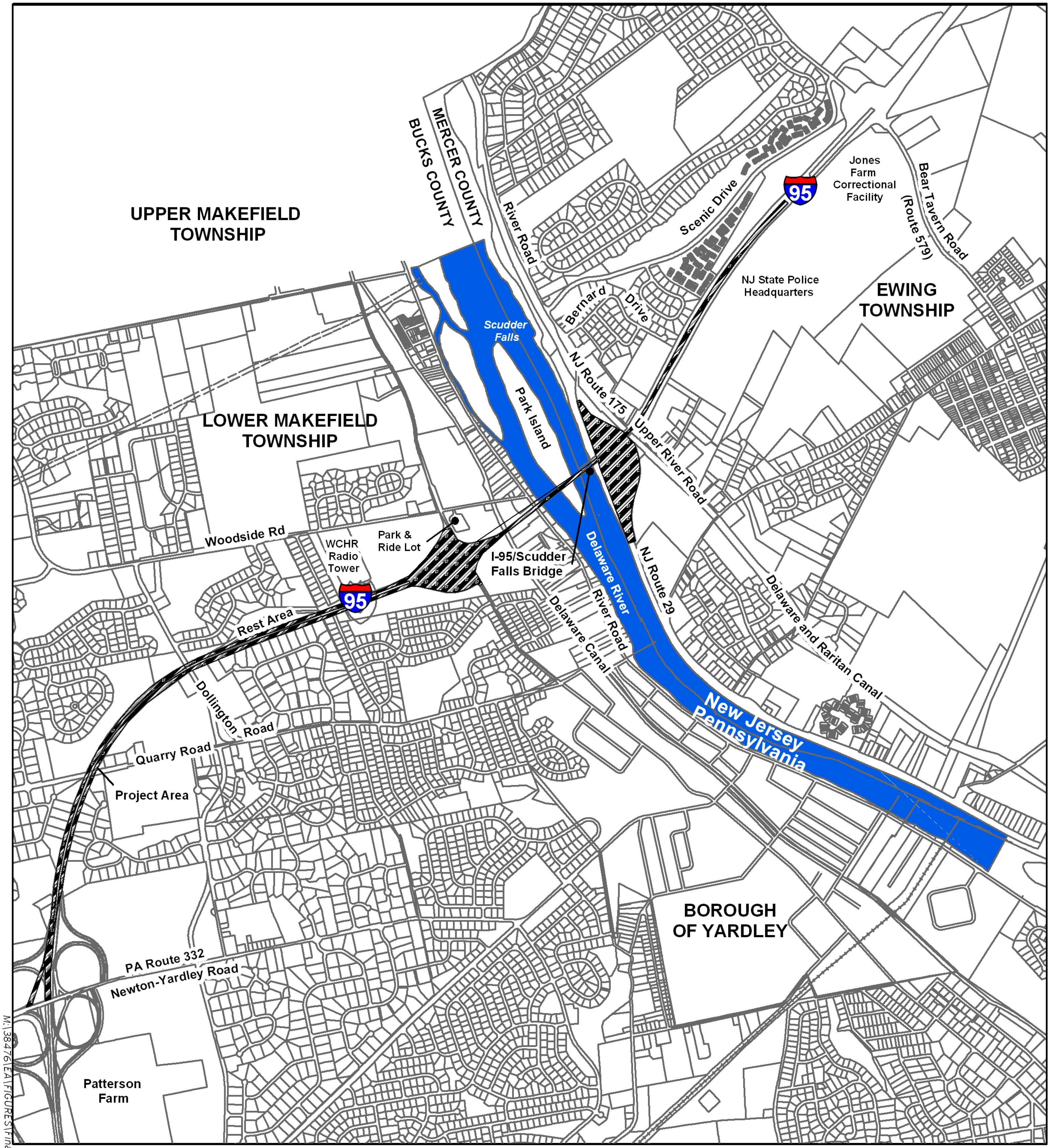
## 13. MAPS/PHOTOGRAPHS




Project Area

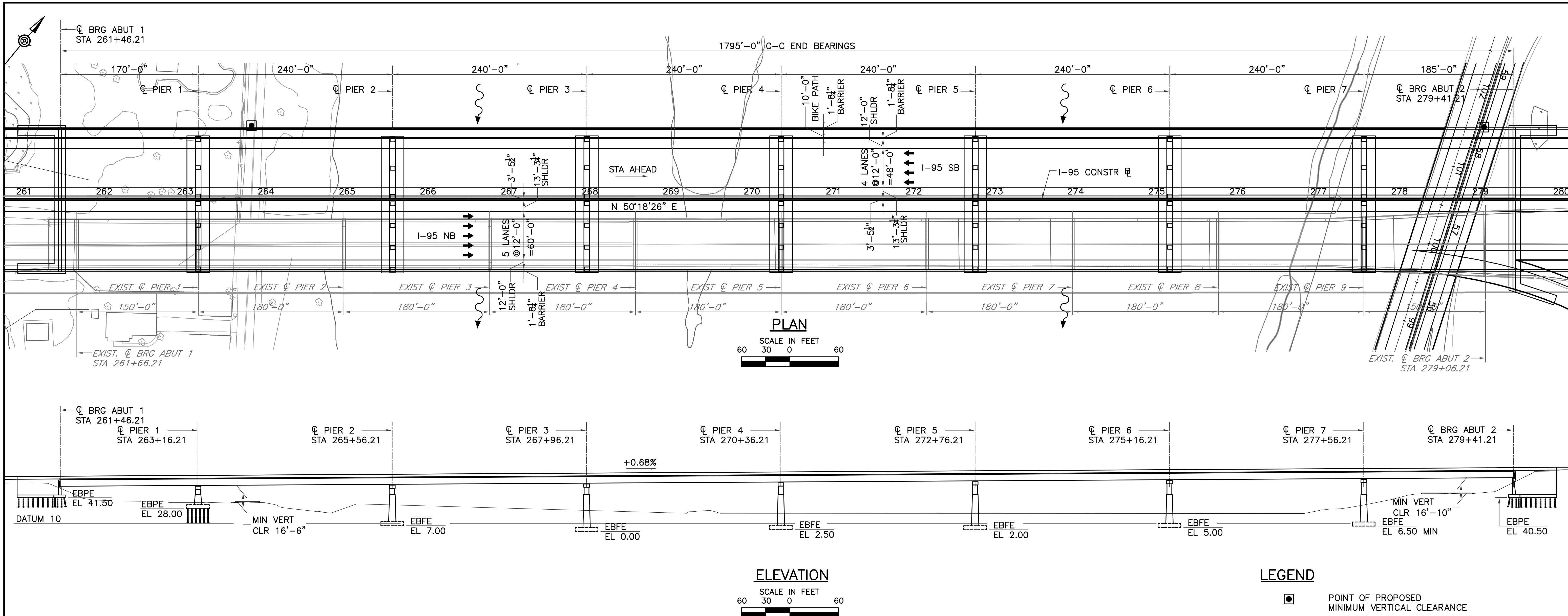
Not to Scale

## I-95/Scudder Falls Bridge Improvement Project

## Project Location Map

**Figure I**

M:\38476\EA\FIGURES\Final EA Figures\Figure I-2 Vicinity Map.mxd




## LEGEND

| | |
|---|---|
| ⊡ | POINT OF PROPOSED MINIMUM VERTICAL CLEARANCE |
| | *EXISTING CONDITIONS* |
| | PROPOSED |
| ➡ | TRAFFIC FLOW DIRECTION |
| | STREAM |
| EBFE – | ESTIMATED BOTTOM OF FOOTING ELEVATION |
| EBPE – | ESTIMATED BOTTOM OF PILE CAP ELEVATION |

## VERTICAL CURVE DATA
## I-95 SURVEY & CONSTR ℄

PVC STA 277+75 — 0.68% — 1.30% — PVT STA 278+98

SOUTHBOUND
PVI STA 278+36.50
ELEV 76.70
VC 123.00'

PVI STA 279+50 EL 78.13 — 1.22% — 1.48% — PVI STA 280+00 EL 78.87

SOUTHBOUND

## VERTICAL CURVE DATA
## I-95 SURVEY & CONSTR ℄

PVC STA 277+75 — 0.68% — 2.93% — PVT STA 282+25

NORTHBOUND
PVI STA 280+00
ELEV 77.81
VC 450.00'

## HORIZONTAL CURVE DATA
## ROUTE 29 SB CONSTR ℄

PI STA 111+28.23
Δ = 20°52'14" RT
D = 04°35'01"
T = 230.21'
L = 455.33'
R = 1250.00'
E = 21.02'

## VERTICAL CURVE DATA
## ROUTE 29 SB SURVEY & CONSTR ℄

PVC STA 106+00 — 3.52% — 3.29% — PVT STA 108+00

NORTHBOUND
PVI STA 107+00
ELEV 68.16
VC 200.00'

# FIGURE 2

| REVISION | CKD. | BY | DATE |
|---|---|---|---|

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER ENGINEER 000000-0

DMJM HARRIS | AECOM
260 S. Broad Street, Suite 1500
Philadelphia, Pennsylvania 19102

**DELAWARE RIVER JOINT TOLL BRIDGE COMMISSION**
I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT

MAIN RIVER BRIDGE
GENERAL PLAN AND ELEVATION – 1

| | | |
|---|---|---|
| Drawn By AG | Engineer JMB | Contract No. XXXXXXXX |
| In Charge | File | Drawing No. 1 of 2 |
| Date 4/23/07 | Scale AS NOTED | Sheet No. 1 of 2 |

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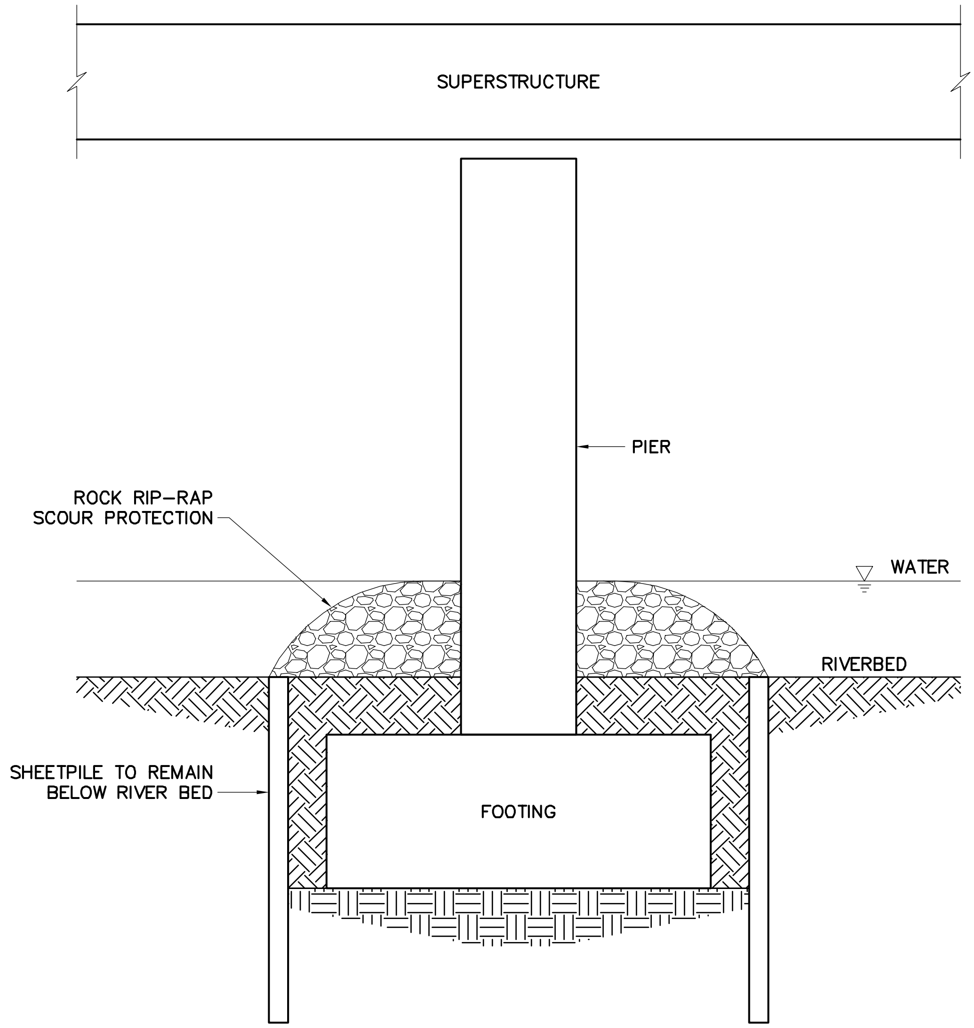
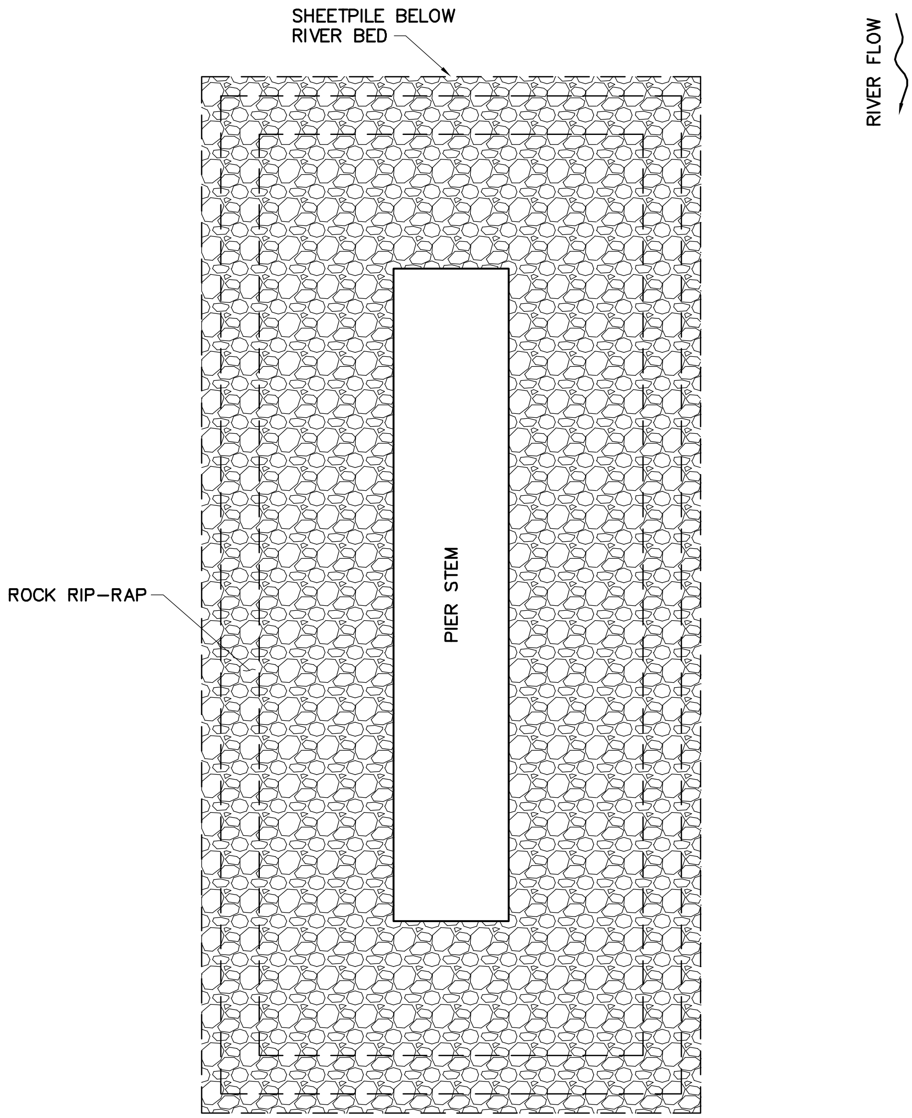


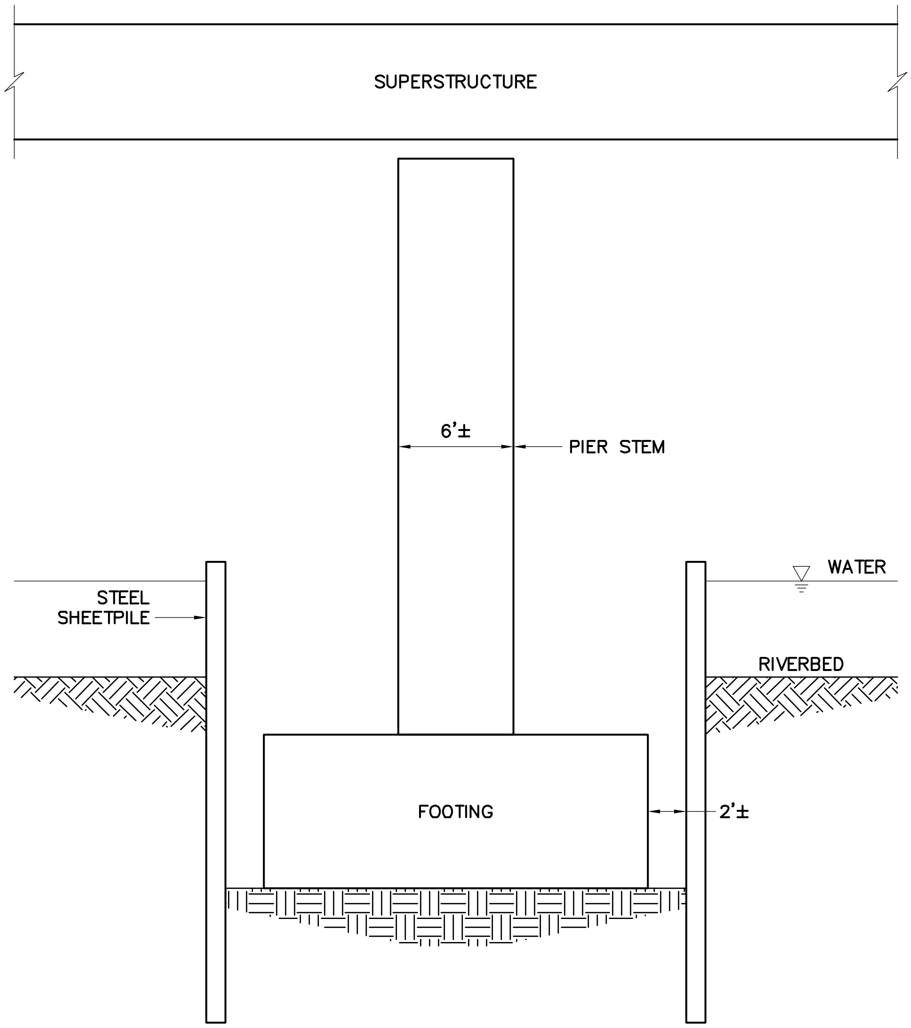

ELEVATION
TYPICAL RIVER PIER
SCOUR PROTECTION

FIGURE 3




PLAN
TYPICAL RIVER PIER
SCOUR PROTECTION

FIGURE 4




ELEVATION
TYPICAL RIVER PIER
CONSTRUCTION

I-95 / SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT
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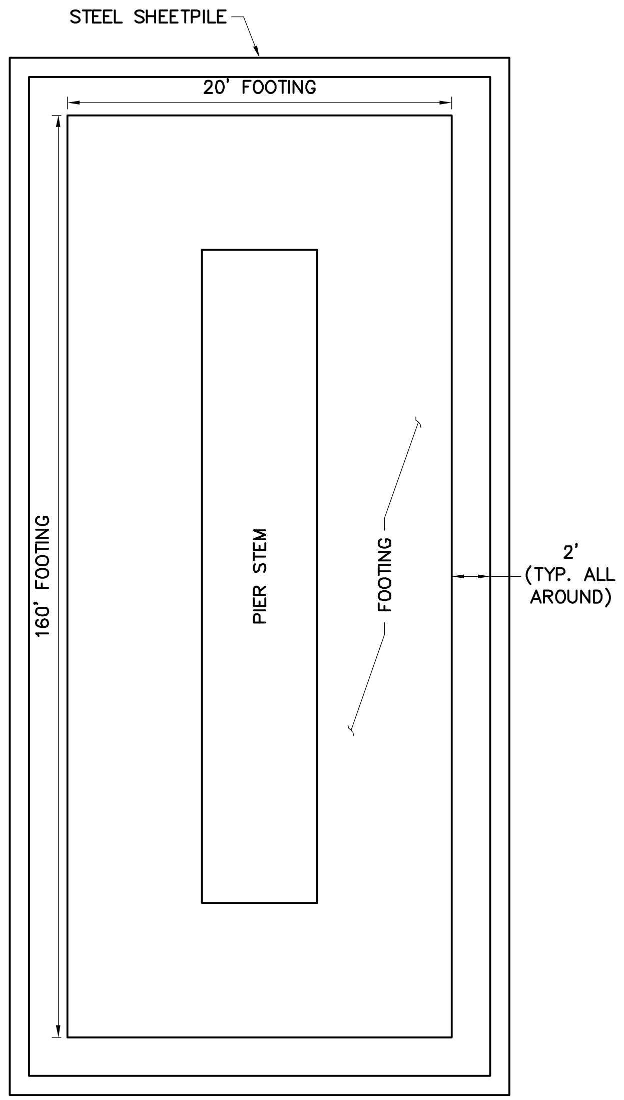
Delaware River Joint Toll Bridge Commission

FIGURE 5




PLAN
TYPICAL RIVER PIER
CONSTRUCTION

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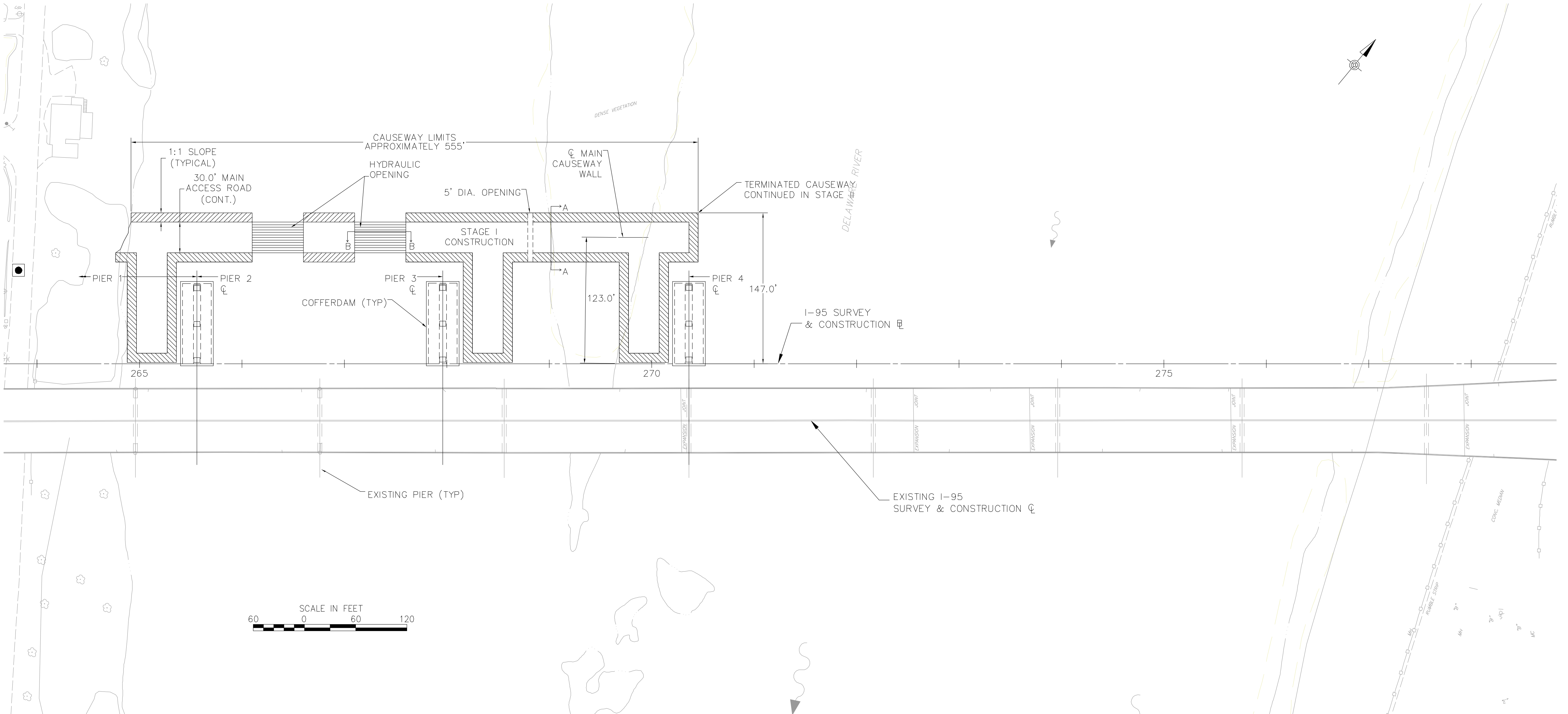
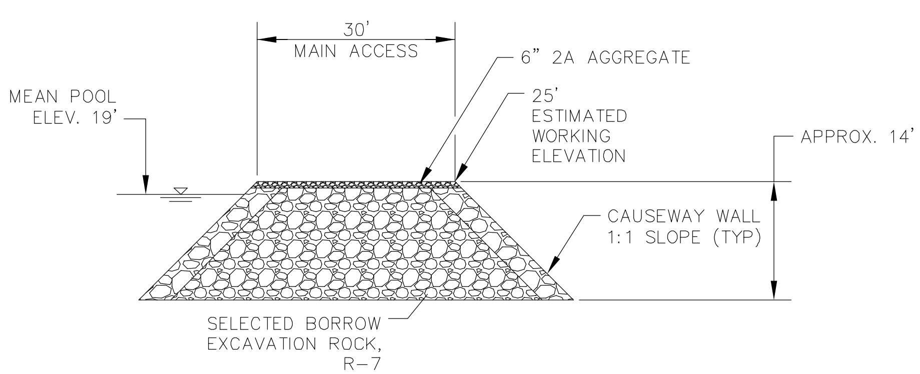
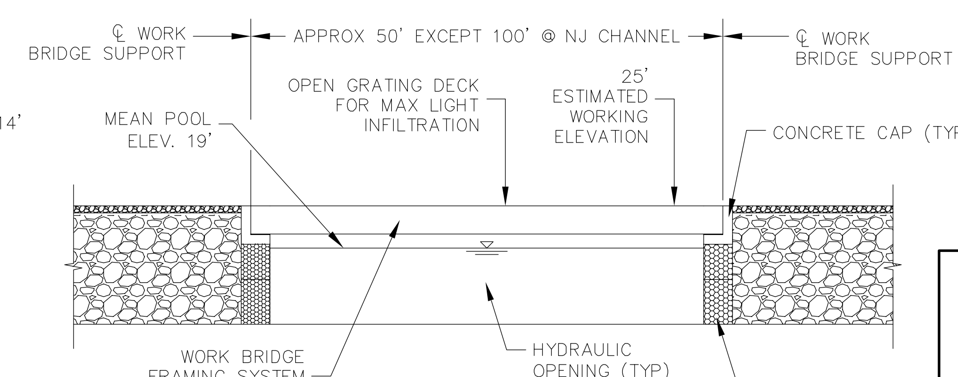
FIGURE 6




SECTION A-A
TYPICAL CAUSEWAY WALL SECTION



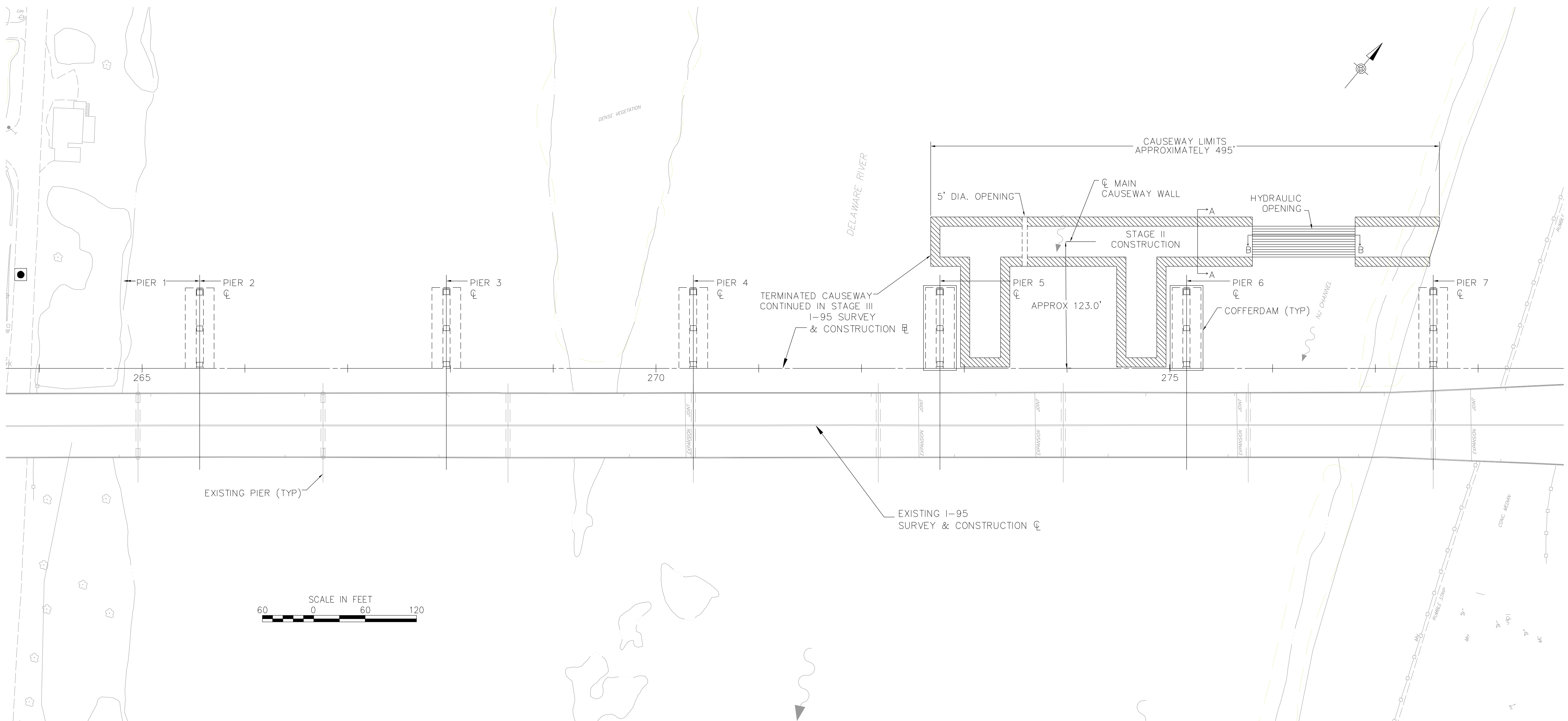

SECTION B-B
HYDRAULIC OPENING
(TYP)

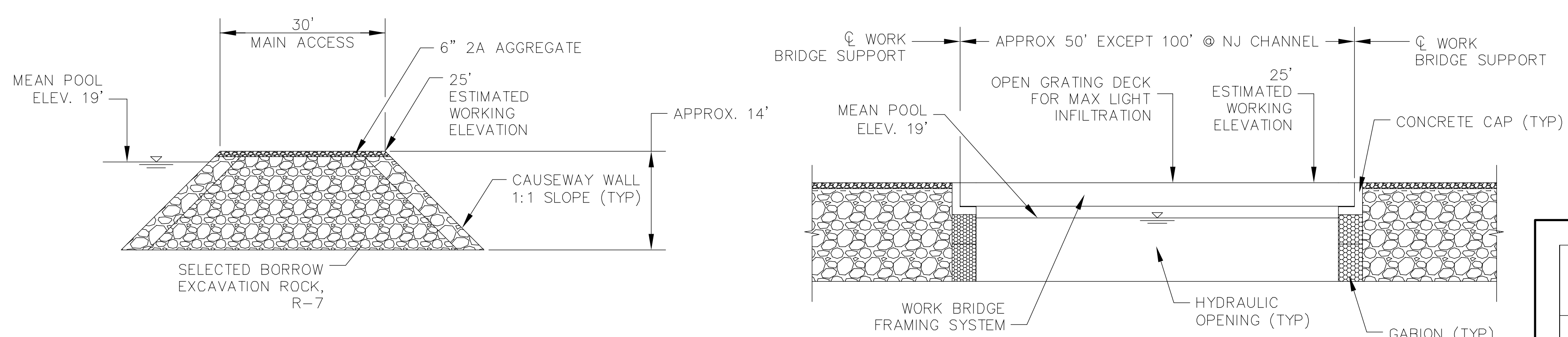
I-95/SCUDDER FALLS BRIDGE IMPROVEMENT
PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
EARTHEN TYPE
STAGE I

FIGURE 7A

Sep, 09 2008 05:52 pm G:\5969.06\Preliminary\Civil\Design\adantonio\Causeway_stage 1.dwg By: Melvina




SECTION A-A
TYPICAL CAUSEWAY WALL SECTION

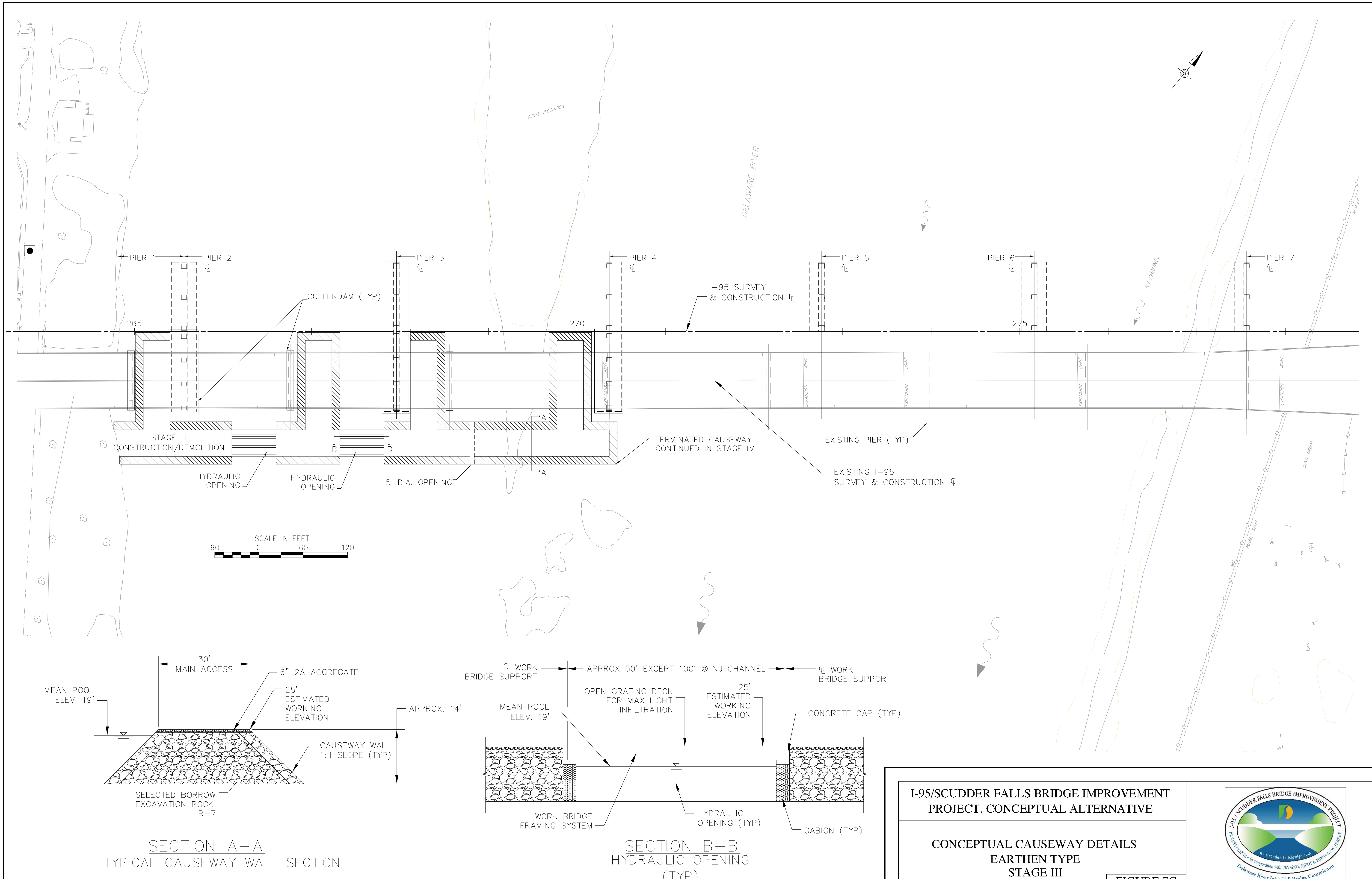
SECTION B-B
HYDRAULIC OPENING
(TYP)

I-95/SCUDDER FALLS BRIDGE IMPROVEMENT
PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
EARTHEN TYPE
STAGE II

FIGURE 7B

Sep, 09 2008 06:10 pm G:\5969.06\Preliminary\Civil\Design\adantonio\Causeway_stage 2.dwg By: Melvina

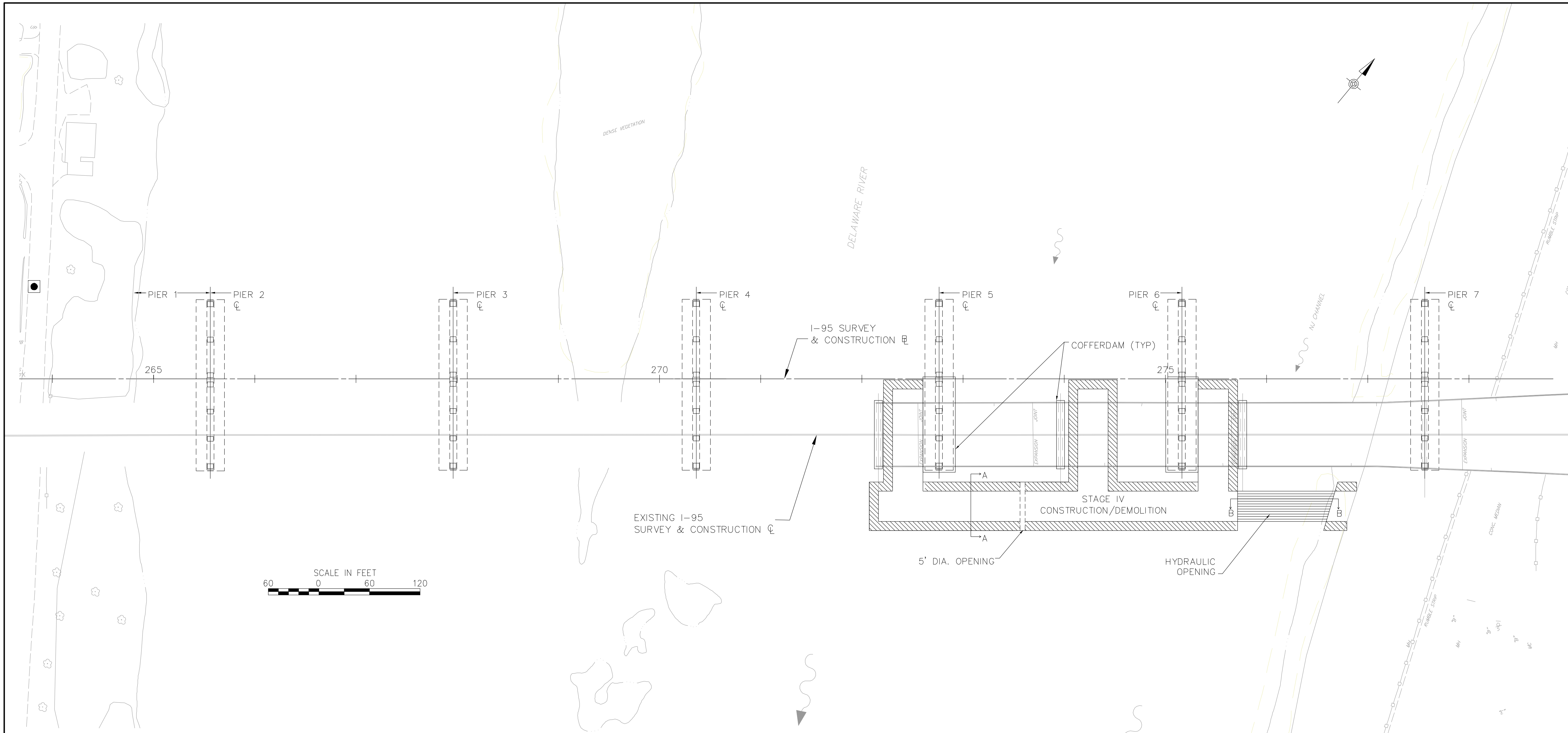


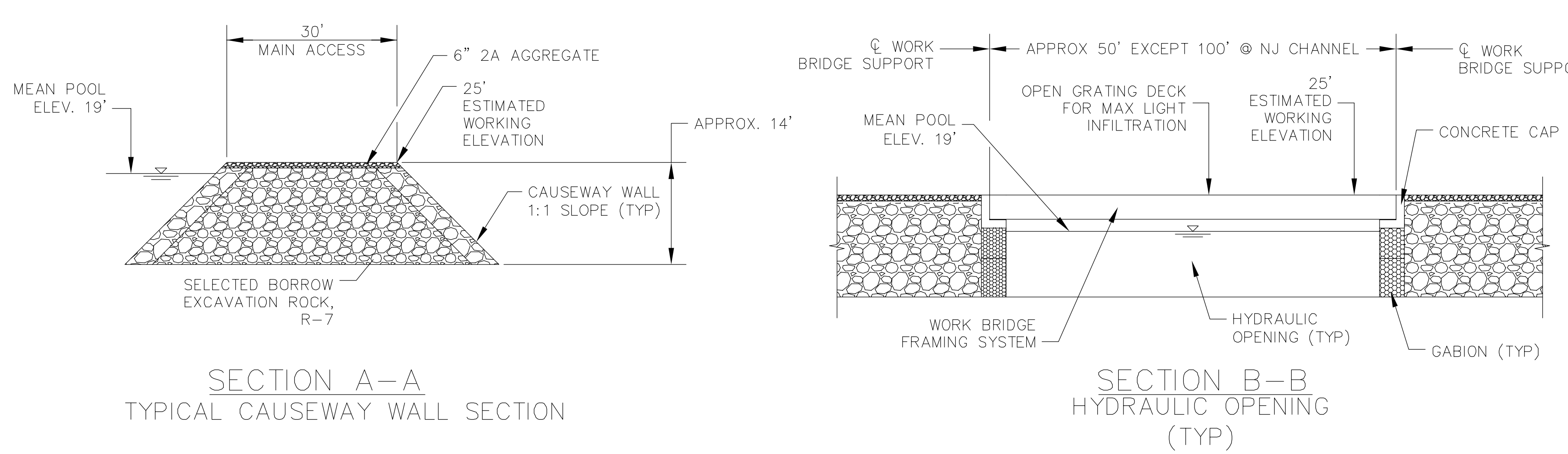

I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
EARTHEN TYPE
STAGE III

FIGURE 7C

Sep, 09 2008 05:56 pm G:\5969.06\Preliminary\Civil\Design\adantonio\Causeway_3.dwg By: Melvina




I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
EARTHEN TYPE
STAGE IV

FIGURE 7D

**CONCEPTUAL SCUDDER FALLS BRIDGE CONSTRUCTION SEQUENCE**

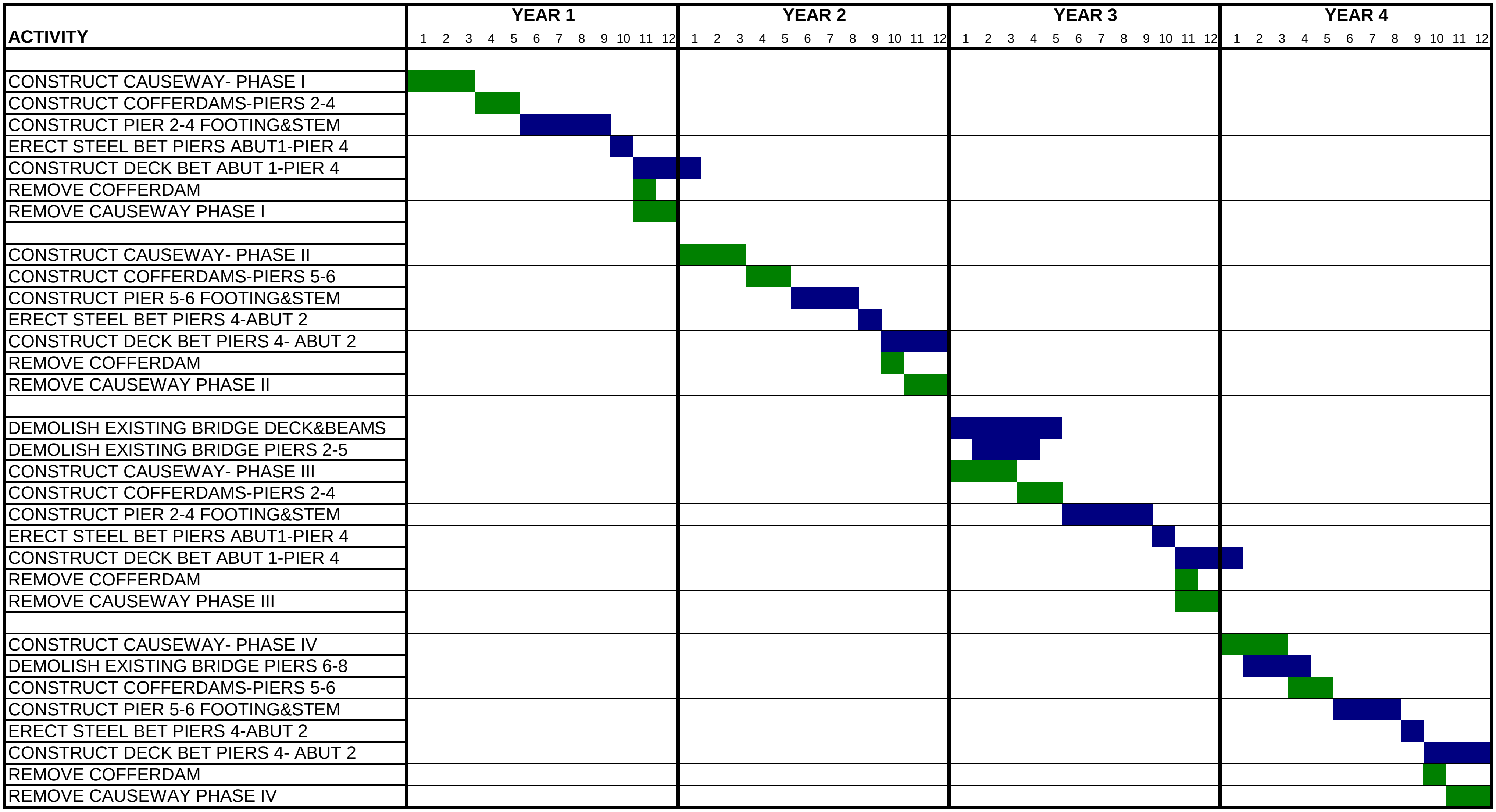
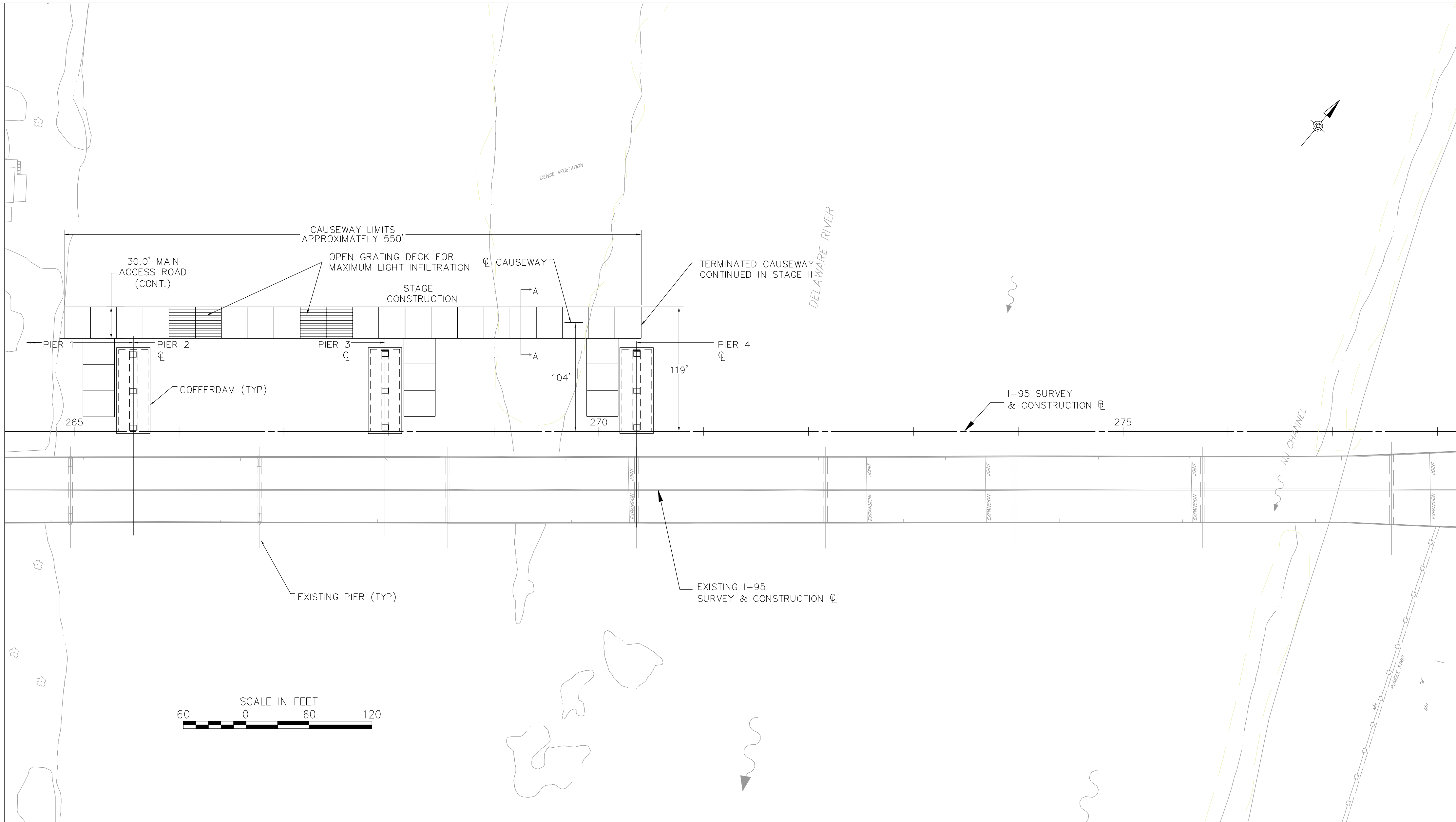
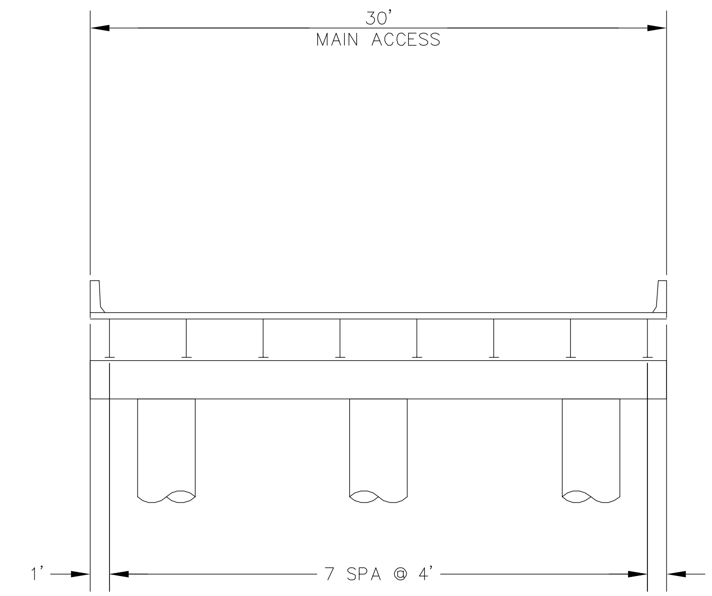


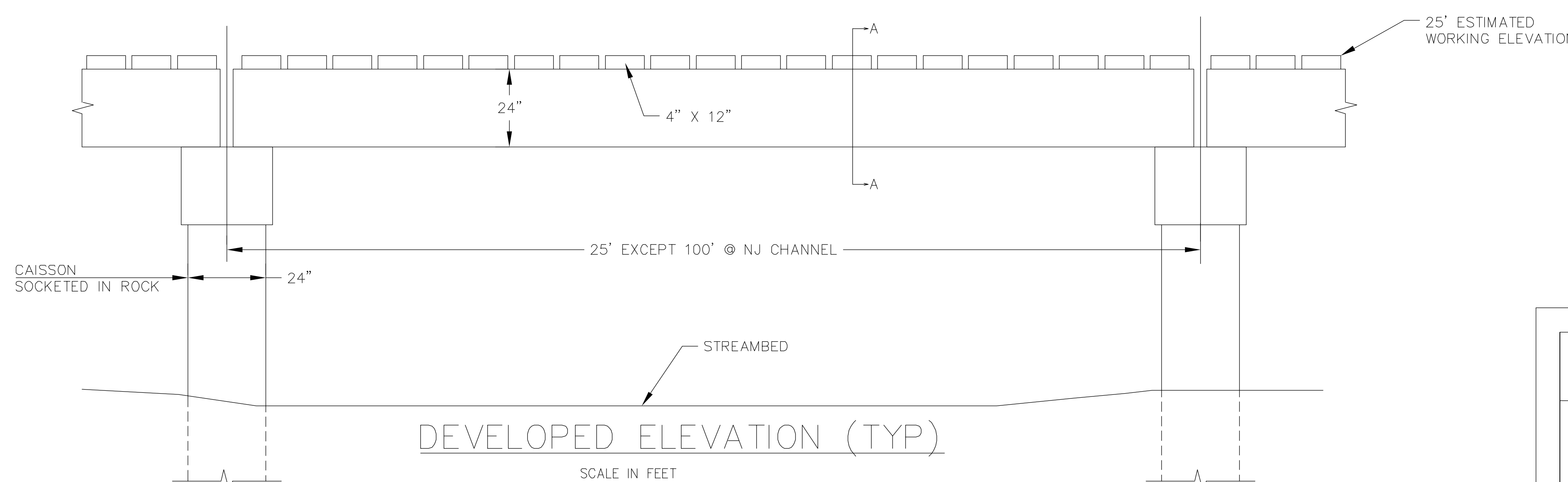

**FIGURE 8**




SECTION A–A
TYPICAL SECTION

SCALE IN FEET
5 0 5 10




DEVELOPED ELEVATION (TYP)

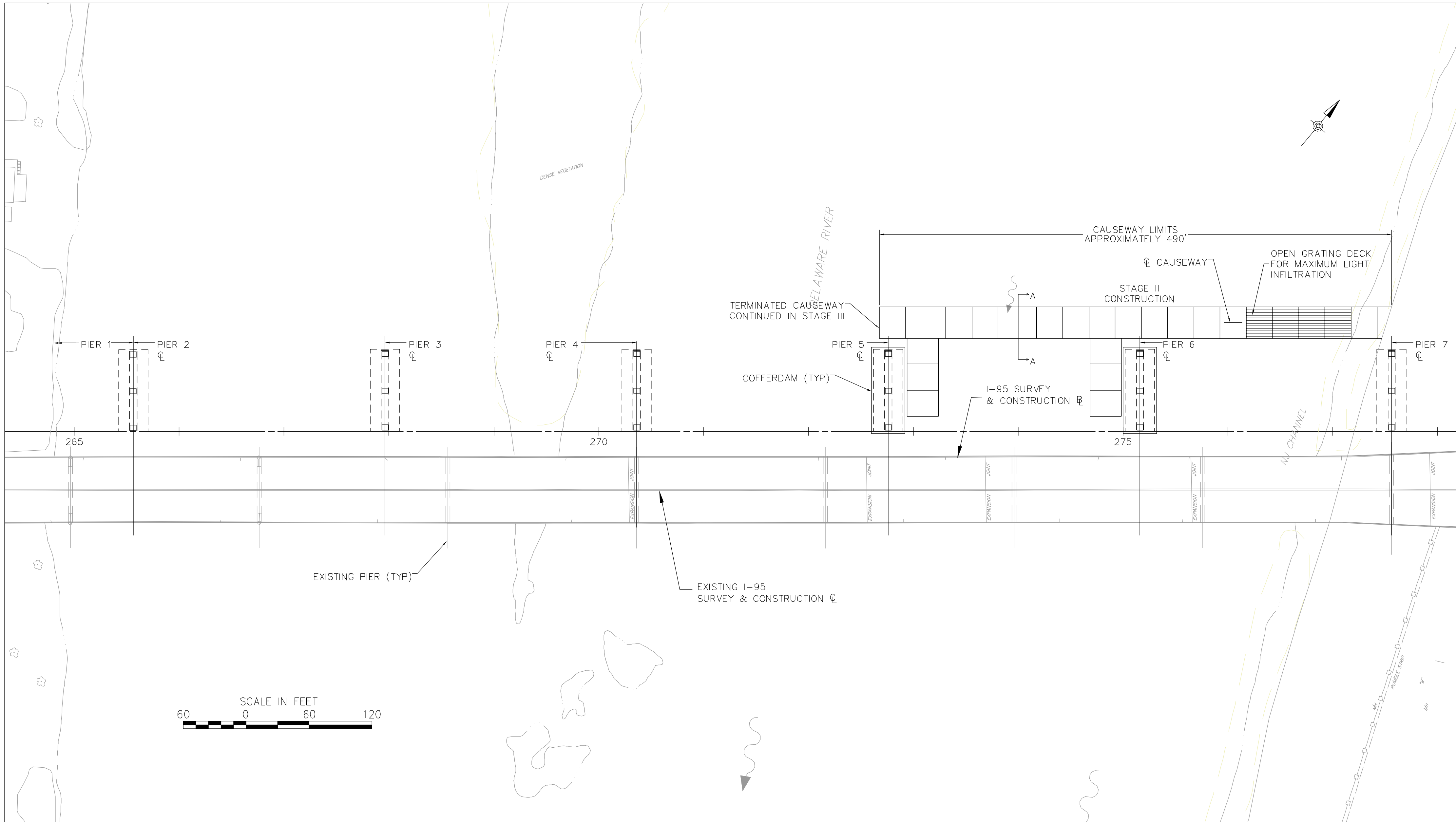
SCALE IN FEET
2 0 2 4

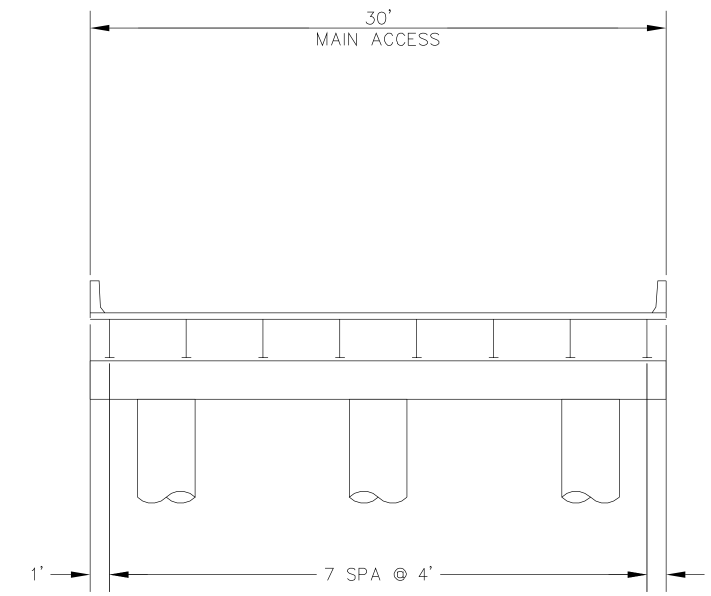
I-95/SCUDDER FALLS BRIDGE IMPROVEMENT
PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
TRESTLE TYPE
STAGE I

FIGURE 9A

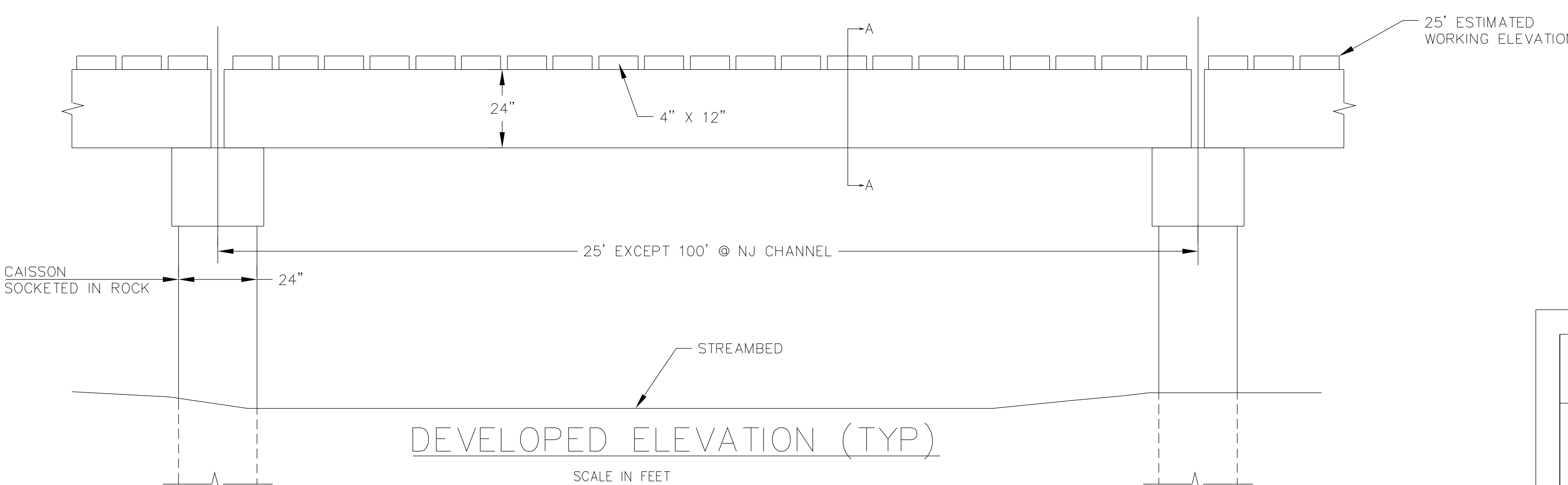
Sep, 09 2008 05:49 pm G:\5969.06\Preliminary\Civil\Design\adantonio\Trestle Causeway_1.dwg By: Melvina




SECTION A–A
TYPICAL SECTION

SCALE IN FEET
5 0 5 10




DEVELOPED ELEVATION (TYP)

SCALE IN FEET
2 0 2 4

I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
TRESTLE TYPE
STAGE II

FIGURE 9B

I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT
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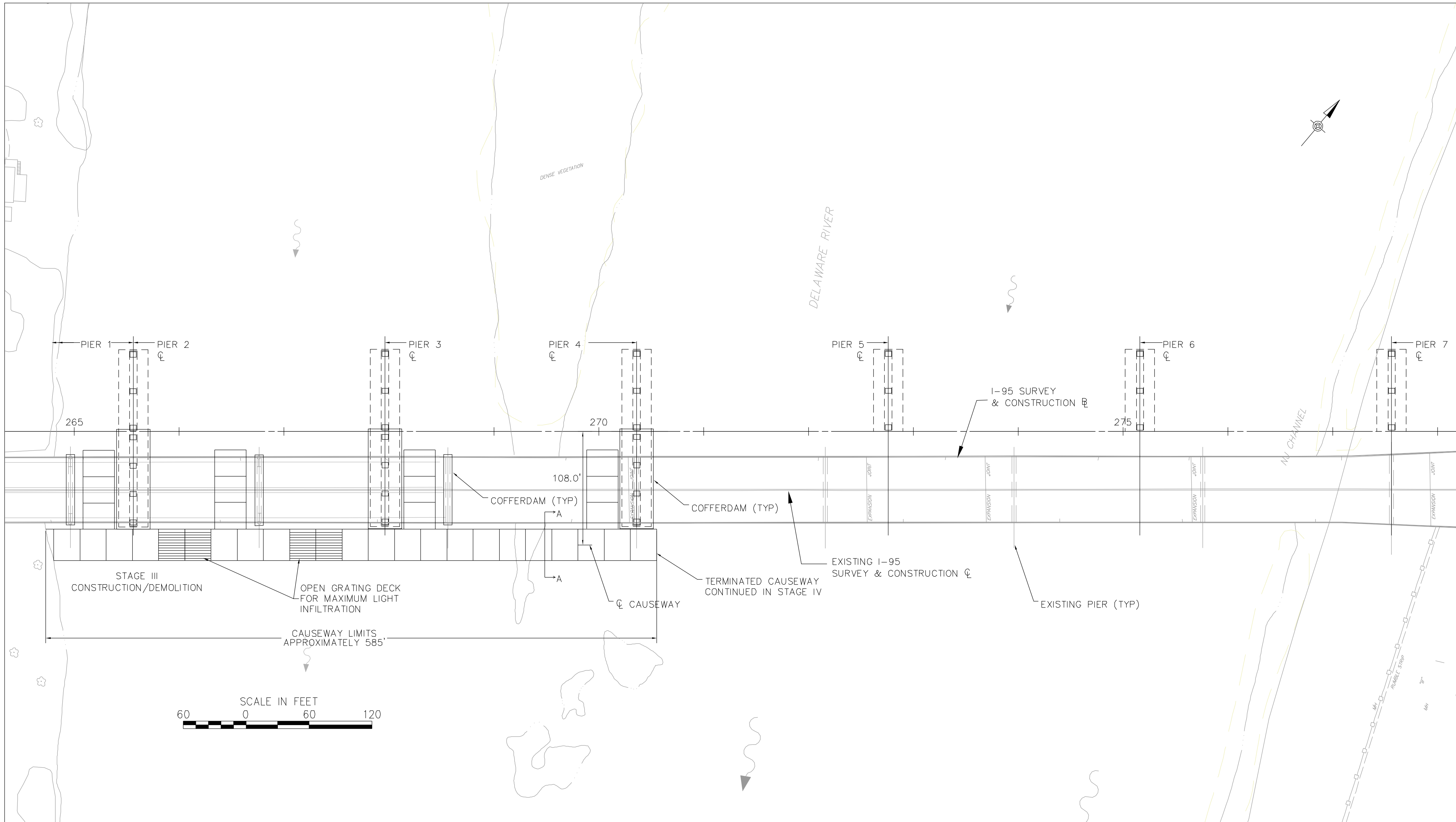
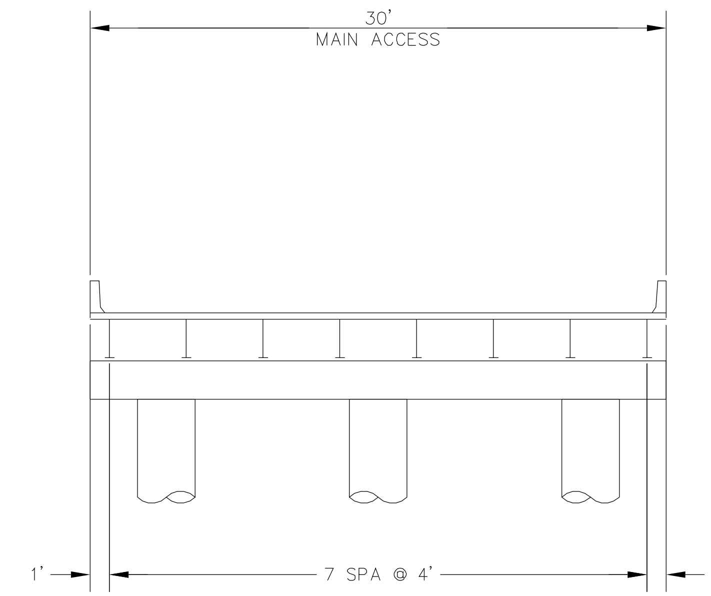
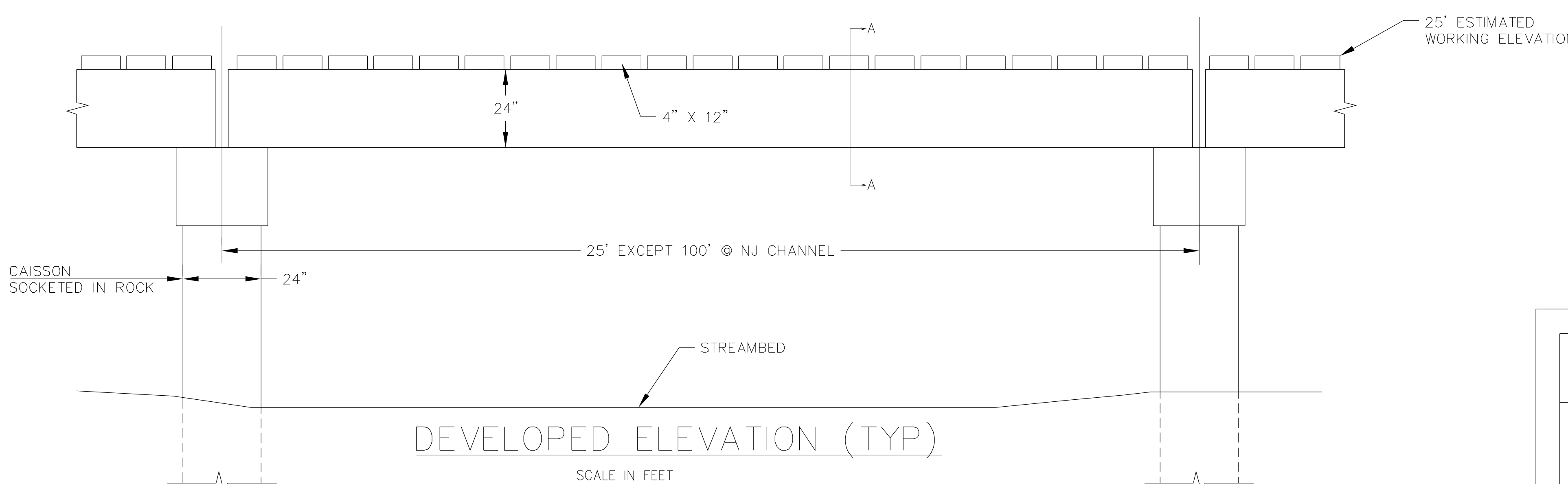



SECTION A-A
TYPICAL SECTION

SCALE IN FEET
5 0 5 10




DEVELOPED ELEVATION (TYP)

SCALE IN FEET
2 0 2 4

I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
TRESTLE TYPE
STAGE III

FIGURE 9C

I-95 / SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT
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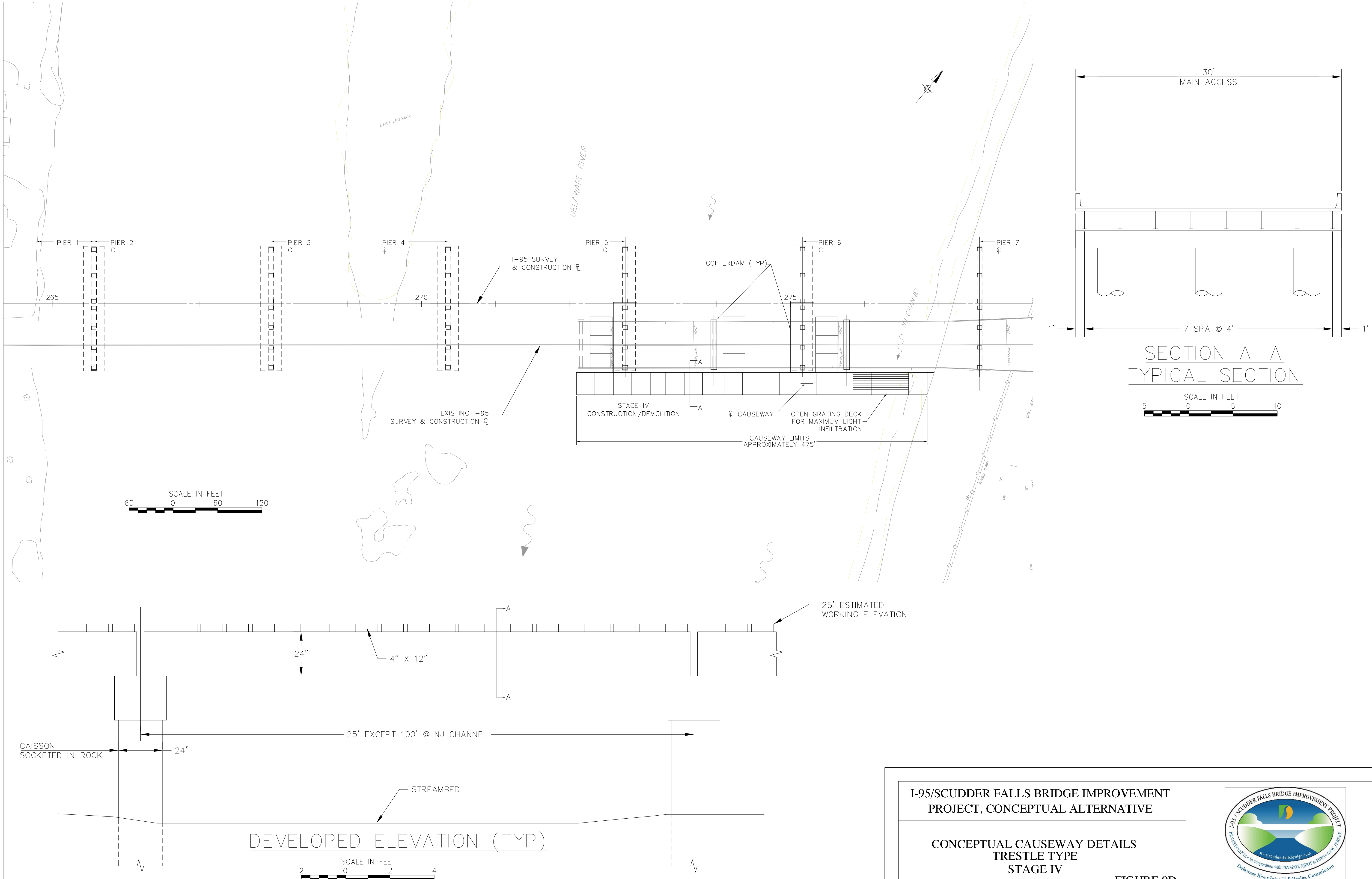
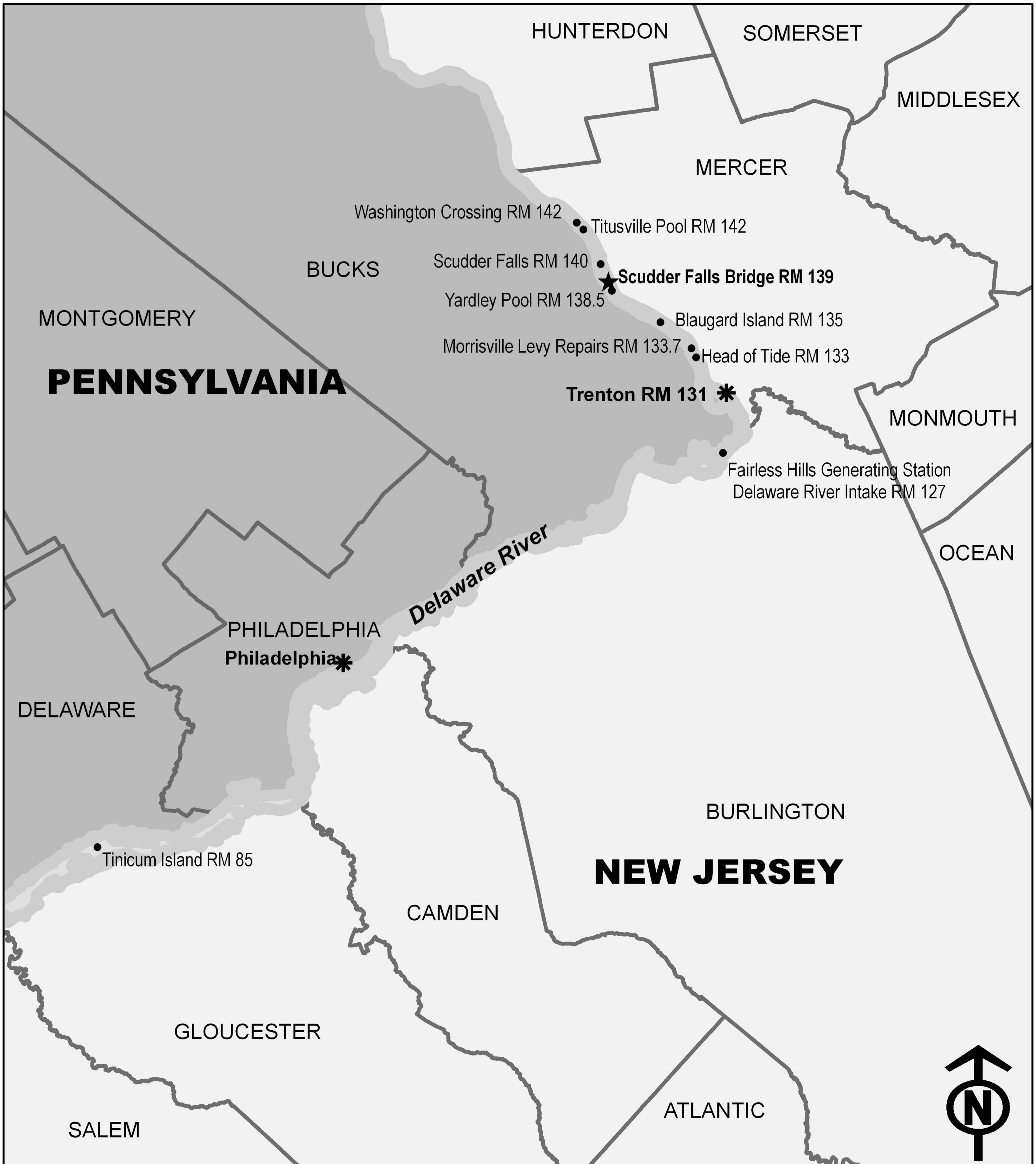



I-95/SCUDDER FALLS BRIDGE IMPROVEMENT PROJECT, CONCEPTUAL ALTERNATIVE

CONCEPTUAL CAUSEWAY DETAILS
TRESTLE TYPE
STAGE IV

FIGURE 9D

Sep. 09 2008 05:50 pm G:\5969.06\Preliminary\Civil\Design\adantonio\Trestle Causeway_4.dwg By: Melvina




Delaware River
River Mile Location Map

FIGURE 10

RM = River Mile