Indian River Inlet
DelDOT BRIDGE

Section 2.0
Project Purpose and Need

Final Environmental Assessment and
Nationwide Section 4(f) Evaluation

II. PROJECT PURPOSE AND NEED

The development of the Purpose and Need Statement for the project was the initiating step in the NEPA process for the project. The statement briefly describes the project purpose and the specific transportation issues that need to be addressed to which the DelDOT is responding in proposing the alternatives and developing the proposed action. The Purpose and Need Statement has been coordinated with the public and regulatory agencies; this early coordination ensures that there is a clear understanding of the issues of the project early in the process. FHWA requested agency concurrence on the project Purpose and Need Statement on August 13, 2003. In September 2003 this document was concurred on by all regulatory agencies except the USCG, which indicated that their concurrence would be withheld until the submission and review of the USCG permit application in accordance with Section 9 of the Rivers and Harbors Act of 1899 and the General Bridge Act of 1946. This concurrence concluded the initial step of the Mid-Atlantic Transportation and Environmental Streamlining Process (MATE) process for the proposed action.

II.A. History of Project Area: In 1934, the first bridge over the Indian River Inlet, a simple span with bridge pier supports within the inlet, was constructed. Between 1934 and present day, three bridges have been constructed over the Indian River Inlet. Prior to 1938, the location of the Indian River Inlet was subject to natural forces creating channels in various locations that periodically closed as sediment was carried into the inlet and were opened by erosion forces and hydraulic conditions, which resulted within the bays. To overcome this periodic natural phenomenon, the ACOE, between 1938 and 1940, constructed a parallel jetty system that created a fixed 500-foot wide inlet as a navigable passage for recreational boats and allowed for a reliable east-west link between the Atlantic Ocean and inland bays. Reports from the ACOE show that as soon as the channel and the jetties were completed in 1940, erosion of the inlet began. **TABLE 1** below summarizes the history of significant events that have occurred at the Indian River Inlet as well as the damage caused by periodic storm events to the three structures that carry SR1 over the inlet.

Table 1: History of Significant Events at the Indian River Inlet

Year	Event
1934	First bridge constructed - a wood trestle bridge over the inlet
1938	14 x 500 foot inlet channel completed by ACOE
1939	Jetties completed by ACOE
1940	**Second bridge constructed – the CW Cullen Bridge over the inlet to replace 1934 Bridge that was damaged by storms**
1941	Sheet pile bulkhead constructed along the inlet by the ACOE
1947	Stone fill added to support bulkhead by ACOE
1948	**CW Cullen Bridge collapsed from ice flow**
1952	Bridge rebuilt and reopened after ice flow damage
1957	Stone jetties repaired after storm damage by ACOE
1962	**Bridge closed due to severe storm damage**
1965	East span of present bridge opened
1972	Removal of old spans from the CW Cullen Bridge begins
1976	Twin west span of the existing bridge built
1978	Sand flood shoal from bay side mined for beach nourishment
1984	Sand flood shoal from bay side mined for beach nourishment
1989	**DelDOT places temporary scour countermeasures (stone riprap blanket) around bridge piers and across the channel to reduce natural erosion rates within the inlet**
1990	Sand replenishment system constructed, designed to pass 100,000 cubic yards/year and has maintained in operation since
1990	Cathodic protection system installed to H-piles
1990 to present	DelDOT continuously performs underwater bridge maintenance inspections and bathymetric surveys to assess stability of the scour countermeasures and the structure

As **TABLE 1** shows, natural ocean driven storm events and ice debris flow have caused and/or contributed to the collapse, failure, or major repair of the three bridges, including the existing twin crossing bridge, over the inlet. All the replacement structures were built with the bridge piers located in the water of the inlet.

The east span of the existing bridge was built in 1965 and the west span was completed in 1976. Previous bridge damage and collapse as well as DelDOT and ACOE monitoring at the inlet indicated that erosion in the inlet was a significant design issue associated with construction of the 1965 bridge. Accordingly, the bridge piers, which exist today, were designed as cofferdam piers with steel H-piles in order to minimize the difficulty of driving piles through a confined zone within a cofferdam. The cofferdam was left in place beneath the tremie seal to provide resistance against expected natural erosional forces within the inlet as well as potential scour conditions at the piers (*Scour Effects on Foundation Capacity*).

In 1984 and 1985 DelDOT performed several inspections around the piers and found the steel sheeting used to create the cofferdams was several feet above the channel bottom and the steel H-piles were exposed to saltwater. Additionally, they found that erosion within the inlet and at the bridge piers were related to both local and long-term scour of several soil strata in the channel. Soil borings indicated that between elevations –37 and –85 feet, the soil is soft, organic, silt clay with sand above and below these elevations. Channel degradation due to scour generally occurs at higher rates when the channel bottom is composed of soft clay rather than dense sands, silts, and clays or even bedrock. Further investigations of the inlet bottom in 1989 indicated that where the channel bottom was comprised of soft clays, the measured scour rate approximated 2.8 feet per year. It was expected that the scour rate would slow as the channel composition changed to dense sands; however, the location of this soil strata generally occurred at the approximate elevation of –85 feet, well below the elevation which can provide adequate support for the bridge pier.

DelDOT's 1989 scour report concluded that in order to protect the bridge from further scour, four solutions were possible:

- Replace the bridge with substructures completely out of the water,
- Build new substructures to support the superstructure,
- Build weir type structures across the inlet to reduce the flow, or
- Protect the channel bed with stone or other material.

The results of this report led DelDOT, in consultation with the FHWA, in 1989 to place temporary scour countermeasures (riprap blanket) along the banks of the inlet and around the piers to lessen the rate of anticipated local scour. Studies have shown that this action resulted in short-term protection of the bridge piers against local scour. However, bathymetric surveys of the inlet continue to show long-term channel degradation and susceptibility of the bridge piers to damage when a storm event propagates the existing scour holes in the channel to the bridge pier foundations. DelDOT and FHWA understood that the temporary scour countermeasures were not a long-term solution to protect the bridge from scour and eventually a permanent fix will be required.

II.B. Purpose: The purpose of the Indian River Inlet Bridge Replacement project is to construct a new bridge on SR 1 that, at minimum spans the existing 500-foot wide fixed inlet, resulting in a new bridge span that does not contain bridge piers in the inlet; thus avoiding the known local and long-term scour problems experienced by the existing and previous bridge piers within the inlet. Part and parcel to this improvement is an opportunity to improve and enhance the safety of the traveling public crossing the structure (automobiles, pedestrians and bicycles) and to maintain SR 1 as an evacuation route for Ocean City, Fenwick Island, South Bethany and Bethany Beach.

II.C. Need: The Indian River Inlet Bridge Replacement Project will develop the details for a new bridge that completely spans the inlet eliminating the need for bridge piers in the inlet. The dynamic of the erosion of the channel bottom is sufficiently complex, raising concerns about maintaining the integrity of the piers that support the existing bridge. At the present time, erosion is occurring at and immediately adjacent to the existing bridge piers, along the existing riprap bank that forms the inlet, along the edges of the jetties, and at the

inlet expansion near the existing USCG facility. Over the lifetime of the bridge, DelDOT has performed maintenance on the structure and installed temporary scour countermeasures to protect the bridge and bridge piers and to attempt to slow the rate of scour and erosion. However, local and long-term scour continues. All installed and executed scour abatement measures are not without cost and will eventually be overtaken by the dynamic natural tidal activity and saltwater environment in the inlet. Additionally, the potential always exists that during a large storm event, the existing scour holes east and west of the bridge will be propagated to the bridge piers, which will significantly affect the stability of the structure.

II.C.1 Erosion of Bridge Pier Foundations: Since the current bridge was built in 1965, erosion has occurred immediately adjacent to the existing bridge piers. During the 1984 and 1985 inspections, DelDOT found that the local scour at the piers was related to both erosion and long-term scour of several soil strata in the channel. Soil borings indicated that between elevations –37 and –85 feet, the soil is soft, organic, silty clay with sand above and below these strata. The scour rate is higher when the soil is soft clay rather than the sand. As the hydrologic forces erode soil from around the piers, the H-piles are exposed threatening the stability of the foundation. Underwater survey results show over the past two years the Indian River Inlet channel has degraded approximately two and half feet in and around the existing bridge piers. Additionally, this exposure results in a deleterious saltwater condition that will hasten the corrosion of the steel sheeting of the cofferdams and the H-piles. DelDOT's underwater divers have seen holes eroded through the cofferdam and witnessed the loss of the confining soil through natural tidal hydrologic processes. The loss of this soil over time will contribute to the instability of the structure and ultimately threaten the foundation of the bridge.

II.C.2. Channel Degradation: Monitoring of the channel bottom by the ACOE shows that during the 1970s there was an acceleration of erosion in the channel bed. Three activities may be linked to the erosion during this time: the sandy soil layer was swept away exposing a silty clay soil; the bridge piers from the CW Cullen bridge (previous bridge) were removed which may have restricted the frictional flow; and the flood shoal was mined for beach replenishment (*Indian River Inlet: An Evaluation by the Committee on Tidal Hydraulics*).

An April 1988 DelDOT study (conducted by Greiner Inc.) reported the scour effects of the bridge piers on the capacity of the bridge foundation. This report found that the H-pile capacity of the piers is ultimately controlled by the soil bearing capacity. As the channel bed erodes and the silty clay and sands are exposed, the ability of the H-piles and soil to carry the design loads will diminish. When the scour depth reaches an approximate elevation of -70 feet, the pier foundation will be inadequate for the AASHTO design loads. DelDOT believed that the study of the scour effect on foundation capacity prepared by Greiner, Inc. was too optimistic as the study used only static analysis. Static analysis failed to agree with the dynamic test during the initial foundation construction. That is, after driving the H-piles to plan length, the blow count and corresponding capacity failed to meet the plan capacity, therefore timber lagging was added to each pile to increase the bearing capacity.

To protect against this instability, in 1989, DelDOT placed temporary scour countermeasures (riprap) around the piers and in the channel bed to minimize the long-term scour of the channel and the local scour of the bridge piers. Recent underwater inspections of the inlet show that the scouring is still occurring in the channel and around the piers, albeit at a reduced rate. Although the riprap has generally stabilized the soil around the piers, the riprap material is moving and settling in localized areas around the piers, especially at the northern pier.

The riprap is not stabilizing the channel bed. Over the fourteen-year period between 1989 and 2003, the channel is shifting and the slope of the channel along the jetties is growing steeper. The deep scour holes in the channel are occurring in the inlet approximately 200-350 feet from the bridge. However, the underwater surveys show these deep scour holes are propagating and getting wider and deeper. (*Indian River Inlet, Scour Workshop Presentation*, Jeff Gebert and Gus Rambo, US Army Corps of Engineers, Philadelphia District, July 2001.) Recent surveys show scour holes both east and west of the existing bridge pier foundations have eroded to a depth of over 95 feet, which if they propagate to the bridge pier

foundations will undermine the structure resulting in likely failure of the bridge foundation. The concern with these deep scour holes is the uncertainty of knowing not whether, but when a strong storm event would propagate these scour holes towards the bridge piers threatening the stability of the bridge foundation, or causing the riprap to slide into the deep holes. **FIGURES 2** and **3** illustrate the deep scour holes in the channel, which are taken from the 3D images of the 1999 channel bathymetric surveys.

II.C.3 2003 Bridge Survey Results: An underwater survey of the bridge piers was conducted in April 2003 and the May 2003 report indicated that at the west face of the northern pier (Pier 3) excessive corrosion of the H-piles has occurred and the majority of the concrete cofferdam is missing or paper thin, allowing hydraulic movement to enter the void below the footing causing scour. The channel bottom material below the footing is sand, and the effect of the hydraulic activity in the inlet is expected to be significant (*Underwater Inspection Report*).

DelDOT also completed a bridge inspection in April 2003. The bridge scored a sufficiency rating[1] of 51.0. While this score is just one point above the score of 50 needed to receive federal funding for replacement of the bridge, the 2003 sufficiency rating dropped 27 points from a sufficiency rating of 78.0 in 2001. Also, the condition of the bridge scored lower in 2003 on several critical elements of interest to this project. (The scores are ranked out of 10, with 10 being highly sufficient.)

	2001	2003
Substructure	6	4
Channel	8	4
Scour Critical	4	3*

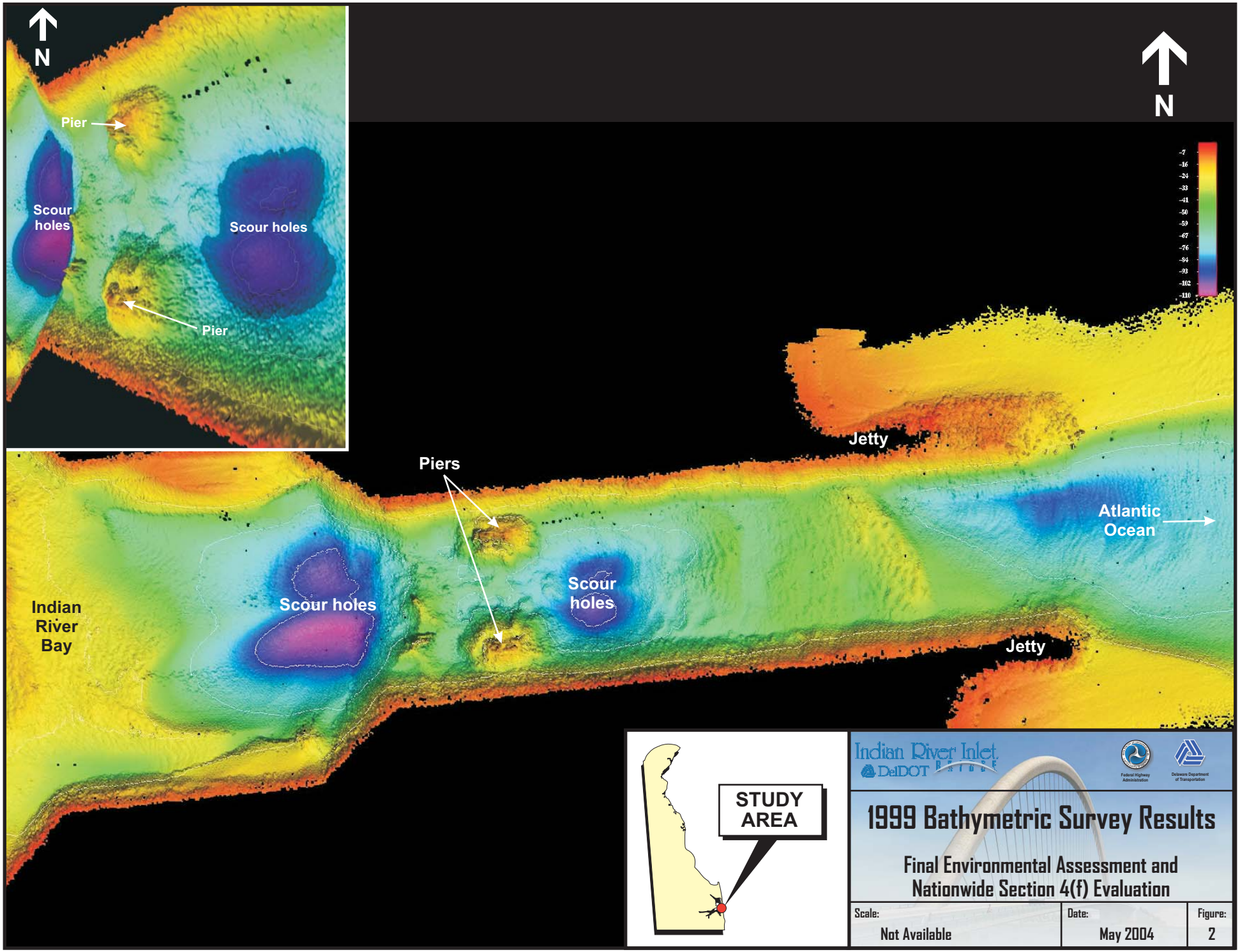
**Score of 3: bridge rated scour critical, potential risk is mild to moderate, continue monitoring until countermeasure in place. Currently DelDOT is continuing the annual inspections of the bridge; there are no plans to install additional riprap.*

The most recent bridge survey and underwater inspection documented that the erosion in the inlet channel and scour at the bridge piers continues to date. DelDOT continues to expend monitoring and maintenance funds at this bridge, yet these problems continue.

II.C.4. Adequate Evacuation Capacity: The Federal Emergency Management Agency (FEMA) has designated SR 1 as an emergency Hurricane Evacuation Planning Route. This designation requires that SR 1 must be capable of serving local citizens during emergency evacuations and remain usable during a reasonably foreseeable catastrophic event. For this reason, it is important that the Indian River Inlet Bridge remain operational during major storm events. If the bridge should be rendered non-operational, people will have fewer evacuation options and experience longer evacuation routes. A recent example was in September 2003 the bridge was closed during the Hurricane Isabel storm event due to stability concerns of the bridge. Removing the uncertainty of the effects of erosion on the piers in the inlet will help to insure that SR 1 will be a viable option during emergency evacuations.

The Indian River Inlet Bridge is a critical link for SR1, which serves regional and seasonal traffic along the Delaware and Maryland coast and is the only land access for visitors to the Delaware Seashore State Park. History has shown a bridge with piers in the Indian River Inlet is susceptible to destructive environmental factors such as saltwater, strong tidal currents, ice, and storms. The existing bridge piers and channel are currently subject to scour from strong tidal activity in the inlet. Maintenance and monitoring of the bridge piers are temporary measures, but not a long-term solution to a serious scour problem. Recent bridge surveys document that the scour problems continue. It is for these reasons that DelDOT has decided, at this time, to develop a bridge that eliminates the persistent scour problem within the inlet, by designing and constructing a structure that spans the tidal inlet and contains no piers within the water.

[1] The sufficiency rating formula used for structure inventory and appraisal is calculated using four separate factors to obtain a numeric value which is indicative of bridge sufficiency to remain in service. The result of this method is a percentage in which 100 percent would represent an entirely sufficient bridge and zero percent would represent an entirely insufficient or deficient bridge. *Bridge Inspection Manual.*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Pier
Scour holes
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Pier
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Piers
Atlantic Ocean
Indian River Bay
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STUDY AREA
Indian River Inlet
DelDOT
Bridge
Federal Highway Administration
Delaware Department of Transportation
1999 Bathymetric Survey Results
Final Environmental Assessment and Nationwide Section 4(f) Evaluation
Scale:
Not Available
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Figure:
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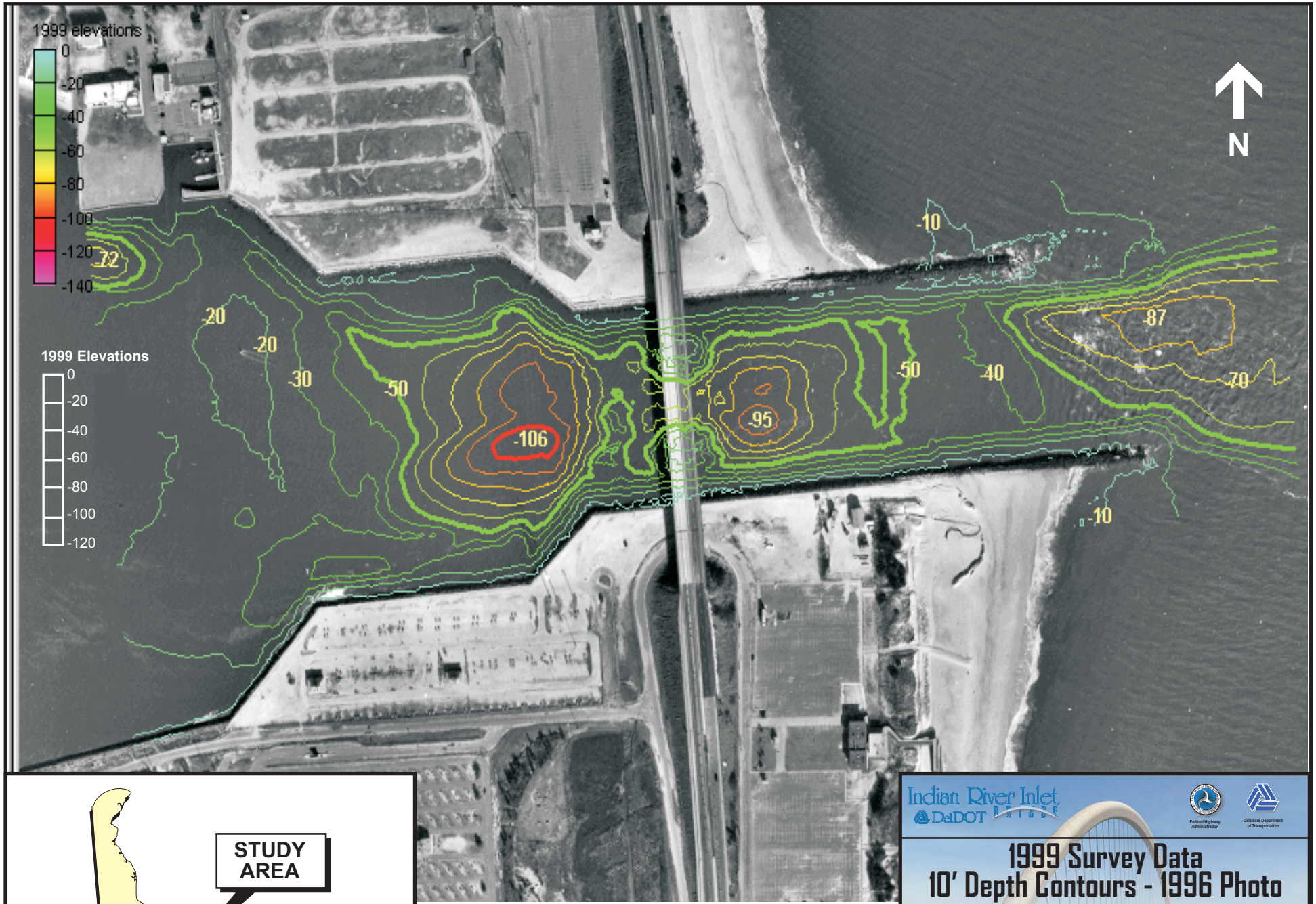

Indian River Inlet
DelDOT Bridge

Federal Highway Administration

Delaware Department of Transportation

1999 Survey Data
10' Depth Contours - 1996 Photo

Final Environmental Assessment and Nationwide Section 4(f) Evaluation

Scale:	Date:	Figure:
Not Available	May 2004	3