Appendix E
Route 92 Engineer's Reports

Note: This appendix was reproduced from the NJDEP LURP Stream Encroachment Permit Application (revised April 21, 1999). Refer to the permit application for the accompanying calculations.

Appendix A
New Jersey Turnpike Authority

Application for
Stream Encroachment Permit

Engineer's Report

Contract No. RT 92-1001
RT 92-1002
RT 92-1003

Section No. 1

Proposed Route 92
from Route U.S. 1 to Interchange 8A
of the New Jersey Turnpike
in
the Townships of
Plainsboro And South Brunswick
Middlesex County

October 30, 1996

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STREAM ENCROACHMENT PERMIT PLANS

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1.0 INTRODUCTION

The New Jersey Turnpike Authority (NJTA) has retained Goodkind & O'Dea, Inc. (G&O) to perform final design for Section 1 of the Route 92 project. Route 92 is a proposed 6.7 mile long, four (4) lane highway which will connect the New Jersey Turnpike at Interchange 8A to U.S. Route 1. A location map is provided on the Title Sheet.

The required Stream Encroachment Permit Application for Section 1 includes the extension of an existing 72" x 44" corrugated metal arch pipe over the Tributary to Shallow Brook, the replacement of an existing 36" dia. CMP culvert over Tributary `A' along Route 130 with a 34" x 53" elliptical RCP culvert, the installation of nine (9) water quality/detention basins, three of which are located within the 100 year floodplain, and the construction of an outfall structure from a proposed basin within the 100-year floodplain of Devil's Brook. A review of hydrology and hydraulics for Devil's Brook is also required.

This report presents the supporting calculations for the Stream Encroachment Permit Application. The calculations include hydrologic and hydraulic calculations, 20% net fill calculations, and water quality/stormwater management calculations. This report provides supporting documentation for the proposed improvements shown on Plan Sheets 6 through 48.

2.0 PROPOSED IMPROVEMENTS

The proposed roadway drainage systems in Section 1 are as follows:

1. From the eastern limit of Section 1 (Toll Road) to the Tributary to Shallow Brook, the roadway drainage is collected by inlet and pipe systems. The roadway drainage is treated and detained by a total of four Proposed Water Quality/Detention Basins. Three of the basins are located within ramp infield areas and the fourth is located along the eastern overbank of the Tributary to Shallow Brook, within the 100-year floodplain. The basins discharge into existing pipe systems or water courses. The overland off-site flow will bypass the proposed basins and will discharge directly into the Tributary.

   Proposed Water Quality/Detention Basin Nos. 1A and 1C discharge into an existing pipe system which originates on the eastern side of the Turnpike Toll Road. This system intercepts offsite overland flow and ultimately discharges into the existing 72" x 44" corrugated metal arch pipe culvert. The roadway drainage from Ramp WTX and the southwest infield area will discharge into Basin No. 1A. Portions of Route 32, the Toll Road and Route 535 will discharge into Basin No. 1C.

A portion of eastbound Route 32 and Ramps WTL and WT will discharge into Basin No.1B. This basin discharges into a swale and pipe system, which ultimately flows into an existing detention basin along Cranbury-South River Road.

2. From the high point at Commerce Drive east to the Tributary to Shallow Brook, the roadway drainage is also collected by an inlet and pipe system. The roadway drainage is treated and detained by Proposed Water Quality/Detention Basin No. 1E located along the western overbank of the Tributary to Shallow Brook, within the 100-year floodplain. The basin discharges directly into the Tributary. The overland off-site flow will bypass the proposed basin and will discharge directly into the Tributary.

   The borings taken at the sites of the proposed basins east of Commerce Drive revealed no presence of groundwater at depths of up to 17 feet. Borings indicate sandy soils in this region.

3. Roadway drainage from the following locations will be collected in either existing or proposed inlet, pipe or swale systems and will discharge into the expanded Park-and-Ride detention basin (No. 1H):

   a. Route 92 - from 600 feet west of Commerce Drive to the high point at Route 130;

   b. Route 130 - from the high point on Route 130 to the intersection of Ramp SLE;

   c. Ramp WN.

   The groundwater at Basin No. 1H is at elevation 103.7.

4. From the Route 92 high point at Route 130 to Ramp NE and a portion of Ramp NE, the roadway drainage will be collected in an inlet and pipe system and discharge into Proposed Basin No. 1G. The groundwater at this location is at elevation 103.7.

5. From the Route 130 high point to approximately 1,200 feet north, Ramps ELN, SW, ES and a portion of Ramp NE, the roadway drainage will be collected in inlet, pipe and swale systems and discharge into Proposed Basin No. 1F. The groundwater at this location is at elevation 101.7.

6. From the Route 130 intersection with Ramp SLE to the Route 130 intersection with Friendship Road, the roadway drainage will be collected in inlet and pipe systems and discharge into Proposed Basin No. 1I.

7. The roadway drainage from Route 130 north of Proposed Basin No. 1F will be collected in the existing drainage pipes with inlets added at the new edge of pavement. The existing pipes discharge into the existing culvert at Devil's Brook.

8. The roadway drainage from Ramp NW will discharge directly into swales along the toe of the western embankment. The swales will be designed in accordance with NJAC 7:13-2.8. The roadway drainage from Ramp NW does not discharge into Basin 1F, due to capacity constraints of this basin.

9. The roadway drainage from Route 92 west of Ramp NE will discharge into swales along the embankment slopes. The swales will be designed in accordance with NJAC 7:13-2.8. When possible, the roadway drainage from this area will be piped to the proposed detention basin, west of the proposed Toll Plaza, within Section 2 of this project.

The proposed culvert/culvert extensions are as follows:

1. The existing Route 32 roadway will be widened by approximately 90 feet in the vicinity of the crossing over the Tributary to Shallow Brook. The existing drainage system consists of closed pipe systems originating along the north side of Route 32, a 72" x 44" metal arch pipe crossing under Route 32 and discharging through a headwall located in the embankment of eastbound Route 32, into the Tributary which flows south-westerly to Shallow Brook. The actual watercourse begins at the Route 32 headwall and continues downstream.

   The existing culvert will be extended with a culvert of the same dimensions and type to a new headwall located in the proposed embankment.

2. The existing Route 130 roadway will not be widened outside of the existing embankment in the vicinity of the crossing over Tributary `A'. However, approximately 300 feet west of Route 130, the proposed relocated Friendship Road will cross over Tributary `A'.

   The existing drainage system consists of a closed pipe system originating along Route 32, flowing south to Route 130, and ultimately discharging through a 36" diameter corrugated metal pipe, along the west side of Route 130 into Tributary `A'. The proposed system consists of a new 34" x 53" elliptical concrete pipe which will be installed along the east side of Route 130 and continue downstream to the west side of relocated Friendship Road.

3.0 EXISTING STREAMS

Drainage patterns for the existing conditions were determined by site investigations and review of the aerial topographic mapping. Points of interest (POI) were selected for analysis to assess the impact of the Route 92 project on existing watercourses. The selection of POI were based on locations where the proposed alignment crosses over the existing stream.

3.1 TRIBUTARY TO SHALLOW BROOK

This tributary is a non-delineated stream. In the vicinity of the proposed widening, the watercourse consists of a shallow channel with cultivated farm field overbanks. Approximately 560 feet downstream of the headwall at Route 32 the stream heads southward through parking lots via a deep grass-lined trapezoidal channel containing a concrete low flow channel. The drainage area is 180 acres.

Surveyed cross sections were taken from the upstream headwall at Route 32 to a point approximately 1,200 feet downstream. With these sections, an hydraulic analysis was performed using the HEC-2 program to determine the existing 100-year floodplain limits and floodway.

3.2 TRIBUTARY `A' TO SHALLOW BROOK

This tributary is also a non-delineated stream. Similar to the above stream, Tributary `A' consists of a shallow channel bisecting a cultivated farm field. The drainage area is 75 acres.

Surveyed cross sections were taken from the upstream headwall at Route 130 to a point approximately 800 feet downstream. The same procedure described above was used to determine the existing 100-year floodplain limits and floodway.

3.3 DEVIL'S BROOK

At the Route 130 crossing over Devil's Brook, this watercourse is a non-delineated stream. The existing culvert under Route 130 is a 4 ft. high x 5 ft. wide concrete box culvert. A ponding area is located on the east side of Route 130 at the upstream face of the culvert. The overbanks of the stream contain dense brush. The drainage area is 350 acres.

Surveyed cross sections were taken 500 ft. upstream and downstream of the Route 130 culvert and a HEC-2 model was prepared to determine the floodplain limits. Route 130 will not be modified or widened in this vicinity; however, a proposed outfall structure will be located on the west side of Route 130 within the floodplain.

4.0 PROPOSED CULVERTS

4.1 TRIBUTARY TO SHALLOW BROOK

A 140 foot extension of the existing 72" x 44" metal arch pipe is proposed over the Tributary to Shallow Brook. As this is an extension of an existing culvert, the skew to the roadway will be the same as the existing skew.

The peak flow for the 2, 10 and 100-year storm events for all stream crossings was calculated using the SCS TR-55 method

assuming fully developed conditions. The capacity of the existing system, under submerged (pressure) conditions, exceeds the 100-year peak flow.

The capacity of the proposed extended culvert also exceeded the 100-year peak flow under submerged conditions.

4.2 TRIBUTARY `A' TO SHALLOW BROOK

A 34" x 53" elliptical concrete pipe is proposed over Tributary `A'. This culvert would begin along the east side of Route 130, continue under relocated Friendship Road, and discharge into Tributary `A' along the west embankment of Friendship Road.

The capacity of the existing 36" dia. corrugated metal culvert is less than a 2-year storm. Although the current NJDEP criteria requires a 100-year storm event design for culverts with drainage areas over 50 acres (Note: Drainage area to Tributary `A' at Route 130 is 75 acres), sizing a culvert to convey the 100-year storm at this location was not considered a reasonable solution since the immediate upstream pipe was incapable of conveying even a 2-year storm. Based on the lack of definable watercourse and the existing 36" diameter trunk line along and under Route 130, a 34" x 53" elliptical concrete pipe has been selected for this crossing.

5.0 HYDROLOGY

For the floodplain delineation, standard hydrologic and hydraulic study methods were used in this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 2, 10, or 100 year period, as required by the NJDEP, have been selected as having special significance for floodplain management. These events, commonly termed the 2, 10, and 100-year floods, have a 50, 10, and 1 percent chance, respectively, of being equaled or exceeded during any year.

The recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increase when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual accedence) in any 50 year period is approximately 40 percent (4 in 10), and, for any 90 year period, the risk increases to approximately 60 percent (6 in 10).

Drainage areas and other hydrologic characteristics of the various streams and ditches were calculated at points where the proposed Route 92 alignment crosses over them. These locations were selected for cross culverts to convey stormwater run-off across the proposed alignment.

The hydrologic calculations were performed using the Soil Conservation Service Technical Release No. 55 Urban Hydrology for Small Watersheds (SCS TR-55) and the HEC-1 program.

The peak discharges were calculated assuming full development as required by the NJDEP. Developed conditions were based on the Existing Land Use Map prepared for the Middlesex County Planning Board.

Table 1 contains a summary of hydrologic information for each of the streams within the project limits.*

TABLE 1
SUMMARY OF DISCHARGES

Stream Name	Drainage Area (Acres)	Peak Discharge (CFS) 2 YR	10 YR	100 YR
Tributary to Shallow Brook	180	35	100	200
Tributary `A' to Shallow Brook	75	55	110	185
Devil's Brook	350	80	225	440

*Note: Only the proposed outfall from Basin 1F is located within the 100-year floodplain of Devil's Brook. The delineation and supporting computations are included for verification only.

6.0 HYDRAULICS

6.1 TRIBUTARY TO SHALLOW BROOK

A hydraulic analysis of the stream was performed using the HEC-2 computer program. Stream cross sections were field surveyed. Channel roughness factors (Manning's "n") used in the hydraulic analysis were assigned on the basis of the field inspection of floodplain areas. The approximate roughness values for the Tributary are as follows: Channel "n" (0.015-0.030) and Overbank "n" (0.060-0.080). All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Starting water surface elevations were obtained from the Shallow Brook backwater profiles as shown in the Flood Insurance Study (FIS).

The water surface profile was drawn showing computed water surface elevations for the 100-year storm. Table 2 provides a comparison of existing and proposed water surface elevations for the stream. These results indicate that the extension of the existing culvert and construction of Water Quality/Detention Basin Nos. 1D and 1E within the floodplain will have no adverse impact on the water surface profile of the Tributary.

TABLE 2

COMPARISON OF EXISTING AND PROPOSED WATER SURFACE ELEVATIONS (WSEL) FOR THE TRIBUTARY TO SHALLOW BROOK 100-YEAR FLOOD

STREAM STATION	LOCATION	EXISTING WSEL	PROPOSED WSEL	DIFFERENCE (ft.)
8+02		117.00	117.00	0.00
8+47	D.S. Face Parking Lot Culvert "A"	117.38	117.38	0.00
9+27	U.S. Face Parking Lot Culvert "A"	117.68	117.68	0.00
9+80		118.58	118.58	0.00
10+66		118.78	118.78	0.00
11+81		118.77	118.77	0.00
12+83		119.07	119.07	0.00
13+40		119.02	119.02	0.00
13+90	D.S. Face Parking Lot Culvert "B"	119.39	119.39	0.00
14+40	U.S. Face Parking Lot Culvert "B"	120.38	120.38	0.00
14+90		122.01	122.01	0.00
15+40		122.19	122.19	0.00
16+40		122.25	122.24	-0.01
17+40		122.27	122.26	-0.01
18+40		122.28	122.23	-0.05
18+59	D.S. Face Proposed 72"x44" Culvert Extension	----	122.53	----
18+90		122.08	----	----
19+40		122.65	----	----
20+00	D.S. Face Exist. 72"x44" Culvert Under Route 32	122.89	----	----

6.2 TRIBUTARY `A' TO SHALLOW BROOK

A hydraulic analysis of the stream was performed using the HEC-2 computer program. Stream cross sections were field surveyed. Channel roughness factors (Manning's "n") used in the hydraulic analysis were assigned on the basis of field inspection. The approximate roughness Values for Tributary `A' are as follows: Channel "n" (0.030) and overbank (0.10). Starting water surface elevations were obtained using the slope-area method (normal depth).

The water surface profile was drawn showing computed water surface elevations for the 100-year storm. Table 3 provides a comparison of existing and proposed water surface elevations for the stream. These results indicate that the installation of a new culvert under Route 130 and Friendship Road will have no adverse impact on the water surface profile of Tributary `A'.

TABLE 3

COMPARISON OF EXISTING AND PROPOSED WATER SURFACE ELEVATIONS (WSEL) FOR TRIBUTARY 'A' TO SHALLOW BROOK 100-YEAR FLOOD

STREAM STATION	LOCATION	EXISTING WSEL	PROPOSED WSEL	DIFFERENCE
22+23		107.31	107.31	0.00
23+24		107.78	107.78	0.00
24+23		108.32	108.32	0.00
25+22		109.05	109.05	0.00
26+20		109.43	109.43	0.00
27+13		109.77	----	----
27+22	D.S. Face Proposed Headwall	----	109.74	----
28+16		110.25	----	----
29+10		110.87	----	----
30+00	D.S. Face Existing 36" Dia. CMP Under Route 130	111.69	----	----

6.3 DEVIL'S BROOK

A hydraulic analysis of the stream was performed using the same method as the previous streams. Channel roughness factors used for the brook are as follows: Channel "n" (0.03) and Overbank "n" (0.080-0.120).

The resulting 100-year floodplain was delineated on the plan. The proposed outfall structure from Basin 1F is located within the 100-year floodplain.

7.0 WATER QUALITY

The water quality design storm is defined as either 1.25 inches of rainfall falling uniformly in two hours or the 1-year 24 hour storm using the SCS type III rainfall distribution in accordance with NJAC 7:13-2.8.

In order to provide water quality for the highway runoff, a total of nine (9) water quality/detention basins are proposed in Section 1 to provide water quality and stormwater management. Stormwater management is described in the next section.

The proposed contributory drainage area to each basin was calculated and the inflow hydrograph to each basin was determined using the criteria mentioned above. The volume of the water quality storm was calculated as the area under the resulting hydrograph.

The proposed basins were located and sized based on volume requirements, topographic constraints, right-of-way, and strategic locations at discharge points. The proposed outlet structures consist of a type double D2 or similar basin with a minimum 3" diameter orifice at the basin invert to pass the water quality storm. Since water quality treatment will occur within the proposed detention basin, the NJDEP also requires that no more than 90% of the total peak storage volume can be released over a 36 hour period (from the time of peak storage). In basins where the detention times could not be met, the minimum 3" diameter outlet orifice was used.

The resulting water quality storm hydrographs were routed through the proposed basins using either Haestad Methods Pond-2 Detention Pond Design and Analysis or the HEC-1 program (See Appendix D).

Table 4 contains a summary of water quality data for the basins in Section 1. These results indicate the following:

1. While Basin Nos. 1A, 1B, 1D, 1F, 1G and 1I provide sufficient storage volume so that outflow is restricted to the 3" diameter orifice, the basins are fully drained prior to the 36 hour detention period;

2. Basin Nos. 1C and 1H meet the water quality detention time requirements;

3. Due to site constraints, i.e. location between Eastbound Service Road, the Tributary to Shallow Brook, and adjacent commercial property, sufficient storage volume for Basin No. 1E could not be provided for the water quality storm. Therefore, in addition to the 3" dia. orifice, outflow will also discharge through the second stage (rectangular orifice) in the outlet structure.

4. All runoff from the proposed pavement is being treated by discharging into basins or swales. The existing Route 130 at the north end of the project is only being repaved. The existing drainage discharges directly into Devils Brook and no changes to the drainage are proposed.

TABLE 4

WATER QUALITY HYDROLOGIC & HYDRAULIC DATA

WATER QUALITY/ DETENTION BASIN NO.	DRAINAGE AREA (AC.)	PEAK INFLOW Q_{WQ} IN (CFS)	PEAK OUTFLOW Q_{WQ} OUT (CFS)	PEAK STAGE (ELEV.)
1A	7.7	4.0	0.4	135.77
1B	3.6	2.2	0.3	139.99
1C	8.8	8.2	0.5	133.45
1D	6.4	5.4	0.5	123.89
1E	5.9	6.3	6.3	123.92
1F	23.5	9.0	0.4	110.43
1G	4.4	6.0	0.4	110.69
1H	30	19	0.3	110.54
1I	8.0	6.0	0.3	110.53

8.0 STORMWATER MANAGEMENT

In accordance with the NJDEP, the engineering standards for stormwater management are as follows: The post-construction peak runoff rate for the 2-year storm event is 50% of the pre-construction peak runoff rate and the post-construction peak runoff rate for the 10 and 100-year storm events are 75% of the pre-project construction peak runoff rate.

In order to provide stormwater management, the proposed water quality/detention basins will be used for this purpose in addition to providing water quality treatment. Basically, above the peak stage of the water quality storm as shown in Table 4, a second stage will be provided in the outlet structure in the form of a rectangular orifice. As an emergency measure, assuming the basin is full and the first and second stage orifices are blocked, the design flow was designed to pass through the grates of the outlet structure.

The existing and proposed conditions peak flows for the 2, 10, and 100-year storms were calculated and the resulting inflow hydrographs for proposed conditions were computed using either the Modified Rational Method (for drainage areas up to 20 acres) or the SCS TR-55 method (see Appendix D for backup calculations).

The resulting inflow hydrographs were routed through each basin using either the Haestad Method Pond-2 Detention Pond Analysis program or the HEC-1 program. The results of these routings are shown in Table 5.

These results indicate the following:

1. All the basins meet stormwater management criteria as set forth in NJAC 7:13-2.8.

TABLE 5

STORMWATER MANAGEMENT DATA

Water Quality/ Detention Basin No.	Existing Peak Flow (cfs)			Maximum Allowable Peak Outflow (cfs)			Proposed Peak Inflow (cfs)			Proposed Conditions Peak Outflow(cfs)			Peak Stage (Elev.)		
	2	10	100	2	10	100	2	10	100	2	10	100	2	10	100
1A	8.8	10.5	16.4	4.4	7.9	12.3	12.0	18.0	25	0.3	0.3	0.4	135.13	135.37	135.55
1B	8.6	12	16	4.3	9.0	12.0	7.3	10	13	0.3	0.3	0.3	139.57	139.68	139.80
1C	3.0	4.1	5.6	1.5	3.1	4.2	23	30	43	0.4	0.4	0.4	132.58	132.82	133.20
1D	20	27	39	10.0	20	29	16	21	30	0.4	0.4	0.4	122.81	123.11	123.57
1E	17.0	22	31	8.0	16.5	23	19	25	34	0.5	6.7	14.6	123.46	123.94	124.34
1F	3.0	16.0	43	1.5	12.0	32	13	36	67	1.0	5	11	110.88	111.80	112.79
1G	7.0	15.0	26	3.5	11.2	19.5	7.0	13	20	1.0	2	5	110.91	110.28	111.67
1H	13	34	65	6.5	25	49	26	56	95	0.4	1.5	10.9	111.07	112.15	112.80
1I	--	--	--	--	--	--	9	19	32	0.7	3.3	7.7	110.76	111.22	111.74

9.0 SOIL EROSION AND SEDIMENT CONTROL

The proposed Route 92 project will be designed in accordance with the "Standards for Soil Erosion and Sediment Control in New Jersey", as directed by the Freehold Soil Conservation District, as well as applicable New Jersey Turnpike Authority and local erosion control regulations. Soil Erosion and Sediment Control Plan Certification will be obtained from the Freehold Soil Conservation District.

In locations where stormwater outfalls are proposed, rip-rap stone slope protection or other acceptable material will be used to control erosion.

During construction of the roadway, erosion control such as silt fence, inlet filters, and sediment basins will be employed to control erosion. The proposed water quality/detention basins will be used temporarily as necessary, as sedimentation basins. A temporary haul road shall be constructed within the proposed ROW to control erosion on local roadways during construction. Wheel cleaning blankets will be installed at points where construction traffic will enter onto local roadways or off the work zone.

Soil Erosion and Sediment Control calculations are included in Appendix E.

10.0 JUSTIFICATION FOR WAIVERS/EXEMPTIONS

10.1 20% NET FILL

The construction of the proposed highway requires placement of a considerable amount of fill within the floodplain. By using the cross section end area method, the total flood storage volume was calculated as 4,164 cubic yards within the proposed right-of-way.

By superimposing the typical section of the proposed roadway, the total fill was computed as 2,284 cubic yards within the flood fringe. The total cut was computed as 1,644 cubic yards.

The percentage of fill within the floodplain is 15% versus the allowable 20%. Therefore, an exemption from this requirement is not required. Calculations for the net fill quantities are included in Appendix C.

10.2 CULVERT AT TRIBUTARY 'A'

The existing 36" diameter corrugated metal pipe serves as the hydraulic control for this crossing. The existing pipe system originates to the north along Route 32 and intercepts flow from the industrial area detention basins. A culvert analysis was performed for this culvert and indicated that it was incapable of conveying even a 2-year storm. Any storm event in excess of a 2-year storm would surcharge the system and overtop the existing Route 130 roadway, ultimately discharging into Tributary `A'.

Although the current NJDEP guidelines require a 100-year storm event design for culverts with drainage areas over 50 acres, sizing a culvert to convey the 100-year storm at this location was not considered a reasonable solution since the immediate upstream pipe was incapable of conveying a 2-year storm. A 34" x 53" elliptical concrete pipe, has been selected for this site.

10.3 WATER QUALITY/DETENTION BASIN NO. 1E

Proposed Basin No. 6 is "landlocked" between the stream, adjacent commercial property, and the proposed eastbound Service Road. It is impossible to provide additional storage volume for this basin given the topographic constraints. While the basin does meet stormwater management criteria, it does not meet water quality detention criteria.

11.0 CONCLUSION

The proposed Route 92 project within Section 1 proposes to construct several improvements which require a Stream Encroachment Permit. They are as follows:

1. A 72" x 44" culvert extension over the Tributary to Shallow Brook.

2. The construction of two Water Quality/Detention Basins (Nos. 1D and 1E) within the floodplain of the Tributary to Shallow Brook including the outfalls from each basin (both 30" diameter RCCP).

3. The construction of relocated Friendship Road within the floodplain of Tributary `A' including construction of a 34" x 53"elliptical concrete pipe culvert under Route 130 and Friendship Road.

4. The construction of Water Quality/Detention Basin No. 1I within the Tributary `A' floodplain including the 24" diameter outlet pipe from the basin.

5. The construction of the outfall structure from Proposed Water Quality/Detention Basin No. 1F within the 100-year floodplain of Devil's Brook.

This report has presented the design calculations and commentary on how the design submitted was developed. The report also explains why several NJDEP design criteria could not be achieved. These requests are justified by the nature of the project and existing physical conditions.

APPENDIX B

NEW JERSEY TURNPIKE AUTHORITY

APPLICATION FOR
STREAM ENCROACHMENT PERMIT

ENGINEER'S REPORT

SECTION NO. 2

PROPOSED ROUTE 92
FROM ROUTE U.S. 1 TO INTERCHANGE 8A
OF THE NEW JERSEY TURNPIKE
IN
THE TOWNSHIPS OF
PLAINSBORO AND SOUTH BRUNSWICK
MIDDLESEX COUNTY

OCTOBER 30, 1996
REVISED FEBRUARY 21, 1997
REVISED APRIL 21, 1999

PREPARED BY:

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3. TRIBUTARY TO DEVILS BROOK #2 (CULVERT AT STA. 544+20)

APPENDIX 2C - 20% NET FILL CALCULATIONS
1. DEVIL'S BROOK (STA. 400+80.28 – STA. 420+45)
2. DEVIL'S BROOK UNNAMED TRIBUTARY #1 (STA. 425+70 – STA. 435+00)
3. DEVIL'S BROOK UNNAMED TRIBUTARY #2 (STA. 441+00 – STA. 460+00)

APPENDIX 2D - SOIL EROSION AND SEDIMENT CONTROL MEASURE COMPUTATIONS

APPENDIX 2E - USGS QUADRANGLE AND HAGSTROM STREET MAP

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STREAM ENCROACHMENT PLANS
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- STREAM PROFILES
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1.0 INTRODUCTION

The New Jersey Turnpike Authority (NJTA) has retained Boswell Engineering to perform final design for Section 2 of the Route 92 project. Route 92 is a proposed 6.7 mile long, four (4) lane highway which will connect the New Jersey Turnpike at Interchange 8A to U.S. Route 1. A location map is provided in Appendix 2E.

The regulated activities in the stream encroachment application for Section 2 include the construction of two (2) parallel 525' wide seven span bridges over Devil's Brook, and the construction of a 48" RCCP culvert at Sta. 544+20. Waivers from the 20% net fill requirement at three locations are also part of this application. Several stormwater outfalls from Route 92 directly to off road areas are proposed as part of this project.

This report presents supporting calculations for the Stream Encroachment Application as pertains to Design Section No. 2. The calculations include hydrologic and hydraulic calculations and 20% net fill calculations. The report also provides documentation in support of the request of the waiver from the 20% net fill requirement.

2.0 PROPOSED IMPROVEMENTS

2.1 GENERAL

The proposed roadway drainage system is as follows:

1. From Sta.434+50 (825' east of the Devil's Brook bridge) to the Section 1/Section 2 boundary at Sta. 592+00, the roadway drainage is collected by curbs and storm drains. This portion of the proposed roadway is serviced by five (5) detention basins and toe of slope ditches. The detention basins are situated near existing swales/ditches to facilitate the basin discharge. All but one of these ditches have drainage areas of less than fifty (50) acres. Retaining walls are also proposed between: 430+85 and 434+92.04 RT., 403+85 and 435+46.70 LT., 440+50.12 and 449+07.63 RT., and 451+00 and 455+28.55 RT., 531+70.42 and 539+45.17 RT., 531+96.51 and 547+46.93 LT., 542+11.86 and 546+33.86 Rt.

2. The remainder of Section 2 between Sta. 434+50 (including the Devil's Brook Bridge) and the Section 2/Section 3 limit at Amtrak were also designed with curbs and storm drains. Retaining walls were located on both sides of the roadway to reduce the impact on freshwater wetlands and reduce floodplain fill. The detention basin that was originally proposed for this section of the alignment was deleted to reduce the impact of the project on freshwater wetlands. It was determined that the construction of a detention basin in the wooded wetland area for this portion of Section 2 would have disturbed approximately two (2) acres of wetlands and would be environmentally counterproductive.

Based on the topography of the existing ground and the embankment that is proposed for Route 92, stormwater run-off from existing drainage areas will be interrupted by the proposed roadway. In these areas, cross culverts will be provided to pass the off-site run-off under proposed Route 92.

2.2 DETENTION BASINS

The roadway drainage system designed for the Route 92 project - Section 2 has incorporated the use of detention basins. The installation of impervious roadway pavements and embankment fills will increase the amount of runoff generated by the area. The purpose of the detention basin is to regulate the rate of runoff that is generated by the proposed highway in accordance with the Flood Hazard Area Control Act (N.J.S.A 13:1D-1 et seq.), hereafter referred to as "FHA".

As requested by the Authority, this office has investigated the use of detention basins that are in full conformance with the New Jersey Department of Environmental Protection (NJDEP) requirements and best management practices (BMP). In the initial stage, minimizing the amount of Right of Way (R.O.W.) acquisition for the basins was the priority. Following meetings between the Authority, Frederic R. Harris (Project Environmental Consultant), PS&S (NJTA General Environmental Consultant) and HNTB (NJTA General Engineering Consultant) and this office, we were requested to revise the detention basins to meet the current NJDEP requirements. This study would place conformance of the detention basins to NJDEP design standards ahead of R.O.W. acquisition costs.

The Route 92 project has been designed to meet the stormwater management and water quality requirements set forth by the NJDEP pursuant to the FHA (N.J.S.A. 7:13-2.8). These regulations require that the detention basin be designed to reduce the rate of runoff by 25% for the 10 and 100 year storms, and 50% for the 2 year storm. In addition, the detention basin must be designed to meet the one (1) year water quality storm requirement, namely to retain no less than 10% of the inflow runoff volume 18 hours past the peak outflow.

The design of the detention basins recognized that the proposed toe of slope ditches will not be tributary to the detention basins. This is due to the relatively flat topography of the area and the existence of regulated floodplains and wetlands within the alignment. It was also desired to avoid a detention basin involving more than 5 feet of embankment which would require a Class IV dam permit. These constraints resulted in the proposed embankment fills being undetained. In order to meet the NJDEP requirements, the detention basins were overdesigned for the roadway pavement areas to offset the impact of the undetained embankment runoff.

As stated earlier, the original detention basin designs were located entirely within the 300' R.O.W. that is proposed for Route 92. Only small, temporary construction easements would have then been required for the original detention basins. Based on a redesign to meet NJDEP requirements, the revised detention basin designs included in this study will require significant R.O.W. acquisition. The approximate amount of acquisition required is 13.7 acres with the following breakdown:

Detention Basin '2B':	2.0 Acres
Detention Basin '2C':	2.6 Acres
Detention Basin '2D':	3.4 Acres
Detention Basin '2E':	3.9 Acres
Detention Basin '2F':	1.8 Acres
Total:	13.7 Acres

Note: Detention Basin 'A' was deleted as discussed above. The hydrologic analysis for the detention basins was performed using the Soil Conservation Service TR-55 method to determine the hydrologic characteristics of the existing and proposed drainage areas. Curve numbers (CN) and times of concentration (Tc) were calculated using this method. For the existing conditions analysis, the area within the proposed Route 92 R.O.W. that drained to each detention basin location was determined. Based on these areas, the peak rates of runoff for the 2, 10, and 100 year storms were computed. For the proposed condition, this drainage area was separated into two subareas: (1) the subarea that drains into the detention basin and (2) the subarea that flows undetained beyond the proposed Route 92 R.O.W. Runoff calculations are presented in Appendix B.

The detention basins were designed and routed using the Army Corps of Engineers HEC-1 Flood Hydrograph Package computer program. A hydrograph was generated for the subarea that drains into the detention basin and routed through the basin. A hydrograph of the subarea that drains undetained from the embankment areas was also calculated. In order to assure conformance with the NJDEP requirements, a composite hydrograph of the routed outflow from the detention basin and the hydrograph from the undetained embankment areas was calculated. This composite hydrograph was then compared to the existing conditions runoff rate.

The proposed detention basins were designed with a multiple stage outlet structure to properly regulate storms of varying recurrence intervals. A low flow (water quality) orifice having a diameter of 3" was included at the bottom of pond elevation. For intermediate storms (10 year), a rectangular weir was provided at an elevation established by the routing analysis. At the top of the outlet structure, an 'E' inlet grate is provided for emergency overflows. In addition to the 'E' inlet grate, an emergency spillway is provided below the top of basin elevation. These outlets are provided for the 100 year storm and in the event that the lower level outlets become clogged. The emergency spillway is 10-20 feet and is different for each basin. A rip-rap low flow channel is provided to direct flows toward the outlet structure. The bottom of the basins have a cross slope of 1% to allow for proper drainage within the basins.

Using this method of analysis, the overall impact of the proposed roadway on drainage conditions can be determined. The HEC-1 calculations are presented in Appendix A with Table 1 summarizing the calculated peak flow rates.

The 25 year storm analysis was also included in the analysis since this storm is used in the pipe sizing calculations for the storm drains located in the low points on the project.

TABLE 1

Summary of Peak Rates of Runoff
Detention Basins 2B and 2E

Design Storms

		2 Yr. (cfs)	10 Yr. (cfs)	100 Yr. (cfs)
Existing	'2B'	12	25	41
	'2E'	5	11	18
Proposed Conditions	'2B'	6	11	18
	'2E'	2	4	7
% Reduction Achieved:	'2B'	50.0%	56.0%	56.1%
% Reduction Achieved:	'2E'	60.0%	63.6%	61.1%
% Reduction Required		50.0%	25.0%	25.0%

3.0 EXISTING STREAMS

Drainage patterns for the existing conditions were determined by site investigations and review of the aerial topographic mapping that was available. Points of interest (POI) were selected for analysis to assess the impact of Route 92 on the existing drainage system in the area. The selection of POI were based on natural features such as existing culverts on streams in the vicinity of the proposed alignment or at locations where the proposed alignment crosses over existing streams.

3.1 DEVIL'S BROOK

As part of this application, information regarding the location of the Devil's Brook floodway/floodplain limits was taken from available information provided in the preliminary design and NJDEP floodplain map panels for the project area. The stream's location and the presence of a floodway having a width of approximately 450 feet was incorporated into the preliminary design. This floodway width necessitated the original design of a bridge approximately 500 feet long to span the floodway as part of the stream encroachment application for the project.

This office began its field research and engineering design of the drainage system for Section 2. During these investigations, we observed field conditions that appeared to differ from what was depicted on the preliminary alignment plans and on the NJDEP map panels. Our initial field investigations indicated that the Devil's Brook had been diverted.

Evidence of this relocation included a demolished culvert at Turkey Island Road and a trapezoidal channel that has been excavated. This channel flows west from the demolished Turkey Island Road culvert and connects into the channel parallel to the Amtrak mainline. Aerial photographs circa 1970 indicate that this channelization work was performed before the NJDEP's flood study of the area. Based on our review of the existing study map panels and HEC-2 output data, it appears that the study was performed in the period between 1980 and 1984. This office has reviewed the existing NJDEP HEC-2 analysis which does not indicate the presence of the Turkey Island Road culvert or the channelization work. However, our subsequent analysis indicated that this diversion has little effect on the 100 Year flood plain.

Our initial approach to the hydraulic analysis needed for the Devil's Brook bridge was relatively straightforward. We have utilized the NJDEP HEC-2 analysis as the existing conditions model. We have modified the NJDEP HEC-2 analysis to model the proposed bridge.

3.2 CULVERT AT STA 544+20

The proposed Route 92 crosses over residential, wooded and farm property within Section 2. Wherever the proposed roadway obstructs drainage patterns, cross culverts have been provided to maintain existing drainage patterns. In order to provide for conveyance of the runoff that is generated from these areas, cross culverts are placed at the apparent low points. At several locations, no definable channel exists.

Based on the absence of a definable channel, this location should not be defined as a watercourse as outlined in Section 7:13-1.2 of the FHA. The culvert at Sta. 544+20 has a drainage area of 103.3 acres. This culvert has been sized to adequately equalize the flow that is generated by the area. The watershed area of this culvert is primarily forested wetlands and farmland. The available aerial topographic mapping and site visits indicate that in the area of the proposed culvert no definable channel exists. Approximately 490 feet downstream of the proposed culvert an existing 18" RCP culvert carries Friendship Road over this swale.

During the preliminary design, design calculations were prepared for this culvert as a perennial watercourse. The culvert sizes that were obtained as a result of the analysis did not correspond to observations made in the field. The analysis performed using the HEC-2 computer program indicated the need for a 12' x 5' reinforced concrete box culvert (RCBC) at this location. A culvert of this size located upstream of an existing 18" RCP culvert at Friendship Road that is functioning properly was not considered a reasonable solution. Based on the lack of definable watercourse and the existing 18" RCP culvert in Friendship Road, a 48" RCCP culvert has been selected for this culvert crossing. The proposed culvert shall provide for adequate conveyance of flow across the Route 92 alignment.

4.0 PROPOSED BRIDGES AND CULVERTS

4.1 DEVIL'S BROOK BRIDGE

Two (2) 525' seven span bridge structures for Route 92 eastbound and westbound are proposed over Devil's Brook.

Based on soil borings taken in the vicinity of the proposed bridge, the average anticipated subsurface profile is as follows:

Depth	Soil Stratum Description
0-2 ft.	Surficial Organic Deposit
2-5 ft.	Intermingled Clayey Silt and Silty Clay
5-30 ft.	Loose to Medium Dense Silt Sand
30-45 ft.	Red Brown Moderately Weathered, Closely Jointed Shale Bedrock

These results were taken from the preliminary foundation recommendation report prepared by PMK Group on April 4, 1996.

4.2 CROSS CULVERT AT STA. 544+20

The cross culverts on the project have been designed to convey flows that would otherwise be obstructed by the proposed roadway alignment. These culverts have been designed using the Rational or SCS method depending on their drainage area. More specifically, the rational method was used for areas up to 20 acres and the SCS method was used for larger drainage areas. The culverts have been designed to meet flows that presently exist. This design approach can be utilized since S. Brunswick Township enforces its stormwater management ordinance. The hydraulic analysis was performed using the Bureau of Public Roads, Hydraulic Engineering Circular No. 5, Hydraulic Charts for the Selection of Highway Culverts, December 1965. As part of the design, inlet and outlet control conditions were reviewed to properly determine the capacity of the proposed culverts.

These cross culverts will be sized to accommodate existing conditions. Middlesex County, South Brunswick and Plainsboro have stormwater management ordinances in effect, requiring all proposed developments to maintain and/or decrease run-off from their sites.

These culverts will be designed for either the 50 year or 100 year storm depending on their drainage area and the design standards applied. The NJDEP requires a 100 year design for culverts under its stream encroachment jurisdiction (a drainage area over 50 acres). The NJTA requires a 50 year design for

culverts having a drainage area less than 50 acres. Based on a delineation of the drainage area for each of the cross culverts, only one culvert (Sta. 544+20) has a drainage area of greater than fifty (50) acres. However, there is no defined channel at this culvert location. Approximately 500' downstream of the proposed culvert is the Friendship Road Culvert which is an 18" RCCP.

For this culvert, the rational method was used in the calculation of the flow for the existing channel at the Route 92 crossing. The hydrologic soil group for this area is soil group C. The flow was determined assuming full development of the drainage area into 2 acre lots with the existing wetlands areas remaining undeveloped. The drainage area for this culvert is 103.3 acres.

The drainage area for this culvert contains numerous depressions which will attenuate the peak rate of runoff. A reduced CN was used for a portion of the watershed to reflect the storage volumes which are present. A peak rate of runoff of 67 cfs was calculated for the 100 year storm.

The existing 18" RCP culvert at Friendship Road serves as a downstream control point. The drainage area of this culvert generates extremely low flows for the reasons discussed above. The culvert design provides for equalization flow across the proposed roadway embankment. The 48" RCCP culvert that is proposed at this location will provide for adequate conveyance of flow.

4.3 PROPOSED DETENTION BASIN '2B' OUTFALL TO DEVIL'S BROOK

The outfall from detention basin '2B' is a 18" RCCP pipe that will outlet to the Devil's Brook. The detention basin has been designed to meet NJDEP stormwater management regulations. Routing calculations for the detention basins are included in Appendix B.

4.4 PROPOSED DETENTION BASIN '2E' OUTFALL TO AN UNNAMED TRIBUTARY TO DEVIL'S BROOK

The outfall from detention basin '2E' is a 18" RCCP pipe that will outlet to the Devil's Brook. The detention basin has been designed to meet NJDEP stormwater management regulations. Routing calculations for the detention basins are included in Appendix B.

5.0 HYDROLOGY

For the flood delineation, standard hydrologic and hydraulic study methods were used in this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10, 50, 100, or 500 year period have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10, 50, 100, and 500 year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. The flood hazard area flood (100 Year + 25%) was also included in the analysis.

The recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100 year flood (1 percent chance of annual exceedence) in any 50 year period is approximately 40 percent (4 in 10), and, for any 90 year period, the risk increases to approximately 60 percent (6 in 10). The analysis reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study.

Drainage areas and other hydrologic characteristics of the various streams and ditches were calculated at points where the proposed Route 92 alignment crosses over them. These locations were selected for cross culverts to convey stormwater run-off across the proposed alignment.

The hydrologic calculations were performed using the Soil Conservation Service Technical Release No. 55 Urban Hydrology for Small Watersheds (SCS TR-55). Run-off hydrographs were generated using the Army Corps of Engineers HEC-1 Flood Hydrograph Package and the SCS TR-55 characteristics.

The existing hydrologic analysis that was performed for the original Devil's Brook study was utilized in this study. Table 2 includes a summary of hydrologic information for each of the streams within the project limits.

TABLE 2

SUMMARY OF DISCHARGES

Flooding Source & Location	Drainage Area* (Sq. Mi).	Peak Discharge (cfs) 10 YR	50 YR	100 YR Flood Hazard	500 YR
DEVILS BROOK					
At the downstream corporate limits	4.24/4.37	290	505	630	788	1,020
At Culver Road	2.24/3.43	255	440	550	688	895
At Hay Press Road	0.80/1.70	240	415	525	656	855
Unnamed Tributary #1 at Sta. 544+20	0.16			67		
Unnamed Tributary #2 at Friendship Road	1.15			560		

* - 4.24/4.37 square miles represent drainage areas obtained from review of USGS maps vs. FEMA FIS.

6.0 HYDRAULICS

6.1 DEVIL'S BROOK

Cross section data, flood discharges, and values of Manning's 'n' were obtained from the existing state flood study.

Water surface elevations of floods of the selected recurrence intervals were computed using the HEC-2 computer program. Water surface profiles were drawn showing computed water surface elevations for floods of the recurrence intervals. Starting water surface elevations for the Devils Brook were obtained from the State Study for the Township of Plainsboro.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of the field inspection of flood plain areas. The approximate roughness values for the Devil's Brook are as follows: Channel "n" (0.040-0.045) Overbank "n" (0.080-0.120). All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

The existing low flow channel that flows parallel to Turkey Island Road will be extended as part of the bridge construction. A low berm set at the same elevation as Turkey Island Road will replicate existing hydraulic conditions in the area.

Table 3 provides a comparison of existing and proposed water surface elevations for the channel relocation. These results demonstrate that the construction of the proposed seven span, 525ft. bridges for the proposed Route 92 project will have no adverse impact on the water surface profile of the Devil's Brook.

Upon review of the existing and proposed conditions analysis of the Devil's Brook floodplain, it was observed that flood velocities in the project area are less than 0.5 feet per second (fps). These flood velocities approach zero and replicate a standing body of water.

6.2 CULVERT AT STA 544+20

A hydraulic analysis of the proposed culvert was performed using the Army Corps of Engineers HEC-2 computer program. Various culvert types were analyzed for hydraulic efficiency and to meet NJDEP requirements. The culvert size determined by the backwater analysis was a 12' x 5' box culvert. As indicated previously, a review of the existing field conditions indicated that the watershed did not justify the construction of a culvert this size. The presence of an existing 18" RCP culvert at Friendship Road approximately 490 feet downstream of the proposed culvert and a lack of flooding in this area, indicates that a 12' x 5'

box culvert is not necessary. No increase in runoff will be created by this project. In order to provide for an equalization of flow created by the 18" culvert at Friendship Road, a 48" RCCP culvert is proposed.

6.3 DETENTION BASIN '2B' AND '2E' OUTFALLS

The detention basins for this project were designed using the Army Corps of Engineers HEC-1 flood hydrograph package computer program. Runoff hydrographs generated were routed through the proposed basins and then combined with hydrographs for the undetained portions of the watershed.

Stage-discharge-storage relationships for the detention basins were developed and inserted into the HEC-1 program via the SE, SQ, and SV cards in each of the input files. The routing analysis indicates that the basins are large enough to regulate the 100-year storm and meet the one (1) year water quality storm requirements.

TABLE 3

COMPARISON OF EXISTING AND PROPOSED WATER SURFACE ELEVATIONS (WSEL) FOR THE DEVIL'S BROOK

FLOOD HAZARD FLOOD (100 Yr.+ 25%)

STATION	EXISTING	PROPOSED	DIFFERENCE
2830	83.99	83.99	0.00
2831	83.99	83.99	0.00
2832	83.99	83.99	0.00
2832.2 (D.S. Proposed Bridge)		84.02	0.03
2832.3 (U.S. Proposed Bridge)		84.02	0.03
2833	83.99	84.02	0.03
2834	83.99	84.02	0.03
2835	83.99	84.02	0.03

7.0 STABILITY ANALYSIS

Stability analyses have been performed for the retaining walls that are located within the project limits. These retaining walls are placed in locations to minimize wetlands disturbance and floodplain fill. The stability analyses are located in Appendix 2G of the report.

8.0 SOIL EROSION AND SEDIMENT CONTROL MEASURES

The proposed Route 92 project will be designed in accordance with the "Standards for Soil Erosion and Sediment Control in New Jersey," as directed by the Freehold Soil Conservation District as well as applicable New Jersey Turnpike Authority and local erosion control regulations. In locations where channel relocations or stormwater outfalls are proposed, rip-rap stone slope protection or other acceptable material will be used to control erosion.

At the Devil's Brook bridge crossing, a low berm is proposed to recreate the existing Turkey Island Road which is to be removed in this area. The low berm and low flow channel downstream will be lined with rip-rap. The relocated low flow channel will have an earth bottom and its side slope lined with embankment slope protection. This will allow vegetation to grow in the channel banks of the low flow channel.

During construction of the roadway, erosion controls such as silt fence, inlet filters, and sediment basins will be employed to control erosion. A temporary haul road shall be constructed within the proposed R.O.W. to control erosion on local roadways during construction. Wheel cleaning blankets will be installed at points where construction traffic will enter onto local roadways or off the work zone.

9.0 JUSTIFICATION FOR WAIVERS/EXEMPTIONS

9.1 20% NET FILL

Devil's Brook

The construction of the proposed highway in the Devils Brook watershed requires placement of a considerable amount of fill within the floodplain. Using the cross section end area method results in a total floodplain volume of 75,573 cubic yards within the proposed R.O.W. By superimposing the typical section of the proposed roadway the total fill was computed as 29,291 cubic yards within the flood fringe.

The percentage of fill within the Devils Brook floodplain is 30.8% versus the allowable 20%. Therefore, an exemption from this requirement is requested. Calculations for the net fill quantities are included in Appendix C.

This request is based on the fact that there is only a limited amount of right of way being acquired for the project. The NJTA is acquiring a 300' wide R.O.W. of which practically all will be used to construct the highway and its appurtenances. The NJTA does not possess surplus R.O.W. within the floodplain to meet the 20% net fill requirement. Due to the linear nature of the project, there is no undeveloped portion of the R.O.W available.

Without the installation of the proposed retaining walls, additional R.O.W. would have to be acquired from private property owners for use other than actual construction of the roadway. The amount of additional R.O.W. that would be required to meet the 20% net fill calculations would be 43.5 acres. The cost of property in the area of the project has been appraised to be $80,000 per acre for upland areas and $15,000 per acre for wetlands. Using the wetland figure above with 100% wetland areas to be acquired, the cost of compliance with the 20% net fill requirement would be $652,000. This acquisition figure is significant and does not include legal and engineering costs. It would also require that the NJTA condemn the 43.5 acres of land from private property owners in the area.

Other alternatives were investigated to reduce the amount of net fill that is proposed to be placed are the following:

1. Additional excavation within the watercourse.
2. Use of retaining walls, steeper slopes, and longer bridges in floodplain areas.

Additional excavation within the floodplain is not feasible due to the presence of wetlands that essentially overlaps the floodplain limits. Any additional disturbance to wetland areas to meet the 20% net fill requirements would be counterproductive from an environmental standpoint.

The proposed Route 92 presently has roadway embankment slopes of 2:1 (horizontal to vertical). The use of steeper side slopes (such as 1.5:1) to minimize the net fill would cause significant stability and maintenance problems, and additional construction costs. The difference in the toe of slope between a 1.5:1 and 2:1 slope would vary depending on the height of fill being placed for the roadway. This reduction in fill does not warrant the maintenance and construction costs that would be incurred to construct the slopes at steeper side sloes than presently proposed. The NJDEP does not presently accept slopes steeper than 2:1 for fill placed within the floodplain, thereby eliminating this option.

Although the use of retaining walls would cost more than the use of a steeper side slope and not eliminate all of the proposed fill in the floodplain, they have been included in the project to reduce wetland impacts and floodplain fill to the largest extent possible. Construction of reinforced concrete retaining walls on poor soils such as those encountered within the wetland areas will require significant over excavation to obtain stable soils. Retaining walls are proposed between Sta. 403+85 and 434+92.04 RT., and 403+85 and 435+46.70 LT., and 440+50.12 and 449+07.63 RT., and 451+00 and 455+28.55 RT., 531+70.42 and 539+45.17 RT., 531+96.51 and 547+46.93 LT., and 542+11.86 and 546+33.86 RT. The installation of retaining walls in this area will reduce the net floodplain fill to 23,291 cu. yd. or 30.8%. Prior to the inclusion of the retaining walls into the project, the net fill for this portion of Section 2 was 67%.

9.2 Unnamed Tributary to Devils Brook

The Route 92 alignment also encroaches into the floodplain of an Unnamed tributary to Devils Brook from Sta. 441+00 to Sta. 460+00 The existing floodplain volume within the proposed Right of Way is calculated to be 834,050 C.F. The proposed fill in this floodplain required by the construction of Route 92 is 379,850 cu.ft. This results in a net fill of 45.5% within the proposed

R.O.W. Prior to the addition of retaining walls and removal of the U-Turn, the net fill for this tributary's floodplain was 65.3%.

Culvert at Sta. 544+20

The proposed Route 92 alignment will encroach into the floodplain of a second unnamed tributary of the Devil's Brook at Sta. 544+20. The existing floodplain volume within the proposed NJTA Route 92 Right of Way has been calculated to be 85,700 cu. ft. The proposed fill required by the Route 92 embankment has been calculated to be 29,500 cu. ft. This fill volume results in a proposed 34.5% net fill where 20% is allowed. Prior to the inclusion of walls at this location, the net fill was 82.0%.

9.3 CULVERT AT STA 544+20

The existence of an 18" RCP culvert at Friendship Road serves as a hydraulic control for the area. In the vicinity of the proposed Route 92 culvert crossing, no detention basin channel exists. The downstream culvert serves as a constriction to flow. The Route 92 culvert that is proposed at this location shall provide for adequate conveyance of flow.

A standard backwater analysis was performed for this location. The results of this analysis called for the installation of a 12' x 5' box culvert. This result is not practical due to the presence of an 18" RCP culvert that appears to be operating properly less than 500' downstream.

Within the watershed, a large percentage of forested wetlands is present. Numerous depressions exist which attenuate the peak rate of runoff. Although a 100 year peak rate of 67 cfs runoff has been calculated, it is unlikely that it would ever be realized. This condition makes the selection of a 48" RCCP culvert to equalize the runoff generated a more prudent choice.

9.4 DETENTION BASINS '2B' AND '2E'

Both detention basins have been revised to meet the 2 year storm requirements for Subareas 'B' and 'E'. As shown in the HEC-1 output, the detention basin will greatly reduce the peak rate of runoff being generated by the roadway.

The design of detention basins 2B and 2E will meet the 1 year water quality requirement established by NJDEP. The peak rate of runoff from the detention basin will be reduced to 1 or 2 cfs. The remainder of the runoff hydrograph for the post development condition is generated by grassed roadway embankments.

9.5 STORMWATER MANAGEMENT BETWEEN AMTRAK AND DEVIL'S BROOK

A portion of the Route 92 project within Section 2 does not contain stormwater management facilities. This portion is located between the proposed Route 92 bridges over Amtrak and the Devil's Brook (Sta. 403+00 to Sta. 428+00). In this area, retaining walls are proposed to reduce the amount of wetlands disturbance. Due to the construction of retaining walls to minimize wetlands disturbance, it is proposed to allow for roadway runoff to drain directly into the wetland areas. This design does not allow for any reduction in the amount of runoff being generated from the project.

One of the questions raised by NJDEP at earlier meetings was why there are no provisions on the permit plans for detention between Devil's Brook and Amtrak. During the design development stage, Boswell Engineering considered several locations as possible detention basin sites. As you know, this entire area is within a floodplain and, with the exception of a small upland area, is predominantly forested wetlands. Additionally, the detention basin would be required to be constructed within the flood hazard area. As such, to account for the loss of flood storage, the basin would have to be much larger than if it was located outside the flood hazard area. Our preliminary calculations indicated that the area of disturbance for such a detention basin would be approximately one (1) acre.

A detention basin was not proposed in the upland field north of McCormack Lake due to the high quality wildlife habitat that this area supports. This upland field breaks up the forested wetland, thus creating habitat diversity. A wildlife survey was conducted which determined that this field, in association with McCormack Lake and the adjacent Devil's Brook wetlands, provide food and cover for migrating birds, particularly grassland birds. According to the wildlife survey report, the greatest diversity of species was observed in the upland fields. Therefore, it was for these environmental and engineering reasons why detention was not provided for this section of Route 92.

In an effort to disperse the roadway run-off and recharge the wetland areas, we propose providing roadway inlets every 400 feet and discharging at 12 locations, as shown on the revised plans.

The next question that was raised concerned the ditch that parallels the base of the retaining wall on the north and south side of Route 92, between Devil's Brook and Amtrak, and if it should be deleted. It was accurately noted during the meeting that the inclusion of such ditches may pose a greater environmental impact to the wetlands and groundwater levels than if the ditch was deleted.

We have reviewed this comment and have revised the plans to delete the ditches that were shown on the previous submittal. Due to the existing topography within this area being extremely flat, a ditch of sufficient width, pitch and depth would pose environmental impacts. The excessive width of the ditch would cause damage to plants and trees along the fringe of the limit of disturbance, which we are attempting to preserve. Also, the excavation of the ditch may act to lower the groundwater table within the wetland area, causing a drying out of certain wetland areas. The original purpose of the ditch was to provide for water quality and as a method of erosion control.

The last question raised for this area was how water quality is addressed. Water quality is addressed and provided for in our design by virtue of the fact that the one (1) year flow at each discharge point is minimal (1-2 cfs). Meeting the water quality requirements for the low run-off volumes is achieved by sheet flow into the wetland areas. This is an acceptable engineering and environmental application for achieving water quality. In accordance with soil erosion and sediment control standards, we are proposing rip-rap aprons at each of the stormwater outfalls. The dimensions of the rip-rap aprons and the rip-rap size (d50) are designed in accordance with Soil Erosion and Sediment Control Standards.

Based on the above, it was determined that the construction of a detention basin in the wooded wetland area for this portion of Section 2 would have disturbed approximately two (2) acres of wetlands and would be environmentally counterproductive.

10.0 CONCLUSION

The proposed Route 92 project within Section 2 proposes to construct several improvements which require a stream encroachment permit. They include the following:

1. Two (2) 525' span bridges carrying Route 92 Eastbound and Westbound over the Devil's Brook.

2. Fill in excess of 20% within the Devil's Brook floodplain.

3. Fill in excess of 20% within Devil's Brook unnamed tributary #1 floodplain.

4. Fill in excess of 20% within Devil's Brook unnamed tributary #2 floodplain.

5. A 18" RCCP stormwater outfall to the Devil's Brook from Detention Basin '2B'.

6. A 18" RCCP stormwater outfall to the Devil's Brook tributary from Detention Basin '2E'.

7. Construction of a 48" RCCP culvert at Sta 544+20.

This report has presented design calculations and commentary on how the design submitted was developed. The report also explains why several NJDEP design criteria could not be achieved. These requests are justified by the nature of the project and existing physical conditions.

This report has discussed the various factors that have influenced the request for an exemption from the 20% net fill requirement for this project. The information provided has discussed the design considerations and alternatives to the proposed design and their effectiveness. Based on this information, the alternatives to the proposed design either have excessive cost, substandard engineering design, or minimal impact on the 20% net fill requirement due to the constraints associated with this project.

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APPENDIX C

NEW JERSEY TURNPIKE AUTHORITY
APPLICATION FOR
STREAM ENCROACHMENT PERMIT

ENGINEER'S REPORT

PROPOSED ROUTE 92
FROM ROUTE U.S 1 TO INTERCHANGE 8A
IN
THE TOWNSHIPS OF
PLAINSBORO, SOUTH BRUNSWICK, AND MONROE
MIDDLESEX COUNTY

SECTION NO. 3
CONTRACTS RT92-3001, RT92-3002 AND RT92-3003

Prepared by:

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October 1996
Revised 2/20/97
Revised 4/21/99

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1.0 INTRODUCTION

The proposed Route 92 consists of construction of a new 6.7 mile long four lane roadway to connect existing New Jersey Turnpike Interchange 8A to U. S. Route 1 in South Brunswick Township, Middlesex County, New Jersey. Section 3 is the portion of the roadway from the Route U.S. 1 interchange to the east side of the AMTRAK rail line. This section includes a grade separated interchange at U.S. Route 1 including connecting ramps, a grade separated crossing of Route 92 over Ridge Road, the relocation of Perrine Road, a grade separated crossing of Perrine Road over Route 92 including connecting ramps, and a grade separated crossing of Route 92 over AMTRAK. The alignment of Section 3 of Route 92 crosses portions of two major watersheds, Devil's Brook on the east end and Heathcote Brook on the west end.

Activities to be performed as part of the Route 92 construction that require a stream encroachment permit include installation of any facility within fifty feet of a watercourse with a drainage area of fifty acres or more. Specific activities that require a stream encroachment permit are indicated in section 2.0 Proposed Improvements of this report.

The impacts of the proposed construction are described in section 4.0 Proposed Bridges and Culverts, 5.0 Floodplain Impacts, 6.0 Hydrology, and 7.0 Hydraulics of this report respectively.

The stream encroachment activities addressed in this report are shown on plan sheets 121 through 182 inclusive.

The Report was revised on February 20, 1997 to include proposed retaining walls within the floodplain of the Tributary to Devils Brook to minimize wetland impacts and to include the revisions at Campus Drive which resulted in the elimination of SMB 3D and no fill placed within the floodplain of Heathcote Brook.

The Report and Permit Plans have been revised April, 1999 to include the following:

1) The elimination of the ultimate installation of a third lane in the median (less impervious surfaces) which results in the need to revise hydrologic and hydraulic computations.

2) Revised hydraulic and net-fill computations at the Tributary to Devils Brook as a result of a reduced roadway width (elimination of grassed median) and reducing fill in the existing pond.

3) Revised grading of SMB-B.

4) New wall on east (upstream) side of U.S. Route 1 crossing and revised drainage at approx. station 147 to 148.

5) Elimination of the proposed storm sewer replacement outfall to Heathcote Brook at the U.S. Route 1 crossing of Heathcote Brook floodplain.

6) Revised discharge location of the Access Road A outfall.

2.0 PROPOSED IMPROVEMENTS

2.1 General

Review of the available topographic maps indicates that the Route 92, Section 3 alignment crosses two major watersheds, Devil's Brook on the east end and Heathcote Brook on the west end. The watershed limits are shown on the Watershed Basin Divide Plan. An existing natural depression is located at the eastern end of the Heathcote Brook watershed, adjacent to the western limit of the Devil's Brook watershed.

The design attempted to comply with the appropriate requirements of the Flood Hazard Area Control Act Rules, N.J.A.C. 7:13-1.1 et seq. March 20, 1995 and Regulations for the Review Zone of the Delaware and Raritan Canal State Park, N.J.A.C. 7:45-1.1 et seq. February 1994. Detailed descriptions of the design procedures and ability to provide compliance with these requirements are presented throughout this report.

The proposed roadway construction includes installation of a complete roadway drainage system, crossings of two watercourses including the associated fill, filling a portion of the existing depression, installing outfalls from several stormwater management basins (SMB's) to the floodplain of Heathcote Brook. Each of these elements is described in the following sub-sections

2.2 Roadway Drainage System

Runoff from the roadway will be collected and conveyed to various discharge locations in a combination of gutters, swales, ditches and pipes. The existing watershed boundary established the portion of the roadway runoff that is discharged to the Tributary to Devil's Brook on the east and the Tributary to Heathcote Brook or to Heathcote Brook on the west. Compliance with the stormwater management requirements of both the New Jersey Department of Environmental Protection (NJDEP) and the Delaware and Raritan Canal Commission (D&RCC) is achieved by routing the runoff through SMB's before discharging to watercourses. The drainage design was prepared to collect and convey the runoff to the SMB's from a pavement area equal to the aggregate new impervious area resulting from the proposed construction.

2.3 Watercourse Crossings

Two existing watercourses that drain fifty or more acres are crossed by the proposed Route 92, Section 3 alignment. These include the crossing of a Tributary to Devil's Brook on the east end of the project and the U.S. Route 1 and Ridge Road crossings of a Tributary to Heathcote Brook on the west end of the project. The crossing of the Tributary to Devil's Brook requires the construction of a new bridge including retaining walls to minimize wetland impacts. The U.S. Route 1 and Ridge Road crossings require replacement of the existing culverts. The fill associated with these installations is considered part of the work included in the stream encroachment permit. Detailed discussion of these installations is presented in Section 4.0 Bridges and Culverts of this report.

2.4 Filling the Existing Depression

The existing depression at the east end of the Heathcote Brook watershed, located between approximately Station 350 and Station 360 is not considered a watercourse because there is no defined path that conveys surface runoff. The storage volume in the depression is adequate to contain the entire 100-year runoff from the area that contributes runoff to it.

2.5 Fill in Floodplain

Fill placed in the floodplain of the Tributary to Devil's Brook and the floodplain of the Tributary to Heathcote Brook is considered included in the stream encroachment permit for the applicable bridge or culvert construction.

2.6 Storm Water Management Basins & Outfalls to Regulated Waterways

SMB's are provided at various locations along the project corridor to provide compliance with the NJDEP engineering and environmental standards for stormwater management stated in N.J.A.C. 7:13-2.8 and the D&RCC requirements stated in N.J.A.C. 7:45-5.0. Roadway runoff from a total pavement area equal to the new pavement area resulting from the Route 92 construction is routed through the SMB system constructed for the Route 92 project to provide compliance with the stated water quality requirements. Attenuation of the runoff conveyed to the SMB's provides the required water quality control.

Primary SMB design parameters include the following:

1) The bottom of the basin is approximately 4 feet above the measured GWT elevation. Small portions near the outlet are 3 feet above the GWT. Ground water table (GWT) elevations were measured in observation wells installed in selected soil borings between March 1, 1996 and June 13, 1996. The locations of the observation wells, summary of GWT readings, and the GWT profile are contained in Appendix E.

2) Side slopes of the basin are one vertical on three horizontal.

3) The minimum bottom slope of the basin is 1.0 %.

4) A triangular shaped riprap lined low flow channel six inches deep and having a six foot top width and a slope of 1 % is provided in all basins with a bottom slope of less than 2%.

5) Maximum embankment height is limited to five feet or less measured between the elevation of the emergency spillway and the toe of slope.

6) A stone covered maintenance road 12 feet wide with maximum 8.0 % profile grade is provided in all basins that are more than five feet deep.

7) The top of the embankment for berms around SMB's is 10 feet wide.

8) Minimum freeboard of 0.5 feet for the 100-year discharge is provided where possible.

9) The emergency spillway provides for release of the runoff if the controlled outlet facility fails to operate properly. The outlet structure consists of a reinforced concrete structure with a 3" orifice opening in the bottom as required to provide water quality control. A weir notch in the wall set above the elevation of the 1-year water quality runoff and at the maximum elevation required to provide the required attenuation allows excess runoff to exit the basin. The grate on the top of the outlet structure functions as the primary emergency spillway. A secondary emergency spillway is provided by allowing the excess runoff to flow over a portion of the embankment with a top elevation equal to or above the elevation of the primary emergency spillway and below the elevation of the top of the embankment. The secondary emergency spillway will be protected with the installation of open cell concrete blocks that provide the required stability while allowing grass to cover the area. This protection is placed across the entire width of the secondary emergency spillway opening, down the embankment slope and at least ten feet beyond the toe of slope.

Specific SMB outfalls to regulated waterways that require a stream encroachment permit are indicated in the following section.

2.7 Specific Items that Require a Stream Encroachment Permit

Specific elements of the Route 92, Section 3 project that require a stream encroachment permit are indicated relative to the watercourse which they impact as follows:

A. Tributary to Devils's Brook Activities

1. Route 92 bridge crossing a portion of the floodplain for the Tributary to Devil's Brook on the west side of the AMTRAK railroad.

2. Storm sewer outfall located on the west side of the Tributary to Devil's Brook floodplain south of the Route 92 crossing.

3. Installation of retaining walls to minimize wetland and transition area impacts.

B. Tributary to Heathcote Brook Activities

1. The existing U.S. Route 1 and Ridge Road crossings of a Tributary to Heathcote Brook are to be replaced.

2. Ramp B crossing

3. The outlet from SMB 3A, located in the east portion of the area between Ridge Road, Route 92, and U.S. Route 1, which accepts roadway runoff from a portion of U.S. Route 1, Ridge Road, and Route 92 discharges to the floodplain of a Tributary to Heathcote Brook.

4. The existing water main in the vicinity of Ramp B, on the west side of U.S. Route 1, is to be replaced. The relocation extends across the entire floodplain.

5. The existing fiber optic line on the west side of U.S. Route 1 is to be relocated below the proposed culvert crossing. The relocation extends across the entire floodplain.

6. The existing water main crossing of the existing culvert in Ridge Road is to be replaced below the proposed culvert crossing. The relocation extends across the entire floodplain, which extends along Ridge Road on both sides of U.S. Route 1.

7. The existing gas main in Ridge Road is to be relocated for its entire length in the floodplain, which extends along Ridge Road on both sides of U.S. Route 1. The relocation includes the crossing below the proposed Ridge Road culvert and the gas main in U.S. Route 1 south of Ridge Road.

8. The proposed underground electric facilities on both sides of U.S. Route 1 in the vicinity of the Route 92 and Ramps ES and NE overpass extend into a portion of the floodplain.

9. The proposed telephone/cable TV facilities on both sides of U.S. Route 1 extend across the entire floodplain.

10. The proposed telephone/cable TV facilities on the north side of Ridge Road extend across the entire floodplain.

11. Relocation of the sanitary sewer force main on the east side of U.S. Route 1 extends across the entire floodplain.

12. Relocation of the existing gas main on the east side of U.S. Route 1 extends across the entire floodplain.

C. Heathcote Brook Activities

1. The drainage and outfall pipe from Access Road A discharges to the Heathcote Brook floodplain.

2. The existing water main is to be relocated in the portion of the floodplain south of the U.S. Route 1 crossing.

3. The existing sanitary sewer is to be relocated in the portion of the floodplain south of the U.S. Route 1 crossing.

4. The existing gas main is to be relocted in the portion of the floodplain south of the U.S. Route 1 crossing.

Additional discussion regarding these activities in the Tributary to Heathcote Brook watershed is presented in Section 4.0 Proposed Bridges and Culverts of this report. Additional discussion regarding these activities in the Heathcote Brook watershed is presented in Section 5.0 Floodplain Impacts of this report.

3.0 EXISTING STREAMS

The proposed Route 92, Section 3 project impacts three existing waterways that drain fifty or more acres. These include:

A. A Tributary to Devil's Brook on the east end of the project which requires a new bridge crossing including retaining walls.

B. A Tributary to Heathcote Brook on the west end of the project which requires replacement of the culvert crossings of U.S. Route 1 and Ridge Road and several SMB outfalls

C. Heathcote Brook, which is impacted by a pipe outlet from Campus Driveway.

Areas contributing runoff to the point of interest on each watercourse were delineated on the available topographic maps. The primary topographic map used for this purpose was the mapping prepared from aerial photographs specifically for the Route 92 design at a scale of one inch equals thirty feet with a one foot contour interval. This mapping was supplemented by the available corridor mapping prepared from aerial photographs at a scale of one inch equals one hundred feet with a two foot contour interval. Delineation beyond the limits of this mapping was based on the USGS Hightstown quadrangle. The contributing area delineation was confirmed by field observation.

Existing ground cover and development were determined from existing aerial photographs and the Hightstown quadrangle USGS topographic map. The results were supplemented and confirmed by field observation.

Information regarding each of these watercourses is presented in the following narrative:

3.1 Tributary to Devil's Brook

The total drainage area that contributes runoff to the Tributary to Devil's Brook at the location of the Route 92, Section 3 crossing is 506 acres. The majority of the drainage area is used as agricultural fields. Single family residential development occupies the remainder of the drainage area. The Tributary to Devil's Brook channel is a relatively narrow and shallow ditch adjacent and parallel to the AMTRAK railroad. The bottom is unlined soil and the banks are covered with vegetation. A 54 inch diameter concrete pipe crossing of the Tributary to Devil's Brook is provided for the dirt road located approximately 1000 feet north of the Route 92 alignment.

3.2 Tributary to Heathcote Brook

The total drainage area that contributes runoff to the Tributary to Heathcote Brook upstream of the Ridge Road crossing is 102 acres and 140 acres at the downstream outlet location west of U.S. Route 1. The majority of the drainage area upstream of the Ridge Road crossing is used as agricultural fields. The drainage

area downstream of the Ridge Road crossing is primarily developed for commercial and industrial uses. Immediately upstream of the Ridge Road crossing, the runoff traverses a broad and flat farm field with no defined watercourse. The existing Ridge Road crossing consists of a fifteen inch diameter pipe. Between Ridge Road and U.S. Route 1, the runoff is conveyed in a narrow open channel with a soil bottom and vegetated sides. A small portion of the 100-year runoff that crosses U.S. Route 1 is contained in the existing 21/24 inch diameter pipes. The remainder of the runoff proceeds overland across U.S. Route 1 and west along Ridge Road in sheet flow to the low point where it proceeds overland toward the northwest, ultimately reaching Heathcote Brook. The existing and proposed regulatory floodplain from upstream of U.S. Route 1 to downstream of Ridge Road is contained within existing right-of-way (ROW) of the New Jersey Department of Transportation (NJDOT). The limited capacity of the existing fifteen inch diameter crossing of Ridge Road and small height of cover over the pipe causes runoff that exceeds the culvert capacity to breach the roadway at approximately elevation 90. The excess runoff proceeds along Ridge Road and overland, ultimately returning to the Tributary to Heathcote Brook upstream of the U.S. Route 1 crossing.

The existing regulatory floodplain upstream of Ridge Road extends beyond the Middlesex County Route 522 ROW. The proposed regulatory floodplain upstream of Ridge Road is contained within ROW to be obtained for the Route 92 project.

3.3 Heathcote Brook

Detailed hydraulic studies prepared by the NJDEP for Heathcote Brook were used to identify the impacts of the Route 92 project. Therefore, additional data regarding the drainage area, character of the drainage basin and channel conditions was not collected for this watercourse.

4.0 PROPOSED BRIDGES AND CULVERTS

The crossing of the Tributary to Devil's Brook requires the construction of a new bridge. The U.S. Route 1 and Ridge Road crossings require replacement of the existing culverts.

The proposed crossings required for the Route 92, Section 3 construction were designed to provide compliance with the provisions of N.J.A.C. 7:13-2.16, Bridges and Culverts. Each of these proposed crossings and the associated impacts on the respective floodplains are described separately in the following narrative.

4.1 Tributary to Devils's Brook

The crossing consists of a bridge that also crosses the AMTRAK railroad and a portion of the Devil's Brook floodplain east of AMTRAK. The bridge consists of five spans with a total length between the full height vertical abutments of 520 feet. Two piers, roadway fill and the proposed retaining walls are located within the floodplain of Devil's Brook on the east side of AMTRAK. The technical documentation required for the stream encroachment permit for piers 3 and 4, the abutment and the fill placed in the Devil's Brook floodplain by the proposed bridge is addressed in the documentation prepared for Route 92, Section 2. The technical documentation required for the stream encroachment permit for piers 1 and 2, the abutment, the retaining walls, and the fill placed in the Tributary to Devil's Brook floodplain and the deck of the proposed bridge is presented in this report. The impacts to the Tributary to Devil's Brook resulting from the proposed bridge include hydraulic impacts and fill impacts. Each of these impacts is discussed in the following narrative.

4.1.1 Hydraulic Impacts

Hydraulic computations were performed for the existing and proposed condition as described in Section 7.0 Hydraulics of this report. The proposed construction includes the following elements that impact the hydraulics:

A. Installation of two piers, the west abutment, and retaining walls in the floodplain.

B. Installation of the roadway fill in the floodplain

C. Installation of riprap lining in the Tributary to Devil's Brook channel and on the over banks.

The proposed installation yields an increase in the water surface elevation not exceeding 0.20 as indicated in the summary tables presented in Section 7.0, Hydraulics.

4.1.2 Fill Impacts

The existing flood fringe volume within the Route 92, Section 3 ROW is 0.90 Ac-ft. The fill placed in the floodplain by the proposed construction is 0.33 Ac-ft. This represents 37 percent of the existing floodplain storage volume which exceeds the allowable twenty percent. Justification for an exemption to the net fill limitation in accordance with N.J.A.C. 7:13-2.8(a)5 is presented in Section 10.0, Justification for Waivers/Exemptions.

4.2 Tributary to Heathcote Brook

Proposed construction that impacts the floodplain of the Tributary to Heathcote Brook includes replacement of the existing culvert crossings at Ridge Road and at U.S. Route 1, and raising the U.S. Route 1 profile.

The Ridge Road crossing revision consists of replacing the existing fifteen inch diameter pipe with a 2' high by 8' wide concrete box culvert. The U.S. Route 1 crossing revision consists of replacing the existing 21/24 inch crossing with pipes of various sizes and a portion of open channel. The proposed system includes the following:

A. 126 linear feet of 34" x 53" horizontal elliptical pipe from the upstream side of U.S. Route 1.

B. 240 linear feet of open grass lined channel in the infield area between U.S. Route 1 and Ramp B, having a bottom width of 20 linear feet

C. 197 linear feet of twin 29" X 45" horizontal elliptical pipes under Ramp B.

D. 17 linear feet of 48" x 76" horizontal elliptical pipe to the outlet.

The pipe system was designed to contain the proposed 100-year runoff without overtopping the roadway in accordance with the criteria of the NJDOT. The excess runoff resulting from the regulatory flood will proceed over the roadway and overland following the same path as the runoff currently follows.

The profile revision of U.S. Route 1 includes the installation of fill to raise the roadway profile in the vicinity of the Ridge Road intersection. The revised roadway profile provides the sight distance required for safety as required by current NJDOT design criteria. The higher roadway profile yields an increase in the water surface elevation for the regulatory runoff at the upstream side of the U.S. Route 1 crossing. However, installation of the proposed U.S. Route 1 crossing and the proposed 2' high by 8' wide box culvert crossing of Ridge Road and the upstream ditch relocation causes the regulatory flood to be contained within public right-of-way, most of which will be acquired by the NJTA for this project.

The proposed culvert dimensions, both for the Ridge Road and the U.S. Route 1 crossings are substantially larger than the existing dimensions. However the intent of N.J.A.C. 7:13-2.16 has been satisfied by providing an installation that avoids an increase in the water surface elevation upstream of the proposed Ridge Road

culvert at the applicant's property line and also avoids an increase in the peak runoff downstream of the proposed culvert as demonstrated in the HEC-1 model of the area.

The impacts to the Tributary to Heathcote Brook resulting from the proposed culvert replacements, SMB installation, and roadway profile revision include hydrologic impacts, hydraulic impacts, fill impacts and utility impacts. Each of these impacts is discussed in the following narrative.

4.2.1 Hydrologic Impacts

The existing regulatory flood runoff and the proposed regulatory flood runoff at several locations resulting from the installation of three SMB's in the watershed are summarized in the following table:

LOCATION	REGULATORY FLOOD RUNOFF (CFS)		
	Existing	Proposed	Difference*
Upstream of Ridge Road	128	130	2
Upstream of U.S. Route 1 **	227	74	-153

* Proposed Regulatory Runoff Minus Existing Regulatory Runoff
** Outflow from HEC-1 Routing Computations

A discussion of the hydrologic computations is presented in Section 6.0, Hydrology of this report.

The SMB's were also designed to address the water quality requirements of both the NJDEP as stated in N.J.A.C. 7:13-2.8 and the D&RCC as stated in N.J.A.C. 45:5. A discussion of the hydrologic computations, particularly the flood routing calculations, is presented in Section 6.0, Hydrology of this report. The three SMB outlet pipes that discharge upstream of the replaced culvert for the U.S. Route 1 crossing are considered minor elements of the stream encroachment permit for the culvert replacement. The inflow and outflow rates for the three SMB's that discharge to the Tributary to Heathcote Brook are summarized in tables contained in Section 6.0, Hydrology of this report.

4.2.2 Hydraulic Impacts

The existing and proposed water surface elevations for the regulatory flood runoff at several locations along the flow path for the Tributary to Heathcote Brook are summarized in the following table:

LOCATION	WATER SURFACE ELEVATION FOR REGULATORY FLOOD		
	Existing	Proposed	Difference*
Upstream of Ridge Road	90.00	90.00	0.0
Upstream of U.S. Route 1	87.56	89.38	1.82

* Proposed Minus Existing

The higher roadway crown line at the barrier curb opening in the U.S. Route 1 and Ridge Road intersection yields a water surface elevation for the proposed condition that impacts the upstream water surface elevation. The area between U.S. Route 1 and Ridge Road functions as a natural detention basin. Therefore, the water surface elevation for this portion of the tributary to Heathcote Brook was established by the HEC-1 flood routing computations. HEC-2 water surface elevation computations were not performed for this reach. The existing fifteen inch diameter crossing of Ridge Road has limited capacity. The excess runoff breaches Ridge Road at approximately elevation 90.0 and proceeds overland, returning to the Tributary to Heathcote Brook upstream of the U.S. Route 1 crossing. The proposed regulatory floodplain upstream of U.S. Route 1 is contained within ROW to be obtained for the Route 92 project.

4.2.3 Fill Impacts

The hydrologic and hydraulic computations indicate that the proposed construction does not increase the discharge at the downstream limit and the increase in the water surface elevation at the upstream construction limit is contained within ROW acquired for the project. The intent of N.J.A.C. 7:13-2.14 to limit the fill placed by a proposed activity is to avoid reducing existing floodplain storage volume that would yield increased runoff downstream. The proposed construction at the U.S. Route 1 and Ridge Road intersection includes installation of several SMB's to avoid increasing runoff at the downstream limit of the construction. Compliance with this requirement is demonstrated in the tables contained in Section 6.0, Hydrology. The HEC-1 flood routing computations upstream of U.S. Route 1 for the proposed condition considers the fill introduced by the construction as indicated by the lower stage-storage curve than for the existing condition. The intent of the net fill limitation has been satisfied. Therefore, the existing and proposed floodways and flood fringe storage volume have not been determined.

4.2.4 Utility Impacts

The utility relocations in the floodplain of the Tributary to Heathcote Brook necessitated by the proposed roadway construction as described in Section 2.7 of this report require a stream encroachment permit. All proposed utility installations in the floodplain will be constructed in accordance with the requirements of N.J.A.C. 7:13-2.10. Each of these utility relocations is considered a minor element of the major stream encroachment permit for the culvert replacements in U.S. Route 1 and in Ridge Road.

5.0 FLOODPLAIN IMPACTS

Proposed construction that impacts the floodplain of Heathcote Brook includes the installation of a storm sewer outfall which accepts runoff from a portion of the existing parking lot of Princeton Executive Campus (Block 98, Lot 2.03) and Access Road A, relocation of the existing water main on the northbound side of U.S. Route 1, and relocation of the existing sanitary sewer located on the northbound side of U.S. Route 1. The impacts on the Heathcote Brook floodplain resulting from the proposed construction include hydraulic impacts, net fill impacts, utility impacts, and other impacts. Each of these impacts is discussed in the following narrative.

5.1 Hydraulic Impacts

The NJDEP prepared hydraulic computations and flood profiles for the Heathcote Brook floodplain study. The proposed relocation of the existing Campus Driveway to the north is located outside the limits of the Heathcote Brook floodplain. Therefore, computations to document the hydraulic impact are not required.

Installation of the outfall from the existing parking lot and the Campus Driveway has no hydraulic impact.

5.2 Fill Impacts

Installation of Access Road A and outfall does not introduce any additional fill in the floodplain.

5.3 Other Impacts

The proposed Access Road A on the north side of Block 98, Lot 2.03 replaces the existing driveway currently located on the south side of the subject property. The pavement from the existing driveway will be removed as shown on the plans. The existing pavement removed (0.35 acres) is more than the new impervious area (0.27 acres) introduced by the construction of the new driveway. The runoff from Access Road A will be discharged to the existing stormwater management basin that accepts runoff from the parking lot and existing access road before discharging to the Heathcote Brook floodplain. Therefore, the engineering and environmental requirements of N.J.A.C. 7:13-2.8 and N.J.A.C. 7:45.5 are satisfied. The outfall located in the Heathcote Brook floodplain is a minor permit element that does not impact the hydraulics or introduce any fill in the floodplain.

The utility relocations in the floodplain of Heathcote Brook necessitated by the proposed roadway construction as described in Section 2.7 of this report require a stream encroachment permit. All proposed utility installations in the floodplain will be constructed in accordance with the requirements of N.J.A.C. 7:13-2.10. Each of these utility relocations is considered a minor element of the major stream encroachment permit for the project.

6.0 HYDROLOGY

Peak runoff for various return frequencies, including the 1-, 2-, 10-, 25-, 50-, and 100-year recurrence interval were computed in accordance with Soil Conservation Service Type III distribution using the U. S. Army Corps of Engineers HEC-1 software. The runoff was computed for several conditions including proposed conditions, which included the proposed Route 92 project construction and existing conditions. The regulatory flood was also computed in accordance with the procedures in N.J.A.C. 7:13-2.3 for the watercourses that drain more than fifty acres and require a stream encroachment permit for the proposed construction.

Times of concentration were determined in accordance with the procedures in Soil Conservation Service Technical Release No.55. Areas contributing runoff to each point of interest were delineated on the available topographic maps. The primary topographic map used for this purpose was the mapping prepared from aerial photographs specifically for the design at a scale of one inch equals thirty feet with a one foot contour interval. This mapping was supplemented by the available corridor mapping prepared from aerial photographs at a scale of one inch equals one hundred feet with a two foot contour interval. Delineation beyond the limits of this mapping was based on the USGS Hightstown quadrangle. The contributing area delineation was confirmed by field observation. Curve numbers for use in the hydrology calculation were based on the Middlesex County Soil Survey and existing ground cover as indicated on existing aerial photographs supplemented by field observation. Ultimate development runoff rates were computed based on the current zoning requirements of both South Brunswick Township and Plainsboro Township.

Hydrology was computed at the following locations:

A. Tributary to Devil's Brook at the Route 92, Section 3 Crossing

B. Several locations of the Tributary to Heathcote Brook in the vicinity of the U.S. Route 1 and Ridge Road intersection

C. Outfall locations of the proposed SMB's that discharge to the Tributary of Heathcote Brook are as follows:

   1. SMB 3A, the east portion of the area between Route 92, U.S. Route 1, and Ridge Road

   2. SMB 3B, the west portion of the area between Route 92, U.S. Route 1, and Ridge Road

   3. SMB 3C, the infield area between U.S. Route 1, Ramp A, and Ridge Road.

The hydrologic computations for each area evaluated, including tables summarizing the results, are discussed in the following narrative.

6.1 Tributary to Devils' Brook

The drainage area of the Tributary to Devil's Brook at the Route 92 crossing exceeds fifty acres. The floodplain delineation required to satisfy the requirements of N.J.A.C. 7:13-2.4 was based on the regulatory flood.

The drainage area contributing to the downstream side of the Route 92 crossing of the Tributary to Devil's Brook was divided into two sub areas for the HEC-1 computations. The runoff from the sub-area contributing to the existing pond was routed through the pond and combined with the runoff from the remainder of the contributing area. The hydrologic computations revealed that the existing pond has limited impact on the regulatory runoff. Therefore, the regulatory runoff computed for the existing condition of 940 cfs was also used to compute the hydraulics for the proposed condition. The hydrologic evaluation of the existing condition was for the existing configuration of the watercourse. The hydrologic evaluation for the proposed condition for the watercourse was for the condition with the proposed Route 92 bridge installed including the riprap in the channel and on the over bank.

6.2 Tributary to Heathcote Brook

The drainage area of the Tributary to Heathcote Brook at both the Ridge Road and U.S. Route 1 crossings exceeds fifty acres. Hydrologic computations included the regulatory runoff computed in accordance with the procedures stated in N.J.A.C. 7:13-2.4.

Specific elements that impact the existing and proposed hydrology are discussed in the following narrative.

6.2.1 Hydrology for Existing Conditions

The drainage area of the Tributary to Heathcote Brook at the U.S. Route 1 crossing includes five existing SMB's, including one natural detention basin as indicated below.

A. A natural detention basin, commonly referred to as the farm pond, upstream of the existing Schalk's Crossing Road culvert.

B. One basin constructed for development (Novatel) on the northbound side of U.S. Route 1 south of Ridge Road.

C. Three basins constructed for development on the southbound side of U.S. Route 1 south of Ridge Road (Holiday Inn and bank).

Hydrologic evaluation of these existing SMB's was performed to determine the existing runoff rates and the impact of the Route 92 construction. Hydrologic data available for three of the four constructed basins was used to develop a separate sub-area for each of them. Peak outflow from the remaining constructed basin was determined assuming that the basin outflow was limited to the pre-development rate from the site.

The outline of the sub-areas used in the HEC-1 model is shown with the hydrologic computations in Appendix A. The results of the hydrologic computations are summarized in Section 6.2.3, Summary of Hydrologic Computations.

6.2.2 Hydrology for Proposed Conditions

The proposed condition hydrology is a modification of the existing condition hydrology to include the proposed Route 92 construction. This includes revising the runoff factors to reflect the proposed pavement. The HEC-1 model was also revised to include routing through the SMB's installed for the Route 92 project. The three proposed stormwater management basins that discharge runoff to the Tributary to Heathcote Brook provide compliance with the engineering and environmental requirements of N.J.A.C. 7:13-2.8 include:

A. SMB 3A, the east portion of the area between Route 92, U.S. Route 1, and Ridge Road.

B. SMB 3B, the west portion of the area between Route 92, U.S. Route 1, and Ridge Road.

C. SMB 3C, the infield area between U.S. Route 1, Ramp A, and Ridge Road.

The outline of the sub-areas used in the HEC-1 model is shown with the hydrologic computations in Appendix A. The results of the hydrologic computations are summarized in Section 6.2.3, Summary of Hydrologic Computations.

6.2.3 Summary of Hydrologic Computations

A. Hydrology of Tributary to Heathcote Brook

The sub-areas built into the HEC-1 model allow determination of the hydrology at the following locations along the Tributary to Heathcote Brook.

1. Upstream of Ridge Road

2. Upstream of U.S. Route 1

3. At the Outfall Location

The results of the HEC-1 model are summarized in the following tables.

Tributary to Heathcote Brook
Upstream of Ridge Road

	Peak Runoff - Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	2-Year	10-Year	25-Year	50-Year	100-Year	Regulatory
Existing Condition	12	41	53	58	72	128
Proposed Condition	7	30	42	48	65	130

The computations are presented in Appendix A

Tributary to Heathcote Brook
Upstream of U.S. Route 1*

	Peak Runoff - Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	2-Year	10-Year	25-Year	50-Year	100-Year	Regulatory
Existing Condition	9	50	76	88	118	227
Proposed Condition	10	26	32	34	39	74

* Outflow from HEC-1 Routing Computations.

The computations are presented in Appendix A

Tributary to Heathcote Brook
at the Outfall Location

	Peak Runoff - Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	2-Year	10-Year	25-Year	50-Year	100-Year	Regulatory
Existing Condition	31	66	100	116	155	293
Proposed Condition	25	56	70	78	93	107

The computations are presented in Appendix A

Although the SMB's installed in the Tributary to Heathcote Brook Tributary watershed substantially reduce the peak runoff for the proposed condition, compliance with the engineering standards for stormwater management for the 10-year runoff cannot be achieved. Justification for an exemption is presented in Section 10.0 of this report.

B. Proposed Stormwater Management Basins

The results of the flood routing computations for the proposed SMB's are summarized in the following tables.

SMB 3A HEC-1 Routing Computations Summary

	Peak Runoff Discharged to Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	1-Year	2-Year	10-Year	25-Year	50-Year	100-Year
Peak Inflow	16	20	37	46	49	59
Peak Outflow	0.5	0.5	2	4	5	7
Water Surface Elevation	92.17	92.56	93.62	93.94	94.09	94.45

The outlet system includes the following elements:

3" orifice with invert elevation 89.0
1.2' wide weir at elevation 93.0
Top of Grate of Outlet Structure at Elevation 94.5
Top of Berm at Elevation 95.5

SMB 3B HEC-1 Routing Computations Summary

	Peak Runoff Discharged to Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	1-Year	2-Year	10-Year	25-Year	50-Year	100-Year
Peak Inflow	4	6	13	16	17	21
Peak Outflow	0.5	0.5	0.5	0.5	0.5	1
Water Surface Elevation	88.66	89.0	90.21	90.70	90.93	91.47

The outlet system includes the following elements:

3" orifice with invert elevation 86.5
Top of Grate of Outlet Structure at Elevation 92.0
10 foot wide emergency spillway crest at elevation 93.0
Top of Berm at Elevation 94.0
See Note 1.

SMB 3C HEC-1 Routing Computations Summary

	Peak Runoff Discharged to Tributary to Heathcote Brook (cubic feet per second)					
Recurrence Interval	1-Year	2-Year	10-Year	25-Year	50-Year	100-Year
Peak Inflow	9	15	27	32	35	41
Peak Outflow	0.5	0.5	2	3	4	8
Water Surface Elevation	89.59	90.05	91.21	91.37	91.47	91.74

The outlet system includes the following elements:

3" orifice with invert elevation 86.5
4' wide weir at elevation 91.0
Top of Grate of Outlet Structure at Elevation 91.75
Top of Berm at Elevation 92.5
See Note 1.

Note 1: "Tide Flex" check valve provided at SMB 3B and 3C to prevent the 100-year w.s. from the Tributary to Heathcote Brook from backing up into the basins and reducing available storage volume.

7.0 HYDRAULICS

Water surface elevations were computed for the portions of the Tributary to Devil's Brook and the Tributary to Heathcote Brook impacted by the proposed construction. The computations performed for each watercourse are explained in the following narrative.

7.1 Tributary to Devil's Brook

Water surface elevations were computed for existing and proposed conditions for the peak regulatory runoff rates evaluated for the portion of the Tributary to Devil's Brook in the vicinity of the proposed Route 92 alignment. The procedures used in the assessment of existing and proposed conditions are presented in the following narrative.

7.1.1 Hydraulics of the Existing Condition

Channel geometry was determined by field survey. Over bank geometry was determined from topographic maps prepared for this project from aerial photographs specifically developed for the design at a scale of one inch equals thirty feet with a one foot contour interval. The cross-section layout is shown on the stream encroachment plans for the Tributary to Devil's Brook area. The computations were performed using HEC-2 software. The existing and proposed floodways were computed using the equal conveyance reduction option in the HEC-2 software. The water surface elevations for the regulatory runoff (100-Year runoff with ultimate development) and for the floodway are summarized in the following table.

Hydraulic Computation Results
For Existing Conditions
for the Regulatory Flood

Cross-Section	Water Surface Elevation (ft)			Width	
	Floodplain	Floodway	Difference	Floodplain	Floodway
100	80.49	80.69	0.20	432	307
300	81.22	81.35	0.13	511	391
400	81.37	81.50	0.13	493	361
450	81.44	81.57	0.13	533	437
500	81.57	81.69	0.12	493	259
550	81.73	81.84	0.11	403	263
600	81.92	82.03	0.12	466	304
650	82.05	82.16	0.11	412	282

Cross-Section	Water Surface Elevation (ft.)			Width	
	Floodplain	Floodway	Difference	Floodplain	Floodway
700	82.15	82.26	0.11	430	253
750	82.25	82.36	0.11	452	227
800	82.38	82.48	0.10	342	212
900	82.78	82.88	0.10	361	211

The computations are presented in Appendix B.

7.1.2 Hydraulics of the Proposed Condition

Water surface elevations were computed with the proposed bridge configuration, including retaining walls, superimposed on the hydraulic (HEC-2) model prepared to compute the water surface elevations for the existing channel and over banks. The bridge configuration was selected to limit the hydraulic impact to less than 0.20 feet along the entire length of the hydraulic model. The proposed bridge construction includes installation of riprap lining in the channel and on the west over banks. The west over bank friction factors were revised accordingly for the computation of the proposed hydraulics. The over bank friction factors for the existing and proposed conditions are 0.10 and 0.04 respectively. The reduction in friction factor in the vicinity of the proposed bridge yields a lower water surface elevation and narrower floodplain and floodway than required for the existing condition. The procedures used for the proposed condition, particularly to establish the friction factors to be used in the computation and the resultant floodplain and floodway widths were determined acceptable to NJDEP as stated in a telephone conversation on April 3, 1996. The memorandum of this discussion is included in Appendix E.

The results of the computations are summarized in the following table.

Hydraulic Computation Results
For Proposed Conditions
for the Regulatory Flood

Cross-Section	Water Surface Elevation (ft.)			Width	
	Floodplain	Floodway	Difference	Floodplain	Floodway
100	80.49	80.69	0.20	432	307
300	81.22	81.35	0.13	511	391
400	81.37	81.50	0.14	493	362
450	81.45	81.58	0.13	404	269

Cross-Section	Water Surface Elevation (ft.)			Width	
	Floodplain	Floodway	Difference	Floodplain	Floodway
500	81.40	81.55	0.16	163	108
550	81.63	81.77	0.14	143	95
600	81.80	81.95	0.14	161	122
650	81.83	81.97	0.14	381	245
700	81.98	82.12	0.13	388	222
750	82.11	82.24	0.13	450	227
800	82.28	82.39	0.11	328	212
900	82.74	82.85	0.10	356	207

The computations are presented in Appendix B.

The computed water surface elevations for existing and proposed conditions for both the floodplain and the floodway are virtually the same as indicated in the following table.

Comparison of Hydraulic Computation Results
For Existing and Proposed Conditions
for the Regulatory Flood

Cross-Section	Floodplain Water Surface Elevation (ft)		
	Existing	Proposed	Difference*
100	80.49	80.49	0.00
300	81.22	81.22	0.00
400	81.37	81.37	0.00
450	81.44	81.45	0.01
500	81.57	81.40	-0.17
550	81.73	81.63	-0.10
600	81.92	81.80	-0.03
650	82.05	81.83	-0.12

Cross-Section	Floodplain Water Surface Elevation (ft)		
	Existing	Proposed	Difference*
700	82.15	81.98	-0.17
750	82.25	82.11	-0.14
800	82.38	82.28	-0.1
900	82.78	82.74	-0.04

* Proposed minus existing

The existing and proposed floodplain and floodway delineations are shown on the plans.

7.2 Tributary to Heathcote Brook

Water surface elevations were evaluated for the portion of the Tributary to Heathcote Brook from the location of the outfall to upstream of the Ridge Road crossing. The evaluation for the existing condition was performed for the regulatory runoff. The NJDOT requested that the proposed culvert crossing provide conveyance of the 100-year runoff for existing development, without ultimate development in the watershed and without overtopping the roadway. Therefore, the evaluation for the proposed condition was performed for the existing 100-year runoff and the regulatory runoff, both with the proposed Route 92 SMB's.

Procedures used in the assessment of existing and proposed conditions are presented in the following narrative.

7.2.1 Hydraulics of the Existing Condition

The evaluation for the existing condition was performed for the existing fifteen inch diameter crossing of Ridge Road and the 16/24 inch diameter crossing of U.S. Route 1. The existing 16/24 inch diameter U.S. Route 1 crossing conveys a small portion, approximately 15 cfs, of the regulatory runoff. The remainder of the regulatory runoff breaches the northbound U.S. Route 1 edge of road and proceeds southward to the opening in the barrier curb at the Ridge Road intersection. The runoff proceeds in weir flow over the U.S. Route 1 crown line and west along Ridge Road and in sheet flow overland toward the north, ultimately reaching Heathcote Brook.

The capacity of the existing 16/24 inch diameter crossing of U.S. Route 1, approximately 15 cfs, was computed for the upstream water surface elevation that breaches the U.S. Route 1 edge of road. The remainder of the regulatory runoff was considered to continue along U. S. Route 1 and cross the crown line at the opening in the barrier curb in the Ridge Road intersection. Weir flow computations were performed

at the barrier curb opening to determine the required flow depth of 1.2' and resultant water surface elevation of 87.76 at the U.S. Route 1 crown line.

Water surface elevations cannot be established for the sheet flow in Ridge Road downstream of the U.S. Route 1 crown line. The floodplain limits for the sheet flow in Ridge Road downstream of the U.S. Route 1 crown line were approximated for illustrative purposes based on evaluation of existing topography.

The water surface elevation upstream of the U.S. Route 1 crossing was established as computed in the HEC-1 routing computations.

The capacity of the existing fifteen inch diameter crossing of Ridge Road is limited by the existing Ridge Road topography. Runoff that causes the headwater to exceed elevation 90.0 breaches the roadway and proceeds overland toward U.S. Route 1. This runoff re-enters the existing channel between U.S. Route 1 and Ridge Road upstream of the U.S. Route 1 crossing.

7.2.2 Hydraulics of the Proposed Condition

A. NJDOT Design

The existing conveyance system for the Tributary to Heathcote Brook is to be replaced with a new system that follows the existing flow pattern for the regulatory runoff. The proposed construction is described in Section 4.0, Proposed Bridges and Culverts, of this report. The proposed conveyance system for the Tributary to Heathcote Brook was designed to provide conveyance for the 100-year (not regulatory) runoff for the proposed condition, which includes the Route 92 improvements, without overtopping the roadway, as requested by the NJDOT. The starting water surface elevation at the outlet end of the pipe used for the hydraulic computations was established at the normal depth elevation in the pipe at that point. Hydraulic losses, including entrance and exit losses at head walls, structural losses, and friction losses were computed to establish the water surface elevations along the proposed conveyance system. The results are summarized in the following table.

Water Surface Elevations at Selected Locations Along the Proposed U.S. Route 1 Conveyance System

LOCATION	WATER SURFACE ELEVATION for 100-Year Runoff	
	Existing Condition	Proposed Condition
Upstream of Ramp B Crossing	N/A	83.99
Upstream of U.S. Route 1 Crossing	87.76	87.50
Upstream of Ridge Road Crossing	90.0	90.0

B. Regulatory Runoff Evaluation

The proposed U.S. Route 1 crossing conveys the 100-year runoff of 50 cfs with a headwater elevation of 89.38. The remaining 24 cfs of the 74 cfs regulatory runoff proceeds overland following the existing flow path and is conveyed across U.S Route 1 at the break in the barrier curb in the Ridge Road intersection. The proposed U.S. Route 1 crown line elevation in the vicinity of the barrier curb opening is higher than the existing crown line elevation at this location. Weir flow computations contained in the HEC-1 model were performed at the barrier curb opening for the 24 cfs excess runoff to determine the required flow depth of 0.56' and resultant water surface elevation of 89.38 at the U.S. Route 1 crown line as compared to the elevation for the existing condition of 88.14. The proposed Ridge Road crossing provides conveyance of the 100-year existing runoff with a headwater elevation of 90.0. The results of the hydraulic computations are summarized in the following table.

Water Surface Elevations at Selected Locations Along the Proposed U.S. Route 1 Conveyance System

LOCATION	WATER SURFACE ELEVATION 100 Regulatory Runoff	
	Existing Condition	Proposed Condition
Upstream of Ramp B Crossing	N/A	84.83
Upstream of U.S. Route 1 Crossing	88.14	89.38
Upstream of Ridge Road Crossing	90.0	90.0

8.0 STABILITY ANALYSIS

The headwalls at the proposed open channel portion downstream of U.S. Route 1 and upstream of Ramp B, at the outlet of the U.S. Route 1 crossing, and retaining walls on the upstream side of the U.S. Route 1 crossing and in the floodplain of the Tributary to Heathcote Brook retain more than four feet of fill. Stability analysis for these structures and walls are contained in Appendix G.

9.0 SOIL EROSION AND SEDIMENT CONTROL MEASURES

The Route 92 project is designed in accordance with the "Standards for Soil Erosion and Sediment Control in New Jersey". Certification will be obtained from the Freehold Soil Conservation District.

The primary soil erosion and sediment control items provided in the Route 92 project include: conduit outlet protection at all storm sewer outlets as required, channel stabilization with either grass or riprap, storm sewer inlet protection, sediment barrier, and stabilized construction entrances. Conduit outlet protection computations for outfalls within floodplains are included in Appendix C. The outfall on the south side of Route 92 located at approx. Sta. 396+50 discharges to an existing pond. Therefore, COP calculations are not required. The specific locations and dimensions of all the soil erosion and sediment control items included in the Route 92 project will be shown on the plans submitted to the Freehold Soil Conservation District for certification.

10.0 JUSTIFICATION FOR WAIVERS/EXEMPTIONS

The Route 92 design attempted to comply with all the requirements of the Flood Hazard Area Control Act Rules, N.J.A.C. 7:13-1.1 et. seq. March 20, 1995 and Regulations for the Review Zone of the Delaware and Raritan Canal State Park, N.J.A.C. 7:45-1.1 et. seq. February 1994 where possible. However, the limited ROW available occasionally precluded the ability to provide complete compliance. Specific elements for which total compliance could not be achieved include

A. Standards for Fill Within the Floodplain (7:13-2.14) for the proposed bridge installation at the Tributary to Devil's Brook

B. Stormwater Management Discharge Reduction (7:13-2.8) at the U.S. Route 1 crossing of the Tributary to Heathcote Brook.

Justification for an exemption from strict compliance with these requirements is presented in the following narrative.

10.1 Fill Within Floodplain of the Tributary to Devil's Brook

Approximately 0.90 ac-ft of existing flood fringe storage volume is available within the proposed Route 92, 300 foot wide ROW. NJDEP regulations state that only 20% of the existing flood fringe storage may be filled. Allowable fill represents approximately 0.18 ac-ft (20% of 0.90 ac-ft). The proposed fill in the flood fringe within the ROW is approximately 0.33 ac-ft, which is 37% of the existing flood fringe storage volume. The proposed fill is based on the full height vertical abutment located at Sta. 397+77 (WB baseline), reduced roadway width of 85 feet (91 feet to outside of walls) and retaining walls installed on both sides of the roadway from the bridge to approximately Sta. 392+00. Approximately 0.77 ac-ft of additional flood fringe storage volume is required to comply with the allowable 20% net fill rule in accordance with N.J.A.C. 7:2.14. Alternatives considered to satisfy fill limitation include:

A. Excavation to restore the lost flood fringe storage volume.

B. Extending the proposed bridge to span more of the flood fringe and reduce the fill volume.

C. Acquiring enough property rights so that the fill introduced in the flood fringe by the project occupies less than 20% of the total flood fringe storage volume on the applicants property.

Each of these alternatives is discussed in the following narrative.

10.1.1 Excavation to Restore the Lost Flood Fringe Storage Volume

The feasibility of providing an excavated basin (low area) on the south side of Route 92 outside the wetland area and above groundwater levels was investigated. The bottom of the basin was set at the ground water table elevation, which yields the maximum possible storage volume. The basin was located west of the fifty

foot wide wetland transition area. The maximum storage that can be achieved in the basin, with the bottom set at the ground water elevation and using a bottom slope of 1%, is approximately 0.25 acre-ft, which represents approximately 76% of the total storage volume to offset proposed fill. However, installation of a fill mitigation basin includes the following problems:

A pipe slope of 0.65% is required to drain the basin to the Tributary to Devil's Brook. Based on the existing ground elevation in this area, the proposed pipe would not have adequate cover through the wetlands. The outlet pipe would have to be located under the roadway embankment slope to provide adequate cover and to minimize filling in the wetlands.

Unusually high GWT elevations may create a situation where there is essentially no effective storage within the basin, especially during the 100-year storm event when the ground will be saturated. It is also noted that setting the bottom of the basin at the groundwater elevation (best case scenario) and using a minimum bottom slope creates a situation where the basin bottoms could be perpetually wet due to capillary action of the groundwater. A wet basin bottom creates safety concerns, maintenance and potential mosquito problems. Raising the bottom elevation of the basins to eliminate this potential problem would virtually eliminate any available storage.

Approximately 1.0 acre of ROW would need to be purchased at a price of approximately $80,000 to provide the area required for installation of the storage basins. The construction cost would increase this amount. This alternative, which provides only part of the storage volume required for compliance, does not appear to be cost effective and also causes several potential problems. Extrapolating the data generated by this study to provide the total required storage volume suggests that more than approximately 1.5 acres at a cost of $120,000 would be required. This expenditure and associated loss of land for development seems unreasonable.

10.1.2 Extend the Proposed Bridge to Span the Flood Fringe

The fill placed in the flood fringe could be reduced by increasing the span length of the proposed bridge. An additional span length of approximately 400 linear feet would be required to span the flood fringe. This would require several additional spans and a resultant additional construction cost of approximately $5,000,000 plus continual maintenance costs for the life of the bridge. This additional cost does not seem warranted.

10.1.3 Acquire Adequate Property Rights

The fill limitation is relative to the total flood fringe storage volume within the applicant's property. Acquiring adequate property rights on either side of the proposed ROW within the existing flood fringe area to increase the available existing flood fringe storage volume increases the magnitude of the 20% fill volume allowed within the applicants property.

This alternative would require an additional storage volume of approximately 0.77 ac-ft (0.77 x 20% = 0.15 ac-ft required) to be purchased to offset the proposed fill and satisfy the 20 % net fill rule. The available storage volume of approximately 1.12 ac-ft. was determined by the average end area of the floodplain fringe shown on the HEC-2 cross-sections outside the proposed property rights. The evaluation indicates that a 1.5 acre surface area of only flood fringe area would be required. Purchasing this approximately 200 foot strip (between ROW and HEC-2 Section 800) would isolate the remainder of the property between the AMTRAK ROW and the eastern edge of the property acquired for net fill mitigation. This isolation can be avoided by either buying only an easement for the flood fringe area, allowing access easements across the flood fringe acquisition, or purchasing the remaining parcel of approximately 5 acres. The ROW required is all located in existing wetlands and is expected to cost approximately $15,000 per acre. This yields a cost of between $23,000 and $75,000. This alternative requires the purchase of excessive property rights and does not seem to be cost effective.

10.2 Stormwater Management for the Tributary to Heathcote Brook

The peak runoff reduction at the outfall of the proposed storm sewer system for the U. S. Route 1 and Ridge Road crossings of the Tributary to Heathcote Brook does not achieve the reduction required by N.J.A.C. 7:13-2.8 for the 10-year runoff. Approximately 96 acres of the total 140 acre area contributing to the Tributary to Heathcote Brook at the outfall location is from offsite areas. The intent of the requirements of N.J.A.C. 7:13-2.8 is not to control runoff from offsite properties. The NJTA and the proposed SMB's should only be required to over attenuate runoff from project specific areas. The regulations require a 50% reduction for the existing 2-year runoff, and a 25% reduction for the existing 10- and 100-year runoff. Therefore, the allowable flow was based on over attenuation of only the onsite portion of the total area to the downstream discharge location. The three SMB's installed within the proposed Route 92 ROW control the runoff from the new impervious area created by the project and provide the maximum attenuation possible. The proposed SMB's provide the attenuation necessary to avoid an increase in the peak runoff at the outlet end of the system. The results are indicated in the following table:

Tributary to Heathcote Brook
at the Outfall Location

	Peak Runoff - Tributary to Heathcote Brook (cubic feet per second)		
Recurrence Interval	2-Year	10-Year	100-Year
Existing Condition	31	66	155
Allowable Flow [1]	26	50.5	118
Proposed Condition	25	56	93

[1] Allowable Flow based on the following:

Offsite area	=	96 acres
Onsite area	=	44 acres
Total area	=	140 acres

2 year,	31	x	96/140	+	31	x	44/140 (.50)	=	26 cfs
10 year,	66	x	96/140	+	66	x	44/140 (.25)	=	50.5 cfs
100 year,	155	x	96/140	+	155	x	44/140 (.25)	=	118 cfs

Additional over attenuation to provide compliance with the requirements of N.J.A.C. 7:13-2.8 for the 10 year storm would require the installation of additional SMB's beyond the proposed ROW.

Therefore, the exemption allowed in accordance with N.J.A.C. 7:13-2.8(a)5 is requested for the 10-year storm.

11.0 CONCLUSION

Route 92 was designed considering the requirements of N.J.A.C 7:13-1.1 et seq. Specific activities associated with the Route 92 construction for each watercourse impacted include:

A. Tributary to Devil's Brook

A bridge over the Tributary to Devil's Brook, including the associated roadway fill,a storm sewer outfall, riprap, and retaining walls to minimize wetland impacts.

B. Tributary to Heathcote Brook

1. Replacement of the existing eighteen inch diameter crossing of Ridge Road with a 2 foot high by 8 foot wide box culvert and associated channel adjustment, fill, headwalls and conduit outlet protection.

2. Replacement of the existing twenty-one inch diameter crossing of U.S. Route 1 with a thirty-four inch high by fifty three inch wide elliptical pipe and associated channel adjustment, fill, headwalls and conduit outlet protection

3. Installation of a grass lined channel downstream of the U.S. Route 1 crossing

4. Installation of two twenty-nine inch high by forty-five inch wide elliptical pipes under Ramp B and associated headwalls.

5. Installation of a forty-eight inch high by seventy-six inch wide elliptical pipe outlet toward Heathcote Brook including associated channel modification, headwalls and conduit outlet protection.

6. Installation of headwalls and outlet pipes from three stormwater management basins.

7. Installation of water mains, fiber optic line, electric, telephone/cable TV, sanitary sewer, and gas lines within the floodplain.

C. Heathcote Brook

1. Installation of an outfall collecting runoff from Access Road A and existing parking lot.

2. Installation of a water main, sanitary sewer, and gas line within the floodplain.

The proposed construction complies with the appropriate requirements of the Flood Hazard Area Control Act Rules, N.J.A.C. 7:13-1.1 et seq. March 20, 1995 except in areas where limited right-of-way precluded the

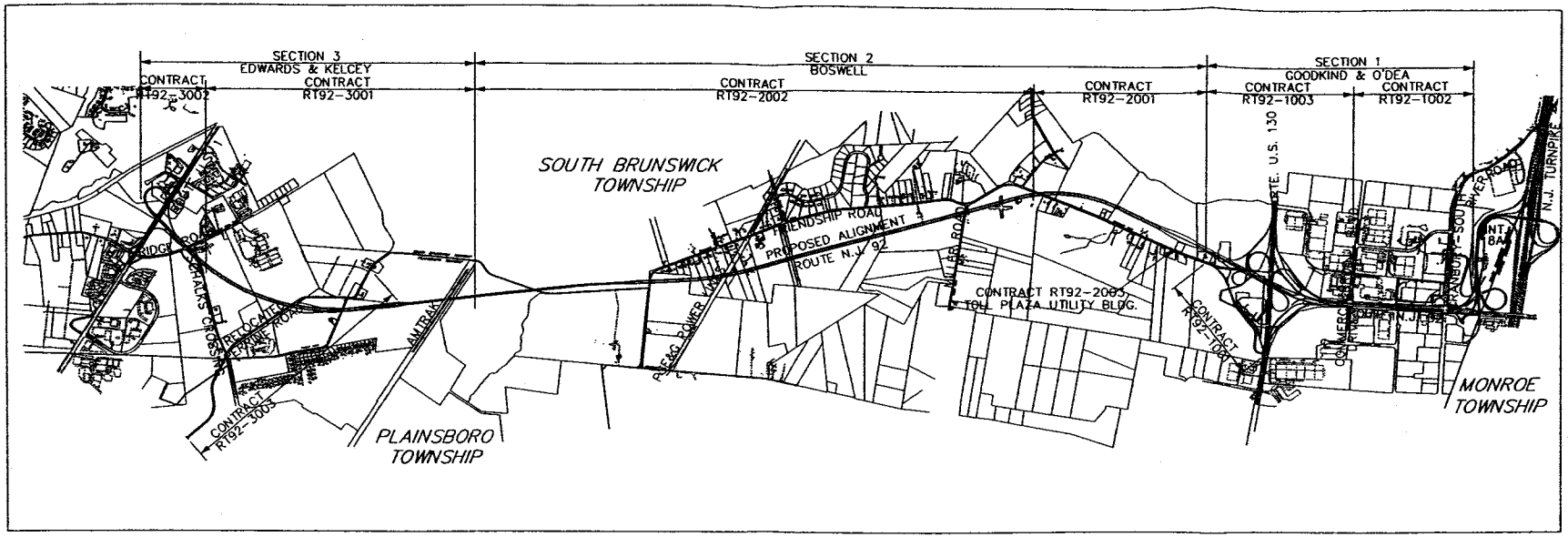
ability to provide complete compliance. Specific elements for which total compliance could not be achieved include:

A. Standards for Fill Within the Floodplain (7:13-2.14) for the proposed bridge installation at the Tributary to Devil's Brook

B. Stormwater Management Discharge Reduction (7:13-2.8) at the U.S. Route 1 crossing of the Tributary to Heathcote Brook.

Justification for an exemption to these requirements is presented in Section 10.1 on page 3-28 and Section 10.2 on page 3-30 respectively of this report.

ROUTE 92



NOTE:
ONLY SECTIONS 1, 2, AND 3 CONTAIN REGULATED ACTIVITIES UNDER THE FLOOD HAZARD AREA CONTROL ACT RULES.

SOURCE: HNTB Corporation

NEW JERSEY TURNPIKE AUTHORITY
PROPOSED ROUTE 92
STREAM ENCROACHMENT PERMIT

REGULATED DESIGN SECTIONS

Frederic R. Harris, Inc.
485 Route 1 South, Bldg. B
Iselin, New Jersey 08830

SCALE: 1"=2600'±
DATE: APRIL 1999
Figure 3.2

X-REFS: 92FRMT-B
LAST EDIT: 04/15/99 12:43 PM
PROJECT: 3150-03 FILE NAME: G:\3150\03\FWP\FIG1-3 1 of 1 WORKSTATION: CADD 08