New Jersey Turnpike Authority
P.O. Box 5042, Woodbridge, NJ 07095

June 30, 2022

Document Change Announcement

2007 Design Manual
Geometric, Geotechnical, and Miscellaneous Updates
DCA2022DM-03

Subject: Revisions to

Section 1 New Jersey Turnpike Geometric Design
Section 2 Garden State Parkway Geometric Design
Section 6 Geotechnical Engineering

Description of Change:

Updates have been made to the Design Manual related to horizontal and vertical clearances, pavement design, reference corrections, and alignment with previously-issued DCA2021DM-03. Updates have been made to the Procedures Manual to align with previously-issued DCA2017DM-03 related to geotechnical design.

Notice to New Jersey Turnpike Authority Staff and Design Consultants
Effective immediately, all contracts currently in the design phase shall incorporate the revisions herein. For advertised contracts awaiting the opening of bids this revision shall be incorporated via addendum. Contact your New Jersey Turnpike Authority Project Manager for instruction.

The revisions may be accessed on the Authority's webpage: https://www.njta.com/doing-business/professional-services

Recommended By:

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Distribution: Senior Staff Engineering, Law, Maintenance & Operations Depts., All Prequalified Consultant Firms, File

Section 1 - New Jersey Turnpike Geometric Design

1.1. General

The geometric design criteria contained herein were developed by the Authority for its own particular needs. They are intended to equal or exceed standards currently being used for limited access highways and should be considered minimum criteria and increased wherever economically feasible. The use of substandard criteria, including absolute minimum ~~/~~ maximum values listed in this manual, shall require a Design Element Modification Request subject to approval by the Authority's Engineering Department. For any items not adequately outlined in this section, the Engineer should refer to the latest edition of *AASHTO A Policy on Geometric Design of Highways and Streets* and *AASHTO Roadside Design Guide*.

The design criteria presented is intended to be used as an aid toward sound engineering design. When individual circumstances arise that are not specifically covered, engineering judgment is to be exercised that represents the intent of the criteria shown. The overall objective should be an aesthetically pleasing and safe design that is geometrically compatible in all respects.

1.1.1. Design Controls

The following design controls shall be applicable on all Turnpike roadways:

1. Design Vehicle
   Design Vehicle WB – 67 (Interstate Semi-trailer) shall control geometric design. See Exhibit 1-1 ~~Exhibit 1-1~~.
2. Clearances
   a. Horizontal – Minimum clear zone width or less with appropriate roadside or median protection as directed by Section 4 of this Manual, and as further directed by Section 3 of this Manual for protection of structures. ~~- Minimum 4 feet clear of paved left or right shoulder edge to obstruction with appropriate roadside protection (see Section 4 of this Manual).~~
   b. Vertical - Minimum vertical clearances shall be maintained over all roadways, including shoulders. Verification of all clearances shall be made with the controlling agency.
      i. Minimum clearance above Turnpike roadways - As directed by Section 3 of this Manual or existing vertical clearance, whichever is greater. When resurfacing or widening a Turnpike roadway under an existing crossing whose vertical clearance is less than the required minimum, the resulting vertical clearance must not be less than the existing condition. ~~Roadway over Turnpike - 15 feet minimum or existing vertical clearance, whichever is greater. When resurfacing or widening under an existing bridge whose~~

~~vertical clearance is less than 15 feet, the existing vertical clearance must be maintained as a minimum.~~

ii. Minimum clearance below Turnpike roadways - As required by the agency having jurisdiction, but not less than the required minimum as directed by Section 3 of this Manual. When resurfacing or widening a roadway under an existing Turnpike crossing whose existing vertical clearance is less than the required minimum, the resulting vertical clearance must not be less than the existing condition.~~Turnpike over any other Road - as required by agency having jurisdiction.~~

b. The PVI (point of vertical intersection of two grades) station shall be located at an even 25-foot station increment where feasible.

c. For an "A" less than or equal to 0.25 percent, an angle point shall be established, and no vertical curve used.

Exhibit 1-81-8 Design Controls for Mainline Roadway Vertical Curves

Design Speed (mph)	Stopping Sight Distance (ft)	Crest K	Sag K
	Minimum		
60	570	245	136
70	730	400	181

1.2.7. Pavement

Pavement design shall be in accordance with SubSsection 6.7.4 of this Manual. The mainline pavement section shall be constructed as shown on Exhibit 1-9. Current pavement mix types to be used for each of the courses shown in the pavement sections shall be as directed by the Authority.

Embankment, Grade A, shall be a minimum of 18 inches deep under travel lanes. In locations where existing pavement is widened, Grade A material is to be deeper, if necessary, to match template grade of existing pavement. Template grade (top of subgrade below Grade A embankment) shall slope transversely a minimum of 2% or match cross slope of roadway. Template grade shall be constructed transversely under the full section, without breaks in cross slope, on each individual roadway and in such a manner as to provide positive drainage (daylight section or underdrains).

In areas where existing and currently designed resurfacing depth approaches 12 inches, or more, at the existing pavement / shoulder interface, investigations shall be made as to the feasibility of leaving the existing shoulder in place as a portion of the proposed pavement section.

At interfaces between Turnpike pavement and the pavement of outside agencies, the higher class pavement shall be constructed first, with offset and steps per course as shown. Account for offset and stepping quantity computations.

The various pavement interface and stepping details shown on Exhibit 1 - 10 through Exhibit 1 - 14 are for Turnpike pavement. Adjust steps accordingly to match other pavement sections. Account for stepping quantity computations. With curb, courses terminate at curb face as shown, any stepping shall be from back of curb.

In the pavement interface details shown on Exhibit 1 - 13, the existing pavement is from the 1985-90 widening construction. Each area shall be reviewed and adjusted

~~to conform with existing construction. Where proposed widening includes resurfacing the adjacent existing pavement, omit the 6-inch removal of the top course and place the new surface course pavement joint at least 2 feet from the existing edge of pavement.~~

~~When computing quantities for asphaltic concrete items, the following conversion factors are to be used for preliminary estimates and are to be verified for each project prior to completion of the final quantities.~~

~~Surface Course 156.0 ± lb/cuft.~~
~~Intermediate Course 157.5 ± lb/cuft.~~
~~Base Course 159.0 ± lb/cuft.~~

~~Tack coat shall be applied to all existing (milled) pavement surfaces just prior to asphalt resurfacing. Tack coat shall also be applied to all exposed cut surfaces of an existing asphalt pavement section which is stepped to interface with a proposed pavement section. Tack coat will not be required between subsequent asphalt layers of proposed pavement unless:~~

~~The underlying layer has been contaminated.~~

~~The underlying layer has been exposed to prolonged traffic use.~~

~~It is otherwise required on the drawings or in special provisions.~~

~~Hot mixed asphalt pavements shall be constructed in accordance with the Standard Specifications, as amended by the Supplemental Specifications. Surface and intermediate courses for Turnpike Pavement shall each be placed in a single lift. The base course for Turnpike Pavement shall be placed in two lifts. Pavement course lifts shall conform to the following:~~

~~The minimum lift thickness shall be three times the nominal maximum aggregate size of the specified pavement mix type.~~

~~The maximum lift thickness shall be five times the nominal maximum aggregate size of the specified pavement mix type.~~

~~The above lift requirements shall apply to U-Turn and Car Parking pavement sections, as well as any variations of Turnpike Pavement used in resurfacing / re-grading projects.~~

~~Exhibit 1-9 Turnpike Pavement (Mainline, Ramp & Shoulders)~~

Exhibit 1-151-21 Minimum Curve Radii for Ramp Design Speed

Ramp Central Radius in Feet for Maximum Superelevation (E_{max}=6%)	Recommended Design Speed (mph)
150	25
235	30
340	35
485	40
650	45
840	50

1.3.3. Stopping Sight Distance

The minimum stopping sight distance for the various interchange ramp design speeds shall be as shown in Exhibit 1-16Exhibit 1 - 22.

Exhibit 1-161-22 Minimum Stopping Sight Distance for Interchange Ramps

Design Speed (mph)	Minimum Stopping Sight Distance (ft)
25	155
30	200
35	250
40	305
45	360
50	425

1.3.4. Horizontal Alignment

1. RadiiRamp Geometry

   a. The desirable minimum radius shall be 235 feet. –The absolute minimum radius shall be 150 feet (waiver required from Chief Engineer). -It is desirable to use as large a radius as project conditions will allow.

   b. Ramp configuration and transition curves shall be as indicated on Exhibit 1-17Exhibit 1 - 23.

c. The minimum lengths of curves shall be as indicated on Exhibit 1-17~~Exhibit 1-23~~.

d. The minimum length of tangent between reverse curves shall be sufficient to accommodate the superelevation transitions between the reversing curves.

e. For typical acceleration and deceleration lane treatment, see Subsection 1.4.

2. Ramp Lane Width

a. Ramp lane width shall vary with horizontal radii as per Exhibit 1-18. Verify horizontal sight distance in accordance with Subsection 1.1.1.3.

b. In the area of horizontal transition curves, it is intended that smooth lane width transitions, controlled by the central radius, be used.

~~1. Ramp lane width shall vary with horizontal radii as per Exhibit 1 - 24.~~

~~2. In the area of horizontal transition curves, it is intended that smooth lane width transitions, controlled by the central radius, be used.~~

~~3. For typical acceleration and deceleration lane treatment, see Subsection 1.4.~~

Exhibit 1-18~~1-24~~ Minimum Interchange Ramp Lane Widths by Radii

Radius at Lane Edge of Inside Curve	Lane Width for One Lane Ramp		Width of Two Lane Ramp
	Des. Min.	Abs. Min.	
150’	22’	18’	33’
200’	20’	17’	30’
235’	20’	16.5’	30’
250’	19’	16’	28.5’
300’	18’	15.5	27’
400’	18’	15’	26’
500’	18’	15’	26’
Tangent	12’	12’	24’

1.3.5. Superelevation

1. Interchange ramp superelevation rates shall be determined from Exhibit 1-19 ~~Exhibit 1 - 25~~ based on a maximum superelevation rate of 6~~%.~~ percent.

   a. For a ramp profile grades less than 0.5 percent, the minimum ramp cross slope is to be increased from 1.5 to 2 percent. ~~-~~When the section is curbed, the shoulder cross slope is transitioned between 2 and 5 percent to control drainage flow along the curb.

   b. If a design assignment involves modification or resurfacing of an existing interchange ramp, the rate of superelevation to be used shall normally follow the current standard, as described in this section. ~~-~~However, if a bridge deck falls within the horizontal curve and the deck superelevation is not being upgraded, the rate of superelevation for the entire length of the horizontal curve shall not exceed that on the existing bridge deck.

Exhibit 1-221-28 Design Controls for Interchange Ramp Vertical Curves

Design Speed (mph)	Stopping Sight Distance (ft)	Crest K	Sag K
	Minimum		
25	155	20	30
30	200	30	40
35	250	47	50
40	305	70	64
45	360	98	79
50	425	136	96

1.3.7. Pavement

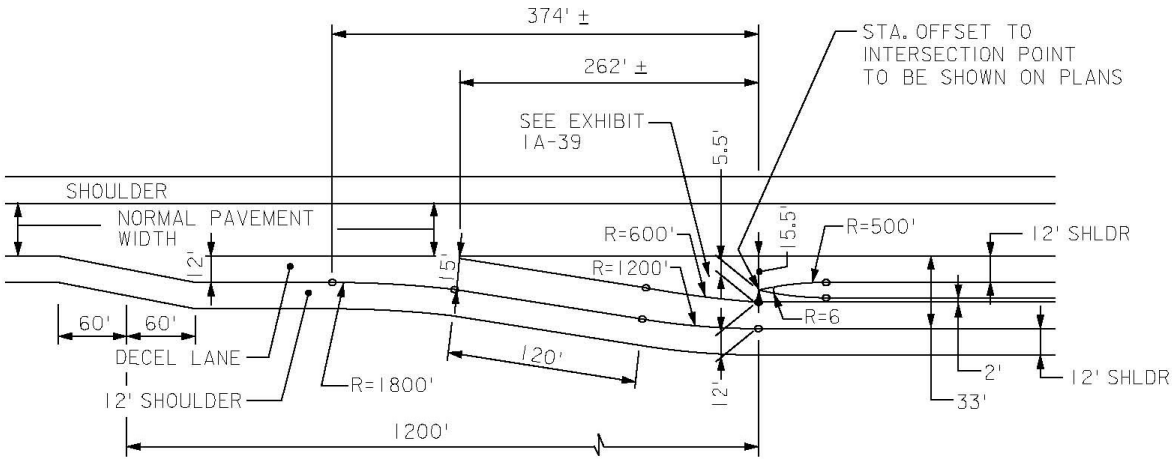
The interchange ramp pavement section shall be similar to the mainline section. See Subsection 1.2.7 1.2.7.

1.3.8. Typical Section

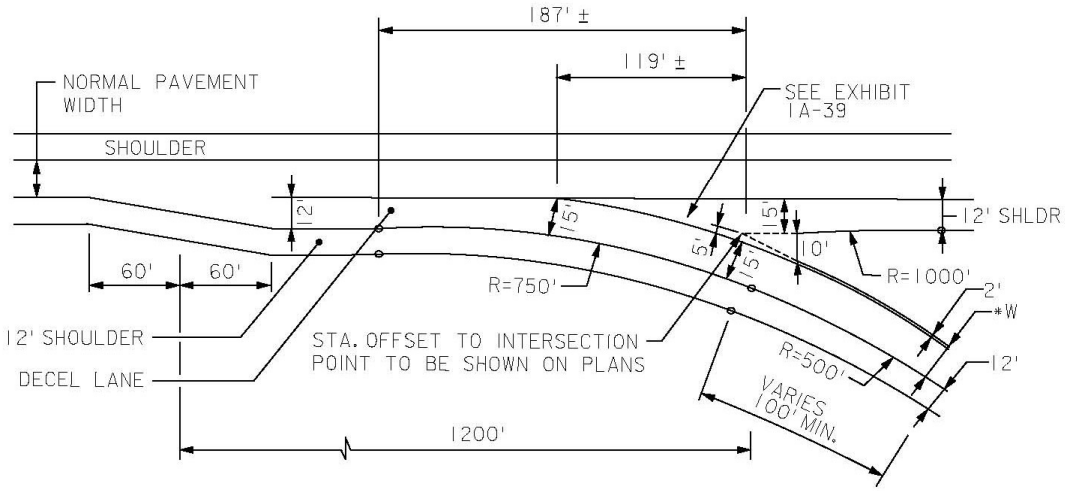
1. For typical interchange ramp dimensions and cross slopes for normal and superelevated sections, see Exhibit 1-23.
2. Rumble Strips shall not be constructed on interchange ramps. Refer to Subsection 1.2.81.2.8 for the limits of rumble strip construction at interchange areas.
3. Median treatment between ramps is shown on Exhibit 1-24.
4. For placement of asphalt lip curb with guide rail, see Section 4.2.6.11.
5. Concrete curb shall be used on the inside edge of shoulder on ramps with a radius of 250 feet or less, except when guide rail and lip curb are used.

6.5. Lateral Bridge Clearances

For ramps, clearances shall be provided as shown on Exhibit 1-25.



TYPICAL DECELERATION LANE FOR PARALLEL RAMP CONFIGURATION



TYPICAL DECELERATION LANE FOR LOOP RAMP CONFIGURATION

* SEE EXHIBIT 1A-24

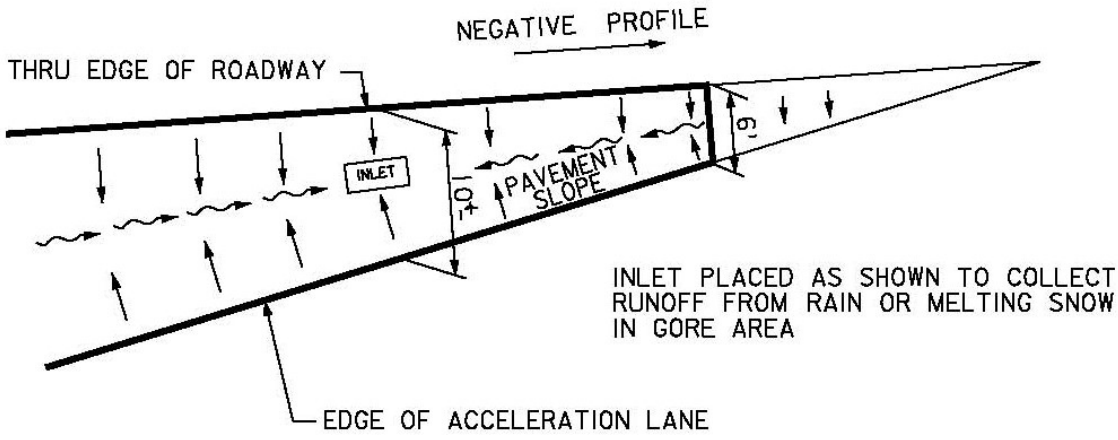
1. The intent of a two-lane exit ramp is to provide successive deceleration lengths, thus requiring a total minimum length of 2,400 feet. ~~-~~A typical two-lane exit ramp is shown in Exhibit 1-31.

2. The treatment of a major split of three lanes into two roadways of three lanes each is different in concept from successive deceleration lanes. ~~–~~In this case a total minimum length of 3,600 feet from the beginning of the split to the nose is required, with each original lane (12 feet) expanding to two lanes (24 feet) simultaneously.

3. A typical lane drop configuration following a deceleration lane exit is shown on Exhibit 1-32.

~~3.~~4. See PM Standard Drawings for exit ramp pavement markings.

Exhibit 1-33- Typical Nose Grading



1.4.3. Climbing Lanes

With a maximum of 3 percent grades, the Authority does not use truck climbing lanes. As indicated in Subsection 1.2.6 ~~1.2.6~~, the absolute minimum length of vertical tangent shall be limited by a maximum permissible loss in truck speed of 10 mph.

1.5. OTHER ROADWAYS

1.5.1. Crossroads

Where local roads are being replaced, the intent of the Authority with respect to any work under the jurisdiction of the state, county, municipality, or any other agency is "replacement in kind", according to the present standards of that agency. ~~-~~All such work is subject to the approval of the Authority's Engineering Department and must be previously agreed to in writing by the concerned agency, as noted elsewhere in this manual and the Procedures Manual.

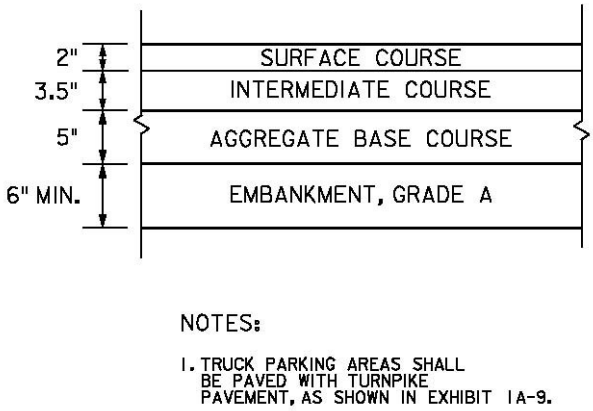
Similarly, all detouring and/or closing of local roads during construction must be approved by the appropriate agencies in accordance with the Procedures Manual.

1.5.2. Access and Service Roads

Treatment shall be similar to Subsection 1.5.1~~1.5.1~~. Where the Authority has jurisdiction, the pavement design shall be in accordance with Subsection 6.7.4 of this Manual.

~~1. For parking lots and driveways at toll plaza buildings and other locations within the Turnpike right of way, the pavement section shall be as shown on Exhibit 1-40. Refer to Subsection 1.2.7 for additional information and details.~~

~~**Exhibit 1-40 Car Parking Pavement Section**~~



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1.5.3. U-Turns

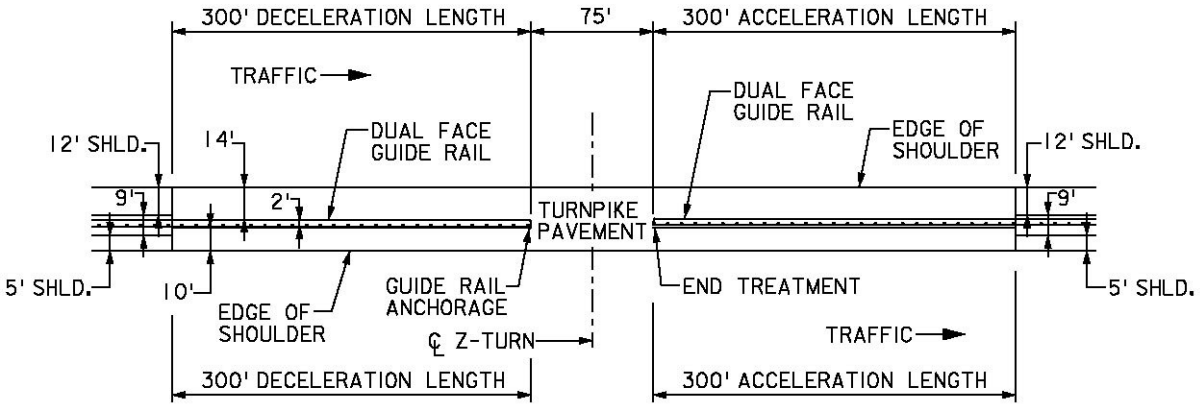
1. U-Turns shall be designated by milepost location. ~~-~~Refer to Section 7 for U-Turn signing.
2. Location
   a. Within one mile of and on each side of an interchange.
   b. No more than five miles apart between interchanges.
3. Configuration and Alignment
   a. All U-Turns shall be grade separated through the end span of a structure when the mainline passes over a crossroad etc., or on a separate overhead structure when necessary.
   b. Maximum profile grade shall be 5 percent.
   c. Rumble strips shall not be placed in the mainline shoulder within 300 feet on either side of the U-Turn entrance~~/~~/exit.
   d. For all other information, see Exhibit 1-34 and Exhibit 1-35.
4. Pavement design shall be in accordance with Subsection 6.7.4 of this Manual.

~~The pavement section for grade separated U-Turns shall be as shown on Exhibit 1-42. Refer to Section 1.2.7 for additional information and details.~~

1.5.4. Z-Turns

1. Z-Turns shall be designated by milepost location.
2. Use and Location
   a. Z-Turns shall be used on dual-dual roadway between same direction roadways as a connection between those roadways.
   b. Z-Turns shall be used in conjunction with grade separated U-turns and shall be approximately 2,500 feet on each side of the U-Turns for 70 mph design speed and approximately 2,000 feet for 60 mph design speeds. ~~-~~The absolute minimum distance shall be 1,500 feet.
   c. Drainage within Z-Turn median shall be maintained.
   d. Refer to Section 7 for signing.
3. Configuration
   a. Z-Turns shall be at-grade crossovers as shown on Exhibit 1-36.
   b. Rumble strips shall not be placed within 300 feet of the Z-Turn opening on either side of the median.
4. Pavement design shall be in accordance with Subsection 6.7.4 of this Manual.~~The pavement section for Z-Turns shall be Turnpike Pavement as shown on~~
5. See GR Standard Drawings ~~GR-14 and GR-15~~ for further details concerning Z-Turn configuration.

Exhibit 1-36~~1-44~~ Z-Turn Geometric Criteria



Z-TURN GEOMETRIC CRITERIA

1.6. GRADING CRITERIA

The general grading criteria set forth in this section are intended to be used as guidelines to achieve an economically feasible, safe and aesthetically pleasing design. ~~–~~Variations to the specified criteria are permissible as long as the design adequately complies with the intent of the guidelines. Design side slopes based on slope stability as determined according to Subsection 6.7. Variations in side slopes should be investigated in order to obtain a favorable earthwork balance. Every effort is to be made to limit the use of critical slopes where feasible so as to eliminate the need for guide rail. ~~–~~Consideration shall be given to the impact on right of way, earthwork, aesthetics, existing trees, utilities, regulated areas, etc.

1.6.1. Grading in Fill Areas

1. Variable side slopes, depending on the height of fill at the PVI of berm, shall be used for all ramps and for existing Turnpike roadways.~~-~~ See Exhibit 1-37.
   a. 0 - 5 feet fills ~~–~~ 6H:1V slope
   b. 5-10 feet fills ~~–~~ 4H:1V slope
   c. 10 feet and greater fills ~~–~~ 2H:1V slope maximum
2. Refer to Section 4 (Guide Rail~~/~~/Median Barrier~~/~~/Attenuator Design) of this Manual for guide rail requirements related to height of fill. ~~–~~Safety grading criteria may be utilized on mainline roadways as directed by the Authority's Engineering Department in order to eliminate guide rail warrants.
3. Mainline and ramp sections shall have a berm width of 6 feet minimum sloping away from the roadway at an 8 percent grade.
4. All roundings shall have 5-foot vertical curves.

1.6.2. Grading in Cut Areas

1. 2:1 maximum side slopes are recommended throughout. See Exhibit 1-37~~Exhibit 1-45~~.
2. Berm widths are the same as for fill sections.
3. All roundings shall have 5-foot vertical curves.
4. Cut sections in rock will be subject to Authority's Engineering Department approval of the Engineer's soils recommendations.
5. In borrow projects, the Engineer shall investigate the possibility of using flatter cut slopes in an attempt to achieve a more favorable earthwork balance.

Section 2 - GARDEN STATE PARKWAY GEOMETRIC DESIGN

2.1. GENERAL

The geometric design criteria contained herein were developed by the Authority for its own particular needs. They are intended to equal or exceed standards currently being used for limited access highways and should be considered minimum criteria and increased wherever economically feasible. The use of substandard criteria, including absolute minimum ~~/~~/maximum values listed in this manual, shall require a Design Element Modification Request subject to approval by the Authority's Engineering Department. For any items not adequately outlined in this section, the Engineer should refer to the latest edition of AASHTO A Policy on Geometric Design of Highways and Streets and AASHTO Roadside Design Guide.

The design criteria are intended to be used as an aid toward sound engineering design. When individual circumstances arise that are not specifically covered, engineering judgment is to be exercised that represents the intent of the criteria shown. The overall objective should be an aesthetically pleasing and safe design that is geometrically compatible in all respects.

2.1.1. Design Controls

The following design controls shall be applicable on all Parkway roadways:

1. All types of design vehicles are permitted on the Parkway south of Interchange 105 at Milepost 106.4, while North of Interchange 105, trucks with a gross weight exceeding 6,999 pounds are prohibited. To be conservative the Design Vehicle WB-67 will be used to control geometric design for the entire roadway, (see Exhibit 2-1).
2. Clearances
   a. Horizontal – Minimum clear zone width or less with appropriate roadside or median protection as directed by Section 4 of this Manual, and as further directed by Section 3 of this Manual for protection of structures. ~~– Minimum 4 feet clear of left or right edge of shoulder to obstruction, with appropriate roadside protection (see Section 4 of this manual).~~
   b. Vertical – Maintained over all roadways, including shoulders. Verification of all clearances shall be made with the controlling agency.
      i. Minimum clearance above Parkway roadways - As directed by Section 3 of this Manual or existing vertical clearance, whichever is greater. When resurfacing or widening a Parkway roadway under an existing crossing whose vertical clearance is less than the required minimum, the resulting vertical clearance must not be less than the existing condition.

      ~~iii.~~ Minimum clearance below Parkway roadways - As required by the agency having jurisdiction, but not less than the required minimum as directed

by Section 3 of this Manual. When resurfacing or widening a roadway under an existing Parkway crossing whose existing vertical clearance is less than the required minimum, the resulting vertical clearance must not be less than the existing condition.~~Roadway over Parkway – 15 feet minimum or existing vertical clearance, whichever is greater. When resurfacing or widening under an existing bridge whose vertical clearance is less than 15 feet, the existing vertical clearance must be maintained as a minimum.~~

ii.

~~Parkway over any other road - as required by agency having jurisdiction.~~

Exhibit 2-122-12 Design Controls for Vertical Curves

Design Speed (mph)	Desirable (6 inch6-inch Object Height)		Minimum (2 foot2-foot Object Height)	
	Crest K (minimum)	Sag K (minimum)	Crest K (minimum)	Sag K (minimum)
25	20	30	12	26
30	30	40	19	37
35	47	50	29	49
40	70	64	44	64
45	98	79	61	79
50	136	96	84	96
55	185	114	114	115
60	245	136	151	136
65	313	157	193	157
70	400	181	247	181

2.3. MAINLINE ROADWAY

2.3.1. Design Speed

A design speed of 70 miles per hour is to be used on the Parkway mainline, except where existing alignment and sight distance restrictions occur or restrictions are caused by existing physical constraints. Design speeds of less than 70 MPH will require written approval from the Authority and in any case shall be a minimum of 5 MPH greater than the posted speed limit.

2.3.2. Pavement Sections and Details

Pavement design shall be in accordance with Subsection 6.7.4 of this Manual. Refer to Exhibit 2-13 through Exhibit 2-18 for typical pavement sections and details. The following notes apply:

When required, Embankment, Grade A, to be a minimum of 8 inches. Inclusion of Embankment Grade A to be determined on a contract-by-contract basis following an existing substrata investigation.

1. In locations where existing pavement is widened, Grade A material is to be deeper, if necessary, to match template grade of existing pavement.

2. Template grade for Embankment, Grade A is to slope transversely a minimum of 2% or match cross slope of roadway. Template grade (top of subgrade) is to be constructed transversely without breaks in cross slope in such a manner as to provide positive drainage (daylight section or provide underdrains).

3. In areas where existing and currently designed resurfacing depth approaches 9 inches or more at the existing pavement/shoulder interface, investigations are to be made as to the feasibility of leaving the existing shoulder in place as a portion of the proposed pavement section.

4. Account for stepping (see Exhibit 2 - 15) in quantity calculations. With curb, courses terminate at the curb face. Any stepping shall be from back of curb.

5. For parking lots and driveways at toll plaza buildings and other locations within the Parkway right of way, the pavement section shall be as shown on Exhibit 2 - 14.

6. U and Z-Turn pavement shall be the same as Parkway mainline pavement.

7. When computing quantities for asphaltic concrete items, the following conversion factors are to be used for preliminary estimates.

   Surface Course 156.0± lb/cu.ft.

   Intermediate Course 157.5± lb/cu.ft.

   Base Course 159.0± lb/cu.ft.

   Conversion factors are to be verified for each project prior to completion of final quantities.

8. Tack coat shall be applied to all existing (milled) pavement surfaces just prior to asphalt resurfacing. Tack coat shall also be applied to all exposed cut surfaces of an existing asphalt pavement section which is stepped to interface with a proposed pavement section. Tack coat will not be required between subsequent asphalt layers of proposed pavement unless:

   a. The underlying layer has been contaminated.

   b. The underlying layer has been exposed to prolonged traffic use.

   c. It is otherwise required on the drawings or in special provisions.

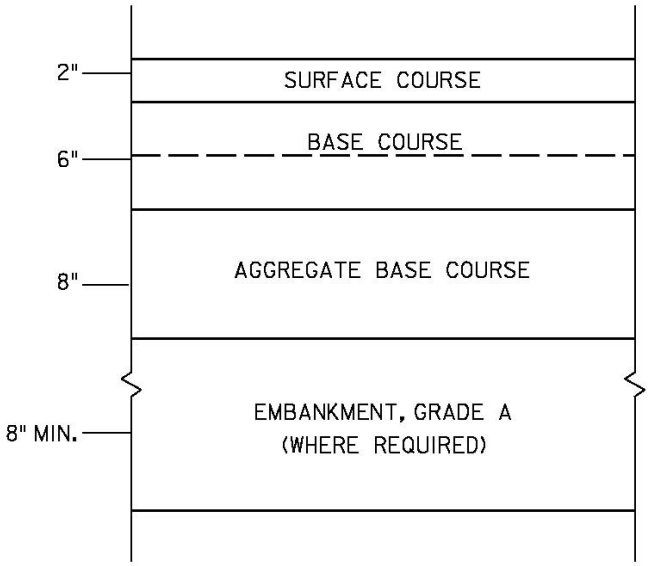
9. Hot mixed asphalt pavements shall be constructed in accordance with the Standard Specifications, as amended by the Supplemental Specifications. The surface course for Parkway Pavement shall be placed in a single lift. The base course for Parkway Pavement shall be placed in two lifts. Pavement course lifts shall conform to the following:

   a. The minimum lift thickness shall be three times the nominal maximum aggregate size of the specified pavement mix type.

~~b. The maximum lift thickness shall be five times the nominal maximum aggregate size of the specified pavement mix type.~~

~~The above lift requirements shall apply to Car Parking pavement sections, as well as any variations of Parkway Pavement used in resurfacing / re-grading projects. Pavement mix types shall be as directed by the Authority.~~

~~Exhibit 2-13 Parkway Pavement (Mainline, Ramps & Shoulders)~~



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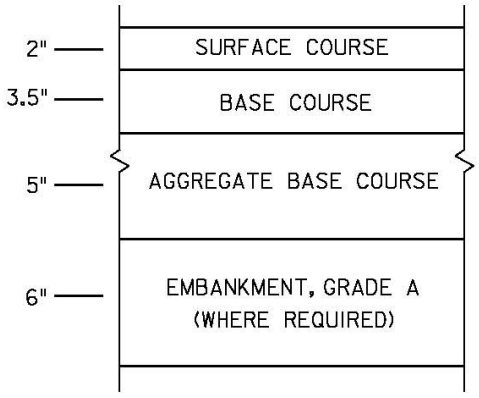
~~Exhibit 2-14 Car Parking Pavement~~



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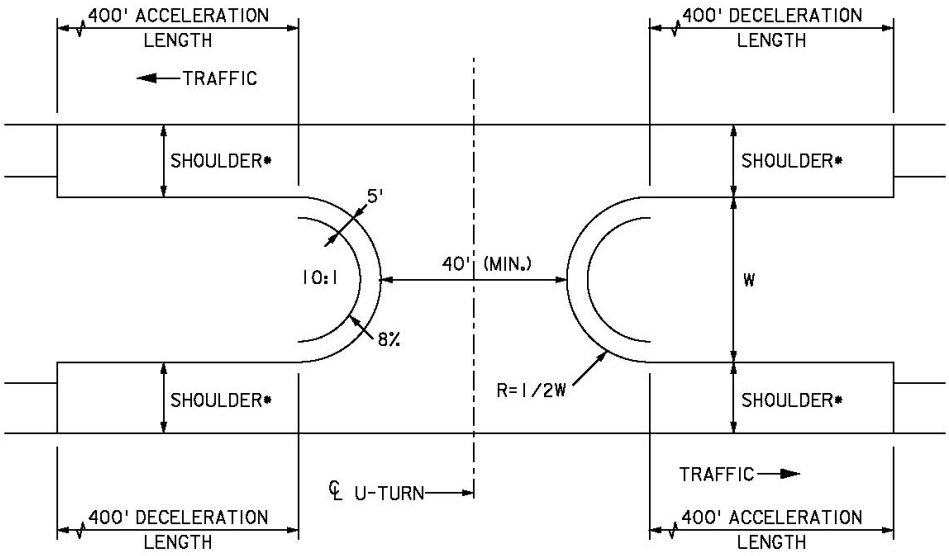
NOTE:
TRUCK PARKING AREAS ARE TO BE PAVED WITH PARKWAY PAVEMENT.

~~3.~~2. Consult ~~NJTA~~ the Authority for location criteria.

~~4. The pavement section for U-Turns and Z-Turns shall be Parkway Pavement as shown on Exhibit 2 - 13.~~

Exhibit 2-28~~2-34~~ U-Turn Geometric Criteria



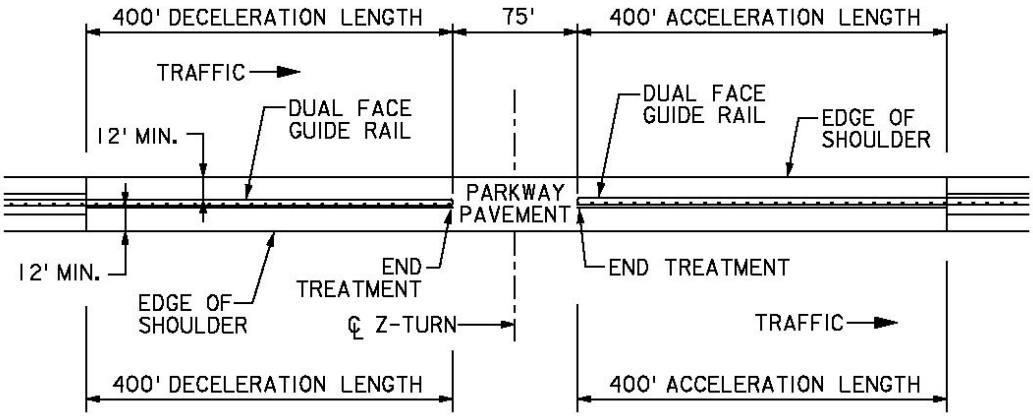
U-TURN GEOMETRIC CRITERIA

NOTES:

1. MAINTAIN DRAINAGE WITHIN U-TURN MEDIAN.
2. RUMBLE STRIPS SHALL NOT BE PLACED WITHIN 400 FEET OF ACCELERATION/DECELERATION LENGTH.

* 10' MINIMUM
12' DESIRABLE
14' WHEN GUIDE RAIL IS PRESENT OR CONSTRAINING GEOMETRY DICTATES

Exhibit 2-292-35 Z-Turn Geometric Criteria



Z-TURN GEOMETRIC CRITERIA

NOTES:

1. MAINTAIN DRAINAGE WITHIN Z-TURN MEDIAN.
2. RUMBLE STRIPS SHALL NOT BE PLACED WITHIN ACCELERATION/DECELERATION LANES.

2.7. GRADING CRITERIA

The general grading criteria set forth in this section are intended to be used as guidelines to achieve an economically feasible, safe and aesthetically pleasing design. Variations to the specified criteria are permissible as long as the design adequately complies with the intent of the guidelines. Design side slopes based on slope stability as determined according to Subsection 6.7. Variations in side slopes should be investigated in order to obtain a favorable earthwork balance. Every effort is to be made to limit the use of critical slopes where feasible so as to eliminate the need for guide rail. Consideration shall be given to the impact on right of way, earthwork, aesthetics, existing trees, utilities, regulated areas, etc.

2.7.1. Grading in Fill Areas

1. Variable side slopes, depending on the height of fill at the PVI of berm, shall be used for all ramps and for existing Parkway roadways. See Exhibit 2-15Exhibit 2-36.
   a. 0 - 5 feet fills – 6H:1V slope
   b. 5-10 feet fills – 4H:1V slope
   c. 10 feet and greater fills – 2H:1V slope maximum
2. Refer to Section 4 (Guide Rail/Median Barrier/Attenuator Design) of this Manual for guide rail requirements related to height of fill. Safety grading criteria may be utilized on mainline roadways as directed by the Authority's Engineering Department in order to eliminate guide rail warrants.

are current on the date the bids are received, and were furnished by the Authority, that indicate the location, character, dimensions, and details of the Work to be done.

PROJECT: The entire work to be performed within the limits and requirements specified for the Contract.

SPECIFICATIONS: The Standard Specifications, the Supplementary Specifications and Addenda, if issued, pertaining to the method or manner of performing the Project and to the qualities of the materials to be furnished for the Project.

SURETY: The corporate body which is bound with and for the Contractor, and which is responsible for the contractor's acceptable performance of the Project and for the payment of all debts pertaining to the Project.

WALL MANUFACTURER: Wall supplier/vendor and shall also include a Professional Engineer licensed in NJ, responsible for the preparation of the Working Drawings and calculations associated with the Retaining Wall.

6.2. PURPOSE & CONTENT

Section 6 of the Authority's Design Manual provides guidance, policies, and standard practice for the Geotechnical Exploration Plan (GEP), geotechnical analysis and design, and construction monitoring. The instructions found within Section 6 constitute the minimum required level of effort on the part of the EOR. The EOR is encouraged to exceed the minimum required level of effort when best practices dictate. The Authority desires the "best value" geotechnical solution, not the "lowest cost" geotechnical solution in cases when these two conditions are not the same.

Section 6 of the manual is intended to work in tandem with the Authority's Procedures Manual. As stated in the Procedures Manual, the Geotechnical Engineering effort will ~~have four phases~~ be conducted in Preliminary and Final Design:

- Preliminary Design - Perform Desk Study.
- Phase A - Geotechnical Engineering: Prepare and submit Phase A Geotechnical Engineering Report, Desk Study and GEP.
- Phase B - Geotechnical Engineering: Perform the Geotechnical Exploration, preliminary design recommendations, and preliminary Phase B Geotechnical Engineering Report.
- Phase C - Geotechnical Engineering: Finalize design recommendations, prepare preliminary plans and specifications, and finalize~~d~~/revise~~d~~ the Phase B Geotechnical Engineering Report.
- Phase D - Geotechnical Engineering: Finalize plans and specifications.

All submittals shall include an electronic copy. Refer to Section 5 of the Procedure Manual for more information on submittal requirements.

Although this Section provides guidance on design and analysis procedures, it does not preclude the need for additional engineering analysis and design procedures to produce a safe, economical and maintainable structure. All calculations shall provide complete and accurate references, and clearly identify the meaning of any abbreviations and symbols. They shall adhere to accepted QA/QC protocol and include initials and date performed and checked. Often special conditions will require engineering judgment to be applied and shall be assessed by the Authority on a project specific basis.

6.3. PREPARATION OF THE PHASE A GEOTECHNICAL REPORT

The Phase A Geotechnical Report shall, at a minimum, consist of a Desk Study and the GEP. The purpose of the Phase A Geotechnical Report is to provide a sound basis for the Phase B work.

6.3.1. Desk Study

A Desk Study is an exploration of relevant existing information which has been previously performed and often by others. Results of this study will be helpful to define existing project conditions and assist in determination of appropriate geotechnical features and their respective design and construction procedures and analyses. A Desk Study shall be performed during Preliminary Design to determine the suitable foundation options for the alternates being evaluated. The information gathered during Preliminary Design for the Desk Study shall serve as the basis for the development of the GEP during Phase A and other contract documents. Minimum requirements for the Desk Study include:

Basic Geologic Understanding: The Desk Study shall provide a basic understanding of the geologic conditions of the site by thorough acquisition and review of available geologic literature relative to the site. “The Geologic Map of New Jersey by Lewis and Kummel” is the standard reference geology map of New Jersey. The New Jersey Geological Survey (NJGS) Surficial Geology Maps of New Jersey and NJGS Bedrock Geology Maps of New Jersey also provide valuable reference information. Additional engineering soils information and soil maps can be obtained from the Rutgers University publications entitled, “Engineering Soil Survey of New Jersey” for each county. The United States Department of Agriculture, Soil Conservation Service also publishes soil maps which are useful when evaluating the upper layers of soil.

Existing Information: Through the EOR the GE shall request from the Authority any existing information relative to the site. The information request shall address existing Borings/soundings made for previous construction nearby, aerial photographs, foundations plans, soil and foundation reports, agricultural soil maps, and Photogeologic Interpretation reports. Sources of information may include the NJDOT Soil Boring Database which is available online. Existing information from the Authority is typically available during the solicitation process.

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
Deep Foundations	For substructure, e.g., bridge piers or abutments, widths less than or equal to 100 ft., a minimum of one exploration point per substructure is required however two points is preferred. For substructure widths greater than 100 ft., a minimum of two exploration points per substructure is required. Additional exploration points should be provided if erratic subsurface conditions are encountered, especially for the case of drilled shafts socketed into bedrock. To reduce design and construction risk due to subsurface condition variability and the potential for construction claims, at least one exploration per shaft should be ~~considered~~ performed during construction for large diameter shafts (e.g., greater than 5 ft. in diameter), especially when shafts are socketed into bedrock.	In soil, depth of exploration should extend below the anticipated pile or shaft tip elevation a minimum of 20 ft., or a minimum of two times the minimum anticipated pile group dimension, whichever is greater. All Borings should extend through unsuitable strata such as unconsolidated fill, peat, highly organic materials, soft fine-grained soils, and loose coarse-grained soils to reach hard or dense materials. For piles bearing on rock, a minimum of 10 ft. of rock core shall be obtained at each exploration point location to verify that the boring has not terminated on a boulder. For shafts supported on or extending into rock, a minimum of 10 ft. of rock core, or a length of rock core equal to at least three times the anticipated shaft diameter for isolated shafts or two times the minimum shaft group dimension, whichever is greater, shall be extended below the anticipated shaft tip elevation to determine the physical characteristics of rock within the zone of foundation influence. Based on the geologic conditions, bedrock is relatively competent along the Turnpike and Parkway and the rock core depth specified above may be excessive. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 ft. of rock core may be required to verify that adequate quality bedrock is present.

1. From AASHTO-LRFD-BDS
2. Consider taking at least one boring per project geologic setting to a minimum of 100 feet or to bedrock, to determine seismic site class.

stress history, overburden stress, pre-consolidation stress, and whether the soil strength in the short term or long-term condition is a desired test output. The GE shall ensure the testing laboratory include images of the soil sample before and after the testing.

F. Consolidated-drained (ASTM D3080) and consolidated-undrained (ASTM D6528) direct shear tests and drained torsional shear tests (ASTM D6467, D7608) shall be performed on disturbed or undisturbed soil samples.

G. Unit weight determination shall be performed in accordance with ASTM D2937.

H. Several compressive strength tests (ASTM D7012) shall be performed on rock core samples. Point Load Index Tests may be performed on irregular or broken rock specimens, but shall not be used solely to estimate rock unconfined compressive strength. When Point Load Index Tests are conducted, a site specific correlation between Unconfined Compressive Strength Test results and Point Load Index Test results shall be developed. Splitting Tensile (Brazilian) Tests may be performed normal to the transverse axis of a trimmed rock core specimen to model horizontal discontinuities or foliations in the upper portion of the bedrock surface, if deemed necessary by the GE and approved by the Authority. The Authority's preferred test is the Uniaxial Compressive Test with Elastic Modulus and stress strain curve. The test is performed normal to the longitudinal axis on a trimmed rock core specimen to model intact rock strength. The testing laboratory shall include images of the rock sample before and after the testing in the test report.

I. Slake Durability Test (ASTM D4644) may be performed on rock core samples of shales and similar weaker rocks to determine the Slake Durability Index (SDI). Los Angeles Abrasion Test (ASTM C131) and CERCHAR Test (ASTM D7625) may also be performed on similar rock types. The SDI and Abrasion Loss may be correlated to predict scour, erosion, degradation and deterioration of rock for design and during construction of shallow and deep foundations or earth retaining structures to account for residual strengths or excessive settlements from relaxation.

J. Chemical tests (Sulfate and pH) for acid producing soils shall be performed in accordance with Section 7 of the NJDEP ~~Draft~~ Flood Hazard Area Technical Manual.

K. Permeability tests shall be performed in accordance with ASTM D2434 and D5084.

ASTM D8169 or AASHTO TP 100 “Standard Method of Test for Deep Foundation Elements under Bidirectional Static Axial Compressive Load”, and or ASTM D1143, "Standard Test Methods for Deep Foundations Under Static Axial Compressive Load" are acceptable test methods. Other methods such as Statnamic load tests or the "Standard Test Methods for Axial Compressive Force Pulse (rapid) Testing" (ASTM D7383) shall be specified and used only with approval by the Authority. When performing such tests on production shafts, care shall be taken not to fail the shafts and specific project guidance should be included in the Contract Documents.

R. Lateral and uplift testing shall be performed if required by the GE, and through the EOR approved by the Authority. Lateral load testing shall be performed in accordance with ASTM D3966 "Standard Test Method for Deep Foundations under Lateral Load". Uplift testing shall be performed in accordance with ASTM D3689~~M~~ "Standard Test Method for Deep Foundation under Static Axial Tensile Load". The Authority prefers that if lateral load tests are required by the GE, they be performed in a pre-bid phase. Given the cost of installing a test shaft and performing a lateral load test pre-bid, this is generally not considered cost efficient to the Authority.

S. The following information shall be obtained from the design and included in the Phase B Geotechnical Engineering Report and in Contract Documents:

- Nominal Axial Compression Resistance
- Factored Axial Compression Resistance
- Nominal Uplift Resistance
- Factored Uplift Resistance
- Top of Drilled Shaft Elevation
- Estimated Top of Rock Socket Elevation (where appropriate)
- Estimated Tip of Drilled Shaft Elevation
- Shaft diameter
- Rock socket diameter (where appropriate)
- Reinforcing size, type, grade and layout
- Spiral bar No. and Pitch or Hoop Bar Nos. and Spacing
- Concrete compressive strength

- Casing outside diameter (thickness, and grade if permanent)
- Casing type (interim or permanent)
- Demonstration and load testing requirement (~~O-Cell~~Bi-Directional Load Test or Static Load Test)
- Boring requirements
- Thermal Integrity Testing and Shaft Inspection Device Requirements
- Bottom of cap elevation (if applicable)
- Cap dimensions (if applicable)
- Length of Casing Seated into Rock
- Overhead clearance, access, or MPT restrictions
- Environmental constraints
- Rock laboratory test results and boring logs
- Sequence of construction (i.e. communication, downdrag)
- Drilled Shaft Layout Plan

T. Vibration and displacement monitoring shall be performed in accordance with Subsection 6.10.2.6.

6.6.1.7. **Micropiles**

In addition to the methods outlined in the AASHTO-LRFD-BDS, the procedures in the Federal Highway Micropile Design and Construction FHWA-NHI-05-039 shall be followed.

A. The minimum center to center spacing between micropiles shall be not less than 30 inches~~.~~ or 3.0 diameters center to center whichever is greater. Axial and lateral nominal resistance within the depth of total scour, for the 100 and 500 Year storm events, shall be ignored as specified in the AASHTO and FHWA references.

B. Axial and lateral resistance shall be reduced in soils susceptible to liquefaction. See Subsection 6.8.4.

C. External loads and overburden pressure which result in lateral squeeze due to underlying soft compressible soils, and lateral spread and lateral flow conditions due to soil liquefaction or other phenomenon shall be considered in the design.

D. Factored downdrag load shall be included in design.

- All drainage requirements
- Coefficient of sliding friction at the base of the modular wall and the soil volume
- Confirmation that external stability and compound stability of the modular wall system has been checked and determined adequate for static and dynamic conditions by the EOR.

6.6.2.11. Soil Nail Walls

Soil nail walls shall be used in applications where ground anchor walls are considered but where construction access, and subsurface conditions indicate a soil nailed structure may be more cost effective or technically feasible. Soil nail walls may require additional right-of-way. Soil nail walls are constructed to support temporary excavations, reinforce existing soil slopes, and permanent cut walls. Soil nails are typically closely spaced (4 to 6 feet.) and unlike ground anchors are not prestressed. Soil nail walls should be designed and constructed following the recommendations and procedures outlined in Subsection 11.12 of AASHTO-LRFD-BDS and FHWA GEC No. 7 "Soil Nail Walls" (FHWA-NHI-14-007). Only solid bars are allowed by the Authority for permanent soil nail applications. Hollow bars are allowed for temporary applications. ~~The AASHTO-LRFD-BDS do not currently (2014) address the design and construction of soil nail retaining walls.~~

The following information shall be included in Contract Documents:

- Nominal Tensile Resistance for Strength Limit State
- Factored Tensile Resistance for Strength Limit State
- Nominal Tensile Resistance for Extreme Event
- Tolerable vertical and lateral deformation criteria
- All drainage requirements
- Confirmation that external stability of the soil nail wall has been checked and determined adequate for static and dynamic conditions by the GE.
- Soil nail bar size, length and grade
- Grout compressive strength
- Type of soil nail (Type A or Type B)
- Corrosion protection requirements
- Soil nail spacing and inclination (typical section and layout plan)

H. In areas where existing and currently designed resurfacing depth approaches 12 inches, or more, at the existing pavement / shoulder interface, investigations shall be made as to the feasibility of leaving the existing shoulder in place as a portion of the proposed pavement section.

6.7.4.3. Parkway Pavements

The following pavement sections for Parkway mainlines, ramps, U- Turns, Z-Turns, and Parking Lots and guidelines shall be followed:

A. The mainline pavement section shall be constructed as shown on Exhibit 6-20~~Exhibit 6-20~~. Current pavement mix types to be used for each of the courses shown in the pavement sections shall be as directed by the Authority.

B. The pavement section for U-Turns and Z-Turns shall be ~~Turnpike~~ Parkway Pavement as shown on Exhibit 6-20~~Exhibit 6-20~~.

C. For parking lots and driveways at toll plaza buildings and other locations within the Parkway~~Turnpike~~ right of way, the pavement section shall be as shown on Exhibit 6-21~~Exhibit 6-21~~.

D. The pavement section for grade separated U-Turns shall be as shown on Exhibit 6-20~~Exhibit 6-20~~.

E. The various pavement interface and stepping details shown on Exhibit 6-22~~Exhibit 6-22~~ through Exhibit 6-26~~6~~ ~~Exhibit 6-25~~ are for Parkway pavement.~~—~~ Adjust steps accordingly to match other pavement sections.

F. Account for stepping (see Exhibit 6-22~~Exhibit 6-22~~) in quantity calculations.~~—~~ With curb, courses terminate at the curb face.~~—~~ Any stepping shall be from back of curb.

G. When required, Embankment, Grade A, to be a minimum of 8 inches. Inclusion of Embankment Grade A to be determined on a contract-by-contract basis following an existing substrata investigation.

H. In areas where existing and currently designed resurfacing depth approaches 9 inches, or more, at the existing pavement / shoulder interface, investigations shall be made as to the feasibility of leaving the existing shoulder in place as a portion of the proposed pavement section.

6.7.4.4. Other Pavements

Where local roads are being replaced, the intent of the Authority with respect to any work under the jurisdiction of the state, county, municipality, or any

2. Risk costs (additional foundation cost, delay of construction due to unknown conditions)
3. Benefits (early accomplishments, future redevelopment)
4. Maintenance cost (annual inspection, annual repairs)
5. A Life Cycle Cost Analysis shall be performed.

F. Reuse options for foundations shall be submitted with Preliminary Design, Phase A, and Phase B submissions.

1. Desk Study during Preliminary Design and Phase A Submission shall include the following:
   - Existing Foundation Information
   - Existing Subsurface Exploration details
   - Proposed Subsurface Exploration details
   - Proposed Investigation for Foundations
   - Qualitative or semi-quantitative risk assessment
2. Phase B Geotechnical Engineering Report shall include the following in addition to the Phase A submission:
   - Risk Management
   - Foundation Design
   - Cost Analysis
   - Life Cycle Cost Analysis
   - Recommendations

6.7.8. Fenders

Bridge structures in navigable waterways shall be protected from vessel collision. Bridge structures shall either be designed to withstand collision force or shall be protected against vessel collision forces by fenders, dikes, dolphins, berms, islands, or other sacrifice-able devices. AASHTO-LRFD-BDS and AASHTO Guide Specifications and Commentary for Vessel Collision Design of Highway Bridges shall be followed.

6.7.8.1. Design of Bridge Substructure Foundations for Collision Force

The foundations shall be designed to withstand the impact loads in an elastic manner. Inelastic design shall not be permitted for foundations to prevent collapse. The design shall be in accordance with AASHTO-LRFD-BDS with the foundation design specified in Subsection 6.5.

6.12. REFERENCES

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2. American Association of State Highway and Transportation Officials (AASHTO), "AASHTO Guide Specifications for LRFD Seismic Bridge Design," 2nd Edition, 2011 with 2015 Interim Revisions.
3. American Association of State Highway and Transportation Officials (AASHTO), "LRFD Bridge Design Specifications," ~~7th~~ 9th Edition, ~~2014~~2020.
4. American Association of State Highway and Transportation Officials (AASHTO), "LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals," 1st Edition, 2015.
5. American Association of State Highway and Transportation Officials (AASHTO), "Standard Specifications for Highway Bridges," 17th Edition, 2002.
6. American Association of State Highway and Transportation Officials (AASHTO), "Standard Specifications for Transportation Materials and Methods of Sampling and Testing".
7. American Railway Engineering and Maintenance-of-Way Association, "Manual for Railway Engineering," Volumes 1-4, 2014.
8. American Society of Civil Engineers (ASCE), Geotechnical Special Publications.
9. Arneson, L.A., Zevenbergen, L.W., Lagasse, P.F., and Clopper, P.E., "Hydraulic Engineering Circular (HEC) 18 – Evaluating Scour at Bridges," Federal Highway Administration Publication No. FHWA-HIF-12-003, Fifth Edition, April 2012.
10. ASTM International, "Annual Book of ASTM Standards".
11. Berg, R.R., Christopher, B.R., Samtini, N.C., "Geotechnical Engineering Circular (GEC) No. 11 – Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volumes I & II," Federal Highway Administration Publication Nos. FHWA NHI-10-024 & FHWA NHI-10-025, November 2009.
12. Brown, D.A., Dapp, S.D., Thompson III, WR., Lazarte, C.A., "Geotechnical Engineering Circular (GEC) No. 8 – Design and Construction of Continuous Flight Auger (CFA) Piles," Federal Highway Administration Publication No. FHWA-HIF-07-039, April 2007.
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42. New Jersey Administrative Code, "Title 7 Chapter 9D - Well Construction and Maintenance; Sealing of Abandoned Wells."

43. New Jersey Department of Agriculture, "The Standards for Soil Erosion and Sediment Control in New Jersey," 7th Edition, January 2014.

44. New Jersey Department of Environmental Protection (NJDEP), "New Jersey Stormwater Best Management Practices (BMP) Manual," February 2004.

45. New Jersey Department of Environmental Protection (NJDEP), "~~Draft~~ Flood Hazard Area Technical Manual," December 2008.

46. New Jersey Department of Transportation (NJDOT), "~~2007~~ NJDOT Standard Specifications for Road and Bridge Construction," ~~2007~~2019.

~~47. New Jersey Turnpike Authority (NJTA) Construction Manual.~~

~~48.~~47. New Jersey Turnpike Authority (NJTA) Procedures Manual.

~~49.~~48. New Jersey Turnpike Authority (NJTA) Standard Specifications.

~~50.~~49. New Jersey Turnpike Authority (NJTA) Supplementary Specifications.

~~51.~~50. Oregon Department of Transportation (ODOT), "Geotechnical Design Manual," April 2010.

~~52.~~51. Puckett, J.A., Garlich, M.G., Nowak, A., Barker, M., "Development and Calibration of AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals," Transportation Research Board (TRB) National Cooperative Highway Research Program (NCHRP) Report 796, 2014.

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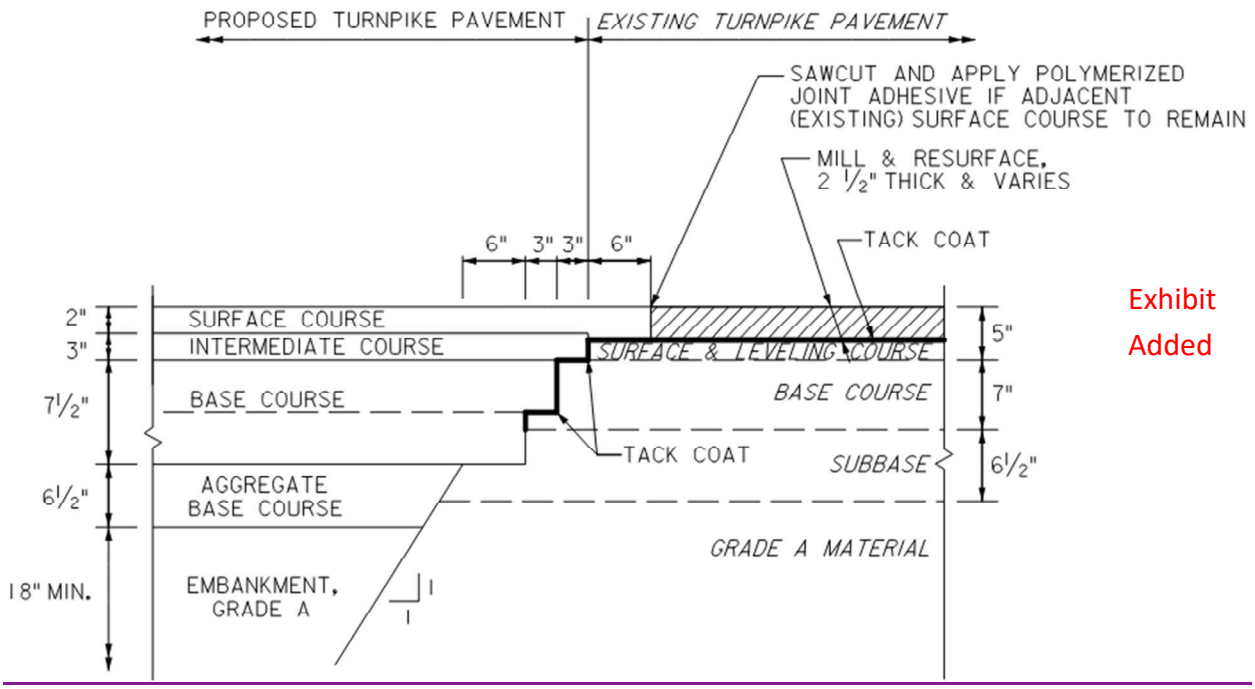
Exhibit 6-17 Turnpike New Pavement Interface with Existing Pavement



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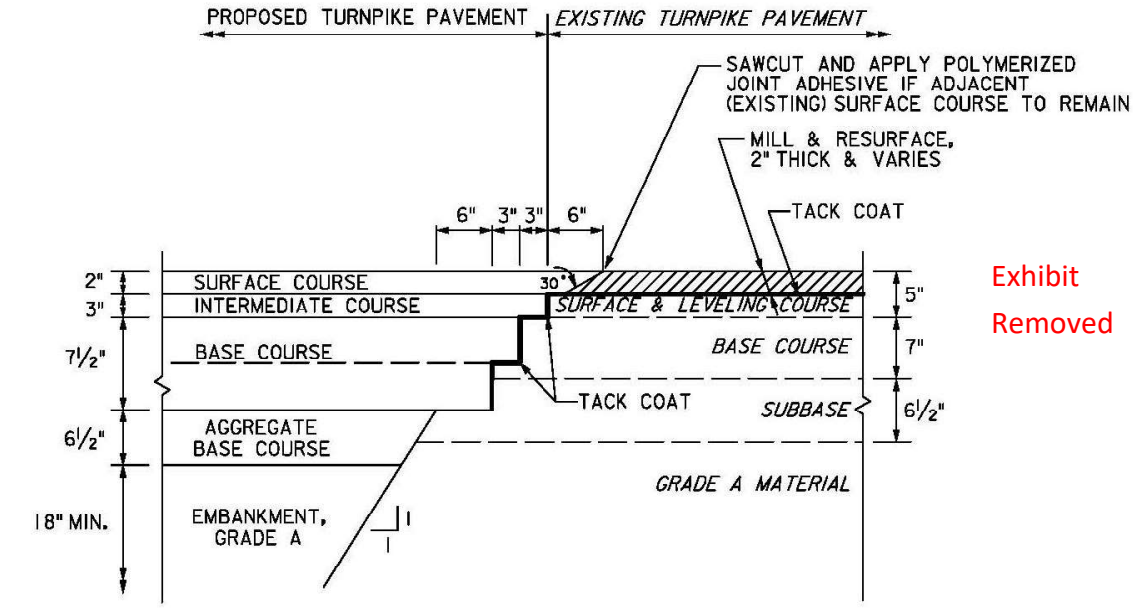

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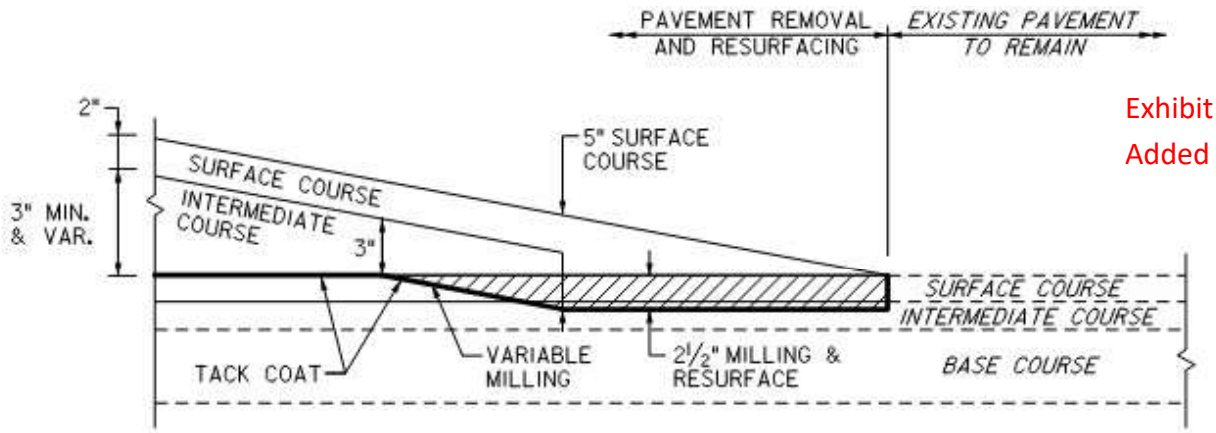
Exhibit 6-19 Turnpike Pavement Removal and Reconstruction Detail



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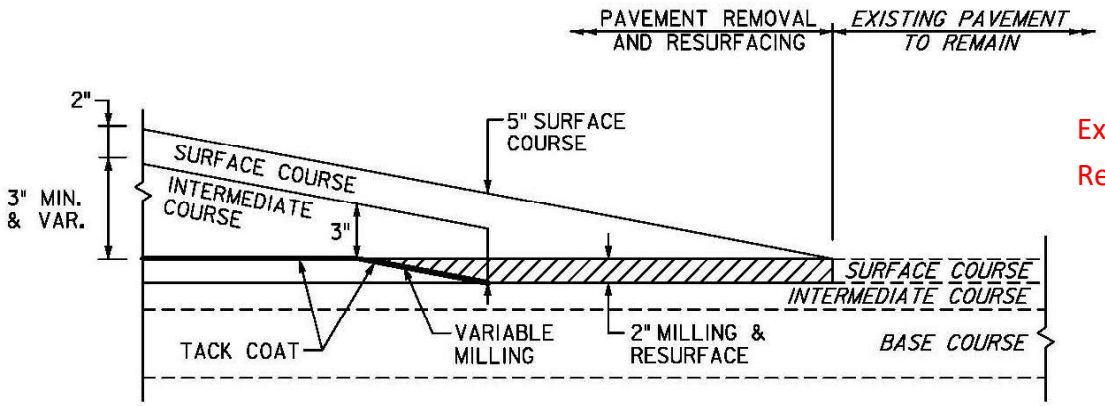

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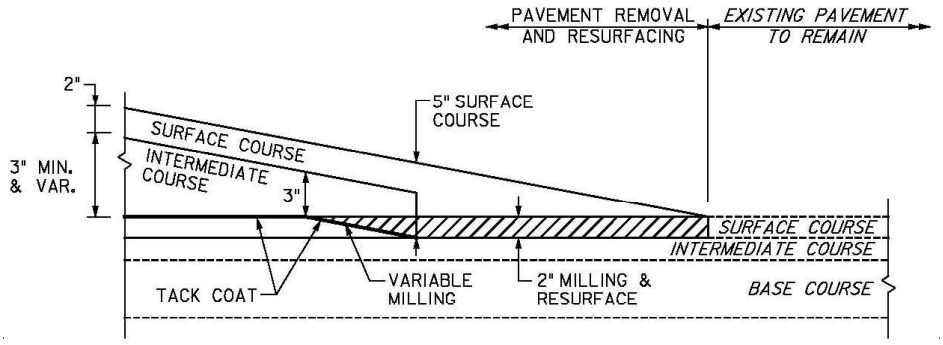

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Exhibit 6-24 Parkway New Pavement Interface with Existing Pavement

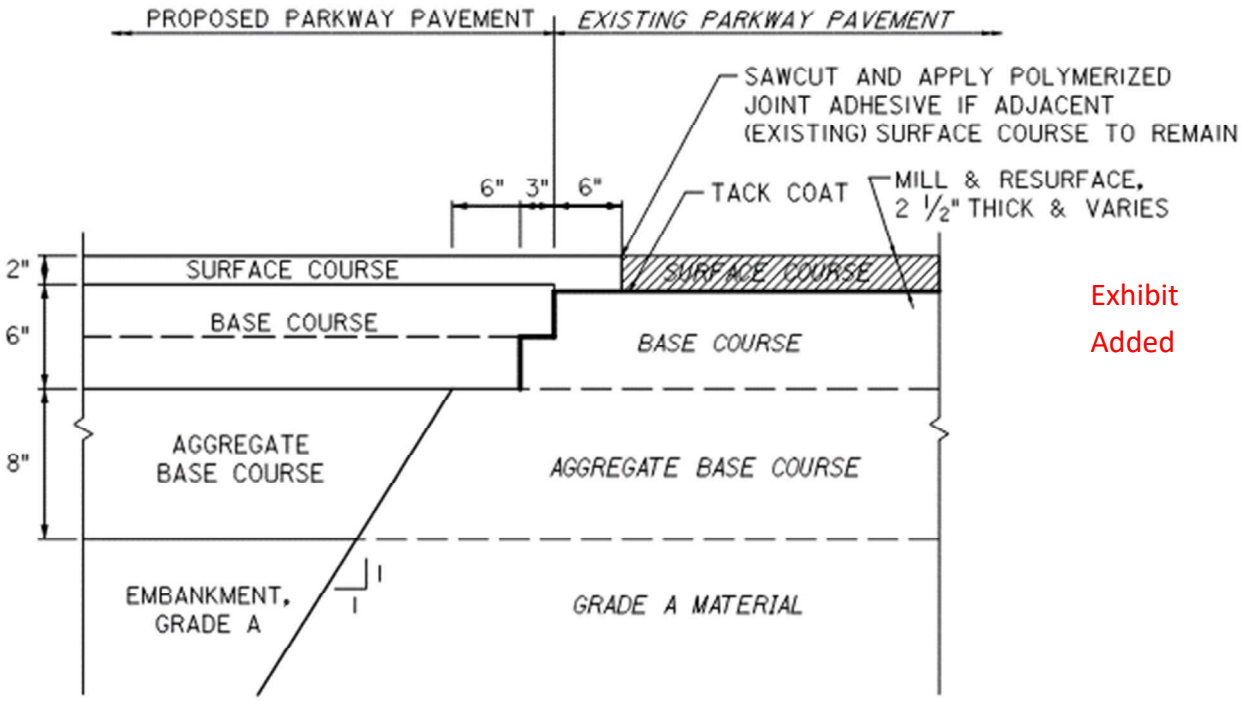
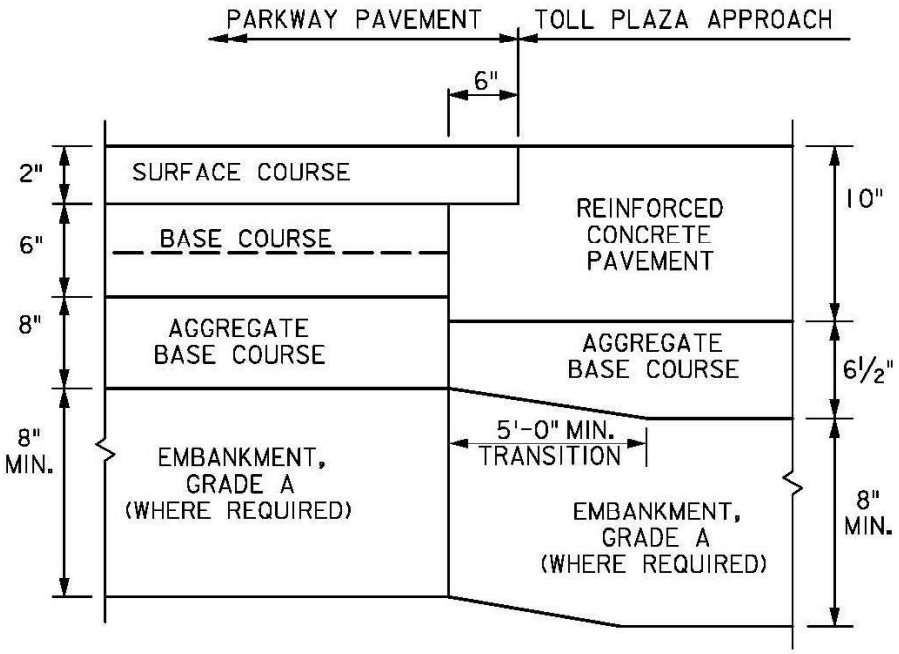


Exhibit Added

Exhibit 6-255 Parkway Toll Plaza-Transverse / Longitudinal Paving Interface



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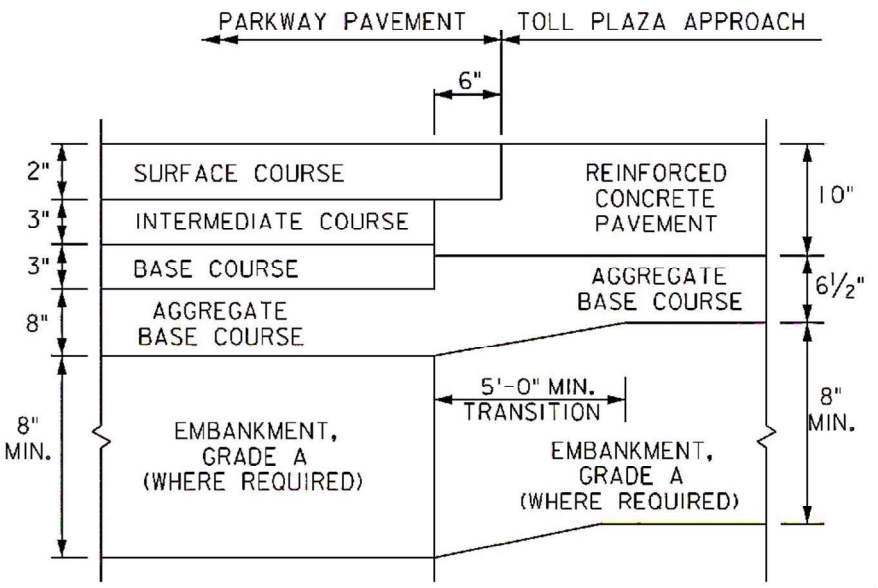

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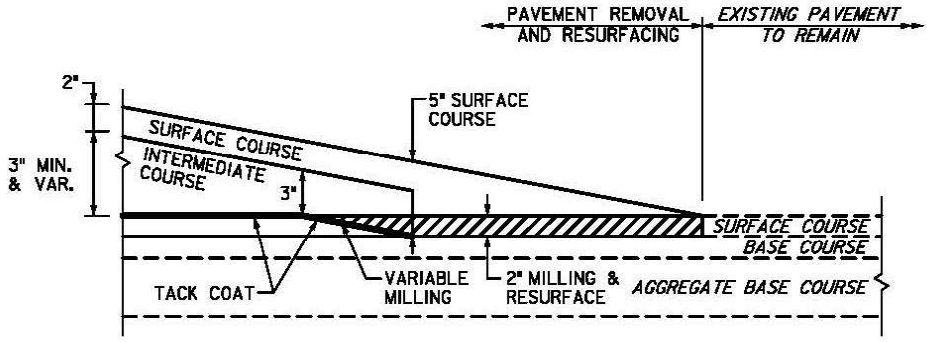
Exhibit 6-266 Parkway Pavement Removal & Reconstruction Detail



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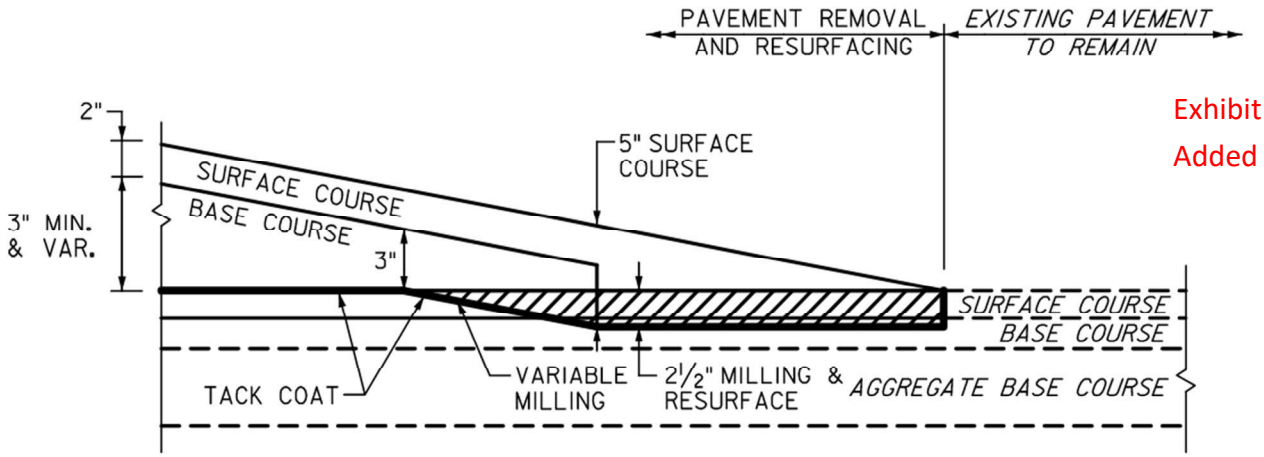

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