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This SSP is used for trenchless methods for culvert construction.

The material specifications for culverts are covered under sections 64 to 67.

Replace section 19-15 with:

19-15 TRENCHLESS METHODS FOR CULVERT CONSTRUCTION

## 19-15.01 GENERAL

### 19-15.01A Summary

1

Section 19-15 includes general specifications for constructing culvert using a trenchless method.

### 19-15.01B Definitions

2

**overcut:** Radial annular gap between excavated bore and outer pipe wall.

3

**fixed interval localized roughness (fixed ILR):** Index values for each wheel path using 25-foot segment length and 250-mm filter.

4

**fault value:** The difference in elevation between surface of adjacent concrete pavement slabs across a transverse joint determined using the FHWA ProVAL automated faulting measurements module.

### 19-15.01C Submittals

#### 19-15.01C(1) General

5

Submittal that includes land survey items must be stamped and signed by a land surveyor who is registered as a land surveyor in the State.

#### 19-15.01C(2) Contractor Qualifications

6

Submit:

1. Summary of the contractor's experience that demonstrates compliance with section 19-15.01D(3)

2. List of at least 5 projects completed in past 5 years that demonstrate the contractor's qualifications and ability to perform the work. For each project includes:

2.1. Project description

2.2. Name and phone number of the owner

2.3. Project completion date

#### 19-15.01C(3) Shop Drawings

7

Submit 5 copies of shop drawings. After review, submit 8 copies for authorization and use during construction.

8

Shop drawings and calculations must be stamped and signed by an engineer who is registered as a civil engineer in the State.

9

Shop drawings must include:

1. Your name, address, telephone number, and email address

2. Description of the trenchless construction method, sequence of operations, type of excavated face support, and spoil removal

3. Manufacturer and type of construction equipment for excavation, boring, spoil removal, lubrication, jacking, and grouting, related operating system proposed, and capability of equipment chosen

4. Plans showing work site layout, cross sections and profile of construction equipment, shield cut, overcut, pipes, and construction operation and sequence

5. Excavation safety plan

6. Proof of certification issued by the equipment manufacturer of the energy consumption, condition, and operational characteristics of all equipment to be used for installing the culvert

7. Additional subsurface exploration, including locations, drilling or sounding methods, and testing methods

8. Details of automated electronic excavation and alignment monitoring and recording system that can produce continuous record of construction activities

9. Details of pipe and pipe joints that can carry and uniformly distribute the thrust of jacking forces, if applicable, and other construction loads in addition to overburden, earth and hydrostatic pressures

10. Dewatering system, and plan to divert, control, and dispose of surface water and groundwater

11. Contingency plan for: failed excavated face, damaged pipe, excessive ground surface displacement and subsurface displacement, deviation of alignment exceeding tolerance, and flooding

12. Methods for inspecting and grouting voids immediately outside of the completed culvert

13. Mitigation Plan for restoring the pavement and ground surface

10

14. Monitoring plan for:

14.1. Culvert grade and alignment control, including monitoring instruments, layout of instrumentation points, construction details, and monitoring frequency

14.2. Ground surface displacement, including generating a digital surface model that extends 50 feet in each direction from the culvert center line alignment based on a grid pattern with a spacing between points no more than 1-foot apart, survey method, survey data processing and analysis method, and digital surface file, in either Civil 3D or Land XML format

14.3. Subsurface displacement, including monitoring instruments, layout of monitoring alignment, points, method, and frequency of the monitoring

14.4. Stability of excavated face, logging of excavated materials, including anticipated volume of excavation and measured volume of removed spoil

14.5. Critical operations of applicable trenchless methods, including: excavation, boring, spoil removal, lubrication, jacking, and grouting

11

15. Calculations of:

15.1. Bracing, shoring, and thrust block design

15.2. Thrust forces and distribution of the forces for applicable trenchless methods

15.3. Groundwater and surface water flow, and placement and capacity of the dewatering system

15.5. Estimated displacement magnitude, profile, and contour on highway pavement and in the subsurface, and preventive measures that control the estimated displacement to be less than the maximum allowed ground surface displacement and subsurface displacement described in sections 19-15.01D(5)(c) and 19-15.01D(5)(d)

15.6. Anticipated quantity of spoils by volume

#### 19-15.01C(4) Culvert Control Line Survey

12

Submit control line survey. Control line may be on a local coordinate system if the control is referenced to the project coordinate system.

13

#### 19-15.01C(5) Daily Construction Record

Submit Daily Construction Record before noon the day after the completion of each work shift.

14

Daily Construction Record must include:

1. Date and time of operation.

2. Key Personnel.

3. Length of constructed culvert, including coordinates and elevation of the beginning and ending (Latitude, Longitude and Northing, Easting, Elevation) of the culvert advanced during each work shift. Record must reference the project coordinate system designated by the Department.

4. Rate of advance.

5. Jacking force.

6. Problems encountered, possible causes, and proposed mitigation.

7. Geological log of excavated face and materials, with the logging performed by a geologist who is registered as an engineering geologist in the State.

8. Monitoring record and field note of:

8.1. Ground surface displacement, including any visible cracks

8.2. Subsurface displacement.

8.3. Culvert line and grade control.

8.4. Anticipated and actual volumes of spoil removed and causes of the volume discrepancy.

8.5. Groundwater table elevation, if dewatering is required.

#### 19-15.01C(6) Contact Grouting Record

15

For applicable trenchless method, submit Contact Grouting Record before noon the day after the completion of each work shift.

16

Contact Grouting Record must include:

1. Injection locations

2. Grout quantity

3. Grout pressure

4. Measurements and observations, including heave, casing or carrier pipe movement, grout loss quantity, communication between grout ports, ground surface, and nearby utilities and storm drains

5. Problems encountered, possible causes, and proposed mitigation

#### 19-15.01C(7) Pavement Smoothness Report

**17**

Submit Inertial Profiler Certification under section 36-3.01C(2).

**18**

Submit:

1. Pre-construction pavement smoothness report before work starts

2. Monthly pavement smoothness report by the 5th day of each month

3. Post-construction pavement smoothness report after construction and pavement restoration for review and acceptance

**19**

Pavement smoothness report must include average values of 5 inertial profiler runs for each lane, including IRI of each wheel path, profile information, fixed ILR, and fault values. The begin and end positions of each fixed ILR must be within 1.0 foot in between runs.

Register with the Department's secure file sharing system and submit pavement smoothness data and report to the Engineer and the Department's secure file sharing system under section 36-3.01C(3)(a).

Pavement smoothness report must include:

1. ProVAL ride quality analysis report for the International Roughness Index of the left and right wheel paths of each lane in a PDF file, including:

1.1. 25-foot fixed interval localized roughness values.

1.2. Inputs, including the specified continuous segment length.

1.3. Raw profile data name selections.

2. GPS data file for each lane in GPS eXchange file format.

3 Manufacturer's recommended calibration and verification test results for the inertial profiler.

4. Inertial profiler's calibration and verification test results, including results for bounce, block, and the distance measurement instrument.

Include Pavement Smoothness Corrections Information in the pavement smoothness report.

Submit raw profile data in an unfiltered electronic pavement profile file format. Use the file-naming convention described in 36-3.01C(3)(a) except for:

X = profile operation, EXIST for existing pavement, MNTR-YYYYMMDD for each monthly monitoring report.

If you are submitting multiple inertial profiler data files, compress the files into a .ZIP file format and use the file-naming convention TT\_EA\_X\_YYYYMMDD.zip.

**20**

Fixed ILR of each wheel path for each run must be presented as follows:

1. Spreadsheet that contains current and all previously recorded fixed ILR.

2. Change of fixed ILR calculated to the nearest whole percentage compared with the corresponding pre-construction fixed ILR.

3. Values increase by more than 10 percent must be highlighted yellow, and those increase by more than 20% must be highlighted orange.

4. Values greater than 180 inches/mile must be highlighted red.

**21**

Fault values at each concrete pavement joint must be presented as follows:

1. Spreadsheet that contains current and all previously recorded fault values.

2. Values greater than 0.75 inches must be highlighted red.

3. Profile with the number of faults greater than 0.1 inches increases by more than 10 percent must be highlighted yellow, and those increase by more than 20% must be highlighted red.

#### 19-15.01C(8) Post-Construction Record

22

Submit a copy of the completed culvert construction inspection, including video recording and photographs.

23

Submit as-built plans showing details and alignment of the constructed culverts, horizontal and elevation survey based on project coordinate system, any problems encountered, and mitigation actions performed.

24

Submit as-built plans showing details of pavement restoration work performed.

### 19-15.01D Quality Assurance

#### 19-15.01D(1) General

25

Not Used

##### 19-15.01D(2) Pre-construction Meeting

26

Hold a pre-construction meeting at least 10 days before the start of construction activities related to culvert construction. The Engineer conducts the meeting.

27

Attendees must include:

1. The Engineer

2. Your project manager

3. Your project superintendent

4. The subcontractors for the trenchless method

28

Provide and present:

1. Culvert construction shop drawings

2. Mitigation plans for both during and after construction

3. Timeline and critical path activities

4. Safety requirements, including Cal/OSHA and Tunnel Safety Orders

5. Status of permits

#### 19-15.01D(3) Contractor Qualifications

29

The contractor for constructing the culvert using trenchless methods must:

1. Have successfully completed at least 5 projects in past 5 years using similar trenchless methods for culvert construction in similar ground and groundwater conditions with similar drive lengths and diameter range.

2. Provide a superintendent, who has successfully completed at least 5 projects similar construction methods for culvert construction in similar ground and groundwater conditions with similar drive lengths and diameter range. The superintendent must be at the site at all times when work is being conducted.

#### 19-15.01D(4) Quality Control

30

Not Used

#### 19-15.01D(5) Department Acceptance

##### 19-15.01D(5)(a) General

31

Not Used

##### 19-15.01D(5)(b) Pavement Smoothness Monitoring

32. The Annual Average Daily Traffic volume must be shown on the Plans.

Pavement smoothness monitoring is required if:

1. Annual Average Daily Traffic volume of the section of highway above the culvert is greater than 100,000.

2. Minimum vertical distance between the bottom of pavement and the top of culvert is less than 6 times the culvert outside diameter.

33

Perform inertial profiler verification tests under section 36-3.01D(3)(b)(ii).

34

Perform pre-construction, monthly, and post-construction pavement smoothness surveys using inertial profiler.

35

Establish control points that can trigger the begin and end positions of each profile run for each lane. The control points must be located at least 0.1 miles from the culvert center line measured along the highway center line. The same control points must be used throughout the construction period.

36

Perform 5 inertial profile runs of each traffic lane between the begin and end control points. The distance measuring instrument (DMI) direction of increase and the DMI station used to record the begin control point must be the same in all profiles of the lane.

37

Fixed ILR must be generated using ProVAL Ride Quality module, with Analysis Type set to “Fixed Interval”, Ride Quality Index set to “IRI”, and Segment Length set to 25 feet. For concrete pavement, fault values must be determined using ProVAL Automated Faulting module, with Nominal Joint Spacing set to the average slab length, Segment Length set to 528 feet, Joint Window set to 2 feet, Joint Detection Method set to “Step”, and Cracks unchecked.

38

Measure pavement smoothness under sections 36-3.01B, 36-3.01C, 36-3.01D, and 36-3.03.

39

Pavement smoothness requirements for both asphalt concrete pavement and concrete pavement based on the average fixed ILR of 5 inertial profiler runs for each lane are:

1. If pre-construction fixed ILR is equal to or less than 180 inches/mile, the fixed ILR must not increase by more than 20% due to construction, with the maximum allowable fixed ILR of 180 inches/mile.

2. If pre-construction fixed ILR is greater than 180 inches/mile, the fixed ILR must not increase by 5 inches/mile compared to pre-construction values.

40

Additional pavement smoothness requirements for concrete pavement are:

1. If pre-construction fault value is equal to or less than 0.75 inches, the fault value must not increase by more than 0.25 inches due to construction, with the maximum allowable fault value of 0.75 inches.

2. If pre-construction fault value is greater than 0.75 inches, the fault value must not increase by more than 0.10 inches compared to pre-construction values.

3. Number of faults with fault value greater than 0.1 inches must not increase by more than 20 percent due to construction.

41

If pavement smoothness exceeds the requirements:

1. Stop work

2. Notify the Engineer

3. Propose an alternative construction method

4. Propose a mitigation plan that includes methods to fill the voids created under the highway and surface street pavements by the construction and restore the density of subsurface materials

5. Increase pavement smoothness monitoring frequency to:

5.1. Every week until the pavement smoothness readings in the areas that exceed the pavement smoothness requirements show no further deteriorating of pavement smoothness, then

5.2. Every two weeks until the pavement smoothness readings in the area above the advancing pipe meet the pavement smoothness requirements for 2 consecutive readings

##### 19-15.01D(5)(c) Ground Surface Displacement Monitoring

42. District Design, Land Surveys, and Utilities should identify on the Plans the critical above ground structures and utilities near the culvert alignment that need to be monitored and the locations of the instruments to be placed. The locations should be accessible.

Identify and mark monitoring points on critical structures at locations shown. Include these points in monitoring surveys. Perform monitoring surveys before noon and at ambient temperature below 85 degrees F.

43

Notify the Engineer at least 15 days before construction for the Department to perform a preconstruction ground surface survey.

44

The Department will provide ground surface monitoring control points. Use the ground surface monitoring control points provided for ground surface displacement monitoring.

45

For monitoring the displacement of highway and street pavement and shoulder, the Department will provide a pre-construction digital surface model to be used in analysis to determine ground surface displacement. Surface modeling will be based upon a grid of points spaced not more than 1-foot apart and will extend 50 feet in each direction from the culvert center line alignment.

46

For monitoring the displacement of highway embankment, the Department will identify the limits of a surface modeling area. Surface modeling will be based upon a grid of points spaced not more than 1-foot apart. Modeling will extend 50 feet in each direction from the culvert center line alignment.

47

Each ground surface horizontal and vertical measurement must be accurate to ± 0.03 feet on pavement and ± 0.1 feet on unpaved surfaces at the 95% confidence level. Each ground surface vertical displacement produced by comparing the latest surface model with pre-construction surface model must be accurate to ± 0.01 feet on pavement and ± 0.1 feet on unpaved surfaces at the 95% confidence level.

48

Before construction, perform ground surface survey based on the Department’s Survey Manual and supplemental guidance. Submit the survey data, surface model, and compared results of your and the Department’s surface model that demonstrate your survey and modeling method comply with the quality requirements described in the Department’s Survey Manual and supplemental guidance.

49

Perform ground surface displacement monitoring survey every week during construction, and every 2 weeks for 1 month after completion of crossing. If ground surface displacement in the pavement above the advancing pipe remains within the ground surface displacement requirements for 2 consecutive weeks, you may reduce the frequency of ground surface displacement monitoring survey to every 2 weeks.

50

Produce the surface model based on ground surface displacement monitoring survey data and compare with the pre-construction surface model. Each monitoring survey may have different grid points.

51

Notify the Engineer at completion of crossing for the Department to perform ground surface survey 1 month after completion of crossing.

52

If measured ground surface displacement exceeds the following requirements:

Ground Surface Displacement

|  |  |
| --- | --- |
| Quality characteristic | Requirement |
| Critical Structure Monitoring Points - Horizontal or Vertical (max, feet) | 0.02 |
| Highway surface (max, feet) | 0.04 |
| Surface street (max, feet) | 0.04 |
| Highway embankment (max, feet) | 0.2 |

53

1. Stop work

2. Notify the Engineer

3. Propose an alternative construction method

4. Propose a mitigation plan that includes methods to fill the voids created under the highway and surface street pavements by the construction and restore the density of subsurface materials

5. Increase ground surface displacement monitoring frequency to:

5.1. Every day until no additional displacement is detected in the areas that exceed the displacement requirements, then

5.2. Every two days until the displacement in the area above the advancing pipe remains within the displacement requirements for 2 consecutive weeks

##### 19-15.01D(5)(d) Subsurface Displacement Monitoring

54

Subsurface displacement monitoring is required if:

1. Culvert outside diameter is equal to or greater than 30 inches

2. Minimum vertical distance between the bottom of pavement and top of culvert is less than 6 times the culvert outside diameter

**55**

For subsurface displacement monitoring, install horizontal in-place inclinometers, ShapeArray, or multiple-point borehole extensometers.

**56**

The equipment and instruments for monitoring subsurface displacement must be accurate to 0.005 inches and have enough capacity to complete the measurements without being reset.

**57**

If you use horizontal in-place inclinometers or ShapeArray to monitor subsurface displacement:

1. Install 2 monitoring systems with:

1.1. One monitoring system at 2 feet above the crown and along the center line of the culvert.

1.2. One monitoring system at 2 feet above the crown and 5 feet away horizontally from the spring lines of the culvert.

2. The monitoring systems must provide displacement profile readings along the entire length of the culvert at an interval of 3 feet or less.

**58**

If you use multiple-point borehole extensometers to monitor subsurface displacement:

1. Install at 5-foot vertical spacing with the lowest extensometer placed at 2 feet above the crown of the culvert, and

2. Install at 10-foot horizontal spacing along the culvert center line.

**59. District Design, Land Surveys, and Utilities should work with utility companies to identify on the Plans the critical underground utilities near the culvert alignment that need to be monitored and the locations of the instruments to be placed. The instruments described in this section** **may be installed near the utilities when needed. But consider the cost.**

Install subsurface displacement monitoring instruments for critical utilities at locations shown.

**60**

Before construction, take readings from subsurface displacement monitoring instruments at least 3 times to establish pre-construction monitoring data that is accurate to ± 0.01 inches.

**61**

Perform subsurface displacement monitoring every working day, and every week for 1 month after completion of crossing.

**62**

If measured subsurface displacement exceeds the following requirements:

Subsurface Displacement

|  |  |
| --- | --- |
| Quality characteristic | Requirement |
| Subsurface displacement (max, inches) | 0.3 |

1. Stop work

2. Notify the Engineer

3. Propose an alternative construction method

4. Propose a mitigation plan that includes methods to fill the voids created under the highway and surface street pavements by the construction and restore the density of subsurface materials

##### 19-15.01D(5)(e) Culvert Line, Grade, and Shape

63

For each culvert:

1. Survey and record control lines at least 7 days before work

2. Observe and adjust measurements of survey control lines weekly. Report discrepancies to the Engineer.

64

Survey and record the centerline of the constructed culvert after each section is advanced, or every 5 feet of advancement, whichever is shorter.

**65**

Line and grade of a culvert centerline must meet the following requirements throughout the entire culvert alignment:

Line and Grade Deviation

|  |  |
| --- | --- |
| Quality characteristic | Requirement |
| Line (max, inches) | 6 |
| Grade (max, inches) | 1 |

**66**

Line and grade variations must be regular and in one direction, and the final flow line must be in the direction shown.

**67**

The completed culvert must have the shape and dimensions as shown throughout the length of the culvert.

## 19-15.02 MATERIALS

### 19-15.02A General

68

For pipe with inside diameter equal to or greater than 36 and less than 48 inches, the pipe sections must have pre-fabricated grout injection ports at the 12 o’clock position at every 8 feet longitudinally.

69

For pipe with inside diameter of 48 inches or larger, the pipe sections must have 3 pre-fabricated grout injection ports at 120-degree spacing at every 8 feet longitudinally.

## 19-15.03 CONSTRUCTION

### 19-15.03A General

70

Construct culvert to the line and grade shown. When a culvert is off line or grade, make immediate alignment correction.

71

Protect existing structures, pavement, and utilities. Restore and repair immediately any damage resulting from construction.

72

Maintain groundwater table at least 2 feet below the culvert invert and shaft bottom during construction.

73

Repair or replace any damaged pipe sections.

### 19-15.03B Excavation

74

Overcut must be less than 1 inch or less than 5% of the culver radius, whichever is less.

75

Notify the Engineer immediately if you encounter obstruction or condition that impedes construction.

### 19-15.03C Contact Grouting

**76**

After completion of culvert installation, inspect annular space for voids. Grout all voids within 48 hours of the completion of pipe installation.

**77**

For a culvert with inside diameter of 36 inches or larger, perform contact grouting through grout injection ports pre-fabricated on the pipe sections. For culvert with inside diameter less than 36 inches, perform grouting with access from the ground surface.

**78**

Grout for contact grouting must comply with section 71-3.01B(2).

**79**

For culvert with a stiffness less than 29 psi, grout pressure at the point of injection must be less than either of the following:

1. 5 psi

2. Manufacturer's instruction

**80**

For culvert with a stiffness greater than 29 psi, grout pressure at the point of injection must be less than 7.25 psi.

### 19-15.03D Restore Highway Pavement

81

After completion of culvert construction, restore highway pavement to conditions as required in section 19-15.01D(5). Restore Asphalt Concrete Pavement use mill and fill. Repair or replace concrete pavement with dowels for any cracks and spalling caused by construction.

### 19-15.03F Post-Construction Culvert Inspection

82

Inspect the entire length of the culvert using electronic video recorder or human entry. Perform inspection under sections 71-3.01A(4)(c)(ii) and 71-3.01A(4)(c)(iii).

## 19-15.04 PAYMENT

83

Not Used