261 Structural Supports for Signs, Signals, Lighting, ITS, and Tolling

261.1 General

The criteria for the structural design of sign, signal, lighting, ITS, and tolling support structures (aka Ancillary Structures) must be in accordance with AASHTO's ***LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals***, as modified by the ***Structures Manual, Volume 3***. Include structural details in the plans for all sign, signal, lighting, ITS, and tolling structures. Use the ***Standard Plans*** for sign, signal, lighting, ITS, and tolling support structures, unless site conditions or other considerations require a custom design.

When a custom support structure is required or otherwise specifically designated in the contract documents, the Engineer of Record (EOR) is responsible for the structural design (including foundations) and the review of the shop drawings. Details for supports attached to bridge structures must be coordinated with the bridge structural engineer and included in the plans. See ***Structures Design Guidelines, Section 1***, and ***Structures Manual, Volume 3,*** for details and restrictions related to making attachments to bridges.

It is the Departments preference to reuse existing mast arm foundations when possible. See ***FDM 261.8*** for guidance on reusing foundations. Foundation reuse may consist of reusing the foundation and anchor bolts as is or rehabilitating the foundation as required.

Sign and signal structures are limited to the following dimensions:

- ***Standard Plans, Index 700-041***, Span Sign Structure: Span Length ≤ 220 feet
- ***Index 700-040***, Cantilever Sign Structure: Cantilever Length ≤ 55 feet
- ***Indexes 700-040*** and ***700-041***, Cantilever & Span Sign Structure: Truss Depth ≤ 8 feet
- ***Indexes 649-030*** and ***649-031***, Standard Mast Arm Assemblies: Cantilever Length ≤ 78 feet
- ***Indexes 649-010*** or ***641-010,*** Steel or Concrete Strain Pole with Signal Cable: Span Length ≤ 250 feet

These dimensional limitations are applicable to both the designs contained within the ***Standard Plans*** and project-specific designs. Any sign or signal structure exceeding these dimensions requires an approved Design Variation with concurrence from the District Structures Design Engineer. See the applicable ***Standard Plans Instructions (SPI)*** for additional information on sign and signal structures.

Steel ancillary structures (highway signs, luminaires, traffic signals, ITS, and tolling) must use a galvanized coating per the ***Standard Plans***. They must not be painted or otherwise coated without written approval of the District Structures Design Engineer. If the local maintaining agency requests a painted or otherwise coated finish, the requesting agency is to provide the funding for the additional construction cost and be responsible for maintenance costs.

Modification for Non-Conventional Projects:
Delete the above paragraph and replace with the following: Steel ancillary structures (highway signs, luminaires, traffic signals, ITS, and tolling) must use a galvanized coating per the ***Standard Plans*** unless specified otherwise in the RFP.

See ***FDOT Modifications to LRFD Specifications For Structural Supports For Highway Signs, Luminaires And Traffic Signals (LRFDLTS-1),*** and ***Structures Manual Volume 3***, for limitations on the use of bridge-mounted signs.

261.2 Sign Support Structures

Use the applicable ***Standard Plans*** for the following sign support structures:

- ***Index 700-010*** Single Column Ground Signs
- ***Index 700-011*** Single Column Cantilever Ground Mounted Sign
- ***Index 700-012*** Single Post Bridge-Mounted Sign Support
- ***Index 700-013*** Single Post Median Barrier-Mounted Sign Support
- ***Index 700-020*** Multi-Column Ground Sign
- ***Index 700-040*** Cantilever Sign Structures (Overhead)
- ***Index 700-041*** Span Sign Structures (Overhead)

Refer to the corresponding ***SPI*** for design information.

For ***Standard Plans, Index 700-010*** Single Column Ground Signs, the contactor selects the appropriate pole size using the sign dimensions given in the plans and the four-step process given in the standard.

Where the distance between the curb and the sidewalk restricts the use of ***Standard Plans, Index 700-020***; ***Index 700-011*** may be used.

The EOR is responsible for the design of all multi-column ground signs and overhead sign structures (including bridge-mounted signs). This responsibility is for the entire sign

structure, including the supports and foundations, as well as all details necessary to fabricate and erect the sign structure. The EOR is also responsible for the shop drawing review in accordance with ***FDM 152*** when sign structure shop drawings are required by the contract documents.

FDOT assigns identification numbers to overhead sign structures. See the ***Structures Detailing Manual, Chapter 2*** for instructions.

Use FDOT standard overhead sign support structures whenever possible. Only use custom (non-standard) overhead sign support structures as a last resort solution. If a custom overhead sign support structure is required:

- Provide a brief written justification for its use.
- Coordinate the proposed design and details early in the plan development process with the District Structures Design Engineer.

Modification for Non-Conventional Projects:
Delete the last sentence above and replace with the following: Use of a custom (non-standard) overhead sign structure is not permitted unless otherwise shown in the RFP.

261.3 Lighting Support Structures

Use the applicable ***Standard Plans*** for the following lighting support structures:

- ***Index 715-010*** High Mast Lighting,
- ***Index 715-002*** Standard Aluminum Lighting.

Refer to the corresponding ***SPI*** for design information.

261.4 Traffic Signal Support Structures

Use the applicable ***Standard Plans*** for the following traffic signal support structures:

- ***Index 649-010*** Steel Strain Poles,
- ***Index 641-010*** Concrete Poles,
- ***Indexes 649-030*** and ***649-031*** Mast Arm Assemblies.

Refer to the corresponding ***SPI*** for design information.

See ***FDM 232*** for determining which locations require mast arms.

Design all structures assuming traffic signal assemblies have rigid backplates in accordance with ***FDM 232.1.5***

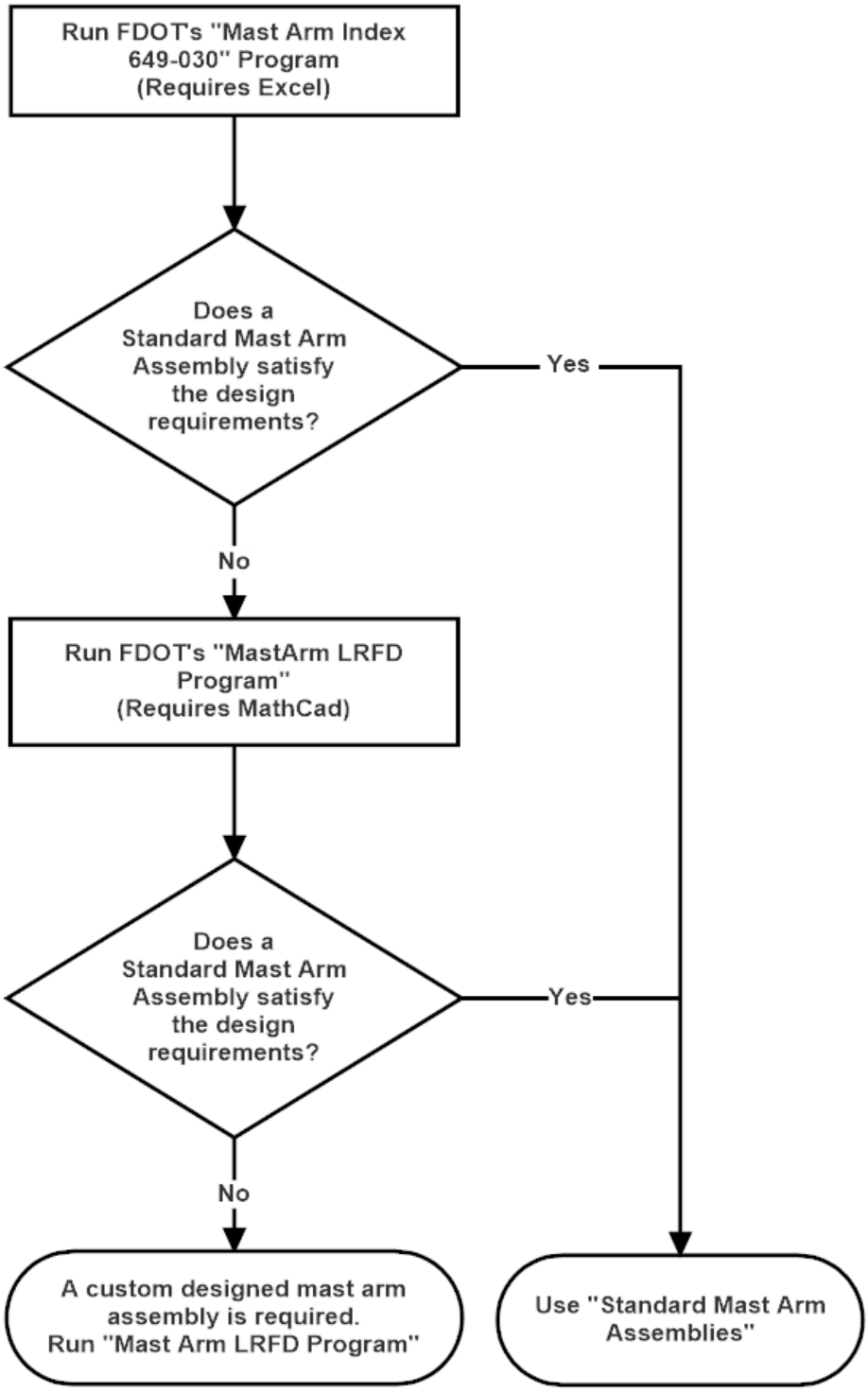
Span wire systems have two strain pole options, rectangular prestressed concrete and round steel. Round steel poles are typically used on longer spans where prestressed concrete poles do not have the required capacity.

For attaching free-swinging, internally illuminated street sign assemblies, see ***Standard Plans, Index 700-050***.

Mast arm assemblies may be standard mast arm signal structures, standard mast arms for site-specific loadings, or custom designs. Use the flowchart in ***Figure 261.4.1*** to determine which type of mast arm design is suitable for the particular application. See ***Standard Plans, Indexes 649-030*** and ***649-031*** and their ***SPI.***

See ***FDM 215.2.11*** for breakaway devices.

Figure 261.4.1 Flowchart for Designing Mast Arm Assemblies



261.5 ITS Support Structures

Use the applicable ***Standard Plans*** for the following ITS support structures:

- ***Index 649-020*** Steel CCTV Poles,
- ***Index 641-020*** Concrete CCTV Poles,
- ***Indexes 700-040*** and ***700-041*** Cantilever and Span Sign Supports to support Dynamic Message Signs (DMS). For additional DMS details, see ***Standard Plans***, ***Index 700-090*** Dynamic Message Sign Walk-In.

Refer to the corresponding ***SPI*** for design information.

Refer to the ***Structures Manual, Volume 3*** for dynamic message sign structure design requirements.

261.6 Toll Gantries

See ***FDM 284*** and the ***FDOT Structures Manual, Volume 3, Chapter 19*** for the design of tolling support structures

261.7 Foundations

Unique site circumstances may require the foundation variables to be modified from the foundations shown in the ***Standard Plans***. If custom designs are required, the Geotechnical Engineer must provide the soil information to be used by the EOR during the design phase of the project.

The foundation design and drawings where special foundations are required are the responsibility of the EOR. The Geotechnical Engineer must provide the EOR the following soils information (this information may be derived from the borings of other nearby structures or from roadway borings):

(1) Soil Type and SPT-N Value

(2) Effective Unit Weight of the Soil

(3) Design High Water Table Level

(4) Effective Friction Angle of the Soil (if applicable)

(5) Cohesion Value (if applicable)

(6) Coefficient of Horizontal Subgrade Reaction

(7) Factored Bearing Resistance (if applicable)

Include the above soils information in the plans. Additionally, Soil Boring Data Sheets must be included in the plans, except for strain poles. This will provide the contractor with

the conditions for which the foundations were designed (as compared to actual on-site conditions) and will establish criteria for any future analysis of the foundations.

261.8 Evaluating Existing Ancillary Structures

Evaluate existing ancillary structures within the project limits in accordance with this section to produce the Ancillary Structures Report as described below in ***FDM 261.8.4***.

When only retrofitting 'flexible' backplates to existing mast arm or span wire signals, see the ***Traffic Engineering Manual (TEM)***.

When existing mast arm structures are being replaced in the same location, perform a condition evaluation of the existing foundation and anchor bolts per ***FDM 261.8.1***. If the condition evaluation and ***Structures Manual, Volume 3 Section 18.2*** criteria are met, the existing foundation and anchor bolts can be reused.

If it's determined that the anchor bolts or concrete foundation cannot be reused as-is, design a foundation rehabilitation per ***Structures Manual Volume 3***. The rehabilitation design must expose the full length of the existing anchor bolts for removal. Install new stirrup reinforcing and anchor bolts as part of the foundation rehabilitation design. The DSDE must approve the reuse or rehabilitation of existing foundations.

Obtain existing plans of the mast arm structures as required. If existing plans are unavailable, use other methods to determine shaft dimensions such as Pile Integrity Testing (PIT) for shaft length. If an existing foundation and anchor bolt system is proposed to be reused, obtain a template of the existing anchor bolt pattern and specify an upright baseplate which can accommodate the existing anchor bolts. See ***Figure 261.8.1*** for guidance on selecting a foundation reuse or rehabilitation procedure.

261.8.1 Condition Evaluation

Perform a Condition Evaluation for ancillary structures that have a proposed change in loading conditions or are proposed for relocation. A Condition Evaluation is a physical and functional assessment that includes inventory of attachments, damage, deterioration, or other potential defects that may cause a reduction in service life or design capacity. Coordinate with the District Structures Design Engineer (DSDE) and District Structures Maintenance Engineer (DSME) prior to performing the Condition Evaluation. Consider the findings of the Condition Evaluation and how the condition may affect the structural capacity of the ancillary structure, paying special attention to items added after initial construction and changes to the structure's section properties. Based on the findings, determine if a detailed structural analysis is required in coordination with the DSDE.

Sources for as-built plans include ***ProDo*** (ProDo is accessible to FDOT staff only), the District Maintenance Office, and the District Design Office.

If a condition evaluation is being performed for mast arm replacement foundation reuse, make the determination if the foundation and anchor bolts can be reused as-is.

261.8.2 Existing Ancillary Structures to Remain In-Place

When adding new or modifying existing attachments to existing ancillary structures, mitigation strategies should be used to reduce additional structural loading to the extent practicable. For example, some mitigation strategies could include:

- Relocating street name signs, no right turn on red signs, or other attachments to the mast arm upright or closer to the base of the arm.
- Shifting the location of existing signals closer to the mast arm upright while maintaining tolerance for lane alignment.
- Replacing existing rigid signal backplates with flexible backplates.
- Replacing existing attachments with lighter/smaller devices that provide the same/similar function and meet ***Manual on Uniform Traffic Control Devices (MUTCD)*** minimum requirements.

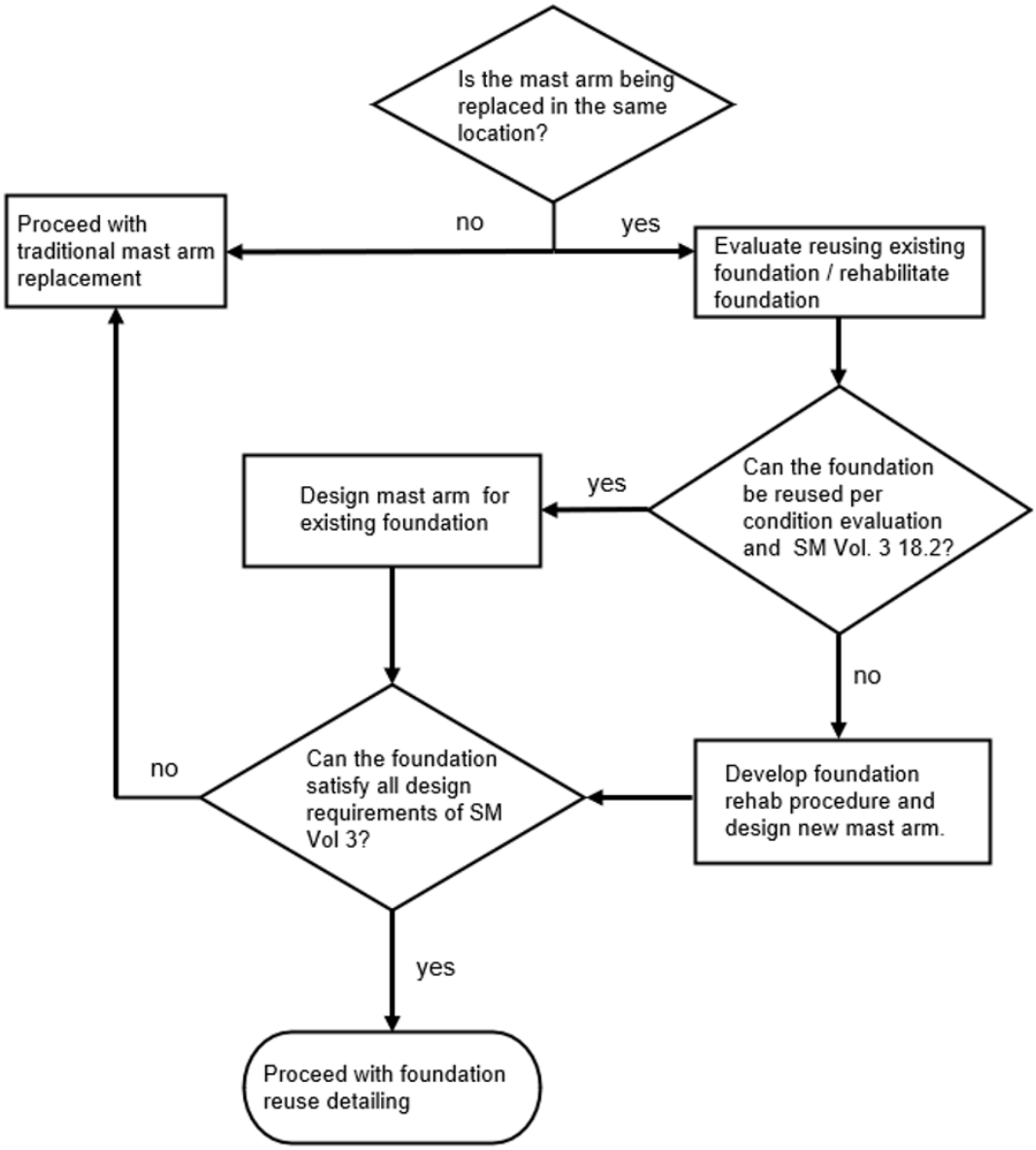
261.8.2.1 Determination of need for Detailed Structural Analysis

A detailed structural analysis of an existing ancillary structure is not required for replacing attachments in-kind (e.g., same or less critical location on the structure; same or less weight or size/EPA) unless warranted by the findings of the Condition Evaluation.

A detailed structural analysis may not be required when adding, modifying, or replacing attachments as described in the following for each ancillary structure type. For these cases, provide a justification in the Ancillary Structures Report. The one-time allowance for additional loads/areas herein is for all attachments in excess of the original design configuration throughout the life of the structure.

Commentary: In some cases, the benefit of adding safety devices to existing structures may outweigh the potential risk of structural failures during the design extreme event limit state. The Department has determined that some level of risk is acceptable to improve safety and that replacement of a slightly overstressed ancillary structure based on an extreme high-wind event is not desirable.

Figure 261.8.1 Flowchart for Determining Foundation Reuse



- **Lighting Structures:**

  Fixtures may be replaced with those having a similar Effective Projected Area (EPA, typically provided by the manufacturer) without detailed structural analysis. The total EPA of all fixtures on the structure must not increase by more than 10% above the documented design EPA (e.g., from Standard Plans Instructions, shop drawings, etc.). If the documented design EPA is not available, use the total existing fixture EPA. Otherwise, perform a detailed structural analysis as described below.

- **Service or CCTV Poles:**

  A total area for existing and proposed attachments of less than 6 square feet may be attached to the upright/vertical pole without detailed structural analysis. For standard CCTV camera support structures, see the ***SPI*** for ***Index 641-020*** (Concrete CCTV Pole) and ***Index 649-020*** (Steel CCTV Pole) for additional loading allowed for future operating needs without a detailed structural analysis. Otherwise, perform a detailed structural analysis as described below.

- **Span and Cantilever Overhead Sign Structures:**

  Sign panel modifications that comply with the original design (e.g., design has already accounted for future panels) do not require a detailed structural analysis. A total area of less than 6 square feet for existing and proposed attachments (other than sign panels) may be attached without detailed structural analysis. Otherwise, perform a detailed structural analysis as described below.

- **Tolling Structures:**

  A total area for proposed attachments (sign panels cannot be attached to tolling structures) of less than 6 square feet may be attached without detailed structural analysis. Otherwise, perform a detailed structural analysis as described below.

- **Strain Pole Structures:**

  For additional devices attached only to the vertical upright with a total area of less than or equal to 18 square feet and a total weight of less than or equal to 145 pounds, no structural capacity analysis is required. Otherwise, perform a detailed structural analysis as described below.

  Commentary: The size and weight limits of the additional devices are roughly based on the maximum allowable for internally illuminated street name signs per ***Standard Specifications, Section700****.*

- **Standard Mast Arm Structures:**

  A “Standard Mast Arm” support structure is one that has previously been, or is currently, included in the ***FDM*** or ***Standard Plans***, regardless of the publication dates. These structures should contain an Identification Tag specifying the Arm

Type which can be used to determine the moment capacity of the horizontal support members. The Arm Type or Identification Tag may be noted in the Department's Bridge Management System (BrM). For structures without an Identification Tag, use the criteria below for non-standard mast arm structures.

Commentary: The Identification Tag is typically located under the handhole cover or terminal compartment cover plate. Access to the handhole cover or terminal compartment should be coordinated with the District Maintenance Office.

For standard mast arm support structures with additional devices attached only to the vertical upright with a total area of less than or equal to 18 square feet and a total weight less than or equal to 145 pounds, no analysis is required.

*Commentary: The size and weight limits of the additional devices are roughly based on the maximum allowable for internally illuminated street name signs per **Standard Specifications**, **Section 700**.*

For standard mast arm support structures with additional loading that results in flexural demand/capacity ratios at the base of the horizontal member less than or equal to 1.10, no further analysis is required. Use the FDOT ***Mast Arm Evaluation Program*** to determine the flexural demand/capacity ratio of the horizontal member.

For standard mast arm support structures with additional loading that results in flexural demand/capacity ratios at the base of the horizontal member greater than 1.10, perform a detailed structural analysis.

For standard mast arm support structures with existing foundations to be reused, and a new arm and upright installed, perform a detailed structural analysis when the proposed mast arm would exceed anchor bolt loads when compared to the existing loading condition. The DSDE must approve whether any existing foundations are to be reused.

- **Non-Standard Mast Arm Structures:**

  For non-standard mast arm structures or those without an Identification Tag, the original as-built plans should be obtained to determine the original configuration of the attachments.

  For non-standard mast arm support structures with additional devices attached only to the vertical upright with a total area of less than or equal to 18 square feet and a total weight less than or equal to 145 pounds, no analysis is required (see commentary above).

  For non-standard mast arm support structures with additional loading (as compared to the configuration of the attachments in the original as-built plans) on the horizontal member that produces an increase in the moment at the base of the

horizontal member of less than or equal to 10%, no further analysis is required. Use the FDOT Mast Arm Evaluation Program to determine percentage increase in moments at the base of the horizontal member.

For non-standard mast arm support structures with an increase in moment at the base of the horizontal member greater than 10%, perform a detailed structural analysis.

For non-standard mast arm support structures with existing foundations to be reused but a new arm and upright are installed, perform a detailed structural analysis when the proposed mast arm structure would exceed anchor bolt loads when compared to the existing loading condition including the one-time allowance for additional loads. The DSDE must approve whether any existing foundations are to be reused.

261.8.2.2 Detailed Structural Analysis

When a detailed structural analysis is required, evaluate the capacity of the structure in accordance with the ***Structures Manual, Volume 3***. The DSDE must review the detailed structural analysis and provide final direction to allow the existing structure to remain, strengthen the existing structure, or replace the existing structure. For projects not in a typical design-bid-build or design-build contract (e.g., permit, push-button, safety), consult the District Traffic Operations Engineer (DTOE) instead of the DSDE. Obtain concurrence from the DSME. The DSME must document the DSDEs or DTOEs decision in BrM.

Contact the DSDE for guidance on a detailed structural analysis for existing ancillary structures without plans, shop drawings, foundation depths, or design calculations.

261.8.3 Existing Ancillary Structures to be Relocated

Perform a Condition Evaluation and detailed structural analysis for all ancillary structures to be relocated.

261.8.4 Ancillary Structures Report

Produce an Ancillary Structures Report including the following:

- Listing of ancillary structures within the project limits including their proposed disposition (e.g., remain in place, relocate, replace, remove)
- Condition Evaluation (if required)
- Justification for when a detailed structural analysis is not required

- Detailed structural analysis (if required)
- Documentation of any required remedial actions
- Other items as specified by the District

Submit the Ancillary Structures Report to the DSDE and the DSME. The Ancillary Structures Report will be stored in PSEE.