MassDOT

Drainage Mapping Guide

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January 2024

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May 2026

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1 Overview

The intent of this guide is to assist MassDOT in the inventory of MassDOT drainage infrastructure in the stormwater asset database. This guide provides information on the interfaces, approaches, and best practices for mapping drainage features in the MassDOT stormwater asset database.

MassDOT owns and maintains an extensive network of roadways and associated stormwater system infrastructure throughout the State of Massachusetts. MassDOT maps and tracks their stormwater assets in a database which contains attributed geospatial data of various drainage infrastructure including inlets, manholes, conveyances, discharge points, and stormwater control measures (SCMs). MassDOT's existing drainage data has been collected incrementally through past mapping efforts and MassDOT's design consultants, either via Water Quality Data Form (WQDF) submissions or direct map inputs.

Completion and accuracy of the existing data varies based on the method of data collection. At the time this guide was first developed, in early 2021, the majority of existing inlet and manhole features were mapped via drive-by Lidar detection and digitizing, and were not field verified or cross checked with drainage plans to confirm attributes such as ownership or utility type. Existing pipe data was limited and mapped on a project basis as needed using georeferenced drainage plans.

MassDOT is working to complete mapping of their stormwater system infrastructure through a dedicated drainage mapping effort. Improving the completeness, accuracy, and consistency of mapped stormwater assets will allow MassDOT to continue to plan and operate a successful stormwater program that supports the safety of the Commonwealth and minimizes environmental impacts while maintaining a properly functioning system.

The goal of MassDOT's drainage mapping effort is ultimately to map the entirety of MassDOT's drainage system along all MassDOT roadways. MassDOT will assign mapping areas based on priority to mapping professionals. This guide outlines MassDOT's expectations and workflows to be used when completing a drainage mapping assignment.

2 Approach to Statewide Mapping

Stormwater features are stored in a centralized stormwater asset database owned and maintained by MassDOT. This drainage information is compiled through use of centralized resources, as discussed in this section.

The workflow for completing drainage mapping of an assigned area includes both desktop and field tasks, as shown below in Figure 1. Gathering initial data, georeferencing plans, and initial mapping of stormwater features are desktop tasks. For roadways missing significant drainage data or features missing key attributes, a gap analysis is performed, and field work completed to finalize mapping. Field work may not always be necessary, and mapping staff should only plan for field visits if directed by MassDOT.

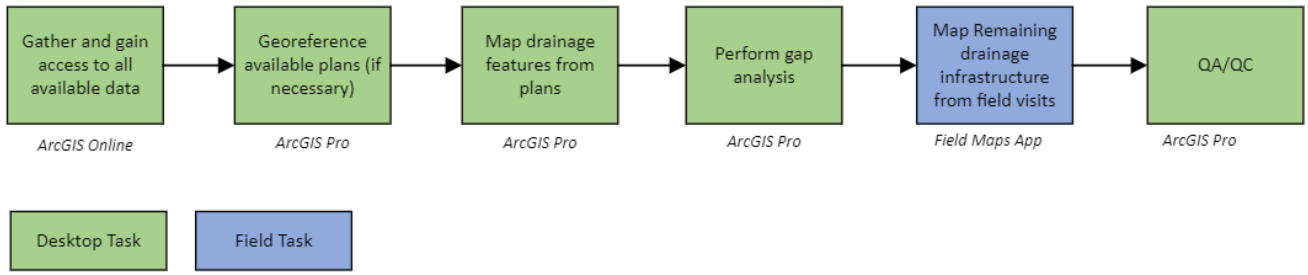


Figure 1

2.1 ESRI Platform

The geographic information system (GIS) mapping applications created by ESRI provide platforms to collect, organize, and share data. ESRI applications allow for desktop and field data collection, data analysis, and reporting. MassDOT uses ArcGIS Pro (desktop), Field Maps for ArcGIS (mobile), and ArcGIS Online for data collection and sharing. MassDOT's stormwater asset database is accessible through ArcGIS Online in the cloud, allowing for data that is updated through any of these three ESRI applications to be synced across all platforms and accessible in real-time. For this drainage mapping effort, each mapping professional will be assigned a version of the stormwater asset database to edit. Edits should only be made to your assigned version and the QAQC Lead will review and approve the edits prior to merging the changes to the parent or "default" database.

Below is a brief overview of each platform used in this drainage mapping effort.

For this drainage mapping effort, adding and editing data should be completed by accessing the MassDOT Drainage Mapping Versioning map in ArcGIS Pro or the Field Maps app.

2.1.1 ArcGIS Online

ArcGIS Online (AGOL) is a cloud-based mapping platform which is used to share and collaborate maps and data. MassDOT has created an online Stormwater Inventory group and a MassDOT Drainage Mapping Versioning map in AGOL specifically for mapping stormwater drainage data. This web map can also be opened in either ArcGIS Pro or the Field Maps app.

Only members of MassDOT's Stormwater Inventory group who have been set up with MassDOT GIS Portal accounts are allowed access to the MassDOT Drainage Mapping Versioning web map and have permission to add and edit stormwater data. Each mapper also will need their own Database Version to complete their mapping work in. To request a GeoDOT account, submit a GeoDOT request form found on MassDOT's webpage (https://www.mass.gov/forms/request-a-geodot-account) and contact a member of MassDOT's Stormwater Unit to be added to the MassDOT Stormwater Inventory group. You will also need to coordinate with MassDOT's Stormwater Unit Unit) to ensure you have access to your own Portal account and Database Version.

2.1.2 ArcGIS Pro

ArcGIS Pro is ESRI's desktop GIS application used to view and edit data and perform geoprocessing. ArcGIS Pro can be used to view existing stormwater data and reference layers, edit attributes, add and delete features, and georeference drainage plans. ArcGIS Pro allows more flexibility and functionality for editing and manipulating data than AGOL.

For this drainage mapping effort, ArcGIS Pro is the primary application for digitizing and editing stormwater data.

To set up ArcGIS Pro for editing MassDOT drainage data, follow the steps below:

1. Download ArcGIS Pro software to a desktop computer.
2. Obtain an advanced license. An advanced license is required to edit data in the MassDOT stormwater asset database.
   - Under "Setting" click on "Licensing"
   - Click on "Configure you licensing options" and click on "ArcGIS Pro Advanced"
3. Open ArcGIS Pro and sign in to AGOL using your GeoDOT (https://massdot.maps.arcgis.com/) account information (Figure 2).

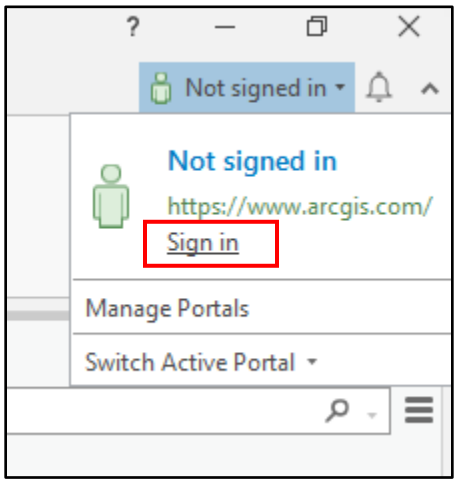


Figure 2

4. Click the "Manage Portals" button and then click "Add Portal" and paste the following URL to add the MassDOT GIS Portal to your Project: https://gis.massdot.state.ma.us/portal/ Sign in to this portal using the credentials you received from MassDOT GIS. These login credentials will be distinct from your GeoDOT login credentials. This will allow you to access the database versions which you will need to make edits.
5. Set AGOL (https://massdot.maps.arcgis.com/) to be the active portal using the "Switch Active Portal" button. This is required to edit MassDOT drainage data and also allows MassDOT to track the date features are added to the database or edited and which user last edited them.
6. Open a Map from the Blank Template (Figure 3). Give your project a name and click "OK".

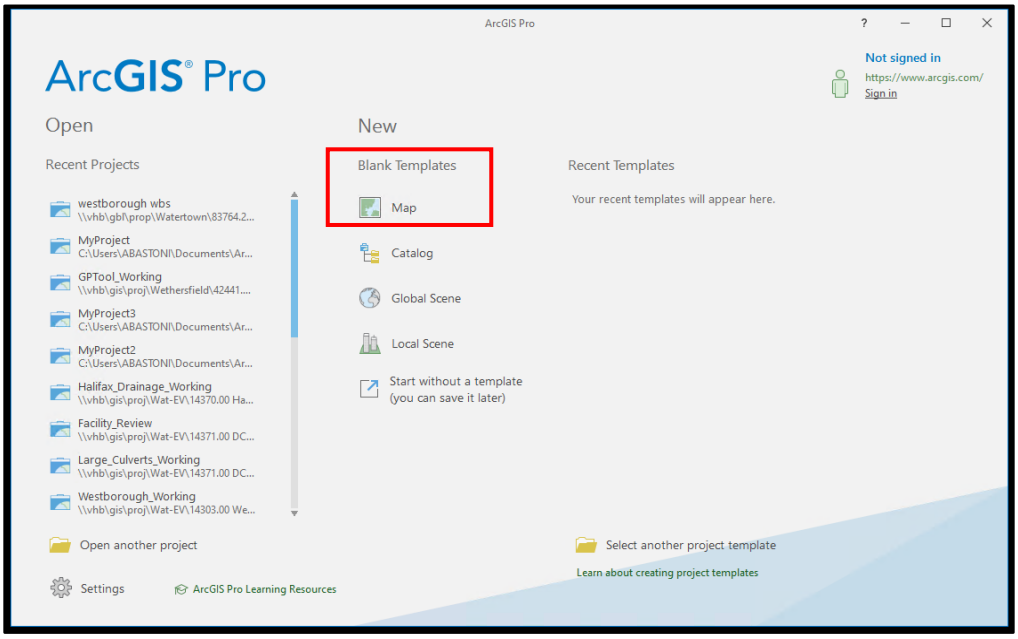


Figure 3

7. In the View tab, click on Catalog Pane (Figure 4).

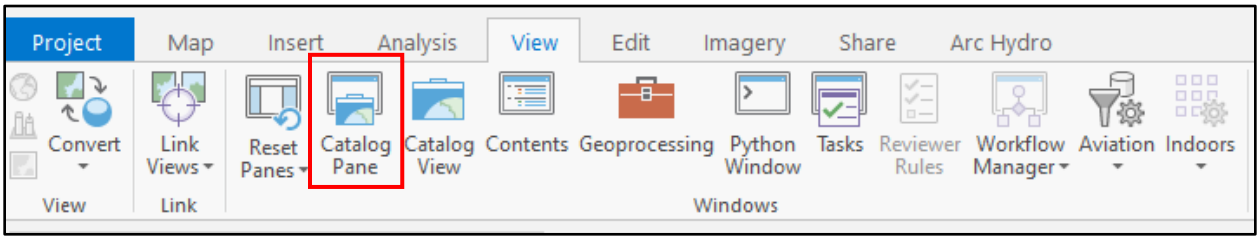


Figure 4

8. In the Catalog Pane, click on Portal, then the icon for "My Groups" (Figure 5). Toggle to "Groups" on the far right to bring up a list of AGOL groups where you are a member. Double click Stormwater Inventory.

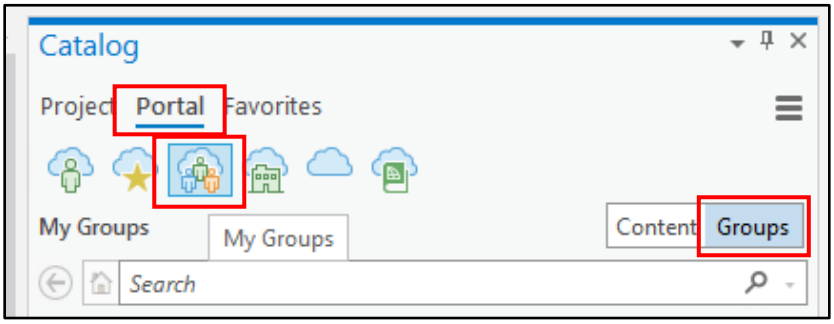


Figure 5

9. Right click on the MassDOT Drainage Mapping Versioning map and select "Add and Open" (Figure 6). It may take a few minutes to load and open the map.

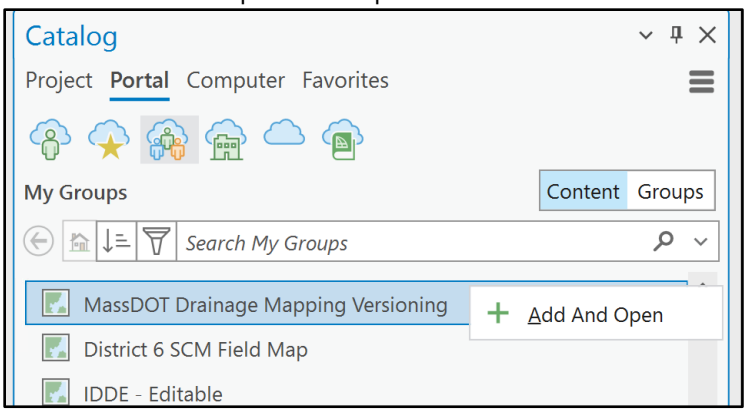


Figure 6

10. In the Contents Pane, navigate to Map Properties. On the Coordinate Systems tab, select "NAD 1983 StatePlane Massachusetts FIPS 2001 (Meters)" if not already listed as the current coordinate system (Figure 7). Click OK and save your ArcGIS Pro project.

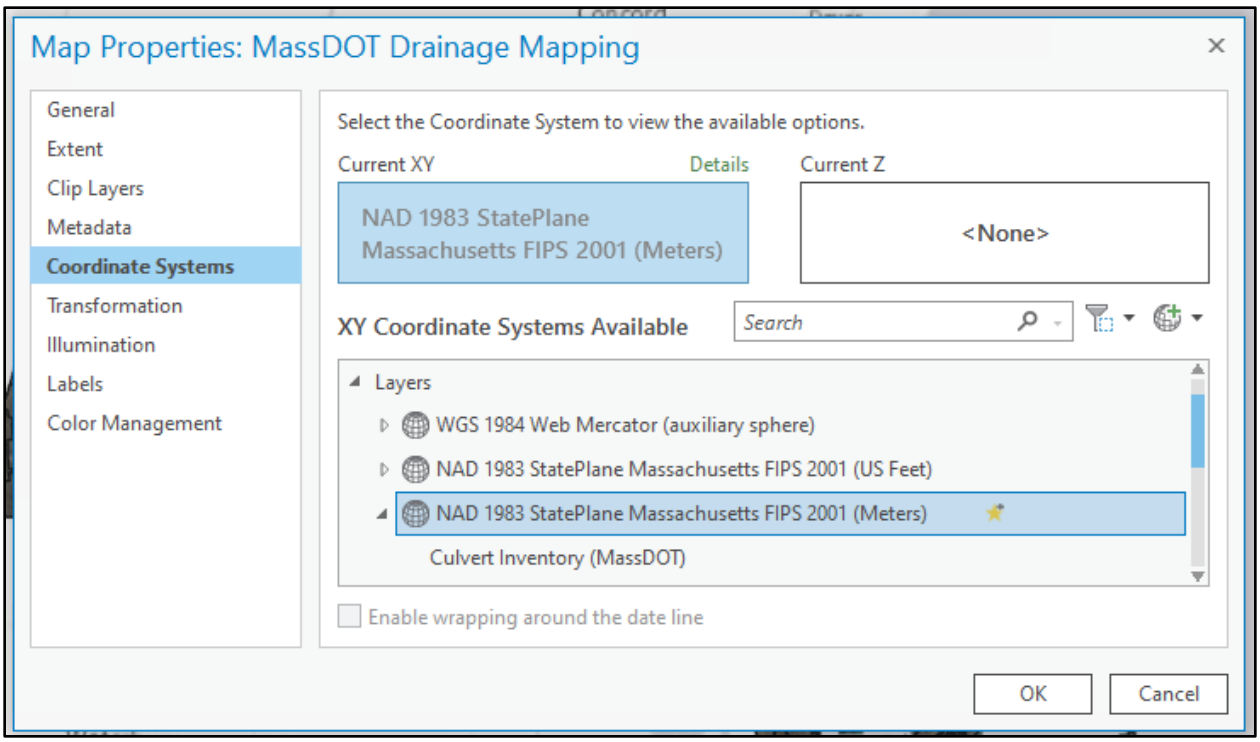


Figure 7

11. In the Contents Pane, select List by Data Source. Right click on "sde.DEFAULT (swAssets)" and select Change Versions (Figure 8).

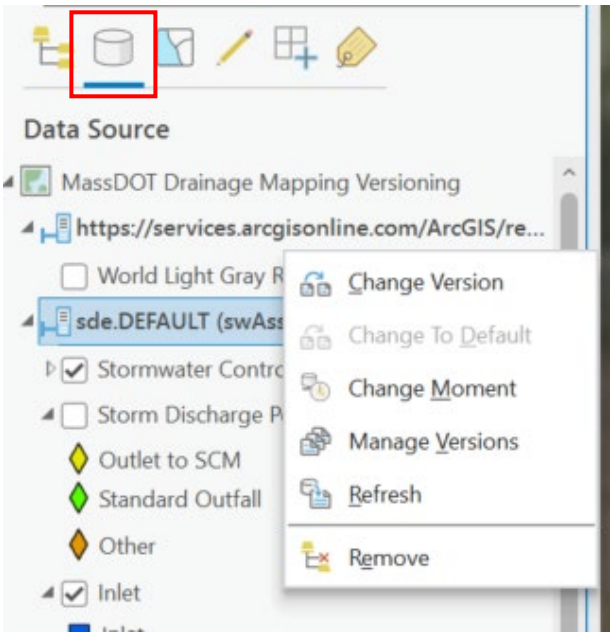


Figure 8

12. Select the database version assigned to you and click OK (Figure 9). It may take a few minutes to switch. In the Contents pane, confirm the data source for the stormwater asset layers updated to the name of the version you selected. Save your ArcGIS Pro Project.

Important! If you do not see points in a version that were mapped, check that they were not accidentally mapped in the default database.

If points were mapped in the default database instead of a version – contact the QAQC Lead to determine next steps. Do **NOT** map these points again in the version as this may create duplicate features.

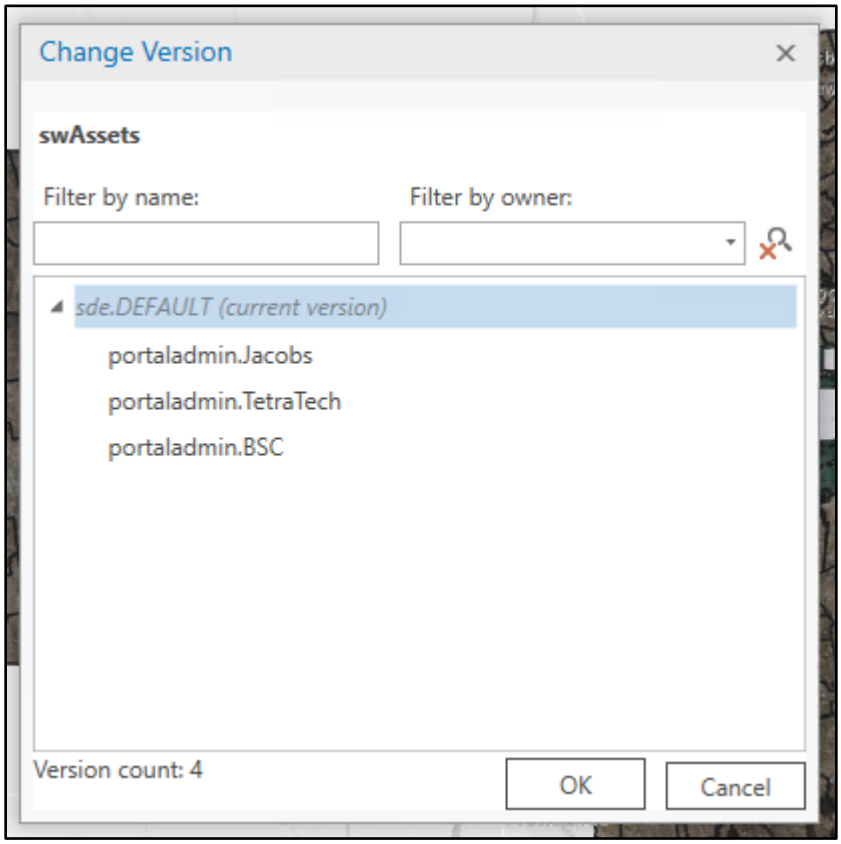


Figure 9

For this drainage mapping effort, the Field Maps app will be used for data collection and editing anytime field work is required.

2.1.3 Field Maps for ArcGIS

Field Maps for ArcGIS (Field Maps app), is a mobile data collection app, which allows users to capture GIS data in the field or remotely. Users in the field utilize web maps on mobile devices to capture and edit data. The Field Maps app will work even when it is disconnected from the Internet and integrates back into AGOL and ArcGIS Pro desktop maps.

The Field Maps app is available on Android, iOS, or Windows devices. This guide includes screen shots from an iOS device. While similar, the layout and use of the Field Maps app on other devices may vary slightly.

To set up the Field Maps app for editing MassDOT drainage data, follow the steps below:

1. Download and open the ESRI ArcGIS Field Maps App (Figure 10). The App can be found within the App Store on all mobile devices.

Figure 10

2. Select "Sign In with ArcGIS Online". Under ArcGIS login, enter your GeoDOT username and password and click "Sign In" (Figure 11).

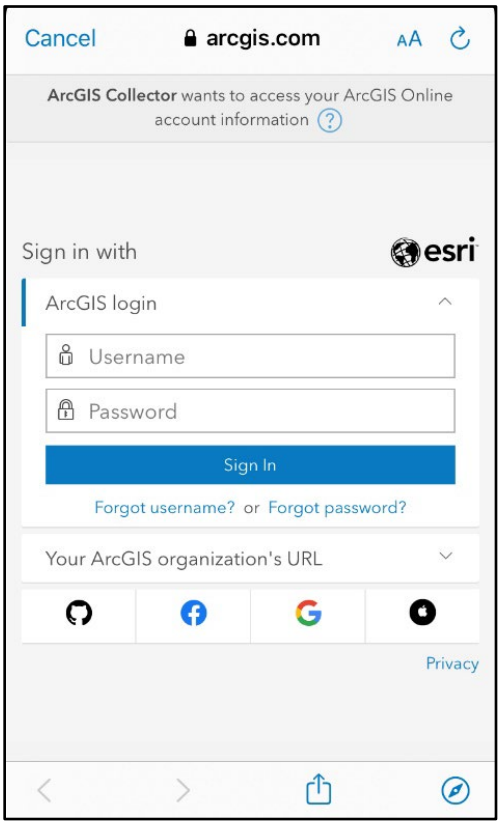


Figure 11

3. Scroll down to Groups and select the Stormwater Inventory group (Figure 12).

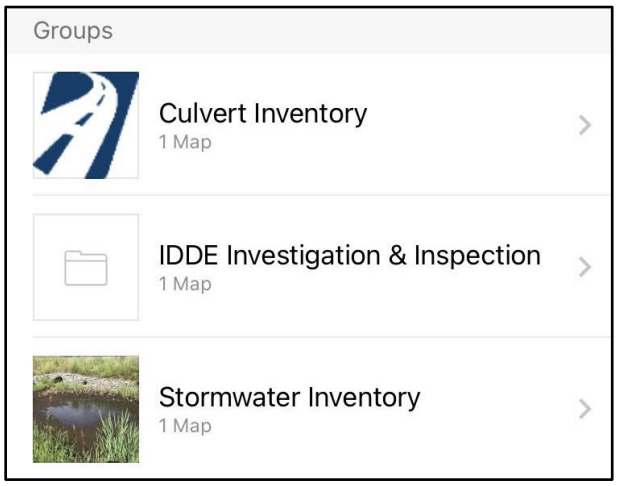


Figure 12

4. Select the MassDOT Drainage Mapping Versioning map (Figure 13). See **Section 4** for detailed guidance on field mapping in ArcGIS Field Maps.

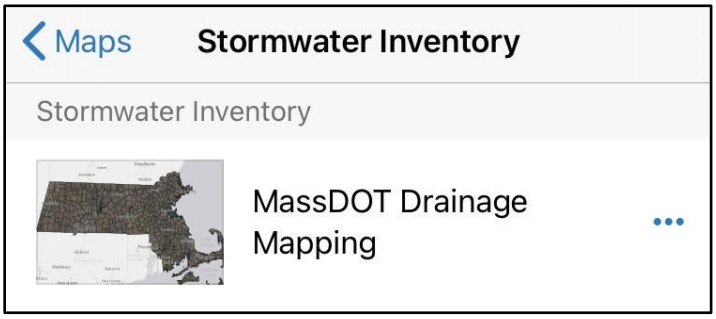


Figure 13

2.2 Data Sources

Desktop mapping of MassDOT stormwater assets relies on several data sources, including existing MassDOT and other statewide GIS data, record construction plans, municipal data (if available), and other tools, such as pictometry and aerial imagery. The following data sources are potential references for this drainage mapping effort as further described in the following sections:

- MassDOT Roads Inventory (https://gis.massdot.state.ma.us/arcgis/rest/services/Roads/RoadInventoryYearEndFiles/FeatureServer)
- MassDOT Culvert Inventory (https://geo-massdot.opendata.arcgis.com/datasets/fe0b508f917242a39dbe5c43c757f21e_0/explore)
- MassDOT Bridges Inventory (https://geo-massdot.opendata.arcgis.com/datasets/7008c8d283f64612b1267e2b36867fd3_0/explore)
- MassDOT record construction plans
- MassDOT stormwater assets database https://gis.massdot.state.ma.us/arcgis/rest/services/Assets/Stormwater/FeatureServer

- USGS National Hydrography Dataset (NHD) Flowlines (https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer)
- Pictometry (https://gis.massdot.state.ma.us/dataviewers/pictometry/)
- Aerial imagery (https://www.mass.gov/guides/connecting-to-massgis-ortho-image-web-services)
- Municipal data (if available)

2.2.1 MassDOT Inventory Layers

MassDOT has developed inventory layers in GIS for roadways, bridges, and culverts.

Roadway Inventory

The Road Inventory layer contains a year-end snapshot of the spatial line work for all of the public and a good portion of the private roadways in Massachusetts. This layer includes roadway attributes for roadway classification, ownership, and route number (Figure 14). For this drainage mapping effort, review this layer to confirm which roadways are MassDOT owned using the "Jurisdiction" field. MassDOT owned roadway features are designated by either the coded value of "1" or directly as "Massachusetts Department of Transportation". Occasionally segments of a MassDOT roadway will have a jurisdiction = null in the roadway inventory. Where these segments are clearly part of a MassDOT roadway network (i.e., ramps, interchanges, highways, etc.), include these segments in this mapping effort. Similarly, where a roadway is not listed as having Jurisdiction =1 but is shown on a plan set within the State Highway Layout, this roadway should be considered MassDOT owned and mapped as part of this mapping effort.

Stormwater assets should be mapped for all MassDOT roadways (Jurisdiction = 1). Assets on any municipal or privately owned roadways should not be mapped.

The most up-to-date road inventory layer is accessible on MassDOT's GIS open portal (https://gis.massdot.state.ma.us/arcgis/rest/services/Roads/RoadInventoryYearEndFiles/FeatureServer) and is also included as a reference layer in the MassDOT Drainage Mapping Versioning map in the Stormwater Inventory group.

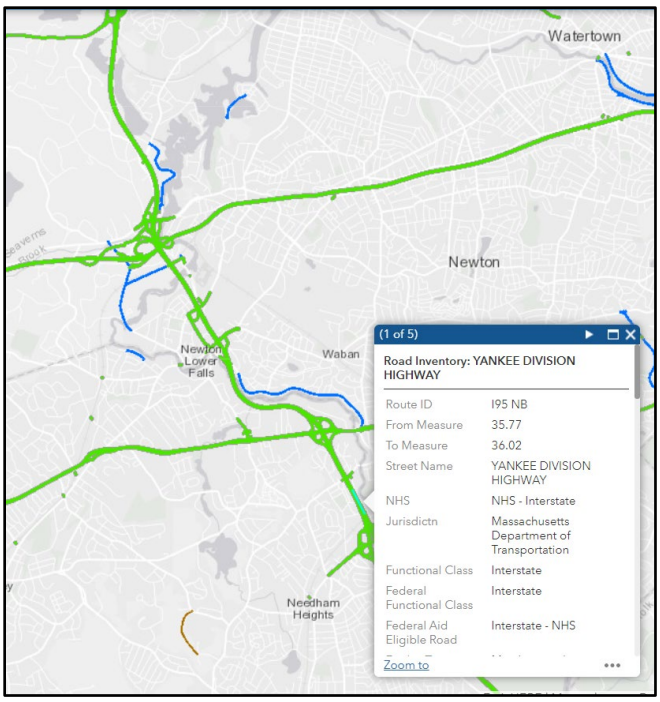


Figure 14

Bridge & Culvert Inventories

The bridge layer contains bridge data from the MassDOT Highway Division Bridge Inspection Management System (Figure 15) including:

- MassDOT and municipally-owned structures with spans greater than 20 feet (National Bridge Inventory structures),
- MassDOT Highway and municipally-owned short span bridges with spans between 10 to 20 feet (BRI structures), and
- MassDOT Highway and municipally-owned culverts with spans of 4 to 10 feet (Note: This category is incomplete and an inventory effort is underway).

The culvert layer contains culverts not included in the Bridge Inspection Management System and are typically smaller than 48-inches in diameter. Culverts in this layer were mapped using georeferenced record construction plans or via field confirmation.

The most up-to-date bridge and culvert inventory layers are accessible on MassDOT's GIS Open Portal (https://gis.massdot.state.ma.us/arcgis/rest/services/Roads/Bridges/MapServer/0 and https://gis.massdot.state.ma.us/arcgis/rest/services/Assets/Culverts/MapServer/0) and are also included as reference layers in the MassDOT Drainage Mapping Versioning map in the Stormwater Inventory group.

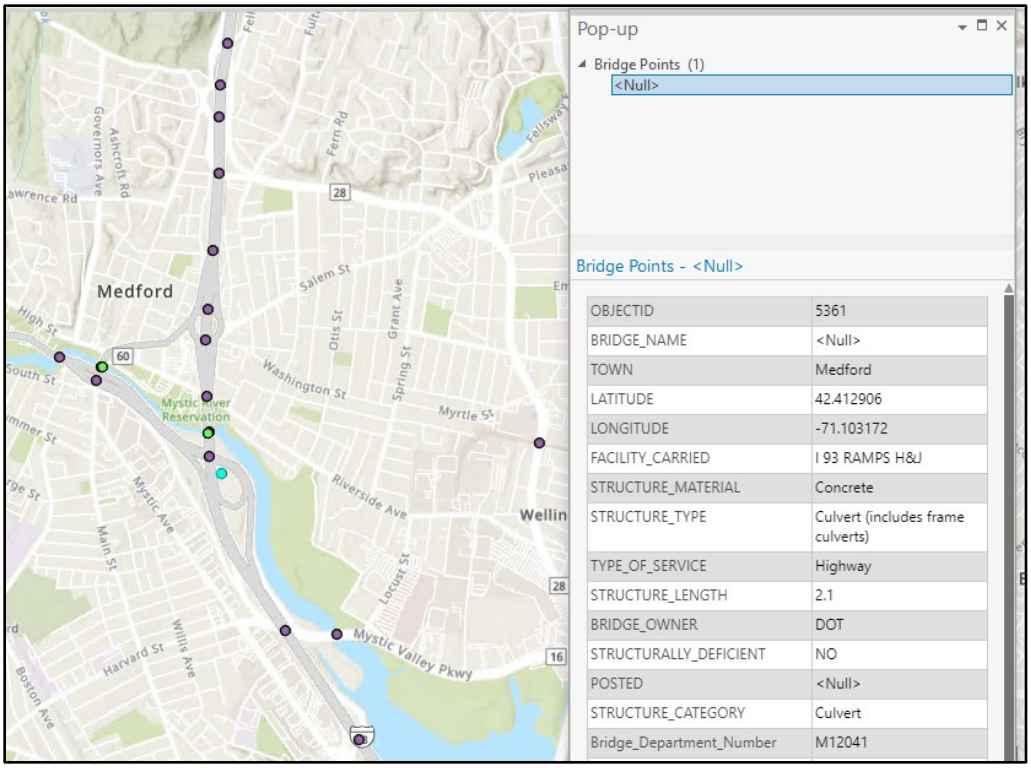


Figure 15

2.2.2 MassDOT Record Construction Plans

The MassDOT Mapping Lead will be responsible for locating and obtaining record construction plans for each assigned mapping area. If additional plans are necessary to complete the drainage mapping, they may be requested through the MassDOT Plans and Records Office (https://www.mass.gov/highway-plans-records). Record construction plans obtained through Mapping Lead and this office will need to be georeferenced (see instructions in **Section 3.2)**.

2.2.3 MassDOT Stormwater Asset Database

MassDOT's stormwater asset database contains many previously mapped features. However, the drainage network of a roadway may be incomplete (e.g., structures are mapped, but not conveyance features) or information about existing assets may be incomplete or missing. Previously mapped features can be used to identify where closed stormwater drainage systems exist (as opposed to country drainage) as well as data gaps. Figure 16 shows a typical example of an area where some stormwater assets have been previously mapped, but assets are missing.

MassDOT's stormwater asset database is accessed in ArcGIS Pro through the MassDOT Drainage Mapping Versioning map as outlined in **Section 2.1.2.**

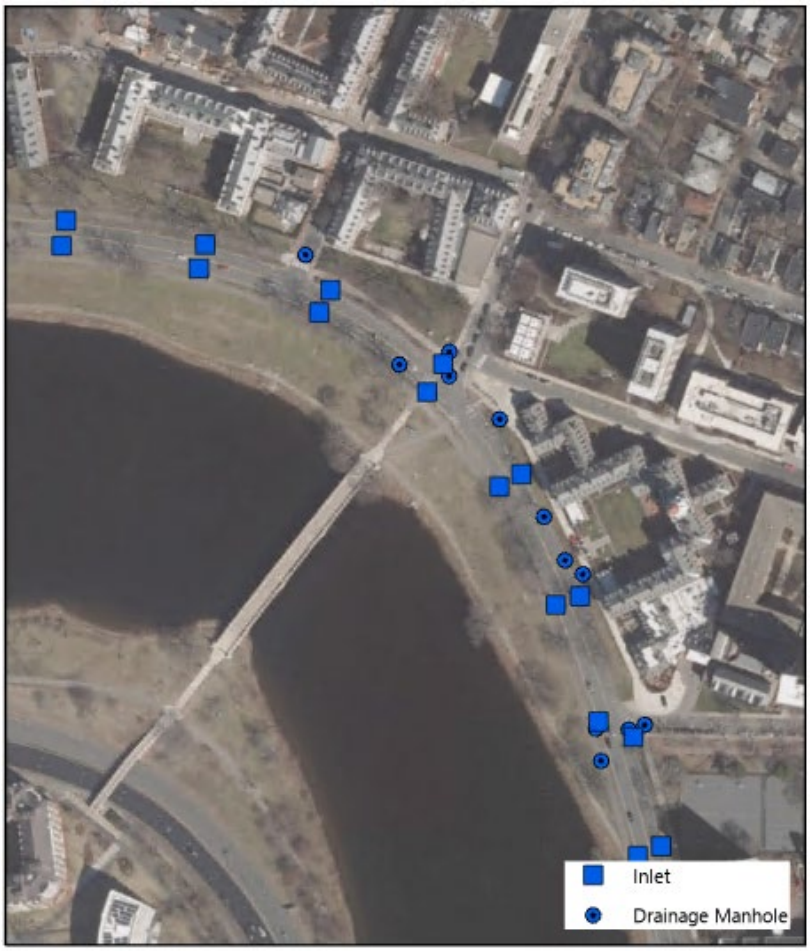


Figure 16

2.2.4 Other Data Sources

USGS NHD FlowLines

The USGS NHDPlus Flowline layers are part of a dataset comprised of stream networks, stream reaches, elevation-based catchment areas, and flow surfaces. This layer can be used as a reference as part of this drainage mapping effort to identify permanent and intermittent streams, and potential culvert or conveyances not identified in other data sources.

The NHD Flowlines layers are accessible on USGS's website (https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer) and are also included as reference layers in the MassDOT Drainage Mapping Versioning map in the Stormwater Inventory group.

Aerial Imagery & Pictometry

High resolution aerial imagery can be used as another data source to identify and confirm the locations of stormwater assets, such as inlets, manholes, check dams, and SCMs.

The MassGIS Massachusetts 2023 USGS Aerial Imagery layer is accessible on the MassGIS website (https://tiles.arcgis.com/tiles/hGdibHYSPO59RG1h/arcgis/rest/services/orthos2023/MapServer) and is also included as a reference layer in the MassDOT Drainage Mapping Versioning map in the Stormwater Inventory group.

The MassDOT Pictometry Viewer displays oblique aerial photographs for the state of Massachusetts for multiple years and view perspectives. The viewer is accessible on MassDOT's website (https://gis.massdot.state.ma.us/dataviewers/pictometry/).

Municipal Data

Municipal data is an important resource that should be utilized during mapping. MassDOT will request municipal data from the appropriate municipal department. For municipalities where drainage data has not been shared with MassDOT, MassDOT will check the municipal website for data available in GIS or other digital format which may be useful.

Municipal data is particularly useful for identifying interconnections between MassDOT and the municipal MS4 drainage system and can be used as an additional data source to identify the location and ownership of other stormwater assets, including outfalls. Although useful for identifying interconnections and ownership of assets, municipal data should not be mapped as part of this drainage mapping effort.

2.3 MassDOT Stormwater Asset Database Design

MassDOT's stormwater asset database is designed to track both spatial and attribute information on various stormwater assets, including inlets, manholes, discharge points, conveyances, and SCMs. This section describes the design of MassDOT's stormwater asset database and the various layers that together complete a drainage network (Figure 17).

Figure 17

2.3.1 Data Types

There are two main types of data in the MassDOT stormwater asset database: feature classes and related tables. Feature classes consist of geometry (i.e., polygons, points or lines) and attributes for each asset. Attributes are information about an asset that won't change, such as material, owner, size, or year installed.

MassDOT's stormwater asset database contains the following feature classes, also referred to as layers:

- Manholes
- Inlets
- Stormwater Discharge Points
- Stormwater Control Measures (SCMs)
- Conveyances
- Miscellaneous Structures
- Interconnections

See **Table 1** for a definition and description of each MassDOT stormwater feature class.

The stormwater asset database also contains the following related tables, each associated with one feature class, used to track inspections performed on each asset:

- Manhole Inspections
- Inlet Inspections
- Stormwater Discharge Point Inspections
- SCM Inspections
- Conveyance Inspections
- Miscellaneous Structure Inspections

This drainage mapping effort, and therefore guide, focuses on developing an inventory of stormwater assets, not collecting condition information. However, general guidelines on when it is appropriate and how to record an inspection can be found in **Section 4.**

An asset will only have one set of attributes but can have multiple associated related records. Inspection forms were constructed as related tables to enable a running history of inspections.

2.3.2 Metadata

The background information that describes a database and its components in ArcGIS is called metadata. An item's metadata can record information such as accuracy, data sources, date created and published, and use limitations and restrictions. This section outlines metadata for MassDOT's stormwater asset database and associated drainage layers.

Metadata for Stormwater Asset Database

Tags: MassDOT, Stormwater, Assets, Roadway

Summary: The purpose of the MassDOT Stormwater assets database is to map MassDOT's drainage network assets and track associated inspections.

Description: This database contains MassDOT infrastructure that collects, conveys and/or manages stormwater runoff and/or conveys watercourses associated with MassDOT owned roadways. Feature classes include point layers (inlets, manholes, stormwater discharge points, stormwater control measures, miscellaneous structures, interconnections) and a polyline layer (conveyances). Each feature class (except interconnections) is associated with a related table that tracks inspections performed on that type of asset. The source of the data displayed is a compilation of multiple sources over several years including digitization of construction plans, CAD data, or imagery datasets as well as field collection of assets.

Credits: MassDOT Environmental Services Section, Stormwater Unit

Use Limitation: This data is in the public domain and therefore can be used by anyone for any purpose. MassDOT shall not be held liable for any errors in this data. This includes errors of omission, commission, errors concerning the content of the data, and relative and positional accuracy of the data. This data

cannot be construed to be a legal document. Primary sources from which this data was compiled must be consulted for verification of information contained in this data.

Extent: West: -73.529499, East: -69.901324, South: 41.231849, North: 42.888311

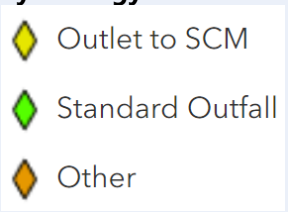
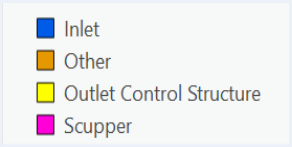
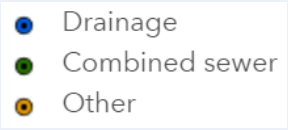
General Notes on Schema: Schema was developed in 2017; updated in January 2021 including deletion of fields, addition of new fields, and updates to domains.

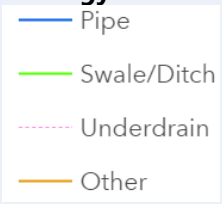
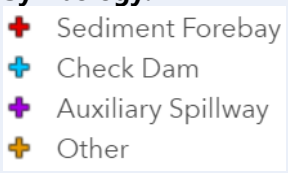
Attributes

Each feature class in the MassDOT stormwater asset database has been designed with specific attributes that support MassDOT's Stormwater as well as Operations and Maintenance Programs. Nonspatial attributes are stored in a table, with multiple columns (fields). Some fields are auto populated by ArcGIS or MassDOT, will be populated manually as part of this drainage mapping effort, or will be populated by MassDOT at a later date.

Review **Appendix A** before starting mapping for a description of all fields for each feature class including data sources, required fields, and MassDOT standards for data population.

Table 1. Stormwater Feature Class Descriptions

Stormwater Discharge Points			
Abbrev. for Asset ID: SWDP **Feature Type:** Point **Inspection Form:** Stormwater Discharge Point	**Symbology:** 	**Description:** This feature class identifies locations where stormwater exits a stormwater system. These points are typically found at the end of closed conveyances. Key fields include discharge type, outlet type, outlet material, and diameter.	**Notes:** This feature class includes standard outfalls, outlets to SCMs, and discharges from open conveyances. Examples may include headwalls, flared end sections, pipe ends, and swale ends. Paved waterways are also mapped as discharge points. Headwalls and flared end sections may be inlets or outlets depending on the direction of flow.
Inlets			
Abbrev. for Asset ID: SWIN **Feature Type:** Point **Inspection Form:** Inlet	**Symbology:** 	**Description:** This feature class identifies locations where stormwater runoff enters a stormwater conveyance system. Key fields include location relative to roadway, inlet type, cover type, the material and sump depth (if present).	**Notes:** This feature class includes catch basins, drop inlets, gutter inlets, curb inlets, and yard drains. Outlet control structures and scuppers are also mapped as inlets. Headwalls and flared end sections may be inlets or outlets depending on the direction of flow.
Manholes			
Abbrev. for Asset ID: SWMH **Feature Type:** Point **Inspection Form:** Manhole	**Symbology:** 	**Description:** This feature class identifies locations of manhole structures, often located where closed conveyance systems come together or change direction. Key fields include location relative to roadway, cover type, manhole type, and total number of incoming pipes.	**Notes:** This feature class includes drainage manholes, although other utility manholes may be included from previous mapping efforts. Utility type should be confirmed if the manhole is not for drainage. Example cover types include standard round, large round, square, rectangular, handhole and pullbox.
Stormwater Control Measures (SCMs)			
Abbrev. for ID: SCM **Feature Type:** Point **Inspection Form:** SCM	**Symbology:** 	**Description:** This feature class identifies any practice or facility that improves, retains or otherwise manages stormwater. Key fields include SCM type, presence of liner or underdrain, SCM status, SCM	**Notes:** This feature class includes both surface and subsurface SCMs. Examples include bioretention areas, constructed stormwater wetlands, gravel wetlands, infiltration basins or linear practices, porous pavement, and leaching basins. Associated SCM features (sediment forebays, check dams,

		design parameters (design storage volume, soil type, watershed area), and annual pollutant removal calculations.	outlet control structures) are mapped as separate points in their respective feature classes.
Conveyances			
Abbrev. for ID: SWCN **Feature Type:** Polyline **Inspection Form:** Conveyance	**Symbology:** 	**Description:** This feature class identifies the conveyance or flow paths of stormwater. Key fields include conveyance type, material type and diameter.	**Notes:** This feature class includes both open and closed conveyance features. Examples include stormwater pipes, drainage ditches or swales, and underdrains. Note SCMs in a linear configuration (linear practices) are mapped as points in the SCM feature class. Culverts should be mapped as points.
Miscellaneous Structures			
Abbrev. for ID: SWMS **Feature Type:** Point **Inspection Form:** Structure	**Symbology:** 	**Description:** This feature class identifies miscellaneous stormwater assets that do not fall within the description of other feature classes. Key fields include location relative to roadway, feature type, and notes.	**Notes:** Examples include check dams, sediment forebays, gabions, level spreaders, auxiliary spillways, vegetated riprap, tide gates. sediment traps and cleanouts. It is assumed all sediment forebays have a variation of check dam/weir and therefore it is not necessary to map a separate check dam point for a sediment forebay.
Interconnections			
Abbrev. for ID: N/A **Feature Type:** Point **Inspection Form:** N/A	**Symbology:** 	**Description:** This feature class identifies locations where MassDOT and another MS4 system interconnect or tie into one another. Key fields include interconnection flow direction, type of structure where interconnection is located, and the non-MassDOT interconnecting system owner.	**Notes:** This feature class includes both incoming interconnections (where another MS4 discharges into MassDOT drainage system) and outgoing interconnections (where MassDOT discharges into another MS4 system). Interconnections are mapped and added to the stormwater asset database as they are identified while digitizing record construction plans, reviewing municipal data or collecting data in the field. Private interconnections are not mapped in this feature class.

3 Desktop Mapping Approach

Consistent data entry is critical to ensure the quality and usefulness of stormwater asset data. To address this, MassDOT has developed a standard mapping approach and expects all mapping professionals to adhere to the workflow outlined in this section.

As part of this drainage mapping effort, MassDOT expects mapping professionals to:

- ✓ **Complete all work within MassDOT's stormwater asset database.** All mapping and editing should be completed only using the MassDOT Drainage Mapping Versioning map shared with the Stormwater Inventory group (see **Section 2.1)**. Edits should be completed in a version of the database assigned to you. No editing or work should be completed in a separate database or local copy of the MassDOT stormwater asset database.
- ✓ **Track mapping progress in the Mapping Progress Tracker Layer.** Throughout the mapping and review process, the mapping professional is responsible to keep attributes in the Mapping Progress Tracker updated to reflect the status of each assigned mapping segment.
- ✓ **Populate required fields.** Where data is available, populate required fields for all stormwater features within an assigned mapping area (see **Appendix A** for required fields by feature class). The data source field for each asset should always be populated.
- ✓ **Check Ownership.** Ensure all mapping edits are consistent with the latest Road Inventory layer and/or supplemental ownership information available to you. Stormwater assets included in this database should be owned and maintained by MassDOT. See Appendix B for an example of how to identify ownership.
- ✓ **Map complete drainage networks.** Where data is available, each individual drainage network to an outfall or interconnection should be complete and include all upstream structures and conveyances.
- ✓ **Snap conveyances to structures**. Where data is available, structures should be connected by conveyances and the end of polyline features should be snapped to the appropriate point feature.
- ✓ **Update spatial and attribute data of existing features**. At the completion of drainage mapping for an assigned area, all point and polyline features should have accurate locations and attributes. There should be no duplicate or extraneous features. It is the responsibility of the mapping professional to review previously mapped stormwater data for accuracy and completeness, which may require moving features, populating missing attributes, and updating attributes (see **Section 3.5.1**).
- ✓ **Review SCMs within the project area.** All SCMs should be mapped and have the plan sheet showing the SCM as an attachment to the point.
- ✓ **Review internally before finalizing**. Before notifying the reviewer that mapping is complete, conduct a review of all stormwater features within the assigned mapping area to check for consistency, completeness and adherence with the approach outlined in this guide. Do not "post" your version to the default stormwater asset database. The QAQC Lead will review the mapping completed in the database version and post updates only after approval.
- ✓ **Finalize mapping based on QAQC Lead review.**

3.1 Update Mapping Progress Tracker Layer

The Mapping Progress Tracker Layer is used to track the status of all MassDOT drainage mapping efforts and associated reviews. Review **Appendix A** for a description of all fields in the Mapping Progress Tracker Layer including data sources, required fields, and MassDOT standards for data population.

When a mapper is assigned an area to digitize, they should find a polygon feature within the Mapping Progress Tracker GIS layer that encompasses the area to be mapped. The polygon should be split to match the area of the plans to be digitized. The mapping status field in the layer for this feature should be marked as "Assigned".

When beginning mapping an assigned area, the **mapper** should complete the following steps:

1. Populate the "Mapper Email" and "Mapper Name" fields. Make sure to use the same name and email address for all areas you map.
2. Populate the "Mapping Start Date" with the date and "Mapping Status" to *In Progress*.
3. Digitize the stormwater infrastructure based on record plans. Add pipes, inlets, outlets, and other stormwater features as needed. Document mapping sources in the Mapping Progress Tracker layer as follows:
    i. "Reference Plan Numbers" - populate this attribute with the applicable job number associated with the referenced record drawings.
    ii. "Relevant Sheets" - populate this attribute with the referenced sheets from the job's record plans.
    iii. "Mapping Comments" - populate this attribute if there are any relevant comments that the future reviewer should be aware of.
    iv. “Center Lane Miles” – populate this attribute with the number of lane miles mapped in total in your mapping area, per the latest Road Inventory layer. The Center Lane Miles field should be manually updated, while the Total Mileage field is automatically populated.

        When there are two roadway inventory line segments for one highway or road, the center lane miles should be calculated separately and added together. The center lane miles should reflect the mileage from the areas you mapped along each of those line segments in the Road Inventory layer. For example, in Figure 18 you would add up the lengths along each of the lines with red arrows, as well as the segments with blue arrows.

Figure 18

v. "Approximate Hours to Map" - populate this attribute with the approximate number of hours it took to complete the mapping.

4. Once you have completed mapping a given area (following completion of the Gap Analysis described in **Section 3.6)** change the "Mapping Finish Date" as appropriate and the "Mapping Status" to *Review Pending*.

5. If the extent of the area ultimately mapped does not align with the Mapping Progress Tracker layer polygon, the polygon feature should be split or its geometry should be edited to most accurately reflect both the mapping extents and mapping status. For example, if the mapping section is mostly complete but has a small area requiring additional follow-up or higher quality plans, the polygon should be split such that the complete area can be marked *Review Pending* and the smaller incomplete area can be marked *Follow Up Needed*.

Once the mapper sets the "Mapping Status" to *Review Pending* and notifies the reviewer that their section(s) are ready to be reviewed, the **reviewer** will begin their review, following the steps below:

1. Create a new entry in the Review Record table, associated with the Mapping Progress Tracker section being reviewed.

2. Populate the "Reviewer Email" and "Reviewer Name" fields.

3. Populate the "Review Start" with the date.

4. Review the mapping section and provide comments using ArcGIS Pro bookmarks. General comments may be included in the "Review Comments" field.

5. Edit the "Review Status" as follows:

   i. Initial Review – This indicates that this is the first time the section is being reviewed. This review will be high level and focused on major trends and global comments.

ii. Complete Review – This indicates that the section has previously had its initial review and is now being reviewed for total completeness. This review will be comprehensive.

iii. Back Check – This indicates that the section has had one (or more) complete reviews and is now being back checked to ensure that all review comments were incorporated by the mapper.

iv. Posted – This indicates that the section was back checked and deemed complete, and the database version was therefore reconciled and posted to the default version.

6. Confirm with the reviewer how to exchange bookmarks. This may be done over email or sharepoint.

7. Once the review effort is complete, populate the "Review Finish" field appropriately and set the "Mapping Status" field to *Review Comments Sent*. At this time, also notify the mapper via email that the comments are ready.

8. If the review does not include comments to address, and the "Review Status" is marked as *Posted*, the reviewer should change the "Mapping Status" to *Complete*.

9. If the reviewer has made comments and changed the "Mapping Status" to *Review Comments Sent* the mapper should repeat the mapping steps beginning at Step No. 2. This should include updating both the "Mapping Start Date" and "Mapping Status" for the follow up mapping efforts.

3.2 Gather Available Data

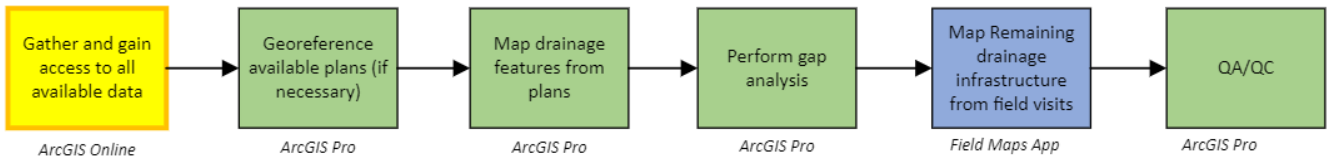


Figure 19

The first step to completing MassDOT drainage mapping is to gather and gain access to all available data.

3.2.1 Set up Drainage Mapping Versioning Map

Follow the steps in **Sections 2.1** to request access to the MassDOT Stormwater Inventory group. Open the MassDOT Drainage Mapping Versioning map in ArcGIS Pro and confirm all stormwater asset layers are visible and editable. Check that the basemap is "Orthos2023. Confirm the map coordinate system is "NAD 1983 StatePlane Massachusetts FIPS 2001 (Meters)".

Check that the database version is updated to list your name and only use this version for all edits. Do not reconcile or post any edits to the default version of the database. The QAQC Lead must first review and accept all changes as part of data QAQC.

3.2.2 Add Georeferenced Record Construction Plans

Record construction plans that have already been georeferenced are currently stored at the following location: S:\CAD\TAM\culverts\GeoRefPlans\. Georeferenced plans may also be found on the Stormwater Unit's Sharepoint website. Consult with MassDOT Stormwater Unit if you are unsure whether georeferenced plans may exist that are not found at the location above.

Complete all drainage mapping only using your version of the MassDOT Stormwater Asset database.

Important! If you do not see points in a version that were mapped, check the default version to ensure they were not accidentally mapped there.

If points were mapped in the default database instead of a version – contact the QAQC Lead to determine next steps. Do NOT map these points again in the version as this may create duplicate features.

To bring these files into ArcGIS Pro, follow the steps below.

1. In ArcGIS Pro, from the Map tab, click "Add Data" and navigate to the folder where the georeferenced plans are saved. Select a TIF file and click "Ok" (Figure 20). Note: multiple files may be selected and added to the map at one time. Mappers can also add folder connections by navigating to the Catalog pane and right clicking "Folders" under the Project tab. By adding a folder connection, tif files can be brought in from desktop or OneDrive folders.

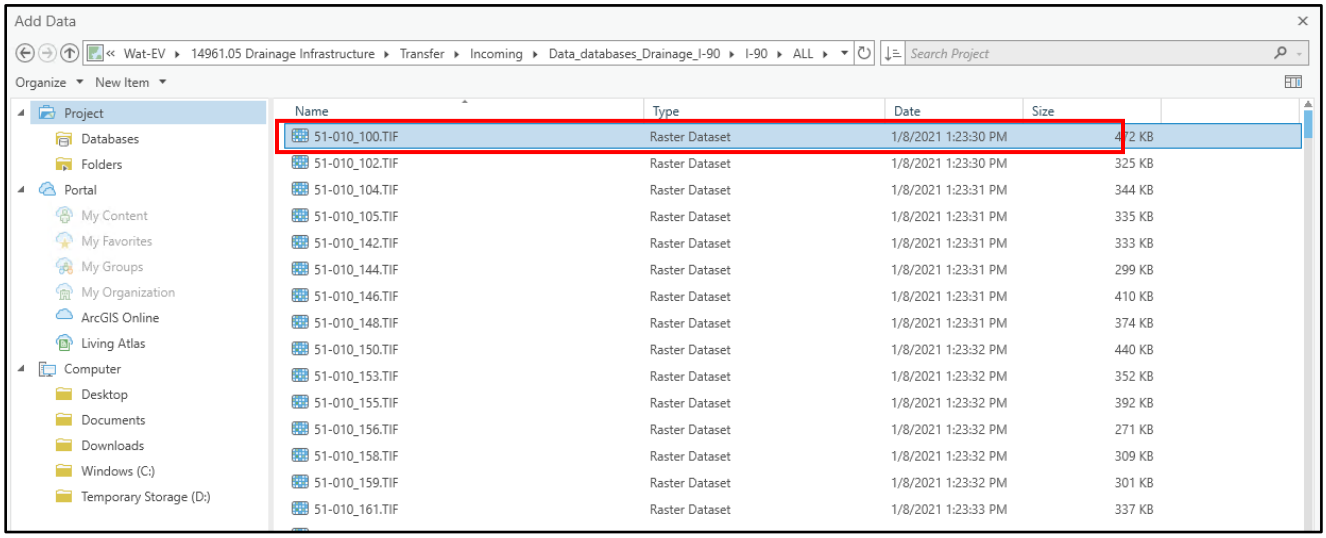


Figure 20

2. In the Contents pane, added georeferenced plans will appear as individual raster layers. Right click and select "Zoom to layer" to zoom to the extents of the record construction plan sheet (Figure 21).

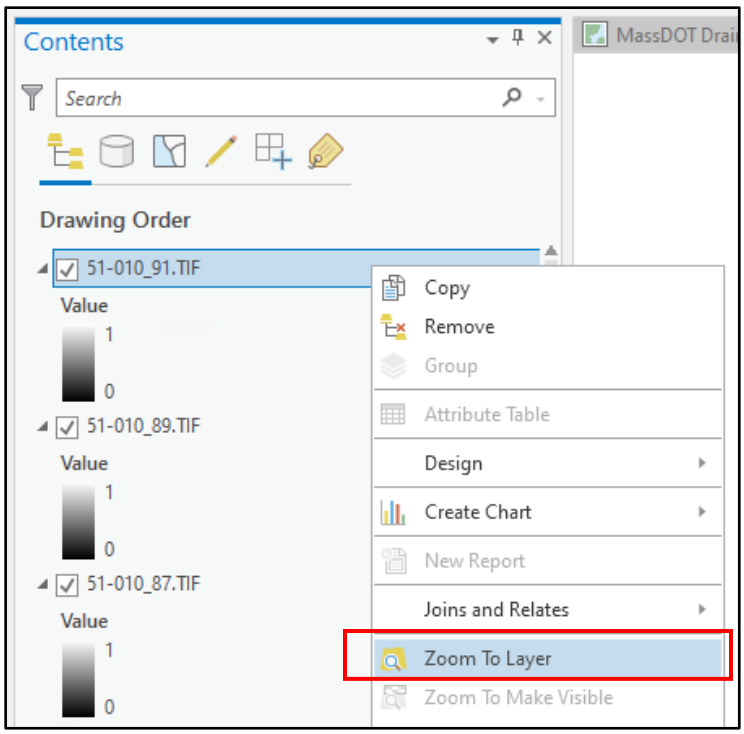


Figure 21

3. When viewing georeferenced record construction plans, it's helpful to adjust the transparency of the TIFF to at least 60% so the aerial map can be seen through the plan. The transparency of a TIFF file can be adjusted in the Appearance Tab under Effects (Figure 22).

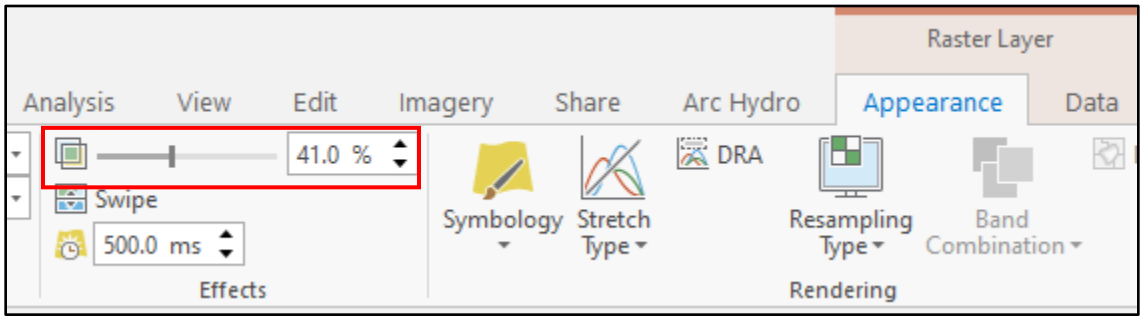


Figure 22

3.2.3 Request Additional Record Construction Plans

After bringing all georeferenced record construction plans into ArcGIS Pro, review the assigned mapping area for MassDOT roadways that do not have coverage. For these areas, request additional record construction plans from MassDOT's Plans & Records Office (https://www.mass.gov/highway-plans-records). Record construction plans obtained through this office will need to be georeferenced following the steps in **Section 3.3**.

3.3 Georeference Plans in ArcGIS Pro

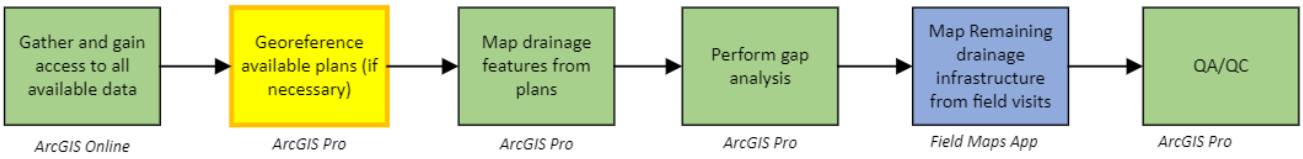


Figure 23

To best map the spatial location of assets, MassDOT record construction plans should be georeferenced before they can be used to digitize stormwater assets. To georeference a record construction plan in ArcGIS Pro, follow the steps below:

1. Save the record plan as a TIFF file (.tif). Files saved as a PDF can be opened in a program such as Adobe or Bluebeam and saved as a TIFF file. It is not recommended to convert a PDF to a TIF by changing the extension of the file from ".pdf" to ".tif" as this may cause the TIF to display incorrectly in ArcGIS Pro.
2. Open ArcGIS Pro, and check map properties to ensure the correct coordinate system is assigned.

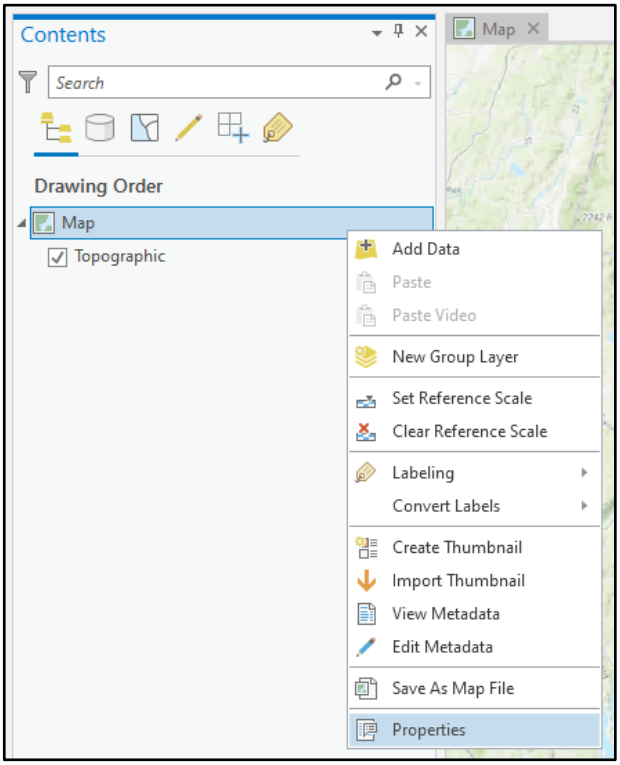


Figure 24

- Right click on Map in the Contents pane and select properties (Figure 24).
- Under the coordinate systems tab, check the current coordinate system is listed as **NAD 1983 StatePlane Massachusetts 2001 (Meters)**. (Figure 25)

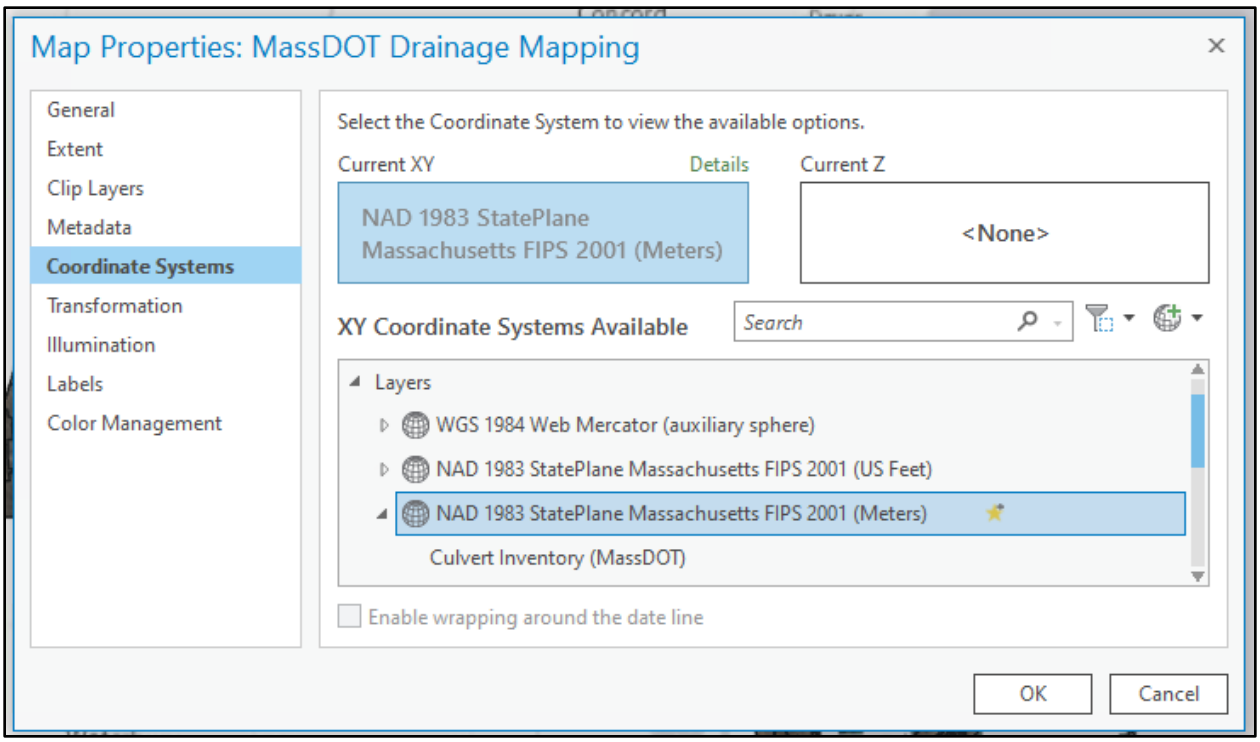


Figure 25

3. In the Map tab, select "Add Data" (Figure 26) and navigate to the folder where the TIFF file is saved. Select the TIFF file and select "OK".

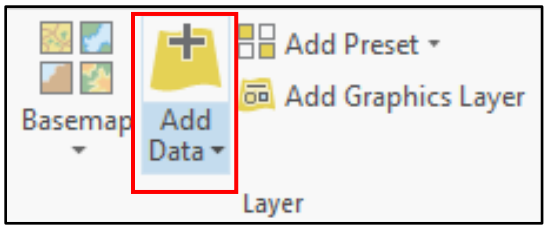


Figure 26

4. If a pop-up screen appears suggesting to build pyramids select "Yes" (Figure 27).

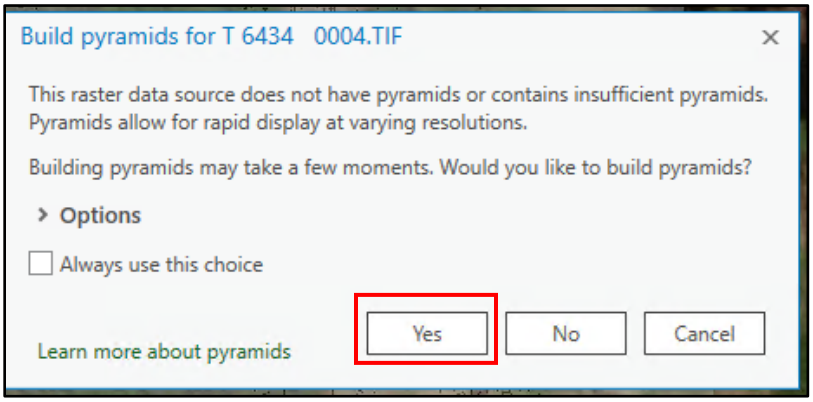


Figure 27

5. Open the Georeferencing toolbar from the Imagery tab (Figure 28). Zoom to the general area depicted on the plan and click "Fit to Display" (Figure 29) and hit "Save" within the Georeferencing toolbar. Once the plan is in the right general area, use the Rescale tool (Step 5a) or control points (Step 5b) to resize the image. Then, rotate or move the image as needed before digitizing.

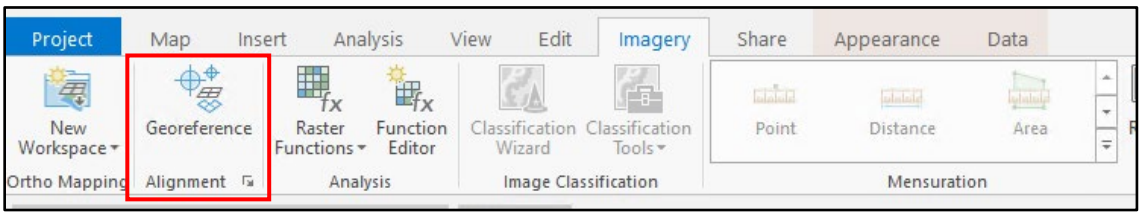


Figure 28

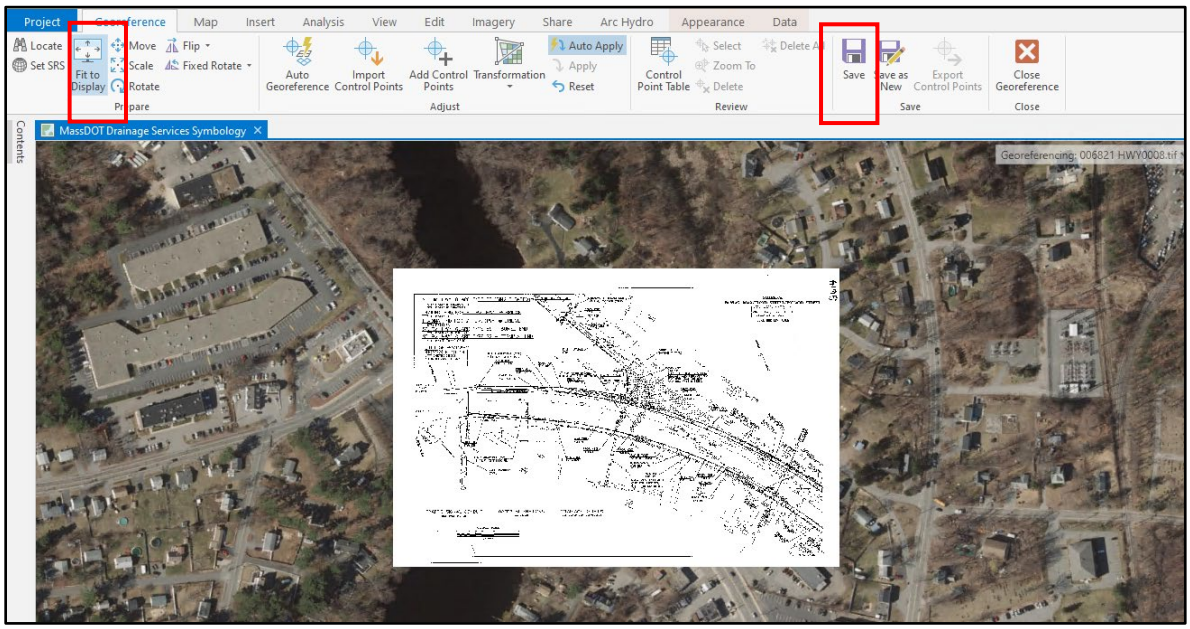


Figure 29

5a: Resize an Image using the Rescale Tool

If the TIF image has a scale, follow the steps below to rescale in ArcGIS Pro:

i. Zoom into the portion of the image that contains the scale or stationing (Figure 30). Using the measuring tool, measure the length of the scale or length from station to station (make sure the measuring tool is set to feet or appropriate units for the plan).

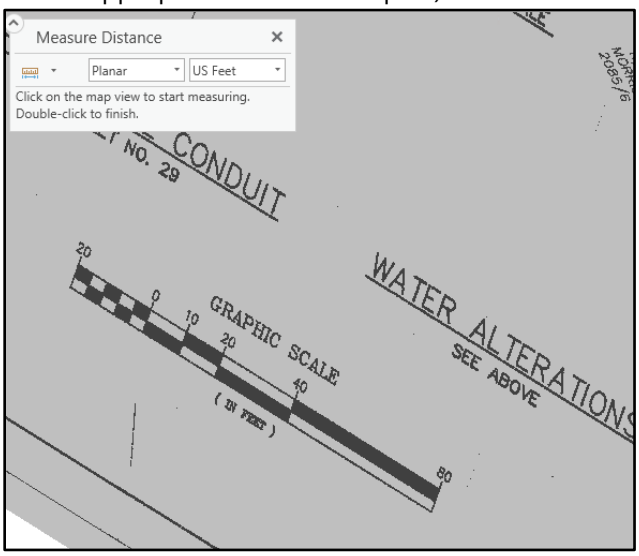


Figure 30

ii. Divide the scale value by the measured value (using measuring tool) to calculate a scale factor. For example, if station spacing should be 100 ft and the measured value is 135.62; the scale factor would be 0.73735 (equal to 100/135.62). **Record the calculated scale factor.**

$$Scale\ Factor = \frac{Scale\ Value}{Measured\ Value}$$

Tip: If you have multiple plans from the same plan set lined up and scaled the same, you can use the same scale factor for all the plans. It might be a good idea to try a few plans within the set just to double check that things are even.

iii. Access the Rescale tool by going to the ArcToolbox in the geoprocessing pane, expanding "Data Management Tools", then "Projections and Transformations", then "Raster" and double clicking "Rescale" (Figure 31). If making multiple rescales with the same scale factor for plans from the same set, right click over Rescale and choose "Batch" to do multiple (see tip below).

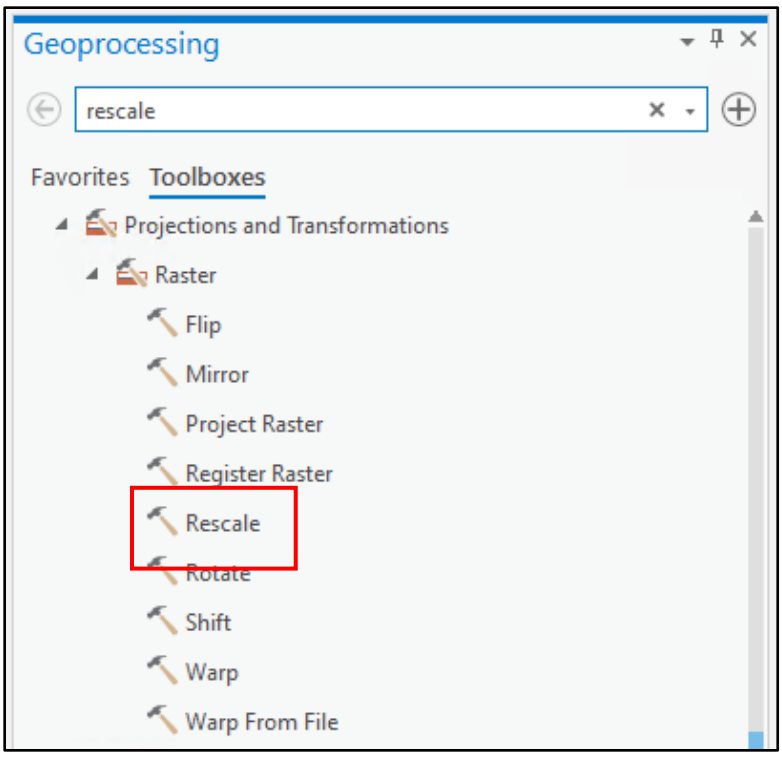


Figure 31

iv. The Rescale dialog box will appear (Figure 32). In the "Input Raster" field, select the original TIF image layer from the drop down menu. **Tip**: an easier method is to click the TIFF in the Contents pane and drag it into the "Input Raster" box.

a. Choose a location and name for the Output Raster Dataset. **It is important that you add ".tif" after the file name in order for it to be properly georeferenced**.

   Naming of the individual files can follow the original file name format and should include the project and sheet number.

b. In the "X Scale Factor" and "Y Scale Factor" fields, type in the scale factor calculated in Step 2 above. Press "Run" in the Rescale dialog box.

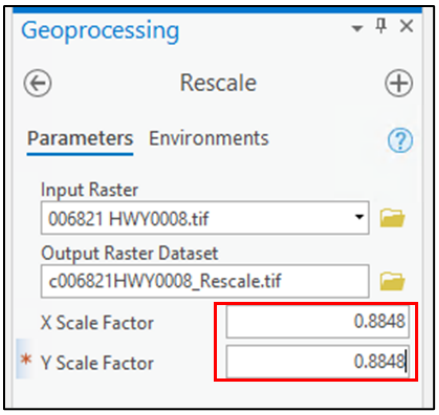


Figure 32

Tip: Batch rescaling can be used to rescale multiple plans from the same dataset that all have been scaled the same with the "Fit to Display" option.

- Right click the "Rescale" tool and click "Batch…". Here, drag all the plans you intend to rescale into the tool. Only the first column, "Input Raster" should be populated. Then, browse for the file location where you want to save the rescaled TIFFs. Then, inset the scale factor, and copy and paste into all the scale factor boxes.
- Click OK. This make take a while.
- Navigate to the Catalog and manually add each newly rescaled image.

v. A newly scaled version of the image will be added to the map. Zoom into the new image's scale and measure the length of the scale using the measuring tool. The scale should roughly match the measured value.

vi. Right click and remove the original, unscaled TIFF file from the Contents pane.

5b: Resize an Image using Control Points

If the TIF image does not contain a scale, follow the steps below to use control points to rescale:

i. Find a control point that can be located both on the aerial basemap and in the plans on the TIFF image. Typically, two points are needed if the points are far enough apart, but three or four points may be necessary. Control points can be drainage structures, intersection corners, buildings or other permanent landmarks, or other features that are clearly matching. In Figure 33, a catch basin and building corner were chosen (red circles).

Figure 33

ii. After identifying control points, in the Georeference tab, click Add Control Points and start to align the TIFF to the basemap (Figure 34). First click a location on the TIFF, then click the same location on the basemap. Continue adding control points until the TIFF image aligns with the aerial basemap.

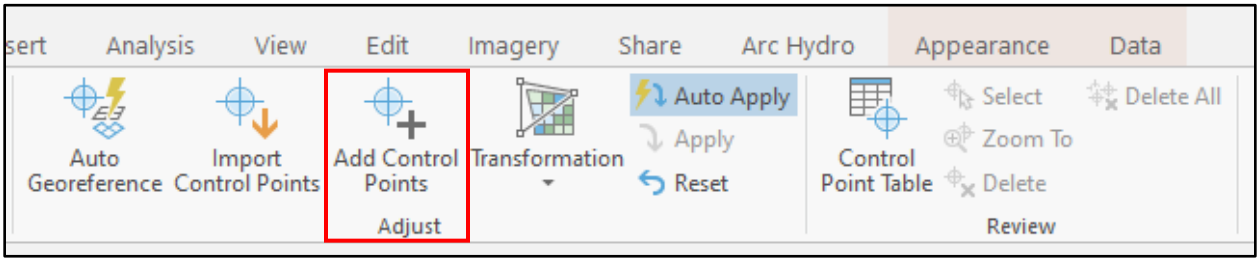


Figure 34

6. Once satisfied with the image location, click "Save" in the Georeferencing toolbar and the spatial information will be saved with the TIFF file (Figure 35).

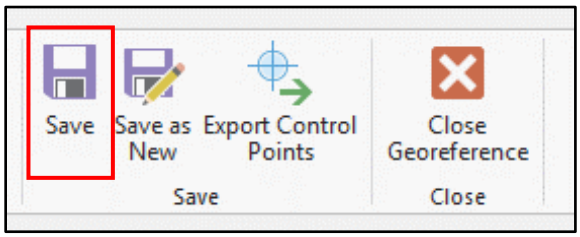


Figure 35

Tip: When georeferencing record construction plans, it's helpful to adjust the transparency of the TIFF to at least 60% so the aerial map can be seen through the plan. The transparency of a TIFF file can be adjusted in the Appearance Tab under Effects (Figure 36).

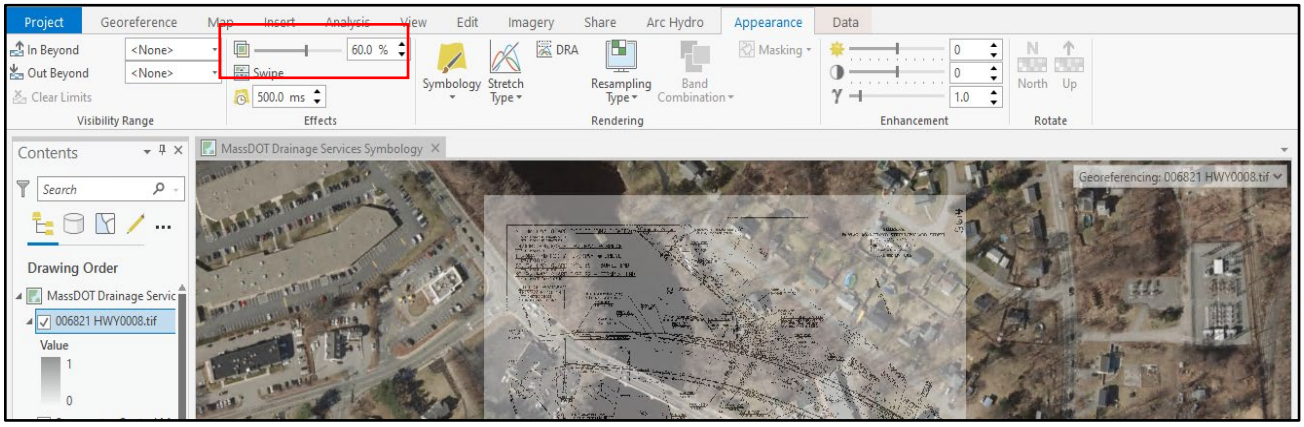


Figure 36

3.4 Upload Georeferenced Plans to SharePoint

After record construction plans have been georeferenced, they should be uploaded to SharePoint (Figure 37) so they are available in the future for reference by individuals using the stormwater asset geodatabase. Plans should be saved to the "Plans Folder by Rt Number" folder (linked below) and organized into subfolders, first by route number and then by town. If the folders representing the route number and town of your record construction plans are not already present in the SharePoint folder, you

will need to create them prior to uploading your plans. Permissions for this folder should be requested to the MassDOT Stormwater Unit. Once granted the folder can be accessed via the link below.

SharePoint Folder Location

https://massgov.sharepoint.com/sites/DOT-Highway/StormwaterandCulvertMapping?e=1%3A903925bdf43d4789bdbadc842f93e567&CT=1779363525134&OR=OWA-NT-Mail&CID=1253bad8-80e1-0c41-7a14-631810bae643

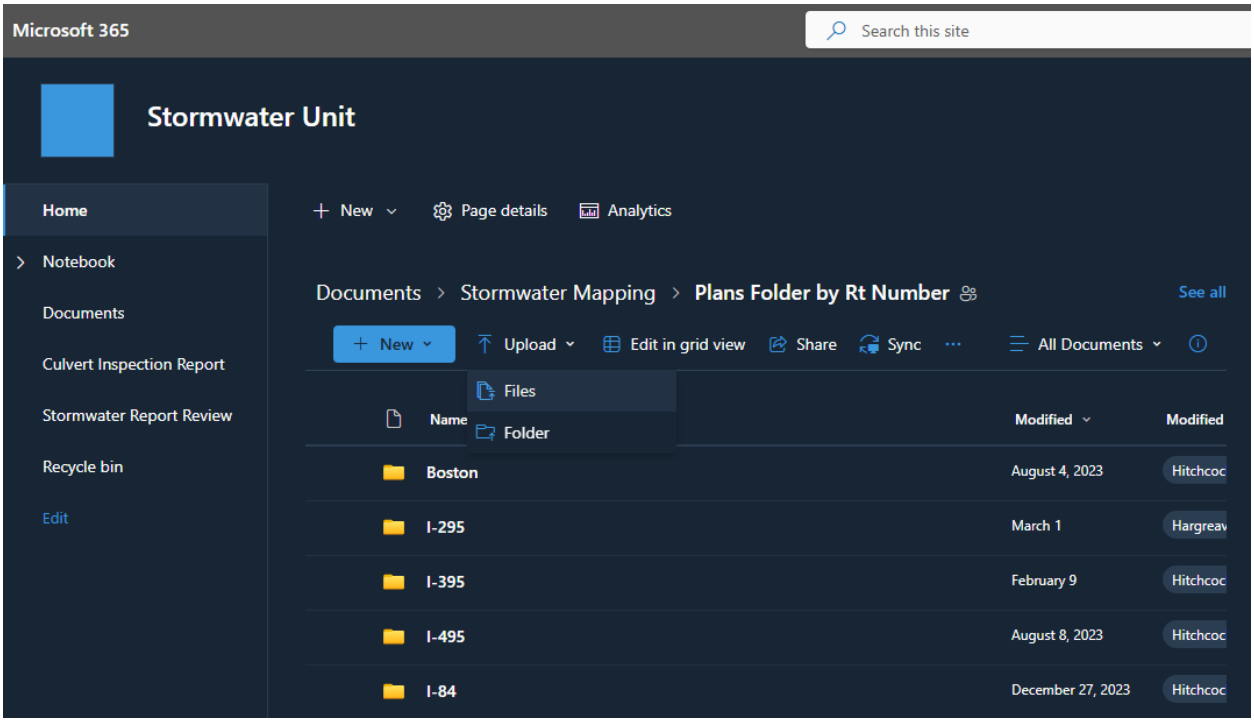


Figure 37

3.5 Map Drainage Features from Plans

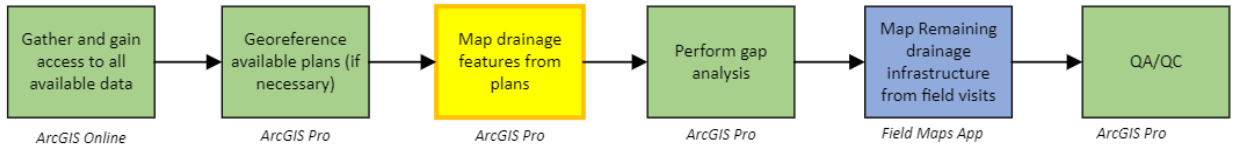


Figure 38

After all available record construction plans have been uploaded to SharePoint, the next step is to begin digitizing the stormwater assets shown on the plans. To ensure consistent and complete data entry, adhere to the guidelines and best practices presented below.

- ✓ **Coordinate System** – Use the coordinate system "NAD 1983 (2011) StatePlane Massachusetts FIPS 2001 (Meters)" when digitizing stormwater features (see **Section 2.1.2**).
- ✓ **Aerial Imagery –** Use "MassGIS Massachusetts 2023 Aerial Imagery" as the aerial basemap.

- ✓ **Required Fields –** Where data is available, populate required fields for all stormwater features (see **Appendix A**).
- ✓ **Conveyance Flow Direction –** Draw conveyances upstream to downstream to capture flow direction (see **Appendix B**).
- ✓ **Snapping** – Enable snapping in ArcGIS Pro when editing (see **Section 3.5.2**). Where data is available, snap conveyances and structures to another stormwater feature (see **Appendix B**).
- ✓ **Previously Mapped Features –** If there are features already mapped in your area from LiDAR mapping, update and relocate those features as needed based on the plans. Only delete previously mapped features if they no longer exist and after confirming there are no inspection records attached to the point.

Review **Appendix B** before starting mapping for guidance on MassDOT drainage scenarios.

The following section outlines the general steps for creating and editing features in the stormwater asset database. The majority of feature geometry and attributes will generally be completed during desktop mapping in the office, but some features may need to be verified or updated in the field (see **Section 4**).

3.5.1 Update an Existing Feature in ArcGIS Pro

The drainage mapping effort will require editing existing stormwater features. Features previously mapped require review for accuracy and completeness. Many features were mapped prior to MassDOT's updates to the stormwater asset database schema in 2021, which included additional fields and domains. These existing features should be edited and updated rather than being deleted and replaced by features.

All existing features should be reviewed to confirm:

- spatial accuracy;
- the feature is correctly mapped; and
- attributes are correct and complete.

In some cases, stormwater assets may have been incorrectly mapped in the wrong feature class (see **Appendix B** for example scenarios and steps to update).

If a previously mapped stormwater feature is accidentally deleted, contact the QAQC Lead.

Include the name of the feature class and the Asset ID (from the default database). The feature will need to be restored to ensure any related records, attachments and data stored in MassDOT's work order software is not lost.

Attribute updates for existing stormwater features may include:

- **populating missing information** (e.g., a manhole does not have the utility type field populated, or an outfall does not have the discharge type field populated)
- **correcting inaccurate data entry** (e.g., SCM type was incorrectly recorded in the notes field and not the SCM type field, or a pipe diameter is incorrect)

Record construction plans may have additional information about an asset that was not available at the time the asset was initially mapped. MassDOT expects all available data to be documented in the stormwater asset database as part of this drainage mapping effort.

Stormwater assets that had been previously documented may no longer be present. After confirming that assets do not exist, mapper should confirm that there are **no related inspection records before deleting**. If there are related inspection records, contact the QAQC Lead for assistance.

To edit the geometry or attributes of an existing stormwater feature in ArcGIS Pro, follow the steps below:

1. Select the feature by clicking Select in the Edit tab (Figure 39). There are several options for selecting a feature in ArcGIS Pro.

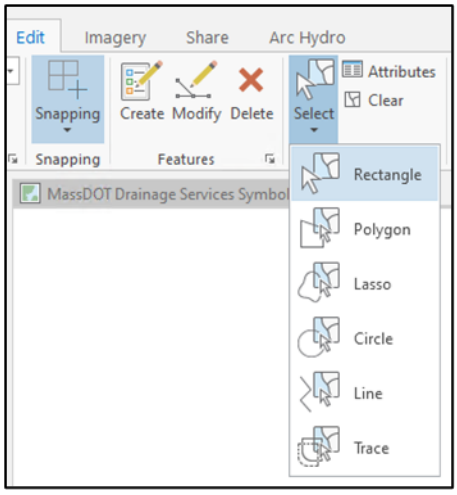


Figure 39

2. Draw a rectangle or lasso around the feature or directly click on the point/polyline. Selected features in ArcGIS Pro will be highlighted light blue (Figure 40).

Figure 40

3. After the feature is selected, click Attributes in the Edit tab to open the Attribute pane (Figure 41).

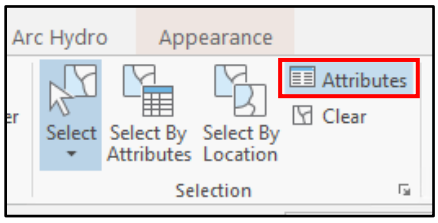


Figure 41

4. Within the Attribute pane, under the Attributes tab, review and update attributes as necessary (Figure 42). Compare record construction plans to the existing attributes for the feature. Be sure to click "Apply" at the bottom to commit edits.

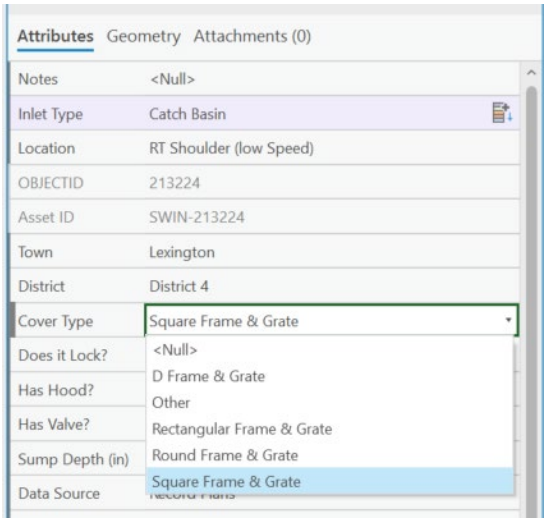


Figure 42

5. Within the Attribute pane, in the Geometry tab, click the icon for "Move" or "Edit Vertices" if geometry updates are required (Figure 43). Geometry can also be updated by clicking Modify in the Edit tab or selecting a specific tool from the toolbar (Figure 44).

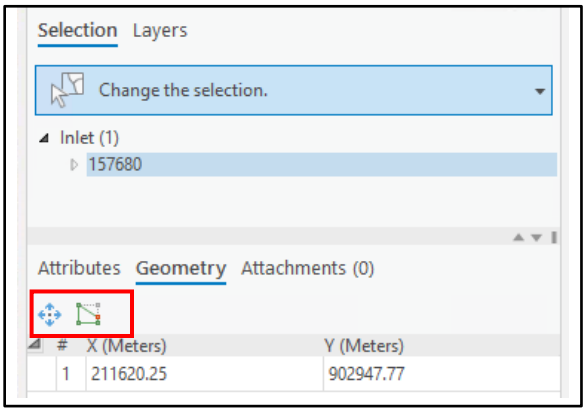


Figure 43

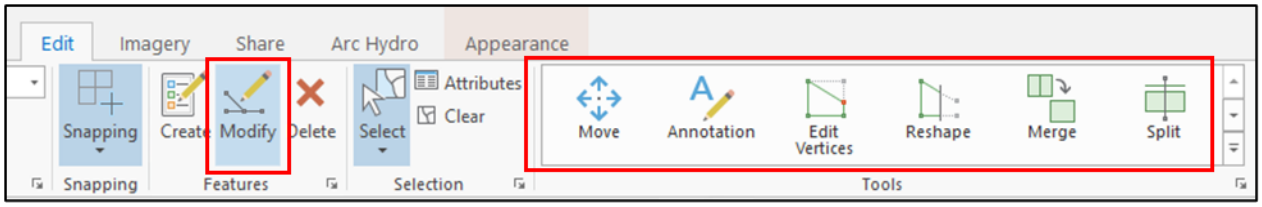


Figure 44

3.5.2 Digitize a New Feature in ArcGIS Pro

In addition to editing existing features, this drainage mapping effort will require digitizing new stormwater features in ArcGIS Pro, following the steps below:

1. Open the Drainage Mapping map in ArcGIS Pro (See **Section 2.1.2**). Ensure snapping is enabled by toggling the CTRL + F5 key, or by clicking "Snapping" on the Edit tab (Figure 45).

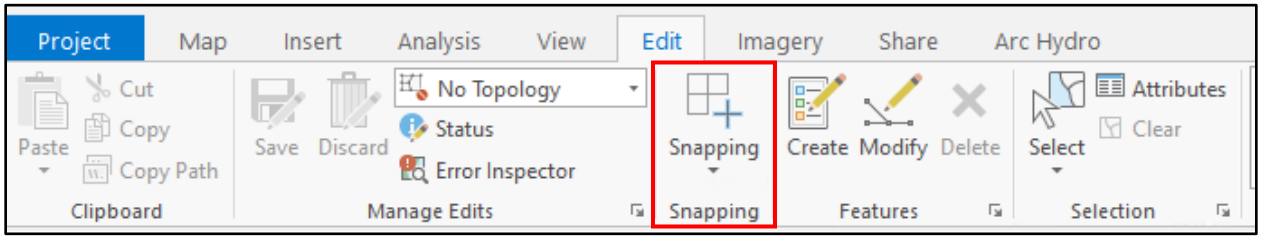


Figure 45

2. On the Edit tab, click "Create" (Figure 46). This will open the Create Features pane.

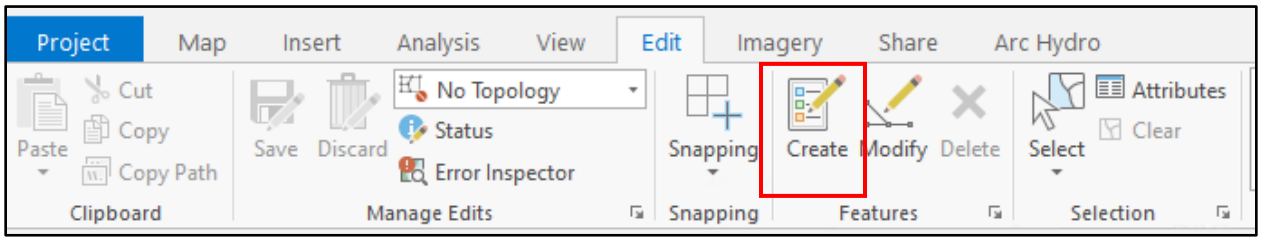


Figure 46

3. In the Create Features pane, click the layer that you would like to add a new feature to. Note only layers that are checked (turned on) in the Contents pane will be listed. Click the arrow on the right-hand side of the box to open the Active Template pane (Figure 47).

Be wary of mismatching plan and aerial information.

If the aerial and planset are considerably different (different drainage pattern, number of structures, structure locations, etc), the planset may be out of date and should not be used for mapping.

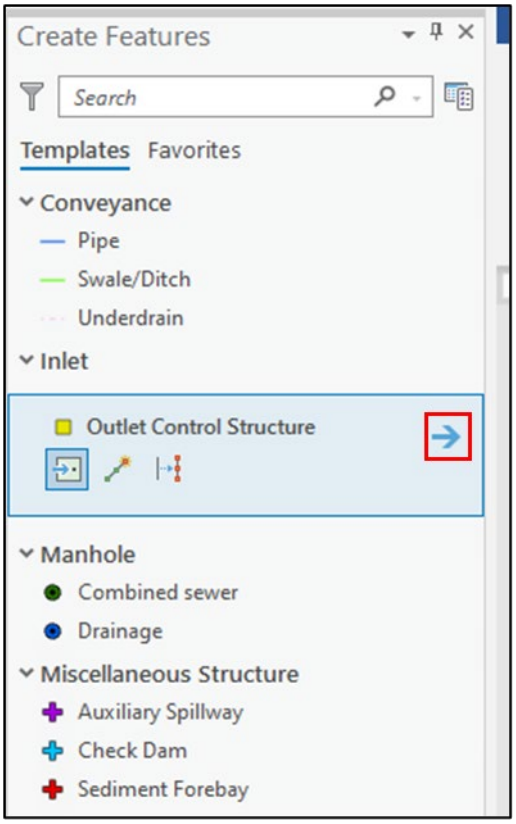


Figure 47

4. In the Active Template pane, populate attributes with available data, paying close attention to required fields. Many attributes have dropdown lists (domains) to facilitate editing and ensure quality data (Figure 48).

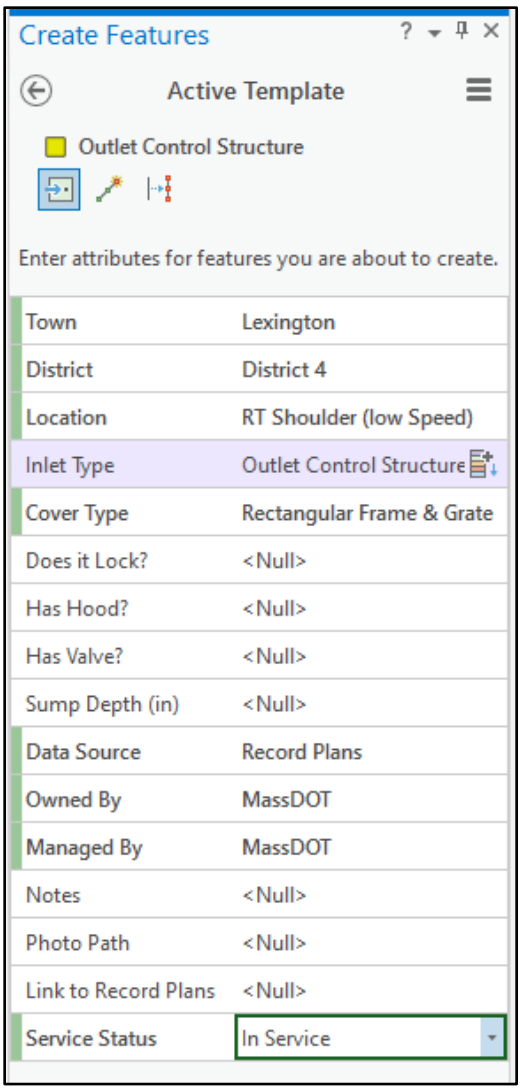


Figure 48

5. Next, draw the feature in the map window (Figure 49). Trace the features from the georeferenced plans, as appropriate. Always check the aerial imagery and digitize to the ortho imagery over georeferenced record construction plans, as georeferencing may be less accurate.

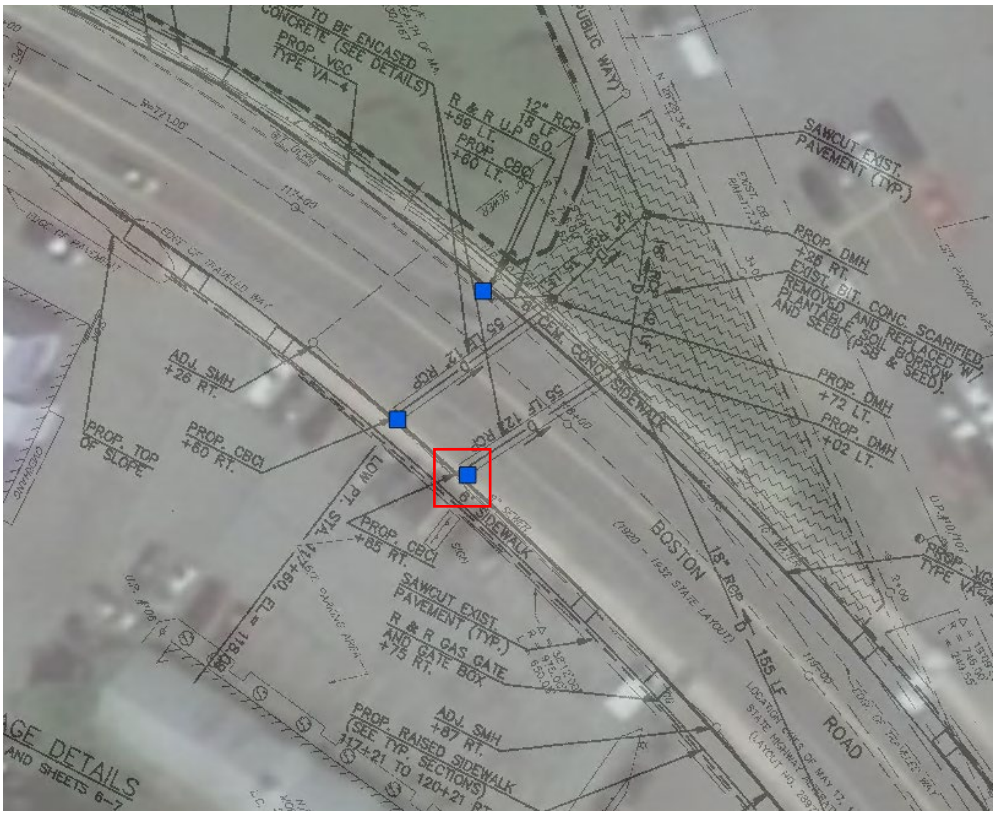


Figure 49

6. Once the feature has been drawn, be sure to save all work in the Edit tab (Figure 50).

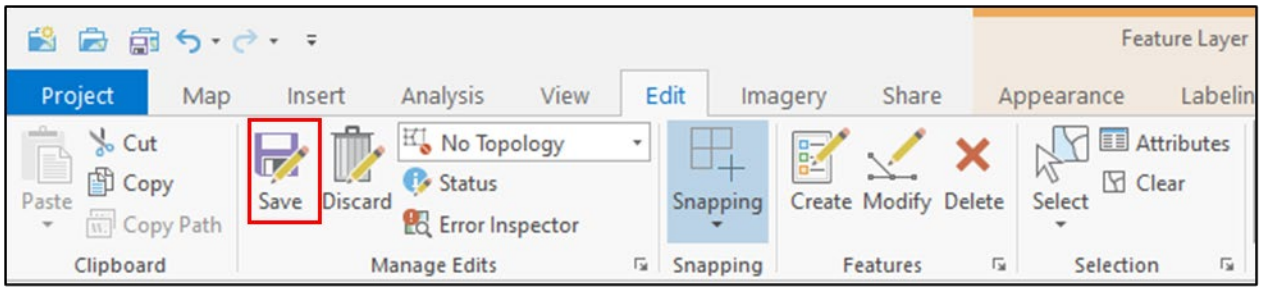


Figure 50

Remember to take your time digitizing! Take the time to fill out attributes and review your work.

3.6 Perform a Gap Analysis

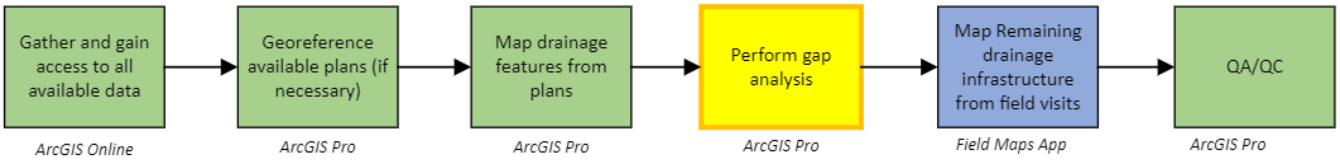


Figure 51

After mapping stormwater assets from all available record construction plans, the next step is to identify data gaps that need to be addressed to complete drainage mapping. This includes reviewing the assigned mapping area for segments of MassDOT roadways missing parts of or an entire drainage network. For these areas, review aerial and other imagery resources to identify if a closed drainage system or other drainage features appear to be present. If a roadway segment does not contain any drainage features (e.g., sheet flow to a vegetated area), no further action is required and the Progress Tracker for that area can be marked as "Completed" with a note that there is country drainage. Note that in cases of country drainage, open conveyance features, such as drainage swales or ditches, should be mapped to document drainage patterns or the area contributing to a stormwater discharge point.

For this drainage mapping effort, a gap analysis is used to identify stormwater assets or roadway segments that require field data collection.

MassDOT does not expect field verification of all assets or attributes (e.g., a visit field is not required to verify an outfall diameter or the material of a pipe if not shown on record).

In some cases, individual stormwater asset locations or key attributes may need to be confirmed in the field (e.g., an outfall location that is not shown on record construction plans). However, field work for individual assets should be limited, as the primary data source for this drainage mapping effort is record construction plans. If there are no stormwater assets shown on a stretch of roadway in the available plans, create a new polygon in the Mapping Progress Tracker for that area with the mapping status "Follow Up Needed". These sections of mapping should be verified through field mapping or looking for other available plans.

Once the gap analysis is complete, the mapping professional should schedule a check-in with the QAQC Lead prior to scheduling field work (if field work is expected as part of the work). The goal of the check in is to discuss the plan for field work, anticipated level of effort, data availability, and to clarify expectations for field data collection. Field work is not expected for most mapping work.

The version should be reviewed and posted **prior** to performing any field work.

4 Field Mapping Approach

Where gaps are found in drainage data and no records plans are available, field work may be required to complete drainage mapping. MassDOT expects all mapping professionals to adhere to the workflows and field protocols outlined in this section when performing field work.

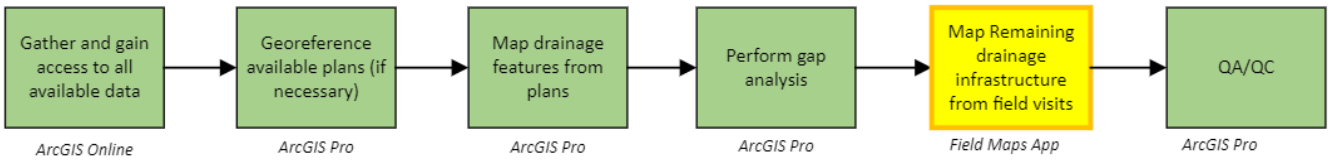


Figure 52

This section provides an overview of field data collection, including how to add and edit stormwater data using the Field Maps app as well as guidance on when inspections should be performed as part of this drainage mapping effort.

Review the following considerations and best practices when planning for field work:

- Make sure the **latest version of ArcGIS Field Maps** is downloaded and up to date on your mobile device. Test opening the MassDOT Drainage Mapping Versioning map in Field Maps prior to going in the field to ensure all layers are loading and editable.
- Make sure **location services are turned on** under the mobile device's settings for ArcGIS Field Maps.
- Be conscious of the battery life of the device. **Plan for a battery backup**, power charger, or backup mobile device with ArcGIS Field Maps installed where field data collection is expected to be lengthy.
- Be conscious of the weather and plan accordingly. **Do not perform field work in unsafe weather conditions**, such as low visibility. Protect the mobile device from precipitation or with a shade on high sun days, as needed.
- Always **be careful of traffic and moving vehicles**. Plan to have appropriate personal protective equipment (PPE) and traffic controls, as necessary.

Before performing field work, contact the **district permit engineer** to determine applicable protocol and procedures. MassDOT districts will likely require access permits and potentially police detail depending on the location of field work.

When mapping a drainage network in the field, look for low points in the roadway and water crossings where inlets or stormwater discharge points may be located or locations where MassDOT drainage enters another system. Focus efforts on mapping structures (i.e., inlets, manholes, and discharge points) and wait to delineate conveyance features until back in the office. Focus on populating attributes that rely on a site visit and wait to populate other attributes (such as location or ownership) until back in the office.

Condition Inspections

While the focus of this drainage mapping effort is to locate and map stormwater assets, there are occasions where a condition inspection may need to be completed. MassDOT does not expect mapping professionals to perform field work for the sole purpose of performing inspections, but rather to complete inspections if stormwater assets are observed to be in poor condition (e.g., a catch basin or forebay full of sediment causing a flooding risk or a cracked manhole cover that is a safety hazard). For assets that are observed to be a hazard and require immediate attention, the mapping professional should coordinate with the QAQC Lead and contact the district maintenance engineer, sharing the Asset ID, a description of the location and issue, and a photo.

If while performing field mapping a MassDOT stormwater asset is observed to be a safety hazard, failing, or in need of urgent maintenance, populate an inspection form for that asset.

When completing an inspection in the field, be sure to:

- Populate the "Action Needed" and "Overall Condition" fields.
- Attach one or more photos to the inspection form clearly depicting the asset location and condition.
- Add any specific observations or other important information on required maintenance to the "Notes" field as necessary.

It is not required to populate all fields in an inspection form as long as it is clear what maintenance action is required.

4.1 Digitize a New Feature in the Field Maps App

To digitize a new stormwater feature in the Field Maps app, follow the steps below:

1. Open the MassDOT Drainage Mapping Versioning map in the Field Maps app and ensure location services are turned on. Refer to **Section 2.1.3** for instructions on downloading and logging in to the Field Maps app.
2. To add a feature, center yourself on the stormwater asset with the mobile device in your hands. Confirm your position is shown accurately in the map.
3. Click on the blue plus "+" sign at the bottom of the screen and select the type of feature you'd like to add from the list that pops up (Figure 53).
    - If collecting a point feature, the new feature will be centered on your current location.
    - If collecting a line feature, the location you start on will be the start of the line (should be upstream). You can either add multiple points along the feature or have the App collect points along a line you walk (walk upstream to downstream). Click the three horizontal dots of a new feature and select "Start Streaming", which will record the path you walk. You may pause if needed by clicking "Pause Streaming". When finished walking the path of the feature you're recording, select "Submit" to record the shape.
4. Add attribute data, filling out the fields where information is available. Many fields have a dropdown list, allowing you to select an option from the list.

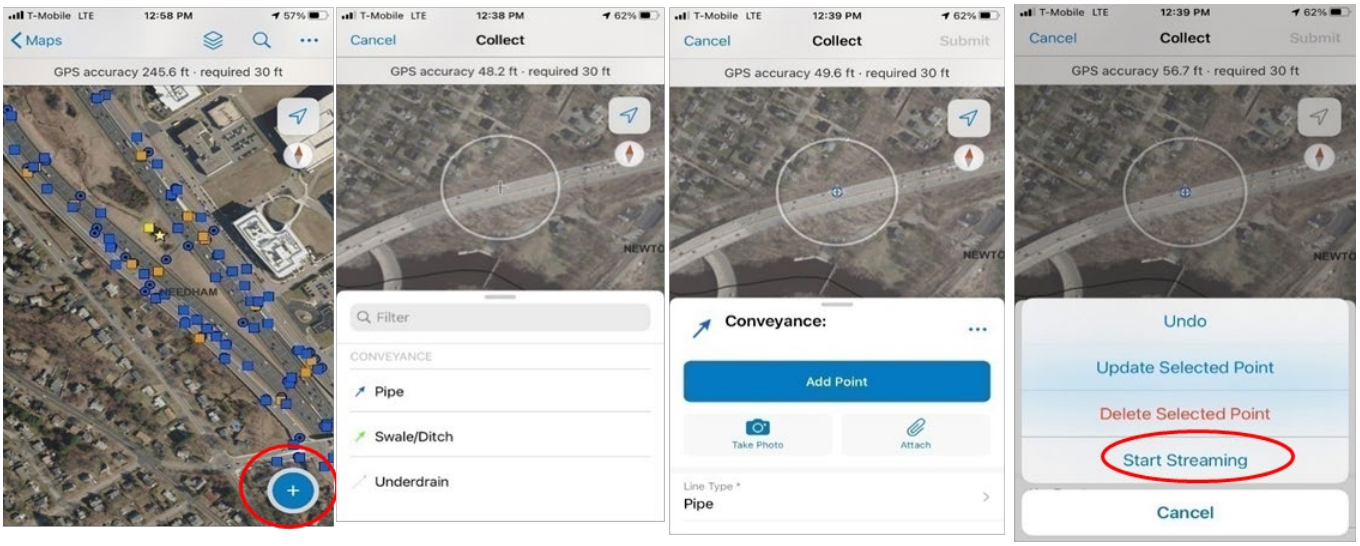


Figure 53

5. Be sure to save the new feature by clicking "Submit" when finished (Figure 54).

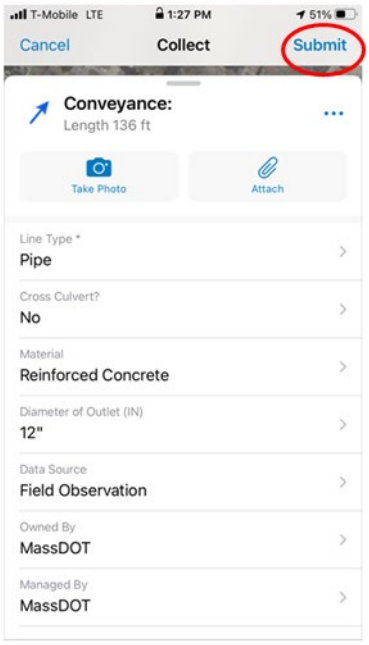


Figure 54

After field work is complete, perform post-processing of data in ArcGIS Pro to populate all attributes, snap features, and confirm accuracy.

4.2 Update an Existing Feature in the Field Maps App

To edit the geometry or attributes of an existing stormwater feature in the Field Maps app, follow the steps below:

1. Use your finger to select the feature you would like to edit. The selected feature will be highlighted light blue. If multiple features are selected, a list will pop up. Click on the specific asset you would like to edit (Figure 55).
2. The attribute list of that feature will appear. Click on the Pen Icon to edit the attributes and the geometry (Figure 55, below). Press "Submit" once edits are complete.

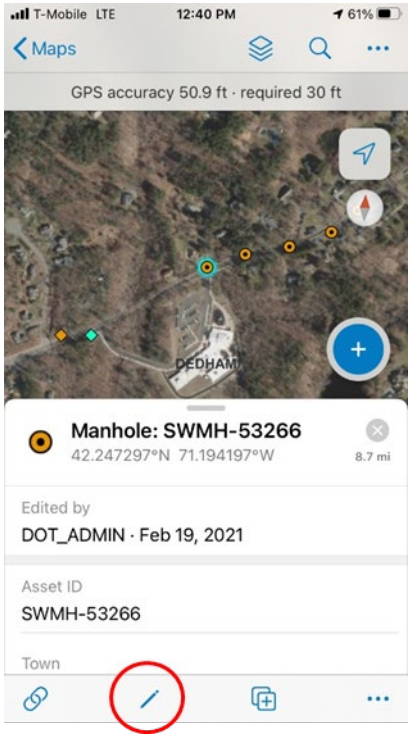


Figure 55

Field Maps Tip: Click on the three dots or scroll to the bottom of the attributes of a selected feature to access more options (Figure 56).

- **Directions** will direct you to another mapping app and give you turn by turn directions to the selected feature.
- **Compass** will give you an approximate distance and direction from you to the selected feature.

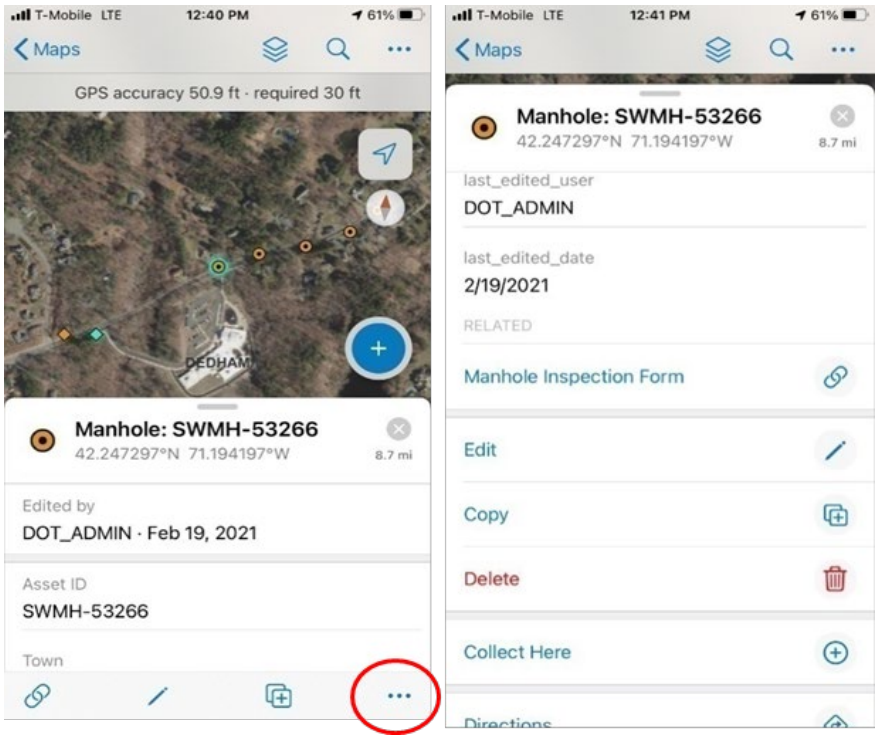


Figure 56

4.3 Complete an Inspection in the Field Maps App

To document a condition inspection in the Field Maps app, follow the steps below:

1. Select the asset you want to inspect. Attributes for the selected asset will appear. Scroll all the way to the bottom of the attribute list and click on the inspections link (Figure 57).

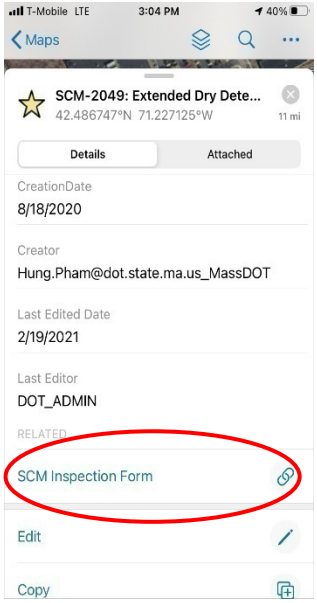


Figure 57

2. All previous inspections for that asset will be listed (if any). Click "Add" to create a new inspection record (Figure 58).

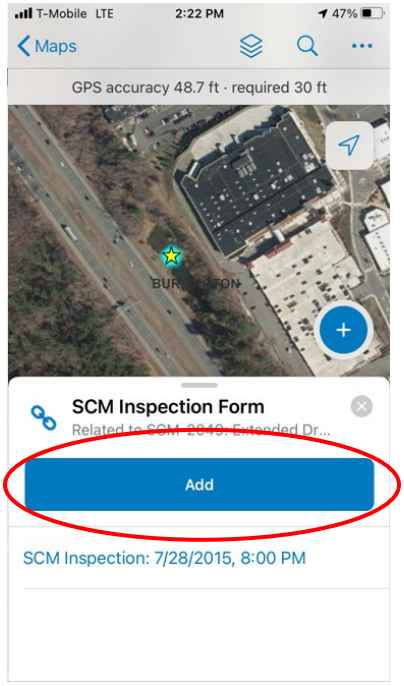


Figure 58

3. Fill out attributes in the Inspection form.
   - Populate the "Action Needed" and "Overall Condition" fields.
   - Add any specific observations or other important information on required maintenance to the "Notes" field as necessary.
4. Take photos of the feature to include with the inspection record.
5. Once complete, hit "Submit" (Figure 59).

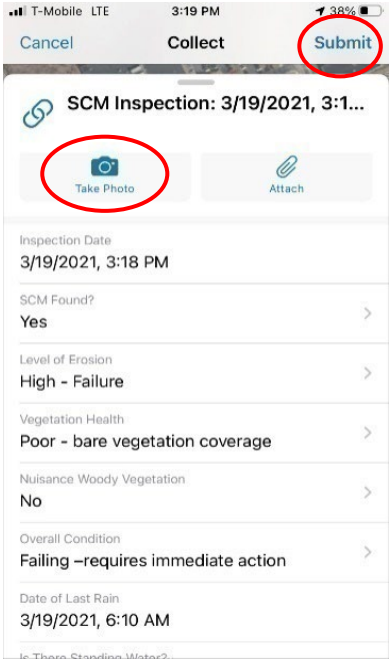

T-Mobile LTE
3:19 PM
38%
Cancel
Collect
Submit
SCM Inspection: 3/19/2021, 3:1...
Take Photo
Attach
Inspection Date
3/19/2021, 3:18 PM
SCM Found?
Yes
Level of Erosion
High - Failure
Vegetation Health
Poor - bare vegetation coverage
Nuisance Woody Vegetation
No
Overall Condition
Failing –requires immediate action
Date of Last Rain
3/19/2021, 6:10 AM

Figure 59

5 Quality Review

After data collection is complete, an internal review of the mapped drainage infrastructure should be performed to ensure that data was collected consistent with this drainage mapping guide.

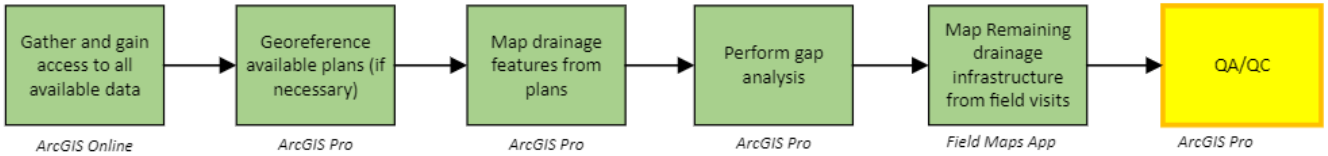


Figure 60

Prior to notifying the QAQC Lead that mapping is complete, the following data checks should be performed:

- ✓ Check for features with no attributes (i.e., blank fields). Also ensure that required fields are populated where information is available. Refer to **Appendix A** for which fields are required to be populated.
- ✓ Scan for features that are not located within any MassDOT drainage network or associated with any MassDOT roadway. Also scan data for missing features or incomplete data (i.e., a drainage network is missing a structure at the end of pipe).
- ✓ Check for duplicate features (i.e., multiple points or lines in the same location when only one feature should be mapped).
- ✓ Check for attributes that are not domain values. When viewing a selected feature in ArcGIS Pro, values that are not within the assigned domain for a field will be highlighted red in the Attribute pane, as shown in Figure 61, below.
- ✓ Confirm that newly georeferenced files are saved here: https://massgov.sharepoint.com/sites/DOT-Highway/StormwaterandCulvertMapping?e=1%3A903925bdf43d4789bdbadc842f93e567&CT=1779363525134&OR=OWA-NT-Mail&CID=1253bad8-80e1-0c41-7a14-631810bae643

The QAQC Lead is responsible for reviewing your database version and merging the edits with the default database

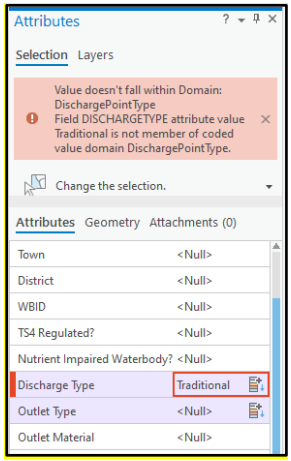


Figure 61

Appendix A - Database Field and Domain Descriptions

The tables below list details for every field in each feature class in MassDOT's Stormwater Asset Database and for the Mapping Progress Tracker layer and Related Review Table, including:

- field alias;
- data type (text, date, number etc.);
- data source (consultant, MassDOT, or auto);
- if the field uses a domain;
- description of the field; and
- allowable length (maximum)**.**

The source column lists which fields will generally be auto-populated by ArcGIS or a MassDOT process at a later date ("Auto"), populated by MassDOT ("MassDOT"), or populated by mapping professionals completing drainage mapping ("Consultant"). There will be some cases where information may be available to fill out a "MassDOT" source marked field, for example if available records plans list SCM treatment values. In this case the mapping professional should fill out the field based on the most up to date source available.

In general, do not overwrite information that is already recorded in the database, unless a more complete and accurate data source is available.

Fields noted with an asterisk (*) are required fields. While the database will not prevent creation of features with null fields, even those marked as required, it is very important to fill out as many fields as possible based on available information. Those marked with an asterisk should be complete for all features as part of this drainage mapping effort.

Additionally, a List of Domains table is included which lists the coded values and descriptions for each domain in the MassDOT Stormwater Asset Database. For fields that use a domain, the name of the domain is listed in the "Domain" column of each feature class table. To view the complete list of coded values and descriptions for each domain, look up the domain name in the List of Domains table.

Mapping Progress Tracker

Mapping Progress Tracker					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Section ID	DOUBLE	Auto (ArcGIS)		Old Object ID from previous version of layer. Needs review to determine approach to keep this updated when new polygons are added.	
Mapper Name*	TEXT	MassDOT Mapping Lead		Name of mapper	60
Mapper Email*	TEXT	Mapping Professional		Email of mapper	50
Mapping Start Date*	DATE	Mapping Professional		Date mapping is initiated	
Mapping Finish Date*	DATE	Mapping Professional		Date mapping status becomes complete or substantially complete	
Mapping Status*	TEXT	All	MappingStatus	Current status of mapping effort in relevant section	30
Mapping Comments	TEXT	Mapping Professional		Comments related to final mapping product (e.g. when MappingStatus = Other See Comments)	255
Follow Up Notes	TEXT	Mapping Professional		Follow up actions required to complete mapping area (e.g. when MappingStatus = Follow Up Needed)	255
Total Center Lane Miles*	DOUBLE	Mapping Professional		Estimate of center lane miles of mapping area. This should reflect the total length of each individual polyline feature in the latest MassDOT Road Inventory layer within the mapping area (e.g. if there are two polyline features along a roadway representing the two directions of traffic, both of those polyline lengths should be added to determine the approximate center lane miles).	
Approximate Hours to Map*	DOUBLE	Mapping Professional		Estimate of time spent mapping, including reviews	
Reference Plan Numbers*	TEXT	All		Project or plan numbers associated with reference plans used (comma delineated list if multiple)	100
Relevant Sheets*	TEXT	All		Sheet numbers of specific reference plans used (comma delineated list if multiple)	100

Mapping Progress Tracker					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Overall Plan Clarity	TEXT	MassDOT Mapping Lead	PlanClarity	Quality of plans that have been located for the given mapping section. Should reflect ability of mapper to decipher plans and complete section based on planset available.	20
Plan Notes	TEXT	All		Notes on plan quality, availability, or progress on obtaining plans.	255
Upcoming Project Number	TEXT	TBD		Added field to track anticipated work	40
Upcoming Project Year	TEXT	TBD		Added field to track anticipated work	40
Shape.STArea()	DOUBLE	Auto (ArcGIS)			
Shape.STLength()	DOUBLE	Auto (ArcGIS)			
Total_Mileage	DOUBLE	Auto (ArcGIS)			

Review Data Related Table

Related Table - Review Data					
Field Alias	**Data Type**	**Source**	**Domain**	**Description**	**Length**
Reviewer Name	TEXT	Reviewer		Name of reviewer	
Reviewer Email	TEXT	Reviewer		Email of reviewer	
Review Start	DATE	Reviewer		Date review began	
Review Status	TEXT	Reviewer	ReviewStatus	Status of review	
Review Comments	TEXT	Reviewer		Global review comments or any other relevant notes from reviewer to mapper (Bookmarks associated with each individual review should be attached as a zip file to each Review Data table entry)	
Review Finish	TEXT	Reviewer		Date review completed (comments provided or mapping area complete/posted)	

Manholes

Manholes					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Asset ID	TEXT	Auto (MassDOT)		Unique MassDOT identifier generated when a new feature is created.	20
Town	TEXT	Auto (MassDOT)	dCity	Name of the Massachusetts Town the feature is located within.	50
District	TEXT	Auto (MassDOT)	dDistrict	Name of the MassDOT highway district the feature is located within.	10
Location*	TEXT	Mapping Professional	Location	Approximate location description of structure relative to roadway (e.g., lane number, shoulder, median, sidewalk etc.)	25
Cover Type*	TEXT	Mapping Professional	MH_CoverType	Shape of structure cover (e.g., standard round, large round, square, pull box etc.).	20
Utility Type*	TEXT	Mapping Professional	Utility	Manhole utility type (drainage, combined sewer, electric etc.). New manholes that are not drainage should not be mapped. For existing non-drainage manholes, record the appropriate utility type or populate as Unknown.	15
Is it bolted?	TEXT	Mapping Professional	YesNo_1	Does the structure have a locking mechanism? If this information is not readily available from plans, leave blank.	5
Does it have a sump?	TEXT	Mapping Professional	YesNo_1	Does the bottom of the structure extend deeper than the lowest invert? If this information is not readily available from plans, leave blank.	5
Does it have a valve?	TEXT	Mapping Professional	YesNo_1	Does the structure have a valve? If this information is not readily available from plans, leave blank.	5
Number of inlets to manhole*	DOUBLE	Mapping Professional		Total number of incoming pipes to the manhole structure.	
Casting Depth (in)	TEXT	Mapping Professional		The depth (in inches) of the manhole casting in which the frame and cover sits on. If this information is not readily available from plans, leave blank.	
Data Source*	TEXT	Mapping Professional	DataSource_1	The source of the data used to map the manhole feature (e.g., record plans).	20
Owned By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on a MassDOT roadway, assume the feature is owned by MassDOT.	15
Managed By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on a MassDOT roadway, assume the feature is maintained by MassDOT.	15
Notes	TEXT	Mapping Professional		Use this field to provide additional information about a manhole structure. This field is not to be used for internal working notes.	250
Photo Path	TEXT	MassDOT		This file path should only be used in reference to MassDOT's network. Will likely not be used as part of this mapping effort.	250
Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the manhole. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250
ServiceStatus	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc)	25

Manholes					
created_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
created_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
last_edited_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
last_edited_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Town Text	TEXT	MassDOT		Name of the Massachusetts Town the feature is located within.	50
District Text	TEXT	MassDOT	District	Name of the MassDOT highway district the feature is located within.	10
Owner	TEXT	MassDOT	OwnMaintain	For drainage features located on a MassDOT roadway, assume the feature is owned by MassDOT.	255
Route_ID	TEXT	Auto (MassDOT)		Name of the Route or interstate the feature is located within.	20
Street Name	TEXT	Auto (MassDOT)		Name of the street the feature is located within.	100

Inlets

Inlets					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Asset ID	TEXT	Auto (MassDOT)		Unique MassDOT identifier generated when a new feature is created.	20
SCMID	TEXT	Mapping Professional		Unique MassDOT identifier for the SCM with which the feature is associated (if applicable).	255
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
Road	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Roadway Type	TEXT	MassDOT	POMP _RoadwayType	These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Location*	TEXT	Mapping Professional	Location	Approximate location description of structure relative to roadway (e.g., lane number, shoulder, median, sidewalk etc.)	25
Reduced Salt Zone	TEXT	MassDOT	YesNo_1	These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Ramp	TEXT	MassDOT	YesNo_1	These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Hotspot	TEXT	MassDOT	YesNo_1	These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Cleaning Frequency Years	DOUBLE	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	
Town Text	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	50
District Text	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	10
Owner	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Route_ID	TEXT	Auto (MassDOT)		Unique ID of the road the feature lies within generated automatically.	20
Street Name	TEXT	Auto (MassDOT)		Name of the road the feature lies within generated automatically.	100
Inspection Schedule	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	20
Follow Up Needed	TEXT	MassDOT		These fields will be populated as part of the Programmatic Operations and Maintenance Plan.	255
Inlet Type*	TEXT	Mapping Professional	InletType	Inlet structure type (catch basin, drop inlet, gutter inlet, headwall, flared end section, outlet control structure, scuppers, etc.)	25

Inlets					
Cover Type*	TEXT	Mapping Professional	Inlet_CoverType	Shape of inlet structure cover (square, round, rectangular, "D" etc.)	25
Does it Lock?	TEXT	Mapping Professional	YesNo_1	Does the inlet have a locking mechanism? If this information is not readily available from plans, leave blank.	5
Has Hood?	TEXT	Mapping Professional	YesNo_1	Does the inlet have a hood (generally only applicable to catch basins)? If this information is not readily available from plans, leave blank.	5
Has Valve?	TEXT	Mapping Professional	YesNo_1	Does the inlet have a valve? If this information is not readily available from plans, leave blank.	5
Sump Depth (in)	DOUBLE	Mapping Professional		The distance (in inches) between the bottom of the structure and the lowest invert. If this information is not readily available from plans, leave blank.	
Data Source*	TEXT	Mapping Professional	DataSource_1	The source of the data used to map the inlet feature (e.g., field observation, record plans).	20
Owned By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on a MassDOT roadway, assume the feature is owned by MassDOT.	15
Managed By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on a MassDOT roadway, assume the feature is maintained by MassDOT.	15
Notes	TEXT	Mapping Professional		Use this field to provide additional information about an inlet feature. This field is not to be used for internal working notes.	250
Photo Path	TEXT	MassDOT		This file path should only be used in reference to MassDOT's network. Will likely not be used as part of this mapping effort.	250
Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the inlet. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250
ServiceStatus	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc.)	25
created_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
created_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
last_edited_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
last_edited_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	

Stormwater Discharge Points

Stormwater Discharge Points					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Asset ID	TEXT	Auto (MassDOT)		Unique MassDOT identifier generated when a new feature is created.	20
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
WBID	TEXT	Auto (MassDOT)		WBID (from MA 2016 303(d) list) of waterbody the feature discharges to.	15
TS4 Regulated?	TEXT	Auto (MassDOT)	YesNo_1	Is the feature within an urbanized area?	5
Nutrient Impaired Waterbody?	TEXT	Auto (MassDOT)	YesNo_1	Does the feature discharge to a nutrient impaired waterbody?	5
Discharge Type*	TEXT	Mapping Professional	DischargePointType	Type of stormwater discharge point (standard outfall, outlet to SCM etc.). Note: overflow features/auxiliary spillways should be mapped as separate features in the miscellaneous structures feature class, not stormwater discharge points.	20
Outlet Type*	TEXT	Mapping Professional	Outlet	Outlet structure type (flared end section, headwall, pipe end etc.)	20
Outlet Material*	TEXT	Mapping Professional	OutletMaterial	Outlet structure material (reinforced concrete, paved, stone/riprap, PVC etc.)	35
Diameter of Outlet*	TEXT	Mapping Professional	PipeDiameter	The insider pipe diameter of the outlet in inches.	10
Has Gate?	TEXT	Mapping Professional	YesNoNA	Does the outlet feature have a gate (e.g., sluice gate, flap gate, flex valve, etc.)? If this information is not readily available from plans, leave blank. Note: tide gates should be mapped as separate features in the miscellaneous structures feature class.	5
Data Source*	TEXT	Mapping Professional	DataSource_1	The source of the data used to map the stormwater discharge feature (e.g., field observation, record plans).	20
Owned By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is owned by MassDOT.	15
Managed By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is maintained by MassDOT.	15
Notes	TEXT	Mapping Professional		Use this field to provide additional information about a stormwater discharge feature. This field is not to be used for internal working notes.	250
Photo Path	TEXT	MassDOT		This file path should only be used in reference to MassDOT's network. Will likely not be used as part of this mapping effort.	250
Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the discharge point. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250

Stormwater Discharge Points					
Service Status*	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc.)	25
created_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
created_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
last_edited_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
last_edited_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
SCMID	TEXT	Mapping Professional		Facility ID for the SCM with which the feature is associated (if applicable). If not applicable, leave blank.	255
Town ID	SHORT	Auto (ArcGIS)	dCity	Name of the Massachusetts Town the feature is located within.	
District_Num	SHORT	Auto (MassDOT)	dDistrict	Name of the MassDOT highway district the feature is located within.	

Stormwater Control Measures

Stormwater Control Measures					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
LEGACYID	TEXT	MassDOT		Superseded MassDOT identifier.	50
Waterbody ID	TEXT	Auto (MassDOT)		WBID (from to MA 2016 303(d) list) of waterbody SCM discharges to.	15
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
SCM Type*	TEXT	Mapping Professional	SCMType	The type of SCM (e.g., infiltration basin, infiltration linear practice, extended dry detention basin, bioretention area etc.).	35
SCM Status	TEXT	Mapping Professional	DesignStatus	The current design status of the feature (active, in construction, 25%, 75% etc.)	25
Is SCM Lined?	TEXT	Mapping Professional	YesNo_1	Does the SCM design include a low-permeability liner (e.g., impermeable geotextile materials or low-permeability earthen materials such as clay)? If this information is not readily available from plans, leave blank.	5
Has Underdrain?	TEXT	Mapping Professional	YesNo_1	Does the SCM design include an underdrain? If yes, map the underdrain as a separate polyline feature in the conveyance feature class. If this information is not readily available from plans, leave blank.	5
Has Staff Gauge?	TEXT	Mapping Professional	YesNo_1	Is a staff gauge located within the SCM? A staff gauge is a device used to record sediment level. If this information is not readily available from plans, leave blank.	5
FlowPath	TEXT	MassDOT	FlowPath	Indicates whether flow path of SCM is direct or indirect. This field may already be populated for some SCMs. This field is not relevant to this drainage mapping effort.	10
Access Notes	TEXT	Mapping Professional		Use this field to provide additional information on how someone doing an inspection or performing maintenance may safely access the SCM. Please note whether there is fencing and/or if the SCM entry is locked.	250
SCM Notes	TEXT	Mapping Professional		Use this field to provide additional information about an SCM. This field is not to be used for internal working notes.	300
Install Date	DATE	Mapping Professional		The date that the SCM was installed. This field may already be populated for some SCMs. If this information is not readily available from plans, leave blank.	
Owned By*	TEXT	Mapping Professional	OwnMaintain	For SCMs located on or adjacent to a MassDOT roadway, assume the SCM is owned by MassDOT. This field may already be populated for some SCMs.	15
MAINTBY*	TEXT	Mapping Professional	OwnMaintain	For SCMs located on or adjacent to a MassDOT roadway, assume the SCM is maintained by MassDOT. This field may already be populated for some SCMs.	15
Soil Type	TEXT	Mapping Professional	SoilType	Soil classification at the location of the SCM. This field may already be populated for some SCMs. If this field is already populated, do not overwrite.	15
Storage Volume (ft^3)	DOUBLE	Mapping Professional		Design storage volume (in cubic feet) of the SCM. This field may already be populated for some SCMs. If this field is already populated, do not overwrite.	
DOT Watershed to SCM (Acres)	DOUBLE	Mapping Professional		Total area (in acres) contributing to the SCM. If this field is already populated, do not overwrite.	

Stormwater Control Measures					
IC Watershed to SCM (Acres)	DOUBLE	Mapping Professional		Impervious area (in acres) contributing to the SCM. If this field is already populated, do not overwrite.	
Treatment Depth (in)	DOUBLE	MassDOT		SCM treatment depth (calculated as SCM storage volume divided by contributing impervious area), used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Annual IC Percent Reduction (%)	DOUBLE	MassDOT		SCM annual percent impervious cover reduction, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Effective IC Reduced by SCM (Acres)	DOUBLE	MassDOT		SCM annual effective impervious cover reduction credit, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Annual P Percent Reduction (%)	DOUBLE	MassDOT		SCM annual percent phosphorus removal, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
P Reduced by SCM (Lbs/Year)	DOUBLE	MassDOT		SCM annual phosphorus reduction credit, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Annual N Percent Reduction (%)	DOUBLE	MassDOT		SCM annual percent nitrogen removal, used for water quality accounting and crediting. If this field is already populated, do not overwrite.	
N Reduced by SCM (Lbs/Year)	DOUBLE	MassDOT		SCM annual nitrogen reduction credit, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Annual TSS Percent Reduction (%)	DOUBLE	MassDOT		SCM annual percent TSS removal, used for water quality accounting and crediting. If this field is already populated, do not overwrite.	
TSS Reduced by SCM (Lbs/Year)	DOUBLE	MassDOT		SCM annual TSS reduction credit, used for water quality accounting and tracking. If this field is already populated, do not overwrite.	
Source of Data*	TEXT	Mapping Professional	SCMDataSource	The source of the data used to map the SCM (e.g., field observation, record plans).	25
Project Number*	DOUBLE	Mapping Professional		The six-digit MassDOT project number associated with the design and construction of the SCM. This field may already be populated for some SCMs.	
Project Name*	TEXT	Mapping Professional		The name of the project associated with the design and construction of the SCM. This field may already be populated for some SCMs.	50
Submitted By	TEXT	MassDOT		Name of SCM designer. This field is not relevant for this mapping effort.	50
Date Submitted	DATE	MassDOT		Date SCM design submitted to MassDOT. This field is not relevant for this mapping effort.	
MassDOT Reviewer	TEXT	MassDOT		Name of MassDOT Reviewer who reviewed SCM design. This field is not relevant for this mapping effort.	50
Review Date	DATE	MassDOT		Date MassDOT reviewed SCM design. This field is not relevant for this mapping effort.	
Photo Path	TEXT	MassDOT		This file path should only be used in reference to MassDOT's network. Will likely not be used as part of this mapping effort.	250
Link to Record Plans	TEXT	Mapping Professional		This file path should only be in reference to MassDOT's network.	250

Stormwater Control Measures					
Plan Sheet Number*	TEXT	Mapping Professional		Populate with plan set sheet number where the SCM is located.	50
Service Status	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc.)	25
CreationDate	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Creator	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
Last Edited Date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Last Editor	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
SCM ID	TEXT	MassDOT		MassDOT identifier.	20
Town_ID	SHORT	Auto (MassDOT)	dCity	Name of the Massachusetts Town the feature is located within.	
District_Num	SHORT	Auto (MassDOT)	dDistrict	Name of the MassDOT highway district the feature is located within.	
Attachments*	N/A	Mapping Professional		Plans for all SCMs should be attached to feature.	

Conveyance

Conveyance					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Material*	TEXT	Mapping Professional	PipeMaterial	Conveyance material type (e.g., concrete, metal, grass, PVC, riprap, etc.)	35
Diameter of Outlet (IN)*	TEXT	Mapping Professional	PipeDiameter	For pipes or underdrains, record the inside pipe diameter in inches, if known. For ditches/swales, leave blank.	10
Owned By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is owned by MassDOT.	15
Managed By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is maintained by MassDOT.	15
Notes	TEXT	Mapping Professional		Use this field to provide additional information about the conveyance feature. This field is not to be used for internal working notes.	250
Data Source*	TEXT	Mapping Professional	DataSource_1	The source of the data used to map the stormwater discharge feature (e.g., field observation, record plans).	20
Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the conveyance. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250
Asset ID	TEXT	Auto (MassDOT)		Unique MassDOT identifier generated when a new feature is created.	20
Cross Culvert?	TEXT	Mapping Professional	YesNo_1	Is this conveyance a cross culvert?	5
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
Line Type*	TEXT	Mapping Professional	LineType	Type of conveyance feature (e.g., pipe, swale/ditch, or underdrain).	15
Service Status*	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc.)	25
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
CreationDate	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Creator	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
Last Edited Date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Last Editor	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
Shape.STLength()	DOUBLE	Auto (ArcGIS)		Length of line feature.	

Town_ID	SHORT	Auto (MassDOT)	dCity	Name of the Massachusetts Town the feature is located within.	
District_Num	SHORT	Auto (MassDOT)	dDistrict	Name of the MassDOT highway district the feature is located within.	

Miscellaneous

Miscellaneous					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
Asset ID	TEXT	Auto (MassDOT)		Unique MassDOT identifier generated when a new feature is created.	20
Associated SCM ID*	TEXT	Mapping Professional		If the feature is an accessory to an SCM, such as a sediment forebay or check dam, list the associated SCM ID. Otherwise, leave blank.	10
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
Location*	TEXT	Mapping Professional	Location	Approximate location description of structure relative to roadway (e.g., lane number, shoulder, median, sidewalk etc.). Populate field if structure location aligns with domain, otherwise leave blank.	25
Feature Type*	TEXT	Mapping Professional	MiscType	Miscellaneous structure type (sediment forebay, check dam, auxiliary spillway, level spreader, vegetated riprap, tide gate etc.).	30
Does it Lock?	TEXT	Mapping Professional	YesNo_1	Does the structure have a locking mechanism? If this information is not readily available from plans, leave blank.	5
Data Source*	TEXT	Mapping Professional	DataSource_1	The source of the data used to map the feature (e.g., field observation, record plans).	20
Owned By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is owned by MassDOT.	15
Managed By*	TEXT	Mapping Professional	OwnMaintain	For drainage features located on or adjacent to a MassDOT roadway, assume the feature is maintained by MassDOT.	15
Notes	TEXT	Mapping Professional		Use this field to provide additional information about a structure. This field is not to be used for internal working notes.	250
Photo Path	TEXT	MassDOT		This file path should only be used in reference to MassDOT's network. Will likely not be used as part of this mapping effort.	250
Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the miscellaneous asset. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250
Service Status*	TEXT	Mapping Professional	ServiceStatus_1	The current status of the feature (actively in service, proposed, retired, etc)	25
created_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
created_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
last_edited_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
last_edited_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Town_ID	SHORT	Auto (MassDOT)	dCity	Name of the Massachusetts Town district the feature is located within.	
District_Num	SHORT	Auto (MassDOT)	dDistrict	Name of the MassDOT highway district the feature is located within.	

Interconnections

Interconnections					
Alias	**Type**	**Source**	**Domain**	**Description**	**Length**
District	TEXT	Auto (MassDOT)	District	Name of the MassDOT highway district the feature is located within.	10
Town	TEXT	Auto (MassDOT)		Name of the Massachusetts Town the feature is located within.	50
Flow Direction*	TEXT	Mapping Professional	FlowDirection	Is the interconnection incoming (into MassDOT's drainage system) or outgoing (from MassDOT's system to a non-MassDOT system)?	25
Interconnection Structure*	TEXT	Mapping Professional	IntStr	The type of structure where the interconnection is located (catch basin, manhole, headwall etc.). Blind tie refers to interconnections that are not located at a structure, but directly into a conveyance feature (i.e., pipe).	20
Interconnection System Type*	TEXT	Mapping Professional	InterSysType	The type of system the interconnection is connected to (Drainage, CSO, or other).	256
Data Source*	TEXT	Mapping Professional	DataSource	The source of the data used to map the feature (e.g., field observation, record plans).	20
Non-MassDOT System Owner*	TEXT	Mapping Professional	OwnMaintain	Ownership of the drainage system interconnecting with MassDOT (e.g., municipality, private utility, other agency etc.). If ownership information is unavailable, populate as Unknown.	15
Permitted?	TEXT	MassDOT	YesNoNA	Does the interconnection have a permit associated with it?	5
Permit Number	TEXT	MassDOT		If the interconnection has a permit associated with it, include the permit number here.	10
Notes	TEXT	Mapping Professional		Use this field to provide additional information about the interconnection. This field is not to be used for internal working notes.	250
Link to Record Plans*	TEXT	Mapping Professional		The Plan and page number used for mapping the interconnection. If a link to record plans is already in the field, this can remain as long as the plans and page number is included.	250
created_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
created_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
last_edited_user	TEXT	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	50
last_edited_date	DATE	Auto (ArcGIS)		Field automatically generated by ArcGIS for editor tracking.	
Associated Facility ID	TEXT	Mapping Professional		Unique MassDOT identifier associated with the feature where the interconnection occurs.	20

List of Domains

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
Action_2	TEXT	CODED	Inspection Maintenance Cleaning Inspection and Cleaning	Inspection Maintenance Cleaning Inspection and Cleaning
Condition_1_1	TEXT	CODED	Good – inspect within 2 years Failing –requires immediate action NA	Good – inspect within 2 years Failing –requires immediate action NA
DataSource_1	TEXT	CODED	Field Observation External Data Source Lidar Digitized 2017 Record Plans	Field Observation External Data Source Lidar Digitized 2017 Record Plans
DesignStatus	TEXT	CODED	Pre-25 Percent 25 Percent 75 Percent 100 Percent PS&E Advertised Design Active In Construction In Design Other	Pre-25 Percent 25 Percent 75 Percent 100 Percent PS&E Advertised Design Active In Construction In Design Other
DischargePointType	TEXT	CODED	Standard Outfall Interim Outfall Final Outfall Outlet to SCM Other Unknown	Standard Outfall Interim Outfall Final Outfall Outlet to SCM Other Unknown
District	TEXT	CODED	District 1 District 2 District 3 District 4 District 5	District 1 District 2 District 3 District 4 District 5

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			District 6	District 6
Erosion	TEXT	CODED	None - No Material Loss Low - Minor Material Loss Moderate - Major Material Loss High - Failure	None - No Material Loss Low - Minor Material Loss Moderate - Major Material Loss High - Failure
FlowDirection	TEXT	CODED	Incoming (to MassDOT) Outgoing (from MassDOT)	Incoming (to MassDOT) Outgoing (from MassDOT)
FlowPath	TEXT	CODED	Direct Indirect	Direct Indirect
InletType	TEXT	CODED	Catch Basin CBCI Double Catch Basin Drop Inlet DSCB Flared End Section Gutter Inlet Headwall Other Outlet Control Structure Scupper (Discharge) Scupper (Non-Discharge) Yard Drain	Catch Basin CBCI Double Catch Basin Drop Inlet DSCB Flared End Section Gutter Inlet Headwall Other Outlet Control Structure Scupper (Discharge) Scupper (Non-Discharge) Yard Drain
Inlet_CoverType	TEXT	CODED	Square Frame & Grate Round Frame & Grate Rectangular Frame & Grate D Frame &Grate Other	Square Frame & Grate Round Frame & Grate Rectangular Frame & Grate D Frame &Grate Other
IntStr	TEXT	CODED	Blind Tie Catch Basin Headwall/Endwall Manhole Inlet Other	Blind Tie Catch Basin Headwall/Endwall Manhole Inlet Other

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
LineType	TEXT	CODED	Pipe Swale/Ditch Underdrain Other	Pipe Swale/Ditch Underdrain Other
Location	TEXT	CODED	Lane 1 Lane 2 Lane 3 Lane 4 Lane 5 LT Shoulder (High Speed) Median Left Median Right Not in Paved Surface On/Off Ramp RT Shoulder (low Speed) Service/Rest Area Side Street Sidewalk	Lane 1 Lane 2 Lane 3 Lane 4 Lane 5 LT Shoulder (High Speed) Median Left Median Right Not in Paved Surface On/Off Ramp RT Shoulder (low Speed) Service/Rest Area Side Street Sidewalk
MaintenanceAction	TEXT	CODED	None Rebuild Frame and Grate/Cover Replacement Structure Cleaning Pipe Cleaning Other	None Rebuild Frame and Grate/Cover Replacement Structure Cleaning Pipe Cleaning Other
MappingStatus	TEXT	CODED	In Progress Review Pending Follow Up Needed Complete Assigned Unassigned Ready to Be Assigned Review Comments Sent	In Progress Review Pending Follow Up Needed Complete Assigned Unassigned Ready to Be Assigned Review Comments Sent

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Substantially Complete	Substantially Complete
			Other See Comments	Other See Comments
MH_CoverType	TEXT	CODED	Standard Round	Standard Round
			Large Round	Large Round
			Special Square	Special Square
			Special Rectangular	Special Rectangular
			Handhole	Handhole
			Pullbox	Pullbox
			Other	Other
MiscType	TEXT	CODED	Sediment Forebay	Sediment Forebay
			Check Dam	Check Dam
			Auxiliary Spillway	Auxiliary Spillway
			Level Spreader	Level Spreader
			Vegetated Riprap	Vegetated Riprap
			Gabion	Gabion
			Tide Gate	Tide Gate
			Riprap Apron	Riprap Apron
			Cleanout Port	Cleanout Port
			Observation/Monitoring Well	Observation/Monitoring Well
			Open Graded Friction Course	Open Graded Friction Course
			Plunge Pool	Plunge Pool
			Staff Gauge	Staff Gauge
			Other (describe in notes)	Other (describe in notes)
Outlet	TEXT	CODED	Flared End Section	Flared End Section
			Headwall	Headwall
			Pipe End	Pipe End
			Other	Other
			Swale end	Swale end
			Paved Waterway	Paved Waterway
OutletMaterial	TEXT	CODED	Reinforced Concrete	Reinforced Concrete
			PVC	PVC
			Paved	Paved
			Stone/Riprap	Stone/Riprap

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Steel	Steel
			Asbestos Concrete	Asbestos Concrete
			Asphalt Coated Corrugated Metal	Asphalt Coated Corrugated Metal
			Cast Iron	Cast Iron
			HDPE	HDPE
			Grass	Grass
			Ductile Iron	Ductile Iron
			Corrugated Plastic	Corrugated Plastic
			Corrugated Metal	Corrugated Metal
			Vitrified Clay	Vitrified Clay
			Unknown	Unknown
			Other	Other
			Concrete (Non-Reinforced)	Concrete (Non-Reinforced)
OwnMaintain	TEXT	CODED	MassDOT	MassDOT
			Private	Private
			Municipality	Municipality
			Other	Other
			Unknown	Unknown
			Other Agency	Other Agency
PipeDiameter	TEXT	CODED	3/4"	3/4"
			1"	1"
			1 1/4"	1 1/4"
			1 1/2"	1 1/2"
			2"	2"
			2 1/2"	2 1/2"
			3"	3"
			4"	4"
			6"	6"
			8"	8"
			10"	10"
			12"	12"
			14"	14"
			15"	15"

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			16"	16"
			18"	18"
			20"	20"
			24"	24"
			30"	30"
			36"	36"
			40"	40"
			42"	42"
			48"	48"
			54"	54"
			60"	60"
			66"	66"
			72"	72"
			75"	75"
			Unknown	Unknown
			Other	Other
PipeMaterial	TEXT	CODED	ABS Plastic	ABS Plastic
			Asbestos Cement	Asbestos Cement
			Asphalt	Asphalt
			Brick	Brick
			Brick Masonry	Brick Masonry
			Cast Iron	Cast Iron
			Clay Tile	Clay Tile
			Concrete (Non-Reinforced)	Concrete (Non-Reinforced)
			Concrete Segments (Bolted)	Concrete Segments (Bolted)
			Concrete Segments (Unbolted)	Concrete Segments (Unbolted)
			Copper	Copper
			Corrugated Metal	Corrugated Metal
			Cured in Place	Cured in Place
			Ductile Iron	Ductile Iron
			Earth & Geotextile	Earth & Geotextile
			Earthen	Earthen
			Fiberglass Reinforced	Fiberglass Reinforced

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Galvanized pipe Geotextile Glass Reinforced Cement Grass High Performance Polyethylene Other Pitch Fiber (Orangeburg) Plastical/Steel Composite Polyethylene Polypropylene Polyvinyl Chloride Pre-Stressed Concrete Cylinder Reinforced Concrete Reinforced Plastic (Truss) RipRap Segmented Block Steel Transite Vitrified Clay Wood Unknown Corrugated Plastic	Galvanized pipe Geotextile Glass Reinforced Cement Grass High Performance Polyethylene Other Pitch Fiber (Orangeburg) Plastical/Steel Composite Polyethylene Polypropylene Polyvinyl Chloride Pre-Stressed Concrete Cylinder Reinforced Concrete Reinforced Plastic (Truss) RipRap Segmented Block Steel Transite Vitrified Clay Wood Unknown Corrugated Plastic
OverallPlanClarity			Needs Review No Usable Plans High Quality Low Quality	Needs Review No Usable Plans High Quality Low Quality
ReviewStatus	TEXT	CODED	Initial Review Complete Review Back Check Posted	Initial Review Complete Review Back Check Posted
BMPAccess	TEXT	CODED	Good- maintained access area for crew and vehicle	Good- maintained access area for crew and vehicle

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Fair- access area designated for crew and vehicle but not maintained Poor- inadequate access for crew and vehicle Failing- inaccessible	Fair- access area designated for crew and vehicle but not maintained Poor- inadequate access for crew and vehicle Failing- inaccessible
SCM_Action	TEXT	CODED	Inspection Maintenance	Inspection Maintenance
SCMDataSource	TEXT	CODED	WQDF Online WQDF Excel IWP Consultant MassDOT Maintenance Inspection Mapping Effort Other	WQDF Online WQDF Excel IWP Consultant MassDOT Maintenance Inspection Mapping Effort Other
SCMSediment	TEXT	CODED	None - no sediment or debris Low - less than 25% sediment accumulation or debris Moderate - 25-50% sediment accumulation or debris High- greater than 50% sediment accumulation or debris	None - no sediment or debris Low - less than 25% sediment accumulation or debris Moderate - 25-50% sediment accumulation or debris High- greater than 50% sediment accumulation or debris
SCMType	TEXT	CODED	Bioretention Area Bioretention Linear Practice Constructed Stormwater Wetland Detention Basin Extended Dry Detention Basin Gravel Wetland Infiltration Basin Infiltration Linear Practice Leaching Basin Media Filter Drain and Embankment Subsurface Infiltration Structure Oil/Grit Separator	Bioretention Area Bioretention Linear Practice Constructed Stormwater Wetland Detention Basin Extended Dry Detention Basin Gravel Wetland Infiltration Basin Infiltration Linear Practice Leaching Basin Media Filter Drain and Embankment Subsurface Infiltration Structure Oil/Grit Separator

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Open Graded Friction Course	Open Graded Friction Course
			Other	Other
			Pavement Disconnection	Pavement Disconnection
			Porous Pavement	Porous Pavement
			Subsurface Infiltration System	Subsurface Infiltration System
			Vegetated Filter Strip	Vegetated Filter Strip
			Wet Basin	Wet Basin
			Wet Linear Practice	Wet Linear Practice
Sediment_1	TEXT	CODED	Sump less than half full	Sump less than half full
			Sump half full	Sump half full
			Sump full	Sump full
			Structure completely full	Structure completely full
			NA	NA
ServiceStatus_1	TEXT	CODED	In Service	In Service
			Proposed Installation	Proposed Installation
			Proposed Retirement	Proposed Retirement
			Retired	Retired
SoilType	TEXT	CODED	Sandy Clay Loam	Sandy Clay Loam
			Silt Loam	Silt Loam
			Loam	Loam
			Sandy Loam	Sandy Loam
			Loamy Sand	Loamy Sand
			Sand	Sand
			Clay	Clay
			Silty Clay	Silty Clay
			Sandy Clay	Sandy Clay
			Silty Clay Loam	Silty Clay Loam
			Clay Loam	Clay Loam
Utility	TEXT	CODED	Drainage	Drainage
			Sewer	Sewer
			Electric	Electric
			Communication	Communication
			Cable	Cable

Domain Name	Data Type	Domain Type	Coded Value	Coded Value Description
			Gas Water Unknown Combined sewer Blind Tie	Gas Water Unknown Combined sewer Blind Tie
Vegetation	TEXT	CODED	Good - full healthy vegetation coverage Fair - majority of area covered with healthy vegetation Poor - bare vegetation coverage Failing - no vegetation, bare soil N/A	Good - full healthy vegetation coverage Fair - majority of area covered with healthy vegetation Poor - bare vegetation coverage Failing - no vegetation, bare soil N/A
YesNo	TEXT	CODED	Yes No	Yes No
YesNoNA	TEXT	CODED	Yes No N/A	Yes No N/A

Appendix B – Example Mapping Scenarios

Below are examples of how to map several scenarios common to MassDOT drainage systems. These examples are included to ensure consistency in the way each of these scenarios are mapped in the stormwater asset database. This appendix is not intended to be a complete list of every drainage scenario and therefore engineering judgment and MassDOT support will be needed in some cases.

Mapping an SCM

When mapping a SCM, it is important to map all relevant drainage features associated with the SCM. For example, in the image below the SCM is mapped as four points total:

- the outlet to the SCM is mapped as one point in the stormwater discharge point feature class,
- the sediment forebay (including the check dam) is mapped as one point in the miscellaneous feature class,
- the SCM is mapped as one point in the SCM feature class, and
- the outlet control structure is mapped as one point in the inlet feature class.

An example of mapping an SCM is shown in Figure 62.

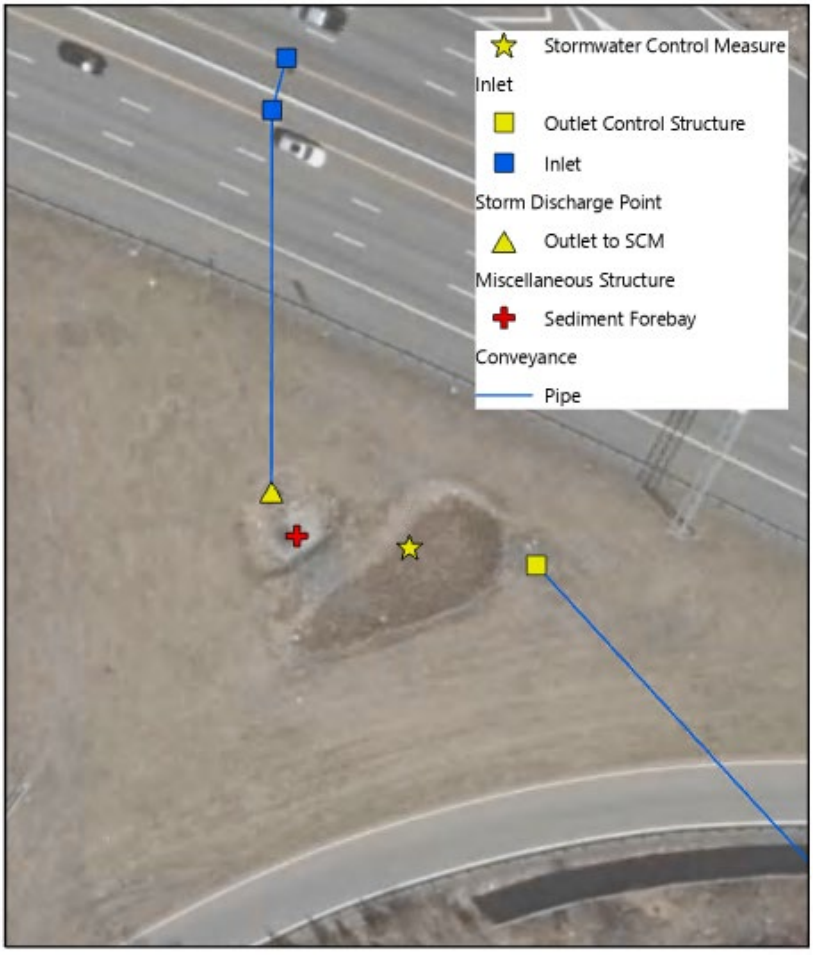


Figure 62

Mapping an SCM with an Underdrain

When an SCM design includes an underdrain, the underdrain pipe is mapped as a line feature in the conveyance feature class. The conveyance type field is populated as “underdrain”. See Figure 63.

Figure 63

Mapping Cleanout Ports

Cleanout ports, or "cleanouts", provide access to underdrains for maintenance and sediment/debris removal. They are often vertical, capped pipes found in some SCMs with underdrains or other subsurface systems.

When mapping cleanout ports, each individual cleanout should be mapped as a Miscellaneous Structure "Other" feature with the Feature Type field populated as "Cleanout Port". When mapping cleanout ports connected to underdrains, which is the case in the plans shown below (Figure 64), cleanout port features should be snapped to underdrain conveyance features (Figure 65).

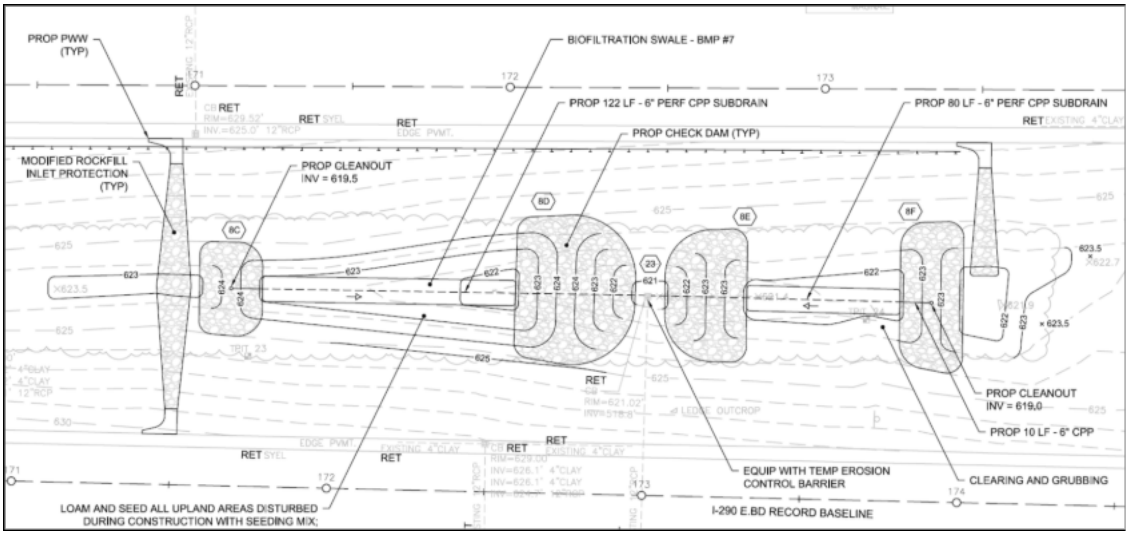


Figure 64

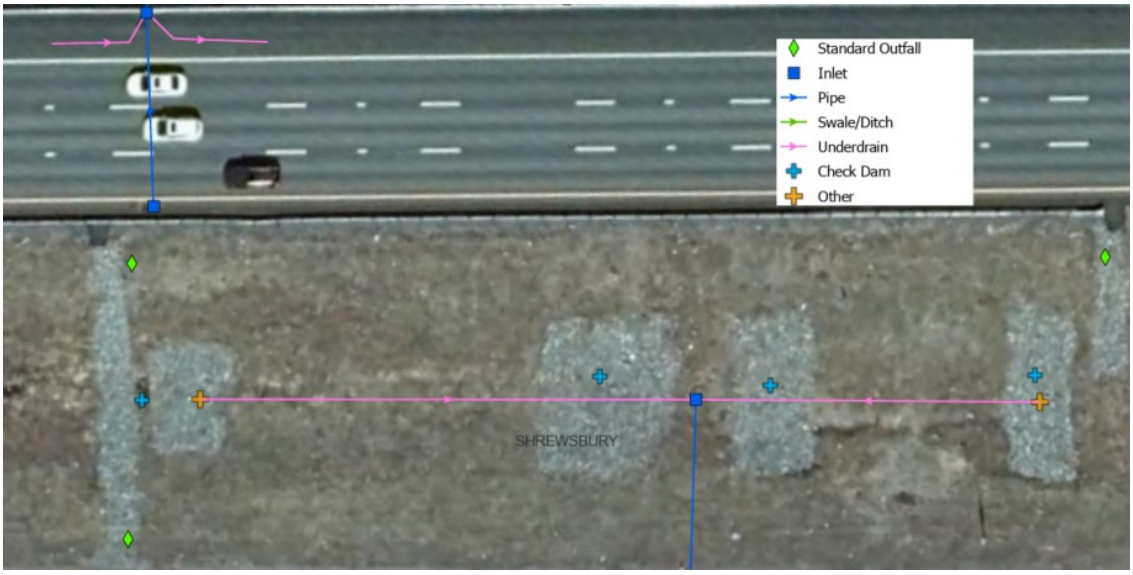


Figure 65

Mapping an Infiltration Linear Practice (Swale with Check Dams) Vs. Conveyance Swale

Figure 66 below is an example of an infiltration linear practice, an SCM designed to treat stormwater by detaining runoff behind a series of check dams to promote infiltration and groundwater recharge. However, because they are labeled in some plan sets as "Infiltration Swales", infiltration linear practices can easily be confused with conveyance swales, which are simply sloped, open channels intended to transport stormwater from one location to another.

To distinguish between these features, is important to consider the function of features labeled as "swales", rather than relying on the label used. Infiltration linear practices function as SCMs and should be mapped as an SCM point with an SCM Type of "Infiltration Linear Practice". On the other hand, Figure 67 shows a conveyance swale that is labeled as a "ditch" on the plans. Conveyance swales should be mapped as conveyance lines with a Line Type of "Swale/Ditch" (Figure 68).

When an SCM design includes check dams, each check dam location is mapped as a point feature in the miscellaneous structures feature class in addition to the SCM point feature. The structure type field is populated as "check dam". As shown in the example below (Figure 66), when a single SCM contains several check dams, each check dam should be mapped as a separate point feature.

Figure 66

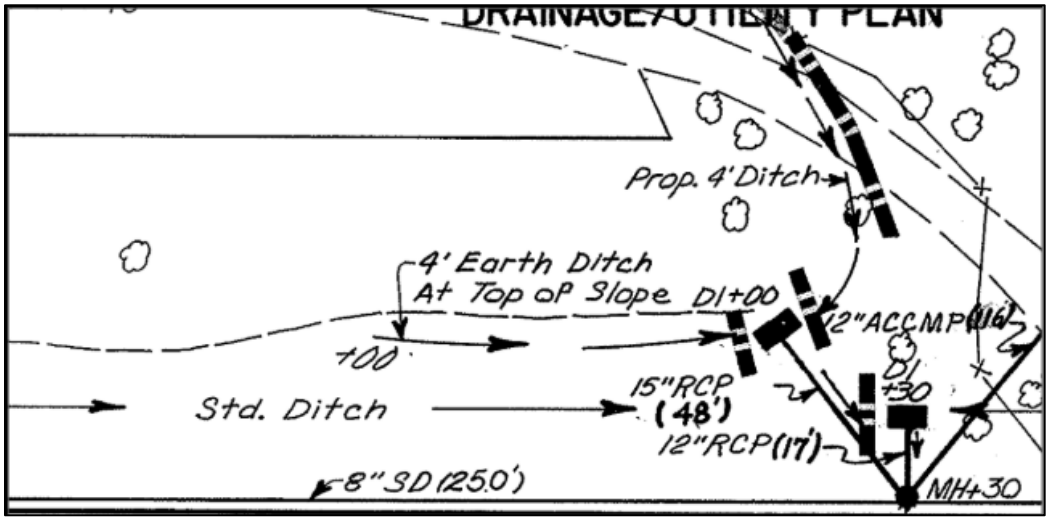


Figure 67

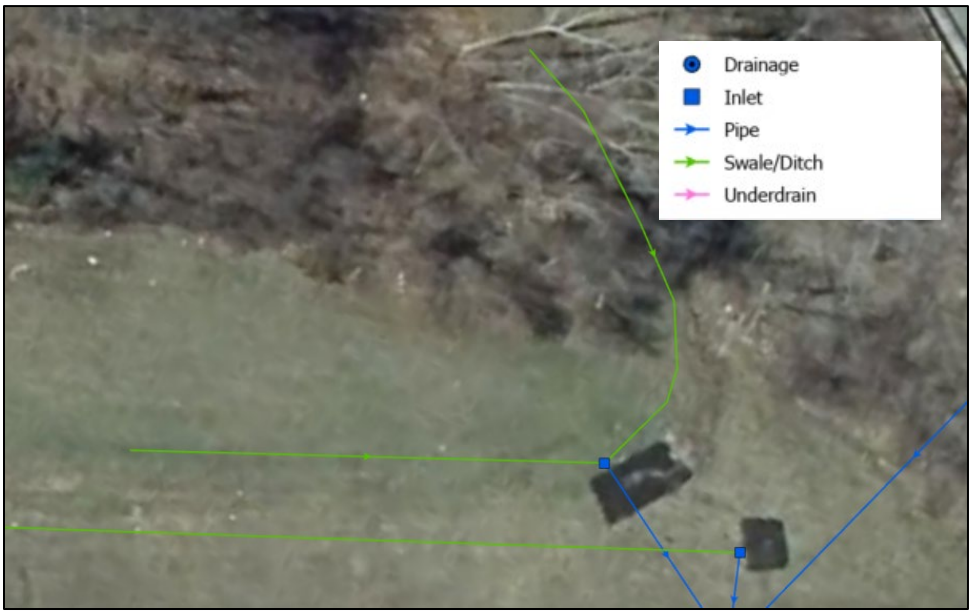


Figure 68

Mapping Outfalls - Discharge Types

When mapping the end of a drainage network in the stormwater discharge point layer, the discharge type field should be populated. There are six options for discharge type, defined below:

- Standard Outfall: end of a drainage system and discharge to a waterbody or upland area
- Outlet to SCM: discharge point into an SCM
    - Although an Outlet to SCM is a type of Interim Outfall, "Outlet to SCM" should be selected where the discharge point is into an SCM, as it is more specific.
- Interim Outfall: refer to "Mapping Interim and Final Outfalls" below for definition
- Final Outfall: refer to "Mapping Interim and Final Outfalls" below for definition.
    - A final outfall is only mapped if there is an "Interim Outfall" upstream. If there is no "Interim Outfall" and the outfall is at the end of the drainage system, this is mapped as a "Standard Outfall".
- Unknown Outfall: refer to "Mapping Conveyances with Unknown Discharges" below for definition.
- Other Outfall: outfalls that do not fit any of the descriptions above.

An example of mapping a standard outfall can be seen in Figure 69.

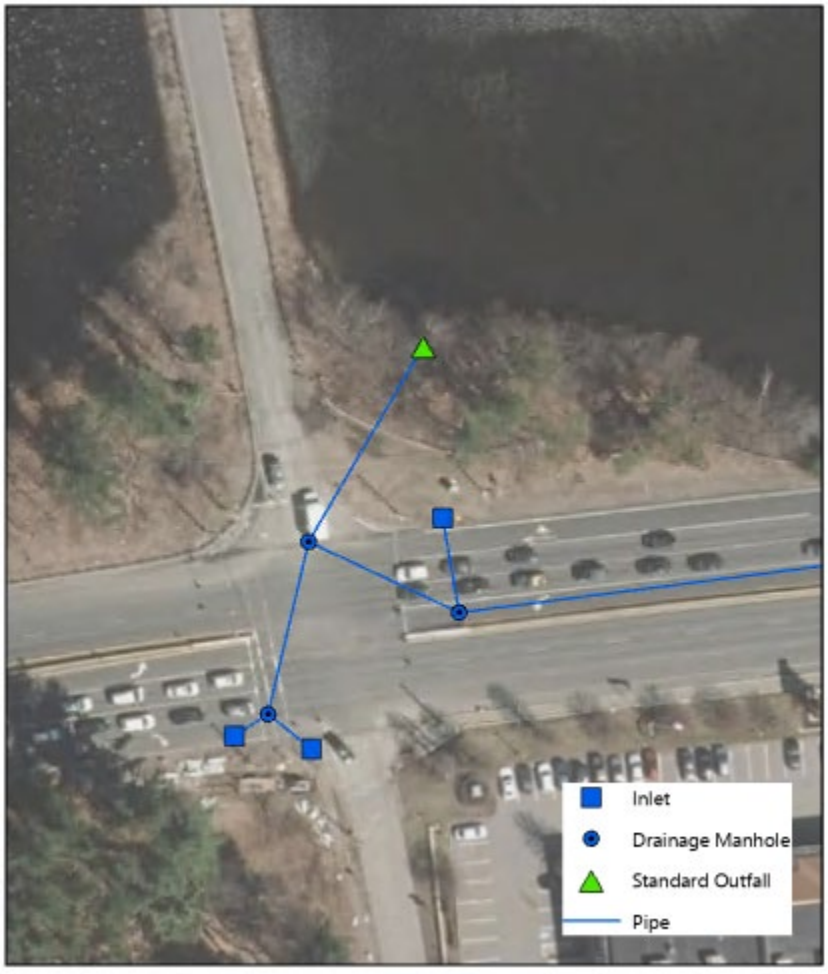


Figure 69

Mapping Interim and Final Outfalls

An interim outfall is an intermediate discharge point where stormwater exits a drainage system before re-entering a drainage system, typically through a stormwater conveyance (such as a swale or pipe). In contrast, final outfalls are the termination of a stormwater network system where there is at least one interim outfall further upstream, and they discharge to locations such as receiving water bodies, resource areas, or other natural environments. It is important to distinguish between interim and final outfalls for the purposes of MassDOT's Illicit Discharge Detection and Elimination (IDDE) program where the most downstream point of a MassDOT owned drainage system (Final Outfall) should be known for screening and sampling purposes.

Figure 71 shows an example of one of the most common interim outfall scenarios where an interim outfall is mapped between a closed drainage system and a swale. Stormwater from the drainage pipe discharges into a conveyance swale before it reaches the final outfall point at the end of the swale. The Discharge Type for the outfall at the end of the 36" reinforced pipe should be mapped as a "Interim Outfall" and the outfall at the end of the conveyance swale should have the Discharge Type "Final Outfall", not "Standard Outfall", since at least one interim outfall exists further upstream in the drainage system.

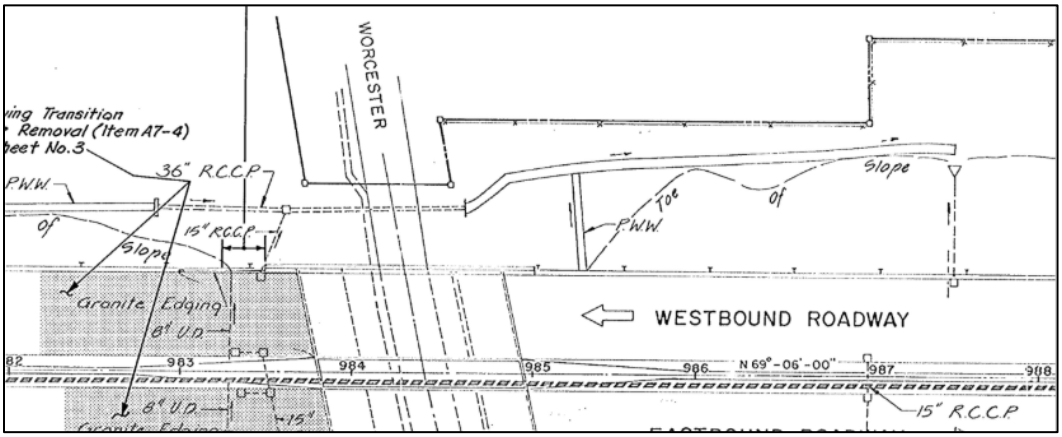


Figure 70

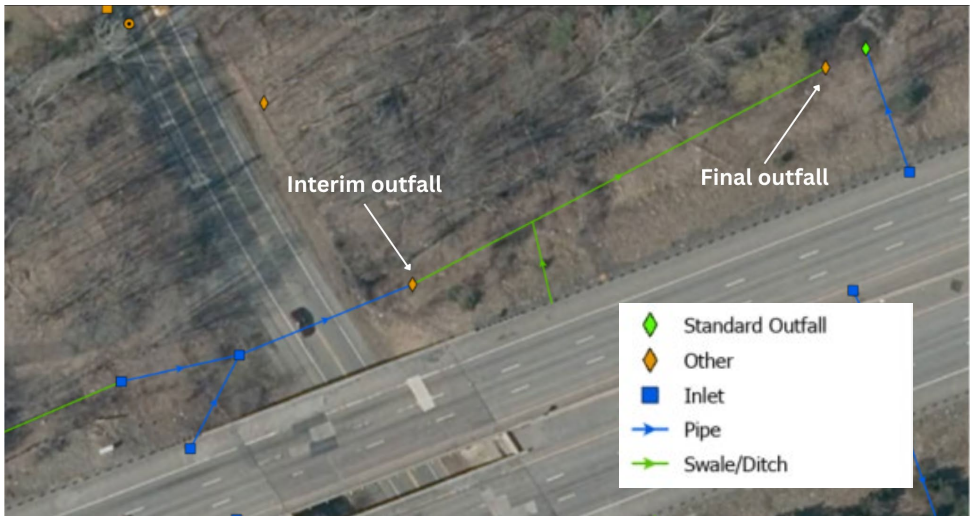


Figure 71

Multiple Pipes Discharging to One Location

If there are multiple pipes discharging to the same location, each point at which water daylights should be mapped as an outfall, as shown below (Figure 72).

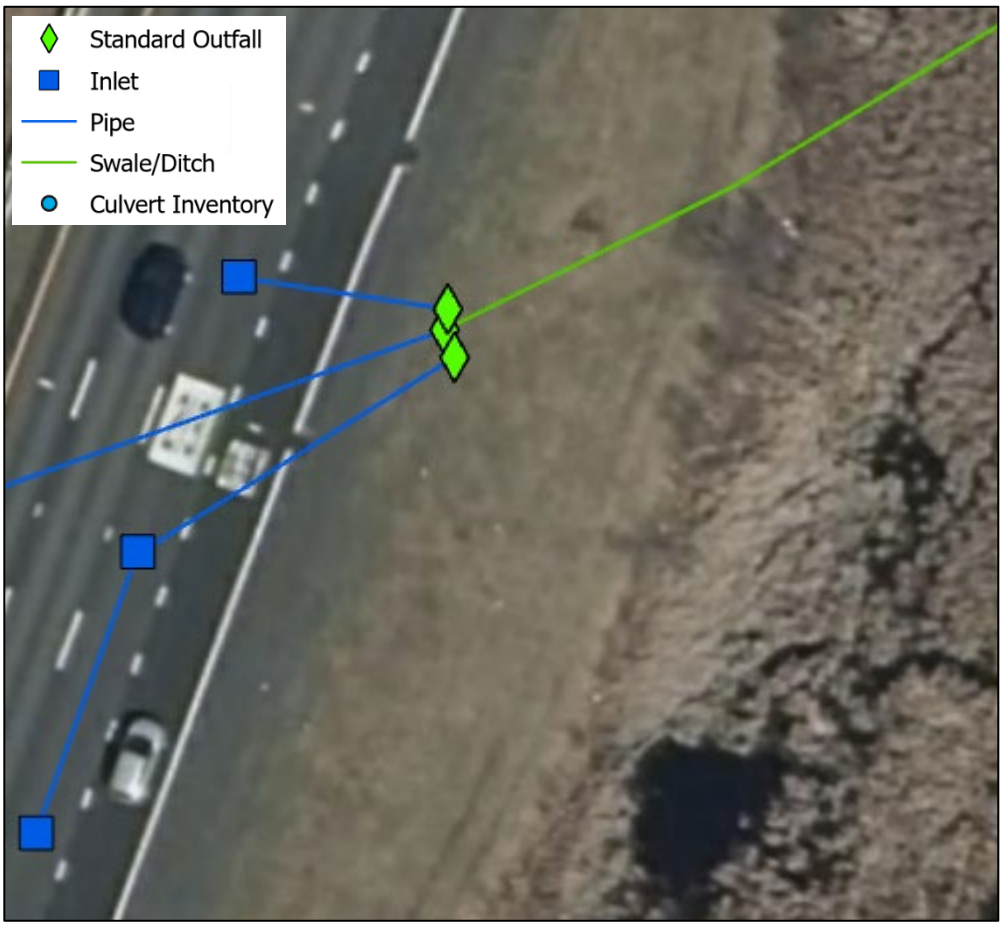


Figure 72

Mapping Conveyances with Unlabeled Pipe Discharges

Some plans show a conveyance without a labeled discharge point. Examples of this are discharge points that go off the page (Figure 73) or conveyances that end with a tilde symbol (

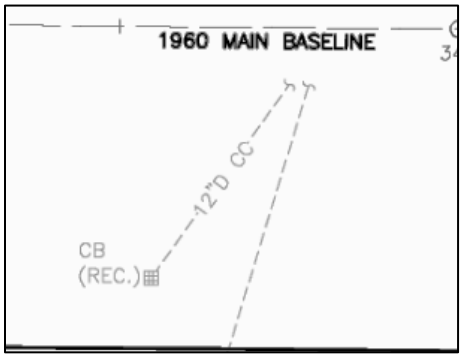


Figure 74). These discharge points should be mapped as Discharge Type "unknown" and a comment in the Notes field added about what is shown on plans (Figure 75).

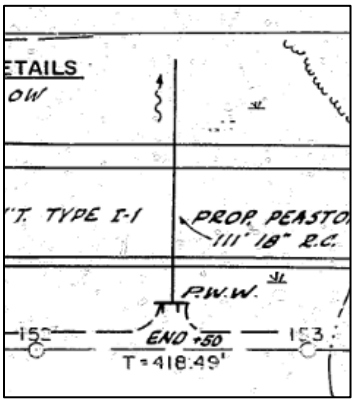


Figure 73

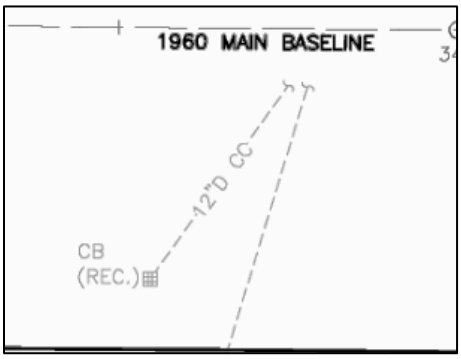


Figure 74

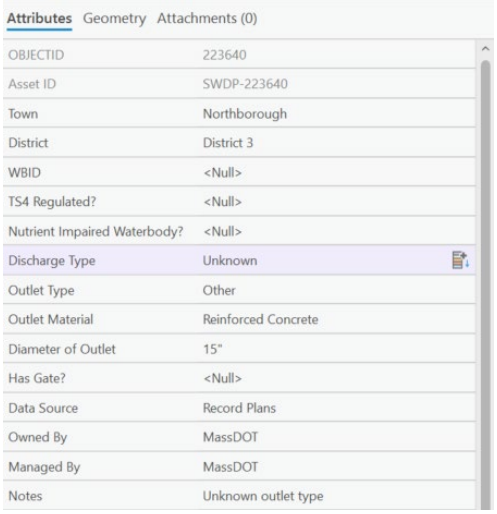


Figure 75

Mapping a Paved Waterway

PWW's are paved areas where concentrated runoff gathers and discharges into another area, generally along the edge of a roadway. Paved waterways are mapped as point features in the stormwater discharge feature class. The outlet type field is populated as "paved waterway". As shown in the figure below (Figure 76), for paved waterway features, the discharge type field may be populated as either "standard outfall" or "outlet to SCM," as appropriate. Refer to Figure 77 for one way that a paved waterway may be represented on a MassDOT plan.

Some additional things to consider when mapping paved waterways:

- **PWWs do not need conveyances mapped with them.** Conveyances should only be mapped with PWWs if there is an extensive length of ditch (paved, rip rap, or otherwise) beyond them which merits a conveyance as well.
- **Mapping paved ditches does not always necessitate mapping a PWW.** A paved ditch that is collecting sheetflow from a steep hill, surrounding infield, etc, does not require a PWW unless there is PWW specifically discharging into the ditch/swale from the roadway

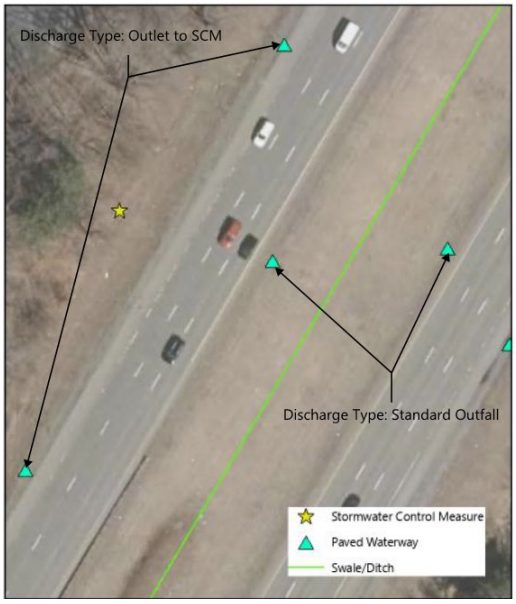


Figure 76

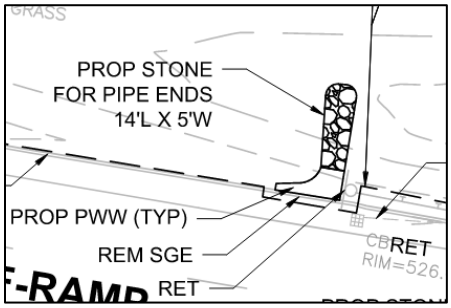


Figure 77

Mapping an Interconnection

Interconnections identify locations where MassDOT and another MS4 system interconnect or tie into one another. Key fields include interconnection flow direction, type of structure where interconnection is located, the non-MassDOT interconnecting system owner, and the Interconnection System Type (Drainage, CSO, or Other). Interconnections are mapped as point features in the interconnections feature class.

An example of how an interconnection may appear on a plan set is included below in Figure 78. In this example, the MassDOT system discharges into a municipal storm system, which is considered an outgoing interconnection. In the figure, the MassDOT system is highlighted in blue and the municipal system is highlighted in magenta. There are two separate interconnection points, at two distinct manholes, where MassDOT's drainage system ties into the municipal system. In this figure, the State and Town Layout Lines are highlighted with dashed lines. Identifying areas where a drainage system spans both a State and Town Layout can help you identify interconnections while mapping.

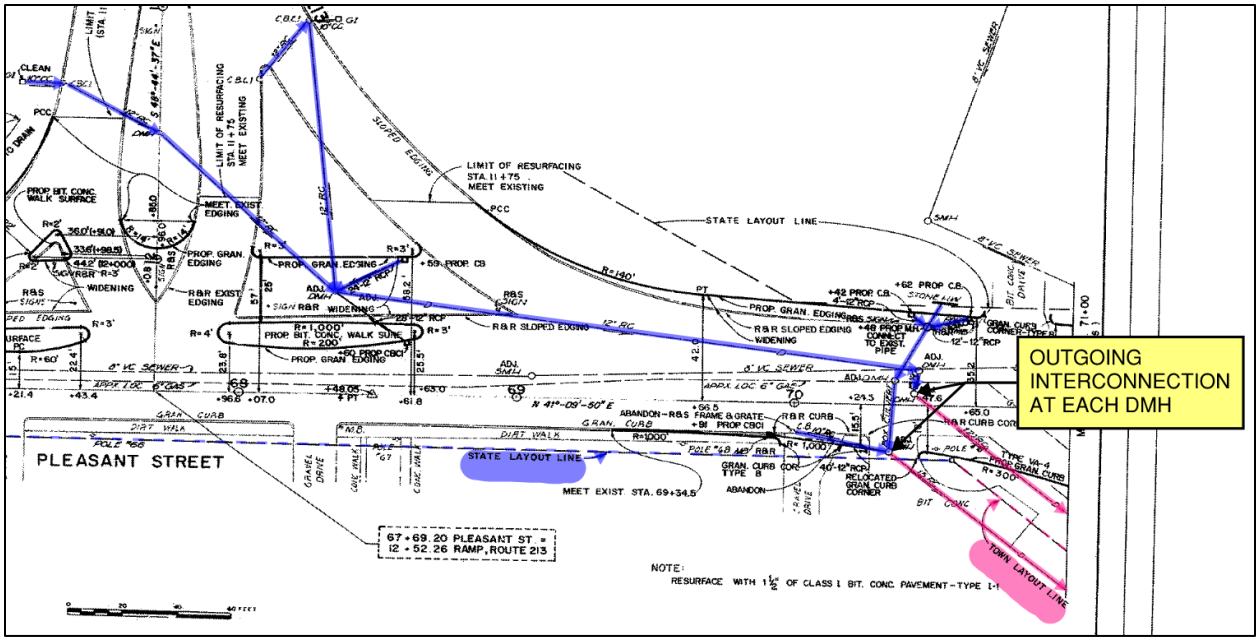
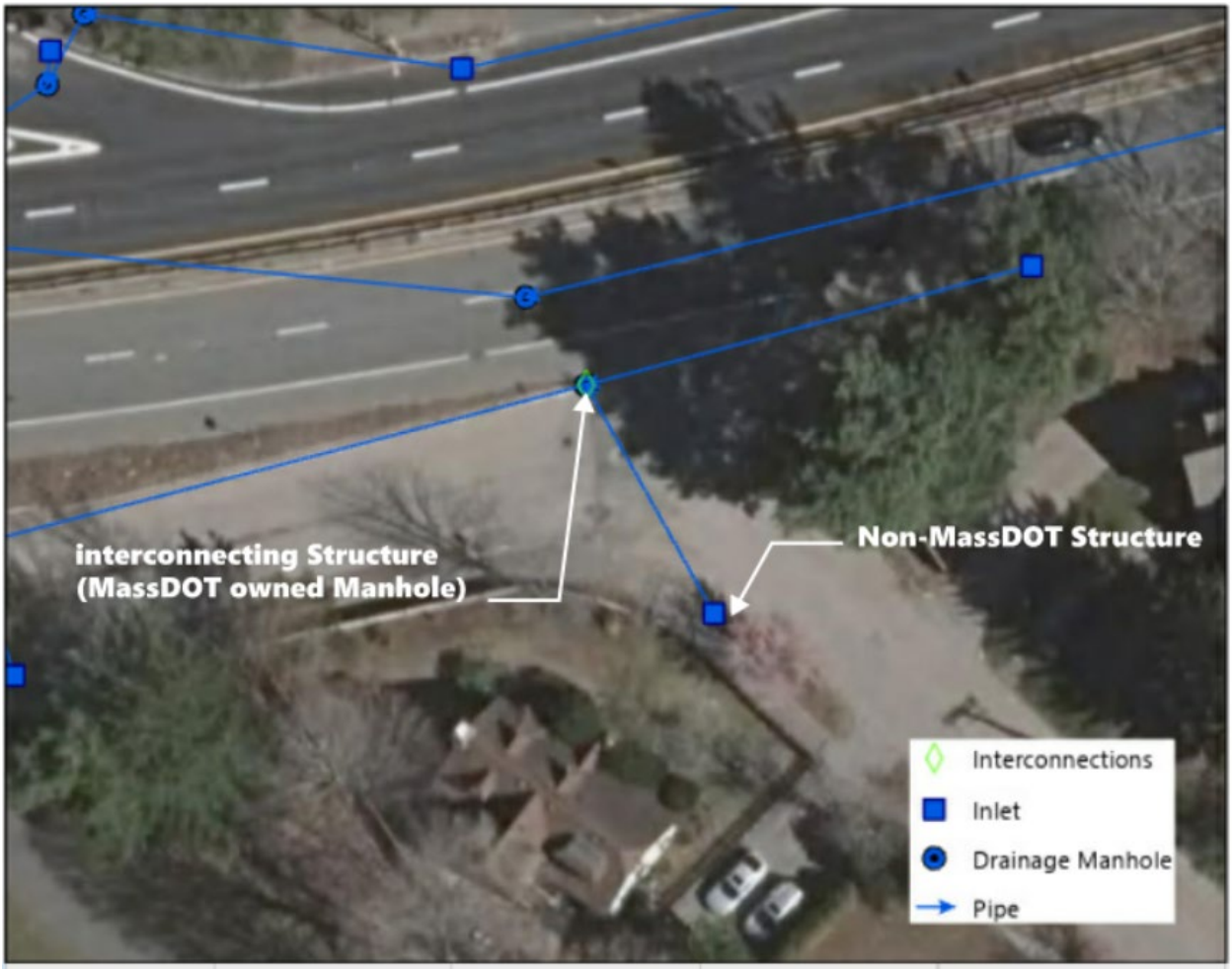


Figure 78

As shown in the figure below (Figure 79), when mapping an interconnection, the interconnection point should be snapped directly on top of the structure (catch basin, manhole etc.) where the interconnection is located (in the previous example, this structure would be each of the connecting manholes). When mapping an interconnection, the direction of flow (incoming or outgoing) and owner of the interconnecting drainage system are a high priority to document.

If possible, map one structure upstream (if the non-MassDOT owned structure is going into the interconnecting structure) or one structure downstream (if the MassDOT owned structure is going into the interconnecting structure) from the interconnection, with ownership denoted. At a minimum a pipe stub (see Figure 80) which shows generally the direction the interconnection is coming from should be mapped.



Associated Facility ID	Flow Direction	Interconnection Structure	Data Source	Non-MassDOT System Owner
SWMH-54631	Incoming (to MassDOT)	Manhole	Record Plans	Municipality

Figure 79

Figure 80

Another example of how an interconnection may appear on a plan set is shown below in Figure 81. In this example, a municipal drainage system discharges into a MassDOT-owned system, which is considered an incoming interconnection. There is one interconnection point at the drainage manhole PROP DMH (1-93) where the municipal drainage system connects to the MassDOT system. In Figure 82, the municipal system is highlighted in magenta and the MassDOT system is highlighted in blue, with the State Highway and Town Layout Lines highlighted with dashed lines.

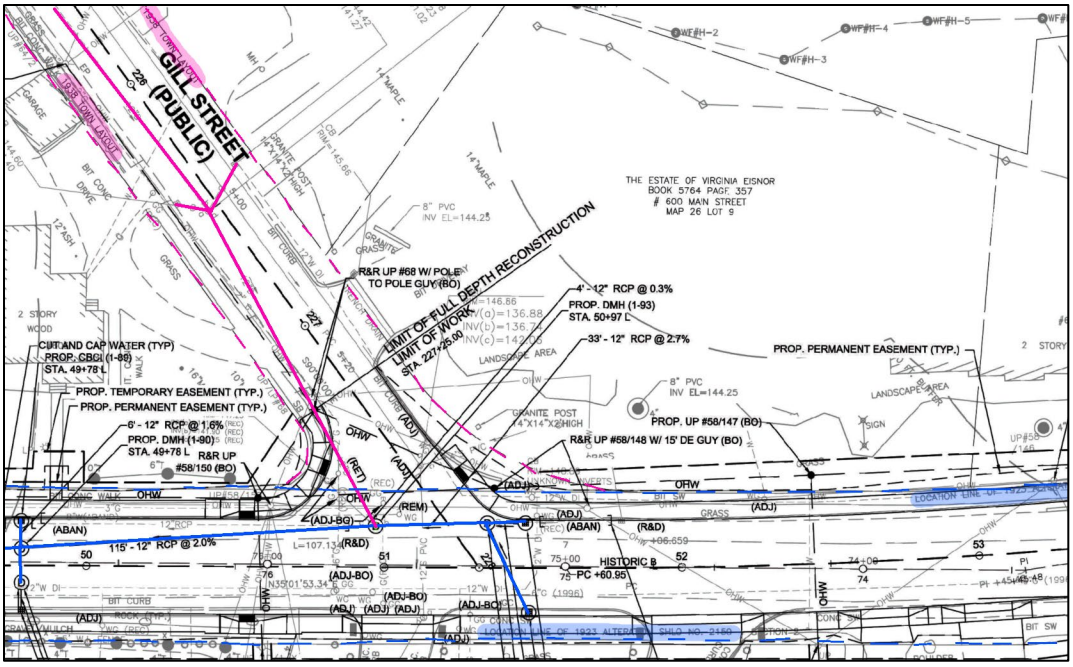
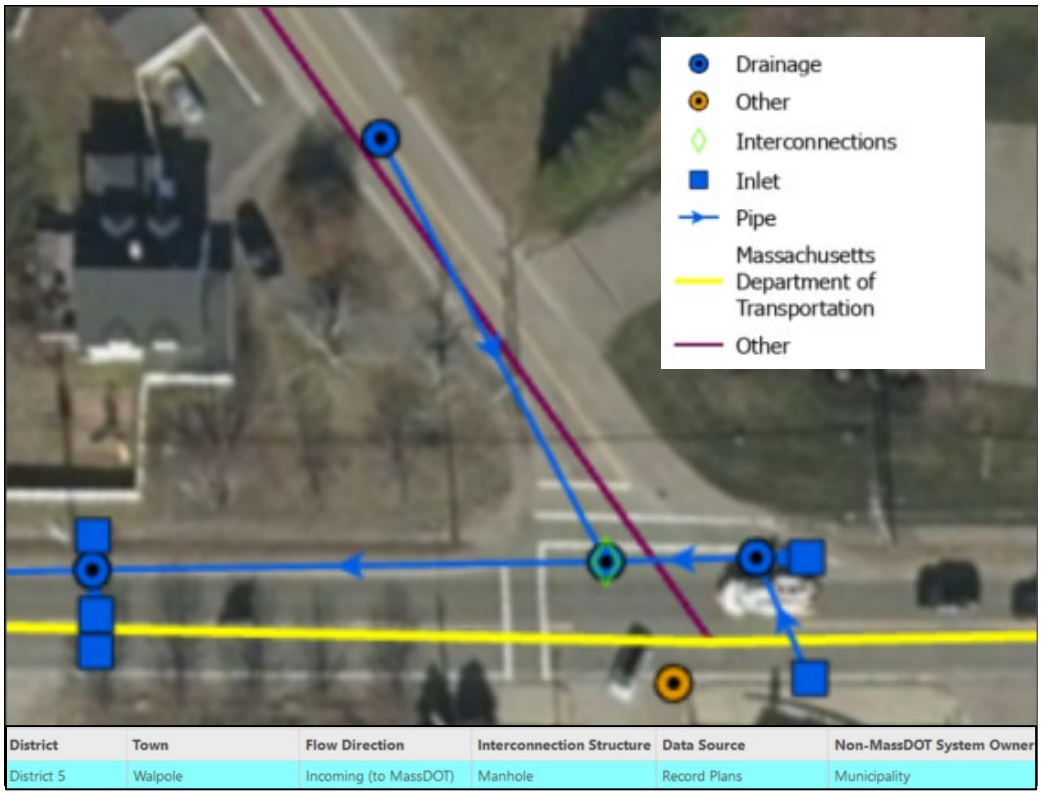


Figure 81



District	Town	Flow Direction	Interconnection Structure	Data Source	Non-MassDOT System Owner
District 5	Walpole	Incoming (to MassDOT)	Manhole	Record Plans	Municipality

Figure 82

Mapping an Interconnection to a CSO

When mapping interconnections to Combined Sewer Overflows (CSO), snap the interconnection point on top of the mapped Combined Sewer manhole. The interconnection point should have the domain type "CSO" populated as the Interconnection System Type.

Determining Ownership of Drainage Assets (MassDOT vs. Municipality)

When mapping new drainage features, make sure that all the stormwater assets shown on the plans are proposed to be owned and maintained by MassDOT.

1. Confirm Roadway Jurisdiction
    a. If the roadway is shown to be owned by MassDOT per the latest Roadway Inventory Layer, the drainage assets are typically assumed to be owned by MassDOT.
2. Review State Highway Layout Limits
    a. Drainage assets located within the State Highway Layout (SHLO) line on the plans are typically assumed to be owned by MassDOT.
3. Identify any drainage easements
    a. Some plans may contain areas labeled as "Permanent Easements" or "Permanent Drainage Easements", which are legal provisions granting MassDOT the right to use a portion of a property for stormwater drainage. Drainage assets located within permanent drainage easements are generally assumed to be owned by MassDOT.
    b. Temporary easements also frequently appear within plan sets. These easements only allow MassDOT to access a portion of a property for construction purposes for a limited time, after which all rights revert to the property owner. As such, drainage assets located within temporary easements are assumed not to be owned by MassDOT.

However, some situations may arise where the ownership of drainage assets is not immediately obvious and may warrant further investigation. In the example below (Figure 83), new catch basins, a manhole, and conveyance features are proposed on a municipal side street as part of a project. While they may appear to be MassDOT-owned because they are proposed within a MassDOT project and connect to the broader drainage system on a MassDOT-owned roadway, these structures lie outside the State Highway Layout, highlighted with blue dashed lines, and are within the Town Layout, highlighted with magenta dashed lines. These features also are not located within a permanent drainage easement. Therefore, the features on the side street should be considered municipally-owned. Map the municipally-owned catch basin and drainage manhole located one feature upstream from each MassDOT-owned interconnecting structure (Figure 84).

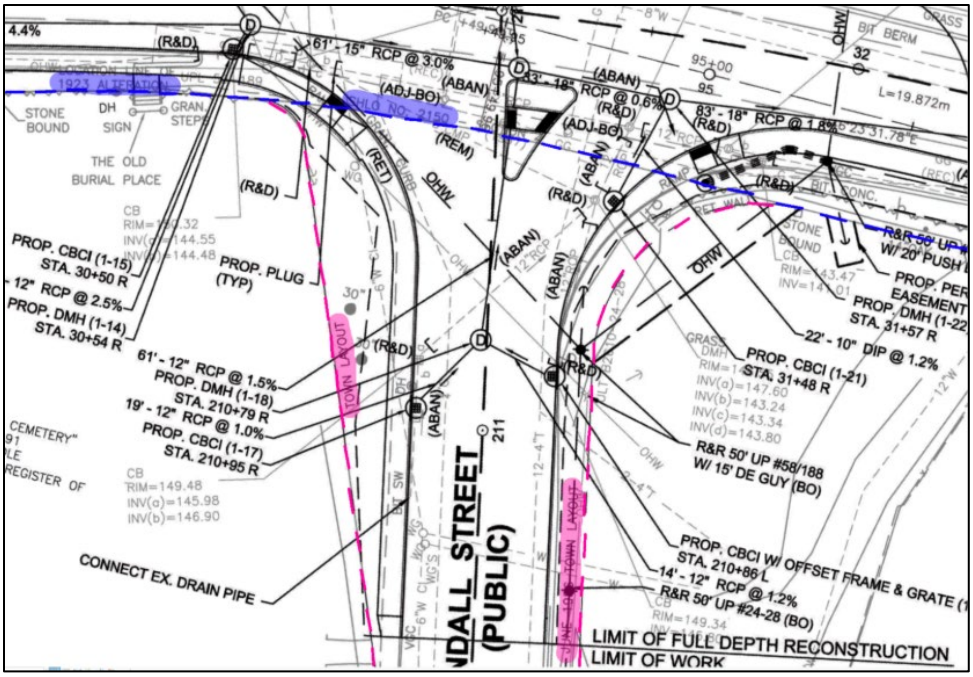


Figure 83

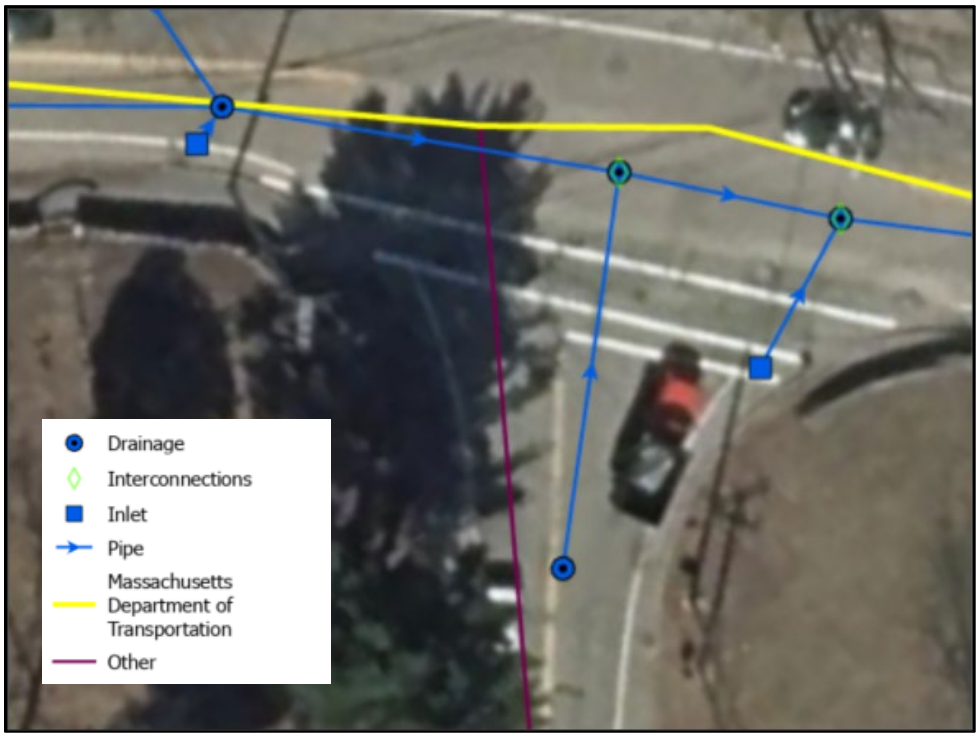


Figure 84

Mapping Blind Ties

Blind ties refer to junction points within a drainage system that are not visible or accessible at the surface level. An example of this occurs when a manhole structure is paved over during a resurfacing project or in the example below, where two different material types or diameters are shown as connected without a manhole. To map a Blind Tie, map a drainage manhole point with the Utility Type “Blind Tie” where the Bline Tie occurs.

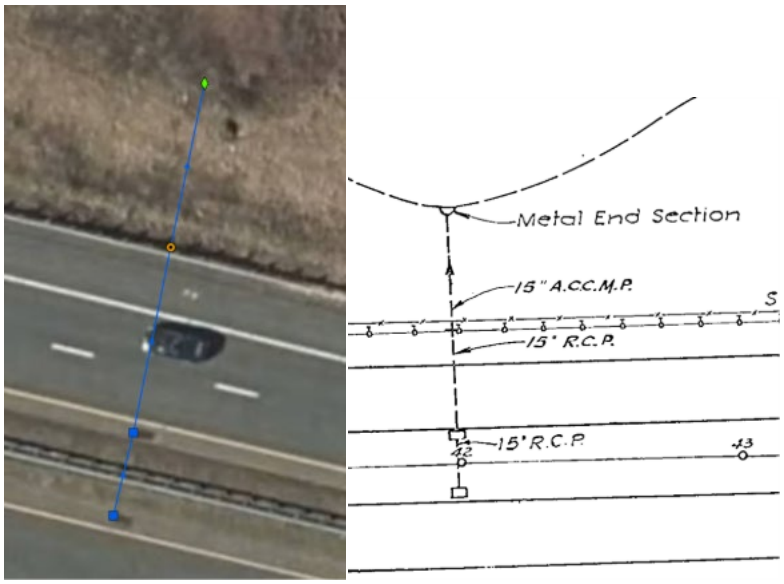


Figure 85

Snapping Features

As stated in the **Section 3.5.2**, snapping features to each other within a drainage network is an important step to complete drainage mapping. As shown in the figure below (Figure 86), the name of the feature being snapped to will appear when hovered over, confirming that the next vertex will be snapped to that feature.

Figure 86

Mapping Flow Direction

As stated in the **Section 3.4**, when mapping conveyances, it is important to draw the feature from upstream to downstream. The figure below (Figure 87) demonstrates how flow direction is established by drawing conveyances in an upstream to downstream direction.

Figure 87

Mapping Culverts

As part of this stormwater effort, mapping professionals will only map culverts that convey stormwater flow. To understand when a stormwater conveyance and culvert should be mapped as part of this drainage mapping effort, refer to the following criteria:

1. If a culvert has a span of 4-feet or greater **do not map**. These features are tracked by the MassDOT Bridge Inspection Management System (BMIS) in the Bridge Inventory point layer.
2. If a culvert has a span of less than 4-feet and conveys a National Hydrography Dataset (NHD) flowline **do not map**. These features are tracked in the Culvert Inventory point layer.
3. If the culvert has a span of less than 4-feet and conveys only stormwater flow **this should be mapped**. These culverts should be mapped in the "Conveyance" feature class of the Stormwater Asset Database.

Generally, assets associated with culverts, such as headwalls or riprap aprons, also should not be mapped in the stormwater database.

Below are several examples of situations where culvert inventory point data, bridge inventory point data, and stormwater features may be present within a given area, and when and how to map or not map features.

In the figures below, a bridge inventory point (Figure 88) and a culvert inventory point (Figure 89) are shown. Both convey streamflow but do not tie into the nearby stormwater network. In this case, the culvert and bridge conveying the streamflow do not need to be mapped as conveyances for this drainage mapping effort.

Figure 88

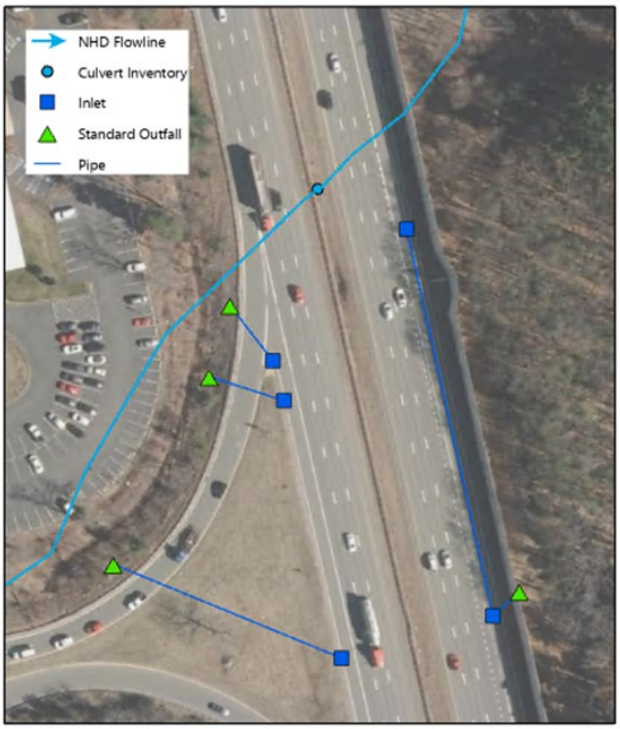

NHD Flowline
Culvert Inventory
Inlet
Standard Outfall
Pipe

Figure 89

Figure 90 shows a stream crossing a roadway, however, no existing culvert or bridge inventory point exists. Although there is no existing point, a conveyance should not be mapped because this culvert only conveys stream flow.

Figure 90

The stormwater network shown in Figure 91 is near a stream crossing under the roadway. In this example, the stormwater network should be mapped, but not the adjacent culvert as it only carried streamflow.

Figure 91

Figure 92 below is an example of where stormwater flow is being conveyed beneath a roadway and discharging to an open area. This conveyance is not mapped as culvert point and does not convey streamflow, therefore is mapped in the stormwater asset database.

Figure 92

Figure 93 below is an example of a situation where stormwater flow is being discharged to a culvert at a manhole. Since the manhole is the location where the stormwater flow meets the receiving water (which is conveyed through the culvert) this is also considered the outfall location. In this case, the manhole and outfall should both be mapped in the stormwater asset database. The culvert should not be mapped in the stormwater asset database as it conveys streamflow and is mapped in the Culvert Inventory.

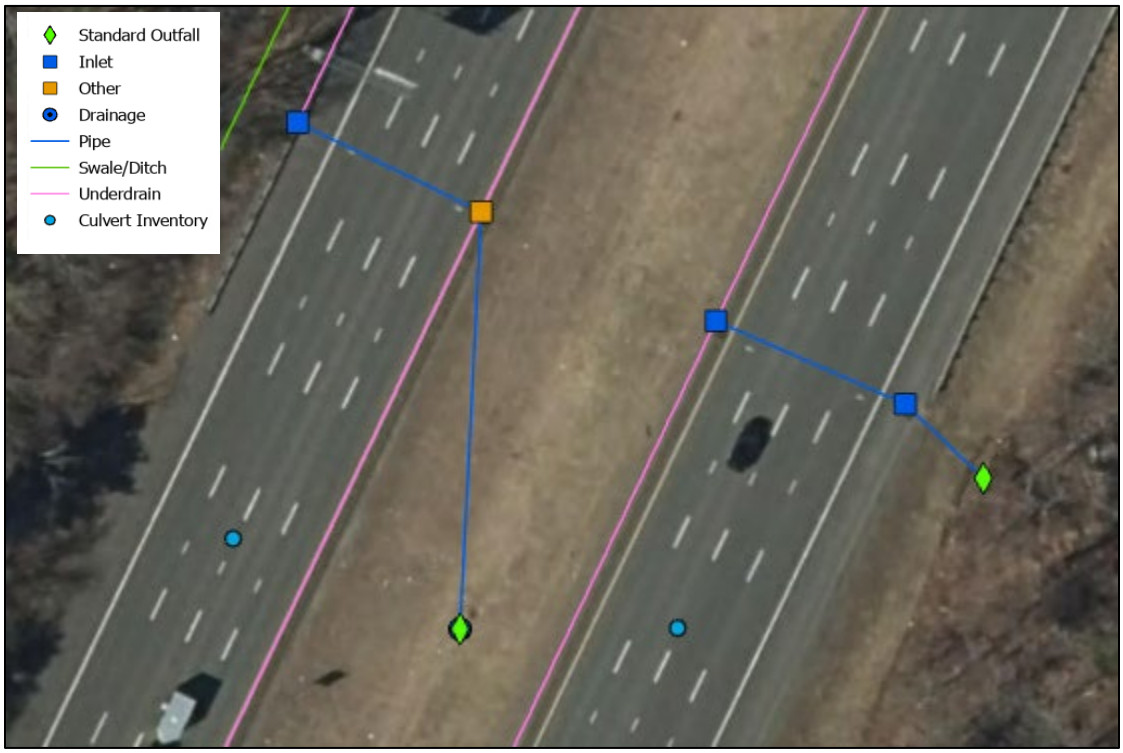


Figure 93

Mapping Scuppers (Discharge and Non-Discharge)

Scuppers are inlet features, typically found on bridges, which consist of a simple opening which allows water to enter and be discharged elsewhere, most often either directly to a waterbody or to a closed drainage system via a downspout. MassDOT's Drainage Mapping effort maps scuppers as an Inlet feature type. When mapping scuppers, it is important to identify where the scupper is discharging to. There are two options for scupper inlet types, described below:

- Scupper (Discharge): Scuppers that drain stormwater directly to waterbodies, resources areas, culverts, or other at-grade location.
- Scupper (Non-Discharge): Scuppers that drain stormwater to a closed drainage system, typically via a downspout.

Figure 94 shows Scuppers (Discharge) points that are receiving runoff from the bridge and are discharging directly to the stream below. These should be mapped as inlet points, even though they are acting as an inlet and a discharge point. Figure 95 shows the underside of the bridge and the scupper downspout that discharges water into the river below.

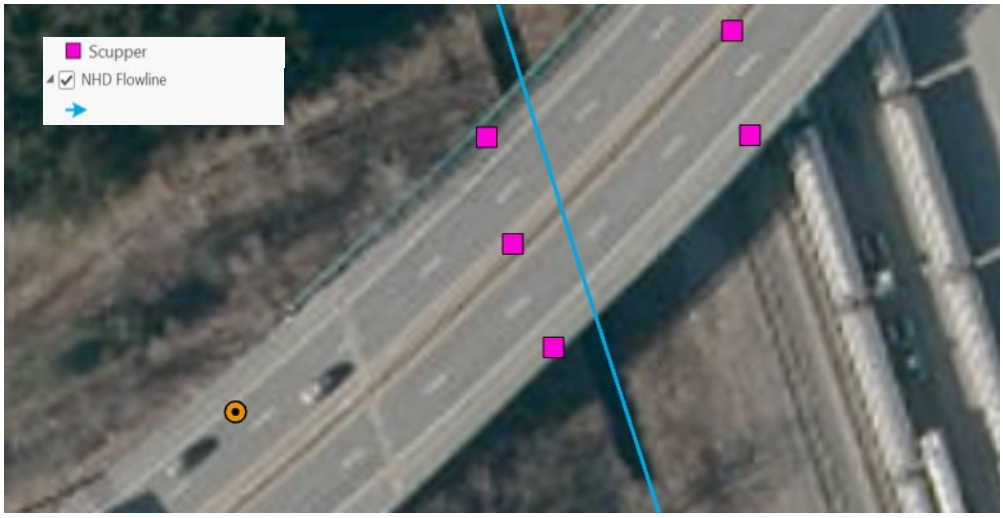


Figure 94

Figure 95

Figure 96 shows mapped scuppers that are receiving stormwater runoff from the bridge. This structure discharges water into a downspout pipe that conveys water from the bridge to the closed drainage system receiving runoff from the road beneath the bridge. This should be mapped as an inlet point with the inlet type "Scupper (Non-Discharge)" as shown below. Figure 97 shows the downspout pipe coming from the scupper, going down below the roadway to the closed drainage system.

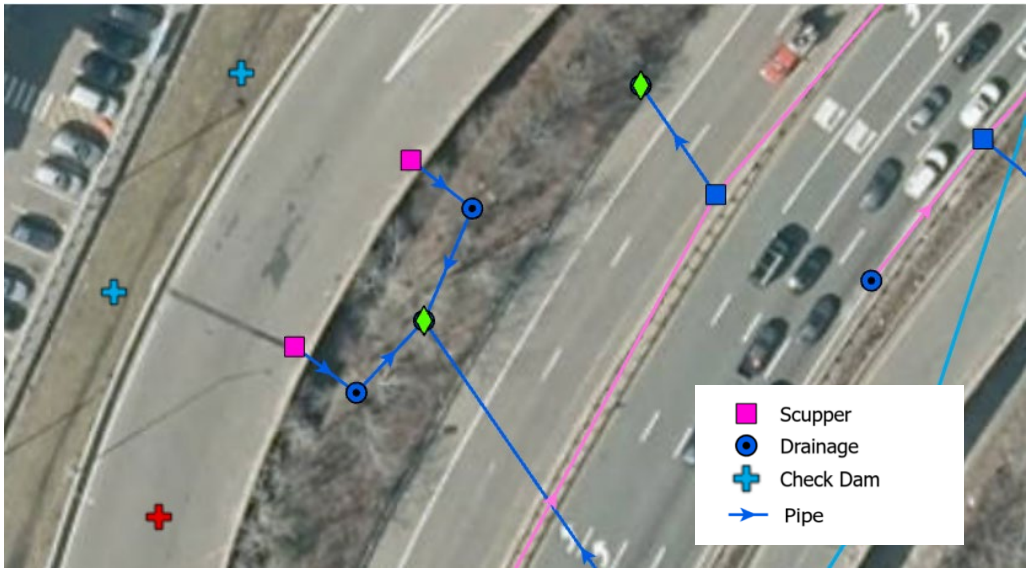


Figure 96

Figure 97

Example Plan Sheet Mapping

In Figure 98 below, symbols representing features in the stormwater database are placed on top of the stormwater feature as shown on a drainage plan as a guide for how to translate a plan to mapped features. The drainage callouts with a red "X" next to them are features that are not mapped while callouts with a green check are features that should be mapped. Features that are called out to be abandoned or removed do not require mapping. Additionally proposed weir BR-2 is not mapped because the miscellaneous point for a sediment forebay always assumes a check dam or weir as part of the forebay.

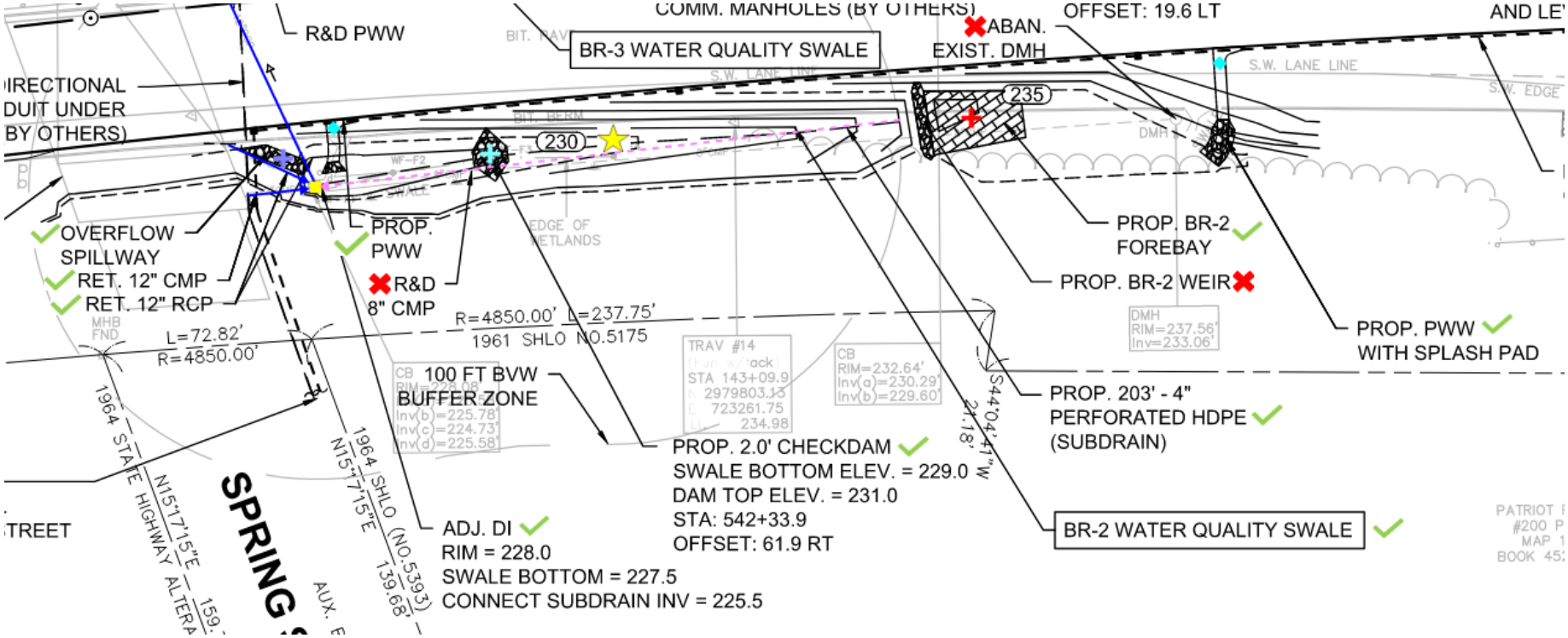


Figure 98

When Existing Features Can be Deleted

Features mapped as a part of the 2017 LiDAR effort, such as inlets, manholes, and outfalls, may appear within an assigned mapping area. However, some of these features no longer exist and may not reflect current conditions. To ensure the drainage mapping effort most accurately reflects MassDOT's existing drainage asset inventory, LiDAR points should be deleted if they no longer exist and have no associated related inspection records.

To determine whether a LiDAR feature exists, first review the plans for obvious signs that the feature no longer exists, such as "R&D" (Remove & Dispose) or "REM" (Remove) callouts. Next, confirm whether the feature exists using aerial imagery, such as Google Maps Street View. LiDAR features should only be deleted after confirmation that the structure no longer exists and has no inspection forms attached to the point.

If the placement of an existing LiDAR feature is offset from the asset's actual location in the field, re-use the existing point and reposition it as needed using the Move tool. Do not delete and replace the existing point in this situation, as MassDOT prefers to retain existing asset IDs whenever possible.

How to Check for Inspection Records

Check for related inspection records by selecting the feature in the attribute window, selecting the three lines on the right-hand corner of the attribute window and navigating to "Related Data" (see Figure 99). If the feature no longer exists but there are related inspection records, refrain from deleting the point and contact MassDOT for guidance.

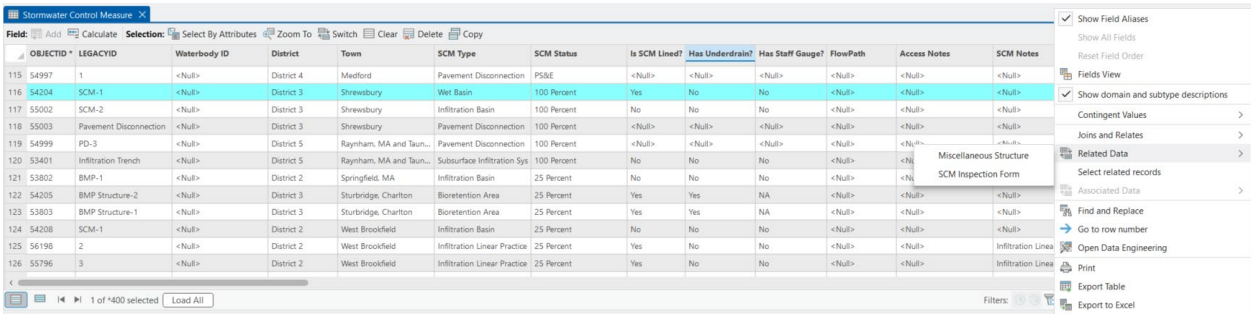


Figure 99

It is important to note that some LiDAR features may include non-drainage manholes, such as sewer and telecommunication manholes. While it may seem sensible to delete them because they are not drainage infrastructure, these features should still be retained after confirmation they exist and/or have attached inspection forms. Update the attribute table for retained features as needed based on new information from the plans.

Transferring an Existing Feature to a Different Feature Class

In some instances, existing drainage features in the MassDOT stormwater asset database are mapped in the incorrect feature layer. In these cases, it may be necessary to move the geometry and attributes of a feature from one feature class to another feature class as part of this drainage mapping effort.

If a feature is in the wrong feature class and it **contains no related inspection records**, mapping professionals may delete the existing feature and create a new feature in the appropriate feature class. If the feature is in the incorrect feature class but **has related inspection records**, contact MassDOT Stormwater Unit to aid in the feature migration.

Examples where features may be incorrectly mapped include:

- An outlet control structure incorrectly mapped as a stormwater discharge point, when it should be mapped as an inlet.
- A headwall incorrectly mapped as an inlet, when it should be mapped as a stormwater discharge point (or vice versa).
- A paved waterway incorrectly mapped as an inlet, when it should be mapped as a stormwater discharge point.
- A linear SCM incorrectly mapped as a conveyance feature, when it should be mapped as an SCM point.
- A check dam or sediment forebay incorrectly mapped in the SCM feature layer, when it should be mapped as a miscellaneous structure.
- A catch basin incorrectly mapped as a manhole.

Below is a step-by-step example on how to move a feature from the SCM feature class to the Miscellaneous feature class.

Step 1: Check for related inspection records (refer to "How to Check for Inspection Records" above). If none, proceed to Step 2. If there are related inspection records, contact MassDOT and do not move to Step 2.

Step 2: Create a new feature in the correct layer. See instructions on how to create a new feature in **Section 3.5.2** (steps 1-5) of the drainage mapping guide. When placing the feature, snap to the location of the feature in the incorrect layer if keeping the same location or create the new feature where most accurate (see Figure 100). In this example, a sediment forebay is incorrectly mapped as an SCM. A new point is created in the Miscellaneous feature class at the location of the check dam.

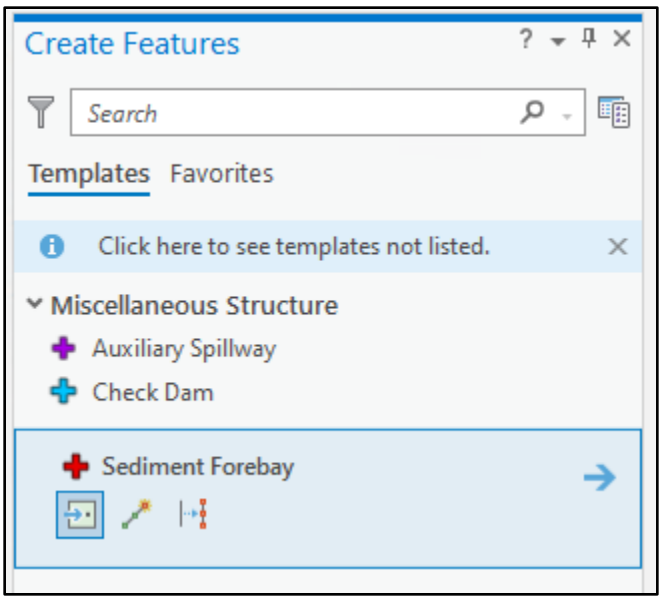


Figure 100

Step 3: Fill out attributes of the new feature based on available information (Figure 101 and Figure 102). The fields will likely vary between the correct and incorrect feature classes.

- ✓ Use record plans, the existing attribute features, and/or field observations to accurately fill out the fields for the new feature to the extent possible.
- ✓ Any relevant attribute information, including notes and attachments, should be copied from the old feature into the most appropriate field of the new feature.
- ✓ Make sure to save changes when done with this step.

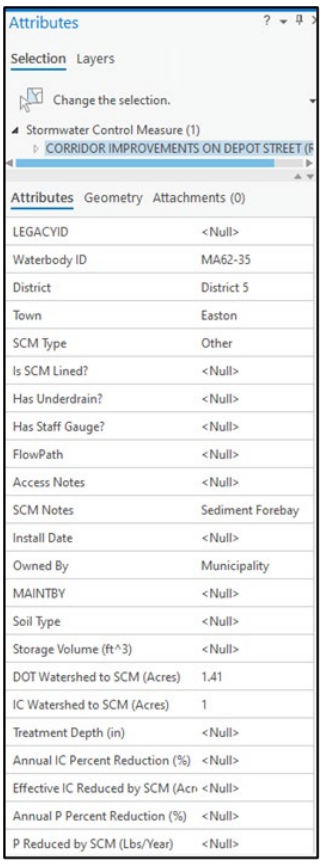


Figure 101

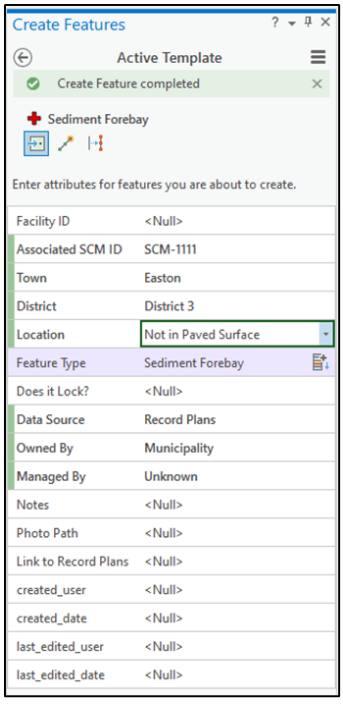


Figure 102

Step 4: Delete the original feature from the incorrect feature class (Figure 103). Select the feature and click "delete" so that only the new feature in the correct feature class remains in the database. Check only one feature is selected before deleting.

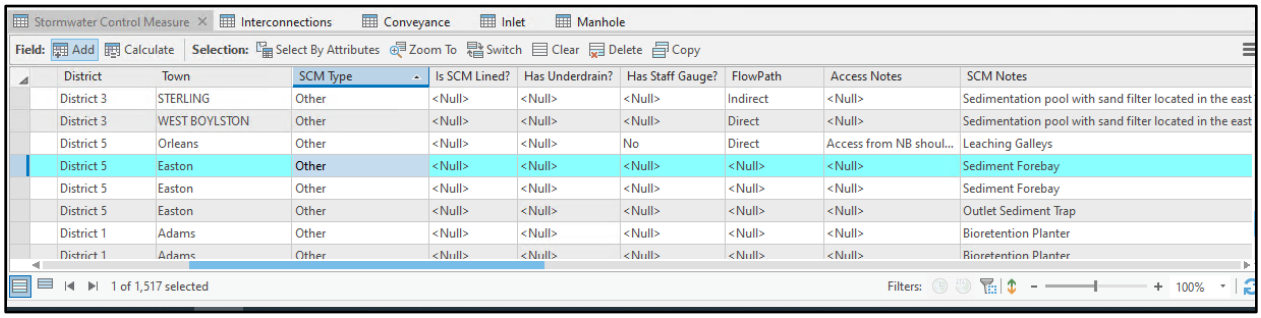


Figure 103