OFFICE OF STRUCTURES

MANUAL FOR HYDROLOGIC AND HYDRAULIC DESIGN

CHAPTER 5

DATA SOURCES AND FIELD SURVEYS

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MARYLAND DEPARTMENT OF TRANSPORTATION™

STATE HIGHWAY ADMINISTRATION

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 5 DATA SOURCES AND FIELD SURVEYS

5.1 INTRODUCTION

5.1.1 Purpose

This chapter presents information on how to identify, locate, and obtain the data required for the study and analysis of hydraulic structures for projects of the Office of Structures (OOS). The data required for study of a project site includes project specific information such as topographic survey completed on a per project basis, structure inspection reports and photographs, and structure as-built or record design plans. The required data may also include general (non-project specific) information such as statewide GIS data, FEMA floodplain studies and models, mapping of environmental features, and watershed characterization data and stream classification.

5.1.2 Overview

The engineer working on an SHHD project should identify the types of data that will be required prior to initiating the analysis. The collection of data for a specific project must be commensurate with the project scope, and tailored to:

- Site conditions
- Scope of the analysis
- Social, economic, environmental, historical, and archaeological requirements
- Unique project requirements
- Regulatory requirements

Section 5.2 provides information regarding the types of data that may be required to complete Structure Hydrology and Hydraulics Division (SHHD) design analysis projects. Section 5.3 provides information regarding potential data sources. Table 5-1 provides a list of common data types and the relative potential data source.

Field topographic survey is typically the most expensive and time intensive data component. A uniform or standardized survey requirement applied to all projects is generally uneconomical and may result in data deficiencies at a specific project site. Therefore, a detailed survey request considering project specific need and purpose must be developed for each study site. Section 5.4 provides guidance on how to request and obtain survey data, allowing for special instructions outlining project specific data requirements.

5.2 TYPES OF DATA REQUIRED

The data requirements for the various areas of study (e.g., hydrology, stream morphology, hydraulics, scour) should be assessed during the early stages of a project. Some data or information will require more effort and time to obtain (e.g., field survey or floodplain studies completed by others). Therefore, for efficiency and ease or workflow, the data request process may not always

occur in line with the analysis sequence. For example, the process to obtain cross section survey for use in the hydraulic analysis should be initiated while the other preliminary analyses needed to conduct the hydraulic study (i.e., hydrology and stream morphology) are still underway.

5.2.1 General

The following general information for the subject structure and project site should be obtained and reviewed at the start of any SHHD project.

- Inspection reports and photos
- Record plans (as-builts) or other record of original construction
- Existing conditions plans (if available)
- Scour rating
- Roadway classification / AADT
- FEMA floodplain study and mapping
- Approximate watershed size and characteristics
- MDE designated use stream classification
- Potential permit and/or agency approval requirements (e.g., tidal vs. non-tidal, FEMA regulatory area)
- Any environmental commitments or constraints
- Adjacent property owner information and development status
- District office written or verbal reports regarding any flooding or other maintenance issues

After preliminary review of the available data, a site visit is typically conducted to review the existing structure and waterway conditions. At a minimum, photographic documentation should be obtained during the field visit. An internal memo or other documentation record may also be advisable, to record any significant project site details or design considerations.

5.2.2 Hydrology

The SHHD typical hydrologic analysis procedure includes use of the most current version of the GISHydro computer program. GISHydro includes a geographic information system (GIS) database with digital terrain data, land use data, and soil data for Maryland. Other data types, as listed following, can be used to verify and improve the characterization and study of the watershed.

- Topographic maps and digital terrain data
- Historical maps and aerial photography
- County zoning data, maps, and master plans (to characterize ultimate development conditions, or potential future land use)
- Stream flow characteristics and gage data
- Watershed physiographic characteristics
- Stream classification and environmental resource mapping
- Reservoir or other flood control structure plans and operational records

- Previous studies and hydrologic models
- Flooding history/records
- Tidal/storm surge data

5.2.3 Stream Morphology

Geomorphology data are important for the analysis of existing channel characteristics and stability. For OOS projects involving a structure over a waterway, a stream morphology assessment is typically completed. Based on the findings of this study, SHHD may also authorize a detailed stream morphology study. The amount and extent of field data collection authorized by SHHD will be dependent on the determination of level of study required for each specific project. The following data may be required, or may be collected, for stream morphology assessments or detailed studies:

- Historical maps and aerial photography
- Sediment transport and mobility related data
- Physiographic and geologic maps
- Stability of form over time (braided and meandering, pool-riffle relationship)
- Scour history/evidence of scour
- Bed and bank material identification
- Potential for large woody debris
- Bedload and scour type, potential for bend scour
- Channel and profile survey
- Geo-referenced photographic documentation
- Features that may affect hydrology or hydraulic studies or stream profiles

5.2.4 Hydraulics

SHHD project analyses typically include the development of a hydraulic model using field measurements (see Section 5.4 for information regarding how to obtain survey data). This includes topographic data for the waterway, data regarding the subject structure type, size, and location, and data representing any other built or natural features impacting hydraulic conditions. The following data types are typically needed for hydraulic studies:

- Topographic maps and digital terrain data
- As-built or record drawings for the existing project structure(s)
- Inspection reports and site photos
- Design or maintenance records for other hydraulic structures impacting flow conditions
- Previous studies and hydraulic models
- Field survey and stream cross section data
- Site condition and land cover data for development of Manning's n roughness coefficients
- Flooding history/records

- Aquatic organism passage (AOP) data (existing blockages and/or priority sites)

5.2.5 Scour

The determination of potential scour is an essential component of structure and foundation design. The potential scour depth is related to the stability of the natural materials at the site, the tractive shear forces exerted by the stream, the magnitude and direction of channel and floodplain flow, and the sediment transport characteristics of the stream. Therefore, data required for scour assessment and analysis includes site characteristics (geotechnical and subsurface data) as well as data from completed project specific analyses (i.e., hydrology, stream morphology, and hydraulics).

Characterization of bed and bank materials for classification of channel type, stability, and bed material gradations is obtained in the stream morphology study. The geotechnical study, which is required for structure design, must include borings and bed material analysis to characterize the substrata for use in the scour study. The following data is required for scour evaluations:

- Previous scour inspection reports and ratings
- Geotechnical borings and subsurface investigations
- Stream morphology studies
- Hydraulic analysis results
- Sediment transport studies

5.3 DATA SOURCES

Sources of potential data include the records and reports of the OOS, other MDOT SHA offices and divisions, other state agencies, and federal agencies. Table 5-1 provide a summary of typical data types required for the various areas of study with reference to the data source and/or data storage location. Note that some data is stored on internal MDOT SHA computer servers or on web applications which are for MDOT SHA internal use only, as indicated with an "*" in Table 5-1.. Therefore, if a study or analysis is being completed by a consultant, this information will need to be obtained from the SHHD Team Leader.

Much of the information used in hydrologic and hydraulic studies is georeferenced spatial or geographic data. SHHD uses GIS data from multiple sources including the Maryland State iMap service (state mapping and GIS data portal), the Eastern Shore Regional GIS Cooperative (ESRGC), and each individual Maryland County. The GIS files needed for site analyses are generally compiled at the inception of a project by OOS GIS specialists, as part of the survey request preparation procedure. This compilation of GIS data can be requested by the SHHD Team Leader for use in project analysis. Table 5-1 provides additional types and sources of GIS data.

Many streams have been analyzed in local flood studies as part of the National Flood Insurance Program (NFIP). For project sites located within a FEMA regulated floodplain, an important source of data is the FEMA flood insurance study (FIS), flood insurance rate map (FIRM), and the hydraulic model used to develop the floodplain mapping. The SHHD, in collaboration with MDE,

has developed a process for hydraulic modeling, which utilizes the FEMA hydraulic model in some cases. As part of this procedure, FEMA mapping and the associated hydraulic model should be obtained and reviewed early in the project development process. Section 5.4 details how this information is used to inform the development of the survey request, especially the determination of cross section survey location.

Table 5-1 Data Types and Source Information

Data Type	Source/Author	Notes and Data Links
Structure Data	*MDOT SHA OOS Roads and Highways	ArcGIS online (AGOL) web application, users can search for an MDOT SHA structure based on location or various descriptive properties. Information available includes OOS inventory number, structure summary description, year built and inspected, mile point location, and links to photos and record drawings. https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=52d7459cbfa2456a85464be4cbe814d8
Structure Inspection Reports	*MDOT SHA OOS Records	Record of the structure inspections conducted by the MDOT SHA Structures Inspection and Preservation Division, https://sam-md.bentley.com/login.aspx (user name and password required for access)
As-Built Plans / Record Drawings	*MDOT SHA OOS Records	Design plans for the existing structure, which can generally be obtained using the MDOT Roads and Highways AGOL web application.
Scour Rating	*Structure Inventory and Appraisal (SIA) Database	Scour rating of existing structure, which is based on the FHWA National Bridge Inspection Standards (NBIS), Item 113 of the Recording and Coding Guide for the Structure Inventory and Appraisal or the Nation's Bridges.
Structure Rating	*Structure Asset Management (SAM) Database	Information on OOS structures including design records, structure ratings, maps, and photos.
Structure Performance and Flooding History	District Office	MDOT SHA has seven district offices. Contact the district offices for information on the current condition of the structure and any known performance or frequent flooding conditions. District map and contact information at https://www.roads.maryland.gov/mdotsha/pages/Index.aspx?PageId=839
Roadway Classification and AADT	Highway Location Reference Reports	Data for each county is provided in a separate report which provides key data by roadway location (milepoint), https://www.roads.maryland.gov/mdotsha/pages/index.aspx?PageId=832

Previous SHHD Studies	*MDOT SHA OOS Records	The SHHD maintains an archive of the analysis reports and models for completed projects. Data from adjacent recently completed projects may be useful for the current project analysis. Information can be obtained from the SHHD Team Leader.
Environmental/ Location Studies and Reports	*Office of Environmental Design and/or Office of Highway Development	For planning level or other large infrastructure projects, coordinate with other MDOT SHA offices to obtain information and data.
Designated Use Classes for Maryland's Surface Waters	Maryland Department of the Environment (MDE)	MDE GIS web application with use classification data for all Maryland streams, as promulgated in Code of Maryland Regulations (COMAR) Section 26.08.02.08. mdewin64.mde.state.md.us/WSA/DesigUse/index.html
Watershed Characteristics and Stream Classification	Environmental Protection Agency (EPA), Office of State and Watershed Partnerships	EPA online mapping tool with spatial datasets from various federal and state agencies providing information on environmental resources and other data sets useful for evaluation of project impacts, https://watershedresourcesregistry.org/states/maryland.html
Environmental Data for Maryland	MD DNR	Maryland's Environmental Resources and Land Information Network (MERLIN), part of the MD iMap mapping system and includes spatial data layers from DNR and other state/federal sources, https://gisapps.dnr.state.md.us/MERLIN/index.html
Critical Area Boundaries	Critical Area Program, MD DNR	Online mapping tool indicating the Maryland Critical Area Program boundaries and designations (areas classified as critical to the health of the Chesapeake Bay with unique regulatory requirements), http://webmaps.esrgc.org/cbca/desktop/Map
Tidal/Nontidal Limits	MD DNR	Online map providing the tidal/nontidal dividing line for Maryland, https://maryland.maps.arcgis.com/apps/webappviewer/index.html?id=fc9f8b3b04a842769e9f72915f45f4e4

Navigable Waterways	USACE, National Waterway Network	The National Waterway Network is a comprehensive network database of the nation's navigable waterways, an online map is available for Maryland, https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=4a36b779938e4eb5a1344ebc3b906805
USFWS Nationals Wetlands Inventory	US Fish and Wildlife Service (USFWS)	Web application with mapping of US wetland resources, including information on wetland type and extent using a biological definition of wetlands, https://www.fws.gov/wetlands/Data/Mapper.html
Scenic and Wild Rivers in Maryland	Maryland Department of Natural Resources	Map showing Maryland's officially designated scenic and wild rivers, dnr.maryland.gov/land/Pages/Stewardship/Scenic-and-Wild-Rivers-Map.aspx
Aquatic Organism Passage (AOP)	North Atlantic Aquatic Connectivity Collaborative (NAACC)	Data and tools for identifying in-stream barriers to aquatic connectivity and opportunities for restoration projects, https://streamcontinuity.org/ and https://naacc.org/naacc_search_crossing.cfm
Bankfull Discharge and Channel Characteristics	US Fish and Wildlife Service (USFWS)	Regression equations and reports for three physiographic regions in Maryland, including Coastal Plain, Allegheny Plateau and Valley and Ridge, and Piedmont. www.fws.gov/chesapeakebay/PDF/stream-restoration/CoastalPlainweb2.pdf www.fws.gov/chesapeakebay/PDF/stream-restoration/Plateau.pdf www.fws.gov/chesapeakebay/PDF/stream-restoration/Section1.pdf
FEMA Flood Insurance Rate Maps, Studies, and Models	MDE Maryland DFIRM Outreach Program	MDE online mapping tool with digital flood insurance rate maps for Maryland, tool serves as a repository for maps, flood studies, and models which can be downloaded from the flood risk application map, mdfloodmaps.net/
FEMA Flood Insurance Rate Maps, Studies, and Models	FEMA Flood Map Service Center	The FEMA official public source for flood hazard information produced in support of the National Flood Insurance Program. Effective maps and flood studies can be downloaded from the site, www.msc.fema.gov/

MD iMap GIS Data	State of Maryland, Geographic Information Office (GIO)	Maryland's mapping and GIS data portal, providing open access to a GIS Data Catalog, Aerial Imagery, LiDAR bare earth points, and Digital Elevation Models (DEMs), as well as interactive maps representing a range of public services and initiatives, imap.maryland.gov/
ESRGC GIS Data	Salisbury University	Eastern Shore Regional GIS Cooperative (ESRGC) library of GIS data, including statewide elevation data in the form of DEMs through the topography server or topography viewer, www.esrgc.org
GISHydro	MDOT SHA SHHD	GIS-based software program for performing hydrologic analysis, developed by University of Maryland for, and in collaboration with, SHHD. Current versions include GISHydro2000 and GISHydroNXT, www.gishydro.eng.umd.edu/
StreamStats	U.S. Geological Survey (USGS)	Web application for water-resources planning and engineering purposes. Map based user interface can be used to delineate drainage areas for user-selected sites, generate basin characteristics, and estimate flow statistics, streamstats.usgs.gov/ss/
USGS Stream Flow Data	U.S. Geological Survey (USGS)	Stream flow data collected at USGS gage sites. Continuously measured water levels are used to compute hourly (or more frequent) time series of stream flows. Available data includes annual peak flows. nwis.waterdata.usgs.gov/usa/nwis/
USGS National Topographic Maps	U.S. Geological Survey (USGS)	Current and historical USGS topographic maps can be viewed using the topoView web application, ngmdb.usgs.gov/topoview/viewer
Maryland Digital Elevation Models (DEM)	State of Maryland, Geographic Information Office (GIO)	DEM data for all of Maryland is available for download at MD iMap, Maryland's Mapping & GIS Data Portal, imap.maryland.gov/Pages/lidar.aspx
USGS 3DEP Elevation Data (DEM format)	U.S. Geological Survey (USGS)	Topographic data for the US is available for download through the USGS 3D Elevation Program (3DEP), www.usgs.gov/core-science-systems/ngp/tnm-delivery

Land Cover Data, Nationwide	Multi-Resolution Land Characteristics (MRLC) Consortium	A comprehensive product created by a group of federal agencies, including the USGS, NOAA, USFS, and others. The National Land Cover Database (NLCD) 2016 provides nationwide data on land cover and land cover change (30m resolution with a 16-classes), https://www.mrlc.gov/
Land Cover Data, Chesapeake Bay Watershed	Conservation Innovation Center (CIC), Chesapeake Conservancy	2013/2014 mapped 1-meter resolution land cover classification dataset for the Chesapeake Bay watershed, https://chesapeakeconservancy.org/conservation-innovation-center-2/high-resolution-data/
MD County Zoning Data	Maryland Counties	Varies County by County, but typically provided on each County's website along with other GIS data.
Field Survey	MDOT SHA	Requested on a per project basis, see Section 5.4
Geotechnical Investigation and Borings	MDOT SHA	Typically requested on a per project basis by the Structure Design Team Leader in coordination with the SHHD Team Leader

*Data is stored on internal MDOT SHA computer servers or on web applications which are for MDOT SHA internal use only. If the study or analysis is being conducted by an off-site consultant, the information will need to be obtained from the SHHD Team Leader.

5.4 SURVEY REQUESTS

5.4.1 Overview and Coordination

For OOS projects, the SHHD typically performs two types of surveys:

- Type 1 HY-8 Survey
- Type 2 Standard Survey
- Type 3 Full Floodplain Survey

Type 1 survey includes data collection of only the minimum information required to develop an HY-8 model. Type 2 and type 3 surveys include survey of stream cross sections and data collection in the area around the subject structure as specified in the survey request. The cross sections surveyed in a type 2 survey typically span the channel and extend 100 feet to both the right and left top of bank, whereas the cross sections in the type 3 survey span the full 100-year floodplain width. The determination of cross section width is based on individual project requirements. The survey type selected for a specific project is based on the level and type of hydraulic analysis required and is to be determined by the SHHD Team Leader.

Type 2 and type 3 surveys are preferably conducted after the stream morphology assessment is completed. Information obtained in the stream morphology study should be used in preparation of the survey request. If it is determined that a detailed stream morphology study or channel stability design work is required, the stream morphologist may need to accompany the surveyors during data collection in order to indicate the critical elements to be surveyed.

Typically, the survey data for SHHD analysis requirements is collected at the same time as the data required for OOS structure design. The OOS Field Surveys Program Manager will coordinate with the SHHD Team Leader and OOS Design Team Leader to ensure that all required data is obtained in the most time and cost-efficient manner.

Type 1 HY-8 surveys are typically completed by the SHHD personnel. Typically, the SHHD Engineer and OOS Field Surveys Program Manager will visit the project site and will:

1. Confirm that the area to be surveyed is within the MDOT SHA right of way (ROW). If the area extends outside of the ROW, ensure that the property owner notification letters have been sent as per MDOT SHA Property Management Systems guidelines. These letters are sent to adjacent property owners and any properties adjacent to the stream reach 2500-ft upstream and downstream of the project site. The guidelines require a thirty-day allowance after the notification letters are mailed before any field survey work outside the ROW can commence.
2. Select a relative elevation using a monumental point at the structure (e.g., wing wall location or structure invert elevation) which can be related to an as-built or construction plan. If no relative elevation can be found, the closest known LiDAR based contour elevation at the site will be selected as a base point.

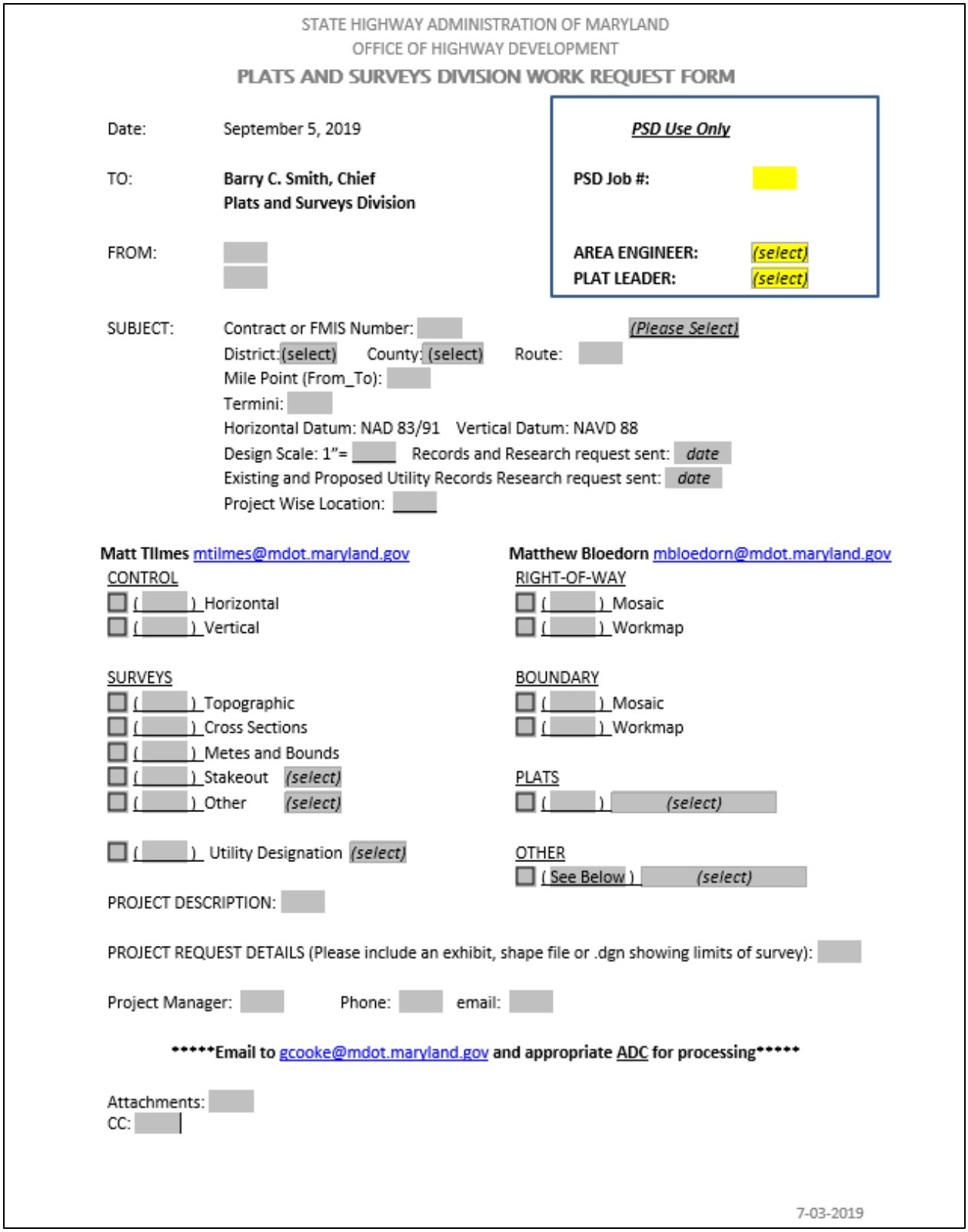
3. Survey one cross section just upstream of the structure, a second cross section just downstream of the structure, and a third cross section approximately 100 ft to 200 ft downstream of the structure. For all three surveyed cross sections, it is important to obtain the thalweg location and elevation. Note that the third (most downstream) cross section should be collected in the location that is determined to result in the highest tailwater (e.g., a riffle or confined area).
4. Survey the stream profile (thalweg). Typically, this includes measurements over a minimum of 100-ft upstream and downstream of the structure, or longer as necessary to determine the average downstream water surface elevation (e.g., typically include 2 riffles and 2 pools, except in very flat areas where the profile should be limited to 150-ft maximum). Data point increments should typically be every 5-ft or at any change in grade.
5. Survey one centerline roadway profile and one roadway profile at the highest point of the roadway (if high point is not the centerline). From the centerline of the structure crossing under the roadway, the distance should be approximately 1,000 ft in each direction. The increment level of station and elevations is at the discretion of the SHHD Engineer, considering roadway safety.
6. Survey the structure dimensions on the upstream and downstream sides to confirm the invert elevations, clear opening size, and structure type. Be sure to include at least two elevations that can be used to tie the structure data to the other survey information.

Type 2 and Type 3 surveys are typically completed by the MDOT SHA Office of Highway Development Plats and Surveys Division (PSD). However, if PSD cannot meet the time allowance demands for a project, SHHD may use an open-end consultant surveyor. For a standard or full floodplain survey, the process of requesting and obtaining survey data usually occurs as follows:

1. The OOS Field Surveys Program Manager will provide the SHHD engineer with an area of mapping (paper copy and digital GIS files) based on the latest topography data (see Figure 5-2). This initial map will be used by the SHHD engineer to develop the survey request and hydraulic concept.
2. The SHHD engineer will work with the OOS Field Surveys Program Manager to develop the survey request. The survey request development map should include the FEMA 100-year floodplain limits, if applicable (see Figure 5-3). If there is no FEMA floodplain mapping for the reach, the engineer will delineate the approximate floodplain limits following contour lines at the base of the valley walls on each side of the stream. The cross section locations need to account for channel alignment and slope changes, significant valley width changes, and morphological features of the channel such as pools and riffles or steps, to the extent practical. The cross section alignment will be guided by the amount of flow in the channel and the floodplain. In case of streams with wide floodplains the valley flows may be more significant and therefore the cross section should be oriented perpendicular to flow lines in the overbank areas rather than the channel. This concept map will be converted into a survey request map by the OOS Field Surveys Program Manager to show only the parts of cross sections to be field surveyed. This map will also serve as documentation of the hydraulic analysis concept, which is critical to establish prior to field survey data collection. The SHHD engineer and OOS Field Surveys Program Manager will

work together to develop data collection survey limits along the stream and roadway at the waterway/structure crossing. The SHHD engineer will provide the OOS Field Surveys Program Manager with the request for any additional survey needs, including properties (buildings).

3. If a project is within a floodplain mapped by FEMA, locating cross sections to be surveyed at the same location as the FEMA effective model cross sections should be considered. It is important to note that FEMA models are developed primarily for insurance mapping purposes whereas SHHD models require a greater level of accuracy and detail. Therefore, cross sections should not be requested to match FEMA if the location is not appropriate for SHHD analysis requirements. For example, for SHHD analysis a cross section at the location of FEMA cross section 56870.51 (Figure 5-3) would be unacceptable.
4. The OOS Field Surveys Program Manager will follow MDOT SHA Property Management Systems guidelines, which includes mailing property notification letters to all adjacent property owners within the derived survey limits. The guidelines require a thirty-day allowance after the notification letters are sent before any field survey work can commence.
5. Once the SHHD Division Chief approves the survey request map and limits, the OOS Field Surveys Program Manager will complete the survey request form (Figure 5-1) and will send the entire survey request package (survey request map, survey request documentation, survey request details/files, and the property owner notification letters mailed) to PSD.
6. An area surveyor with PSD will be assigned the survey request. They will process the request in terms of (1) reviewing the request, (2) performing a man-hour estimate, (3) deciding if the survey can be completed by MDOT SHA crew within the required time constraints, or if the survey should be completed by a PSD open-end consultant. If it is decided that an open-end consultant will do the survey work, the OOS Field Surveys Program Manager will complete a man-hour estimate and coordinate with the SHHD Team Leader to confirm that all data has been provided to the consultant performing the survey. In addition, a PSD liaison will be assigned so that PSD can provide the MDOT SHA field book to the open-end consultant.
7. Deliverables (survey data including road profile, detailed structure survey, topography data and cross section data) are provided as follows. If the survey is being completed by PSD, after the completed survey is processed and reviewed by both PSD and the OOS Field Surveys Program Manager, all data will be placed in a designated ProjectWise folder. The OOS Field Surveys Program Manager will migrate this data in with the existing topography. The processed data will then be provided to the SHHD engineer. If the survey is being completed by an open-end consultant, the OOS Field Surveys Program Manager will obtain, review, process, and migrate the data in with the existing topography. The processed data will then be provided to the SHHD engineer and to PSD for archive storage purposes. The field survey book will be returned to the PSD liaison at this time.
8. Survey request maps are typically prepared by the OOS Field Surveys Program Manager. If this is not the case, the map preparer should contact the SHHD Team Leader to obtain the current CADD standards to be used for the survey request map.



STATE HIGHWAY ADMINISTRATION OF MARYLAND
OFFICE OF HIGHWAY DEVELOPMENT

PLATS AND SURVEYS DIVISION WORK REQUEST FORM

Date: September 5, 2019

PSD Use Only

PSD Job #:

TO: **Barry C. Smith, Chief**
Plats and Surveys Division

FROM:

AREA ENGINEER: *(select)*
PLAT LEADER: *(select)*

SUBJECT: Contract or FMIS Number: *(Please Select)*
District: (select) County: (select) Route:
Mile Point (From_To):
Termini:
Horizontal Datum: NAD 83/91 Vertical Datum: NAVD 88
Design Scale: 1"= Records and Research request sent: *date*
Existing and Proposed Utility Records Research request sent: *date*
Project Wise Location:

Matt Tilmes mtilmes@mdot.maryland.gov

CONTROL
☐ ( ) Horizontal
☐ ( ) Vertical

SURVEYS
☐ ( ) Topographic
☐ ( ) Cross Sections
☐ ( ) Metes and Bounds
☐ ( ) Stakeout *(select)*
☐ ( ) Other *(select)*

☐ ( ) Utility Designation *(select)*

Matthew Bloedorn mbloedorn@mdot.maryland.gov

RIGHT-OF-WAY
☐ ( ) Mosaic
☐ ( ) Workmap

BOUNDARY
☐ ( ) Mosaic
☐ ( ) Workmap

PLATS
☐ ( ) *(select)*

OTHER
☐ (See Below) *(select)*

PROJECT DESCRIPTION:

PROJECT REQUEST DETAILS (Please include an exhibit, shape file or .dgn showing limits of survey):

Project Manager: Phone: email:

*****Email to gcooke@mdot.maryland.gov and appropriate ADC for processing*****

Attachments:
CC:

7-03-2019

Figure 5-1. PSD Survey Request Form

5.4.2 Survey Guidelines

5.4.2.1 General Survey Request Guidelines

The following general guidelines should be followed when developing a standard or full floodplain survey request:

1. Data should be referenced to the horizontal datum of NAD 83/91 and vertical datum of NAVD 88, unless there is a specific reason to use a different datum (e.g., such as an attempt to tie-in to old survey). Note that OOS approval is required to use any non-standard datum.
2. Mapping spatial coordinates should be defined as either State Plane Maryland FIPS 1900 in MicroStation or projected to NAD 1983 HARN State Plane Maryland FIPS 1900 (US Feet) in ArcGIS.
3. Prior to development of the survey request, the SHHD engineer should develop an initial estimate of the 100-year flow pattern and floodplain extent to assist in establishing the number, location and configuration of the required cross sections.
4. The cross sections used in the hydraulic model must typically span the 500-year floodplain, and at a minimum the 100-year floodplain. However, these full cross sections do not need to be surveyed. Typically, SHHD cross section survey will include the channel and 100-ft to either side of the stream channel banks. A LiDAR based DEM can be used to define the remaining floodplain limits of the cross section.
5. The survey request map should be developed at a project specific appropriate scale (typically between 1" = 20' to 1" = 200'). An example survey request map is provided as Figure 5-4. The map should clearly depict the following information, as applicable:

   <u>To understand the topography:</u>

   - North arrow, scale bar and scale number (i.e. 1”=100’), and legend
   - Major and minor contours (preferably at a 2-ft interval), with major contours labeled with the respective elevations
   - Planimetric data including roadways, driveways, buildings, stream lines, tree/wooded area lines
   - Stream name, arrow indicating flow direction, and roadway labels, where appropriate
   - Title block with roadway and stream name, structure number, FMIS number, and the wording of “Survey Request Map”
   - Information documenting the source and dates of all features

   <u>To understand what is to be surveyed:</u>

   - Cross section lines at the requested survey locations with the respective cross section numbers (numbered from downstream to upstream)
   - Roadway centerline profile line(s) with respective profile number(s)
   - Data collection boundary line enclosing the requested data collection survey area
   - Cross section coordinate table with the cross section numbers, the starting point northing and easting, and the ending points northing and easting. Note that coordinates should be shown as looking downstream left to right.

- Road profile coordinate table with profile numbers, the starting points northing and easting, and the ending points northing and easting.
- Stream profile (thalweg) coordinate table with profile numbers, the starting points northing and easting, and the ending points northing and easting. Note, this is only included if survey of the stream profile is required for channel design or other purposes.
- Data collection boundary coordinate table with indicators for each corner or bend in the boundary (capitalized point letters) that correspond to the boundary shown on the mapping, with latitude and longitude coordinates provided for each point.
- Building coordinate table with indicators for the approximate center of each building (capitalized point letters) that correspond to points shown on the mapping, with latitude and longitude point coordinates provided for each point.

6. When identifying the cross section locations and alignments to be surveyed, as needed for the hydraulic modeling and analysis, the following factors should be considered:

- Presence of tributaries (cross sections in the immediate vicinity of the confluences).
- Sharp bends in the waterway (cross sections should not overlap).
- Significant changes in bed slope, stream channel size, and/or surface roughness characteristics (additional cross sections are usually needed at such locations).
- Presence of hydraulic structure(s) downstream of the proposed project for possible backwater effects at the starting cross section.
- Controlling features and conditions (natural or manmade) should be surveyed, such as the narrowest point in the valley, berms, and abandoned dams or roads that no longer cross the stream but are located in the valley. There should be a representative number of cross sections at the top of riffles or controls such as utility crossings so the bed profile in the hydraulic model is representative of actual site conditions.
- Typically, cross sections should span a reach length of 1500 to 3000-ft downstream and 1500 to 2000-ft upstream. The reach should extend to a suitable location to start the computations downstream and cover the possible hydraulic impacts upstream. Slope should be considered, with longer reaches required for flatter channel slopes.
- Typical spacing between cross sections is 50 to 200-ft for smaller streams, and up to 500-ft for larger streams, as measured along the stream channel. Closer spacing may be required near the project structure, or any other structures impacting the system hydraulics. This must be evaluated on a case-by-case basis, considering factors such as height of the embankment, channel erosion, limits of outlet protection, and extent of wing walls/abutments.
- Cross sections should be perpendicular to anticipated flowlines. The requested cross section locations should be selected to obtain representative channel data, including all controlling hydraulic features (e.g., valley constrictions, existing and abandoned structures) and any abrupt changes in discharge, slope, shape, or roughness. Cross section data should be collected in both pools and riffles, although typically more data at riffles is required as these stream features control bed form.

7. All hydraulic structures within the project reach should be surveyed. For each structure, a minimum of 2 cross sections both upstream and downstream is required. The cross sections

immediately upstream and downstream of the structure should be at the toe of the roadway embankment slope. The next adjacent upstream and downstream cross section should be placed at a location which is representative of channel conditions and hydraulic control (e.g., top of a riffles or through a confining location).

8. For all buildings within the anticipated l00-year floodplain, the following information shall be obtained (see Figure 5-5):

- Name and address of owner
- Street address of structure (i.e., building)
- Elevation at which the floodwaters enter the building first (lowest point of entry)
- Elevation at which the floodwaters enter the first floor (first floor elevation)
- Plan view with dimensions; coordinates of any two corners

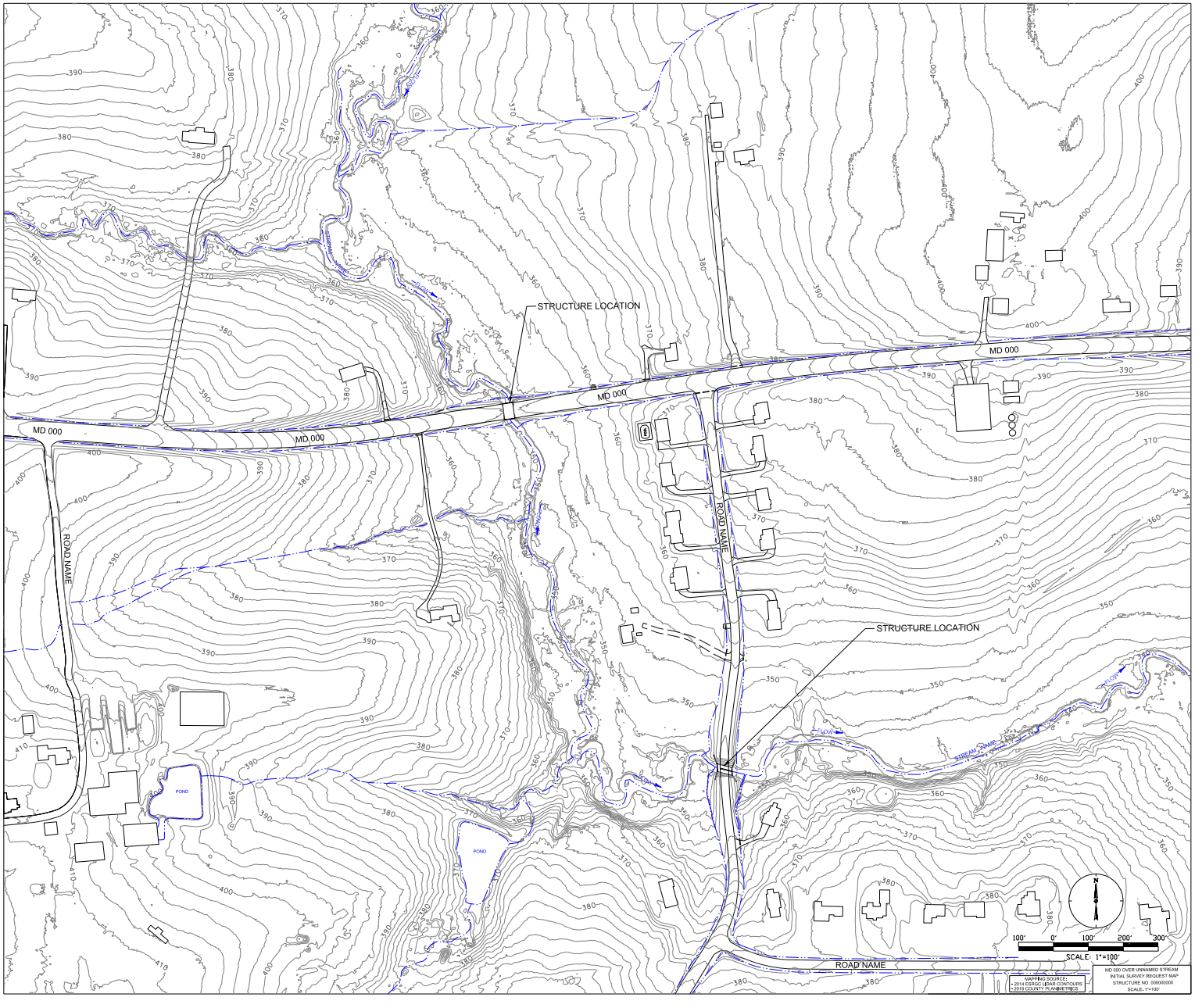


Figure 5-2. Initial Survey Request Map Example

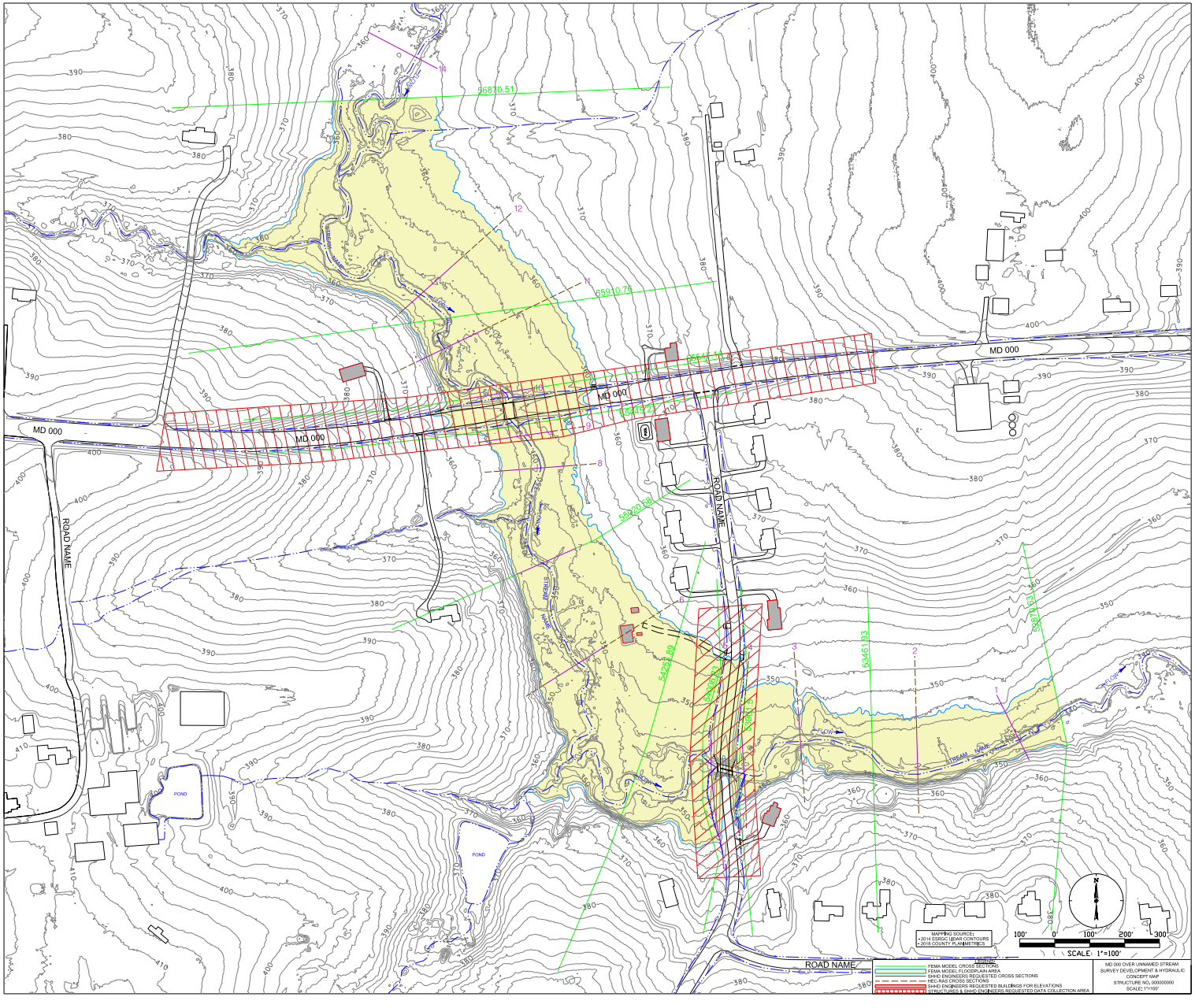


Figure 5-3. Survey Development and Hydraulic Concept Map Example

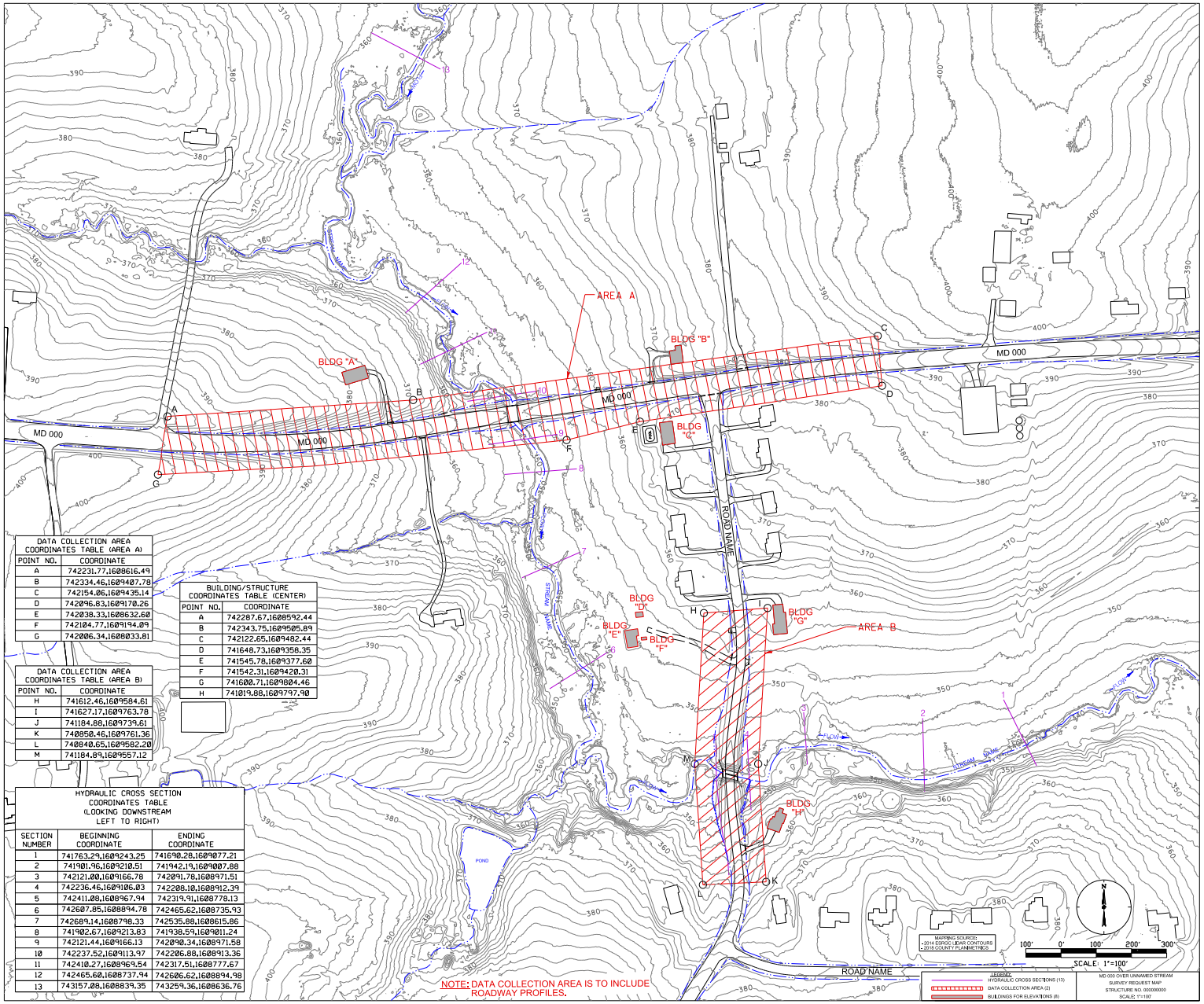


Figure 5-4. Survey Request Map Example

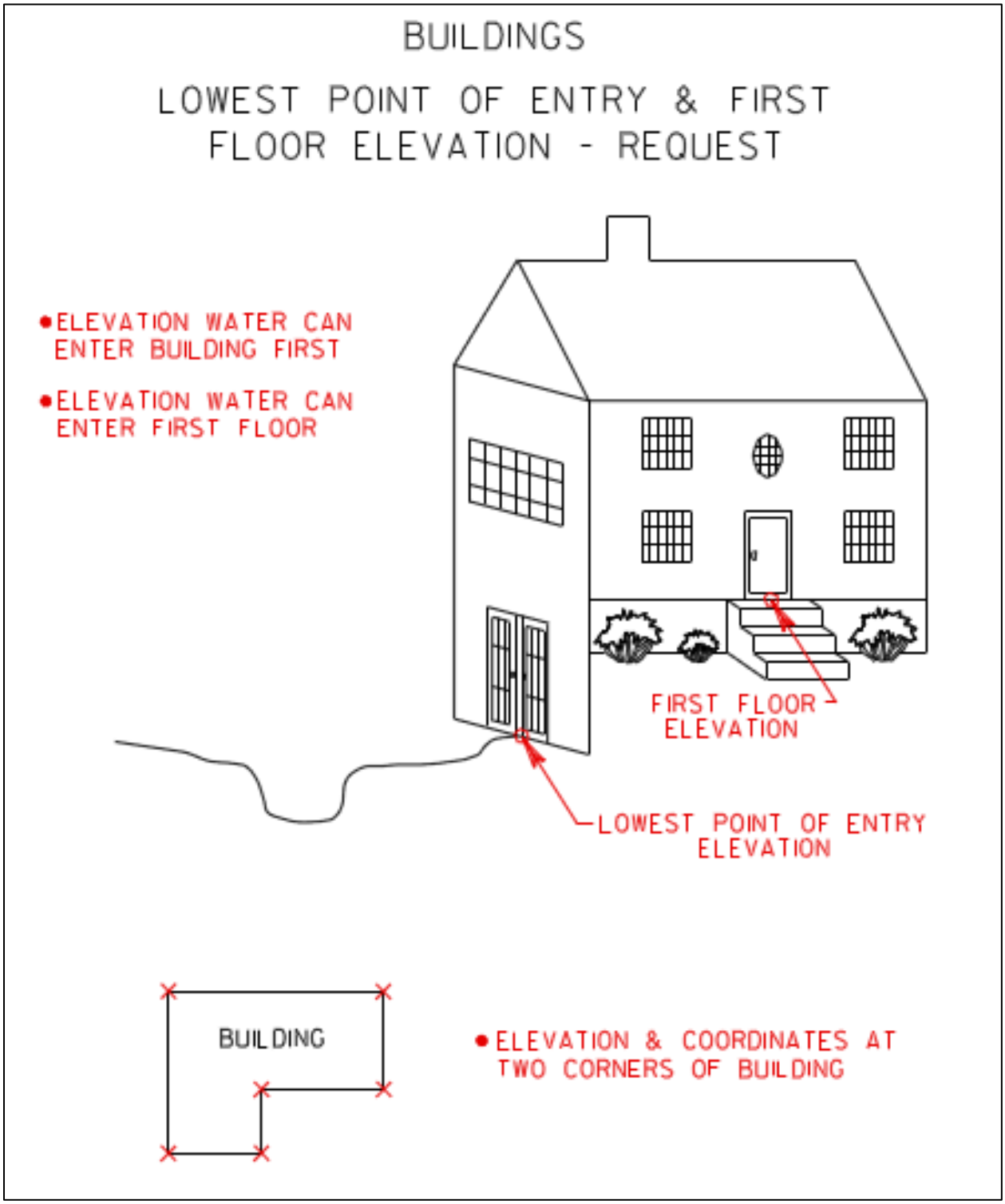


Figure 5-5. Survey Data Requirements for Buildings Potentially in the Floodplain

5.4.2.2 Cross Sections Survey Guidelines

The following guidelines should be followed when surveying cross-sections for SHHD hydraulic analysis requirements. Figure 5-6 provides an example of the required survey data points.

1. The location and orientation of the cross sections should be maintained as shown on the survey request. Typically, these sections should follow a straight line where possible.
2. Elevations and offsets should be obtained for all points of major grade break (i.e., slope change) along the cross section.
3. Obtain the offsets and elevations of points along the cross section where the ground cover changes significantly (e.g., land cover changes from trees to grass).
4. Locate by offset and station, conditions such as scour, holes, erosion, islands, wetland boundary flagging, and utility structures.
5. Obtain the offsets and elevations of the edges of water for every cross section and the water surface elevation.
6. The bottom of stream channel should be surveyed, including the deepest point in the stream (thalweg), using a minimum of 8 points. Larger stream channels (> 10-ft wide) usually require more points to properly define a detailed stream channel.
7. The horizontal coordinates of all points on the cross section should increase from left to right (looking downstream in the direction of flow).
8. Full floodplain cross sections should extend to the approximate 100-year floodplain limits. Standard channel cross sections should extend from the top of bank to a distance of 100-ft on both sides of the stream.
9. Main stream channel should be identified clearly when multiple channels exist.
10. For concave banks provide a horizontal offset along the water surface from the vertical.
11. Avoid debris jams and channel blockages to the extent practicable; in some instances, this may require coordination with the SHHD.
12. If a stream channel profile is required, both bed elevation at the thalweg and water surface elevation data should be collected. Data points should be collected at grade breaks, the beginning and end of riffles, and the beginning and end of pools. Data points should be obtained a minimum of every 25-ft.

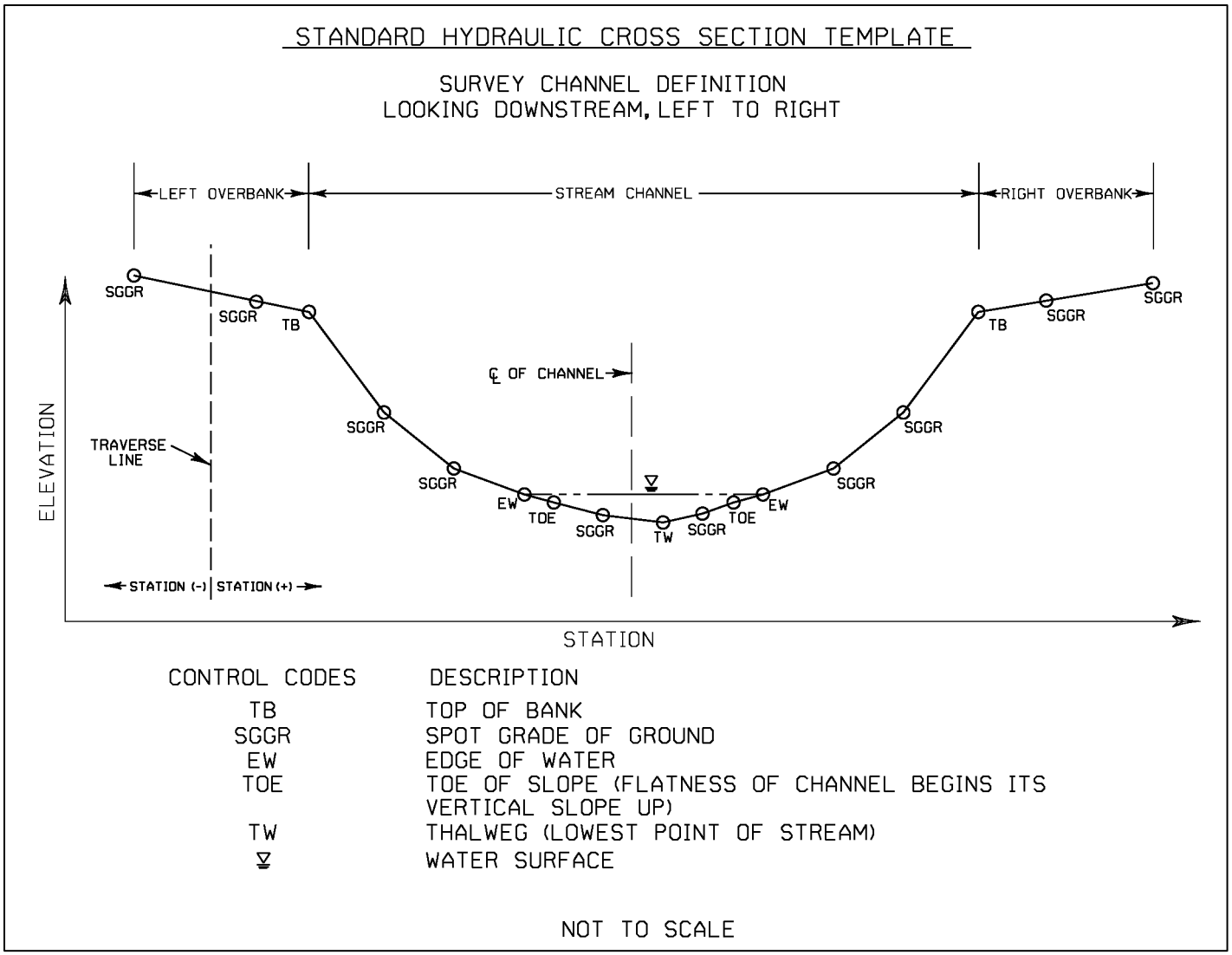


Figure 5-6. Survey Data Requirements for Cross Sections

5.4.2.3 Structure Survey Guidelines

The surveyor shall develop a detailed sketch (with dimensions and reference elevations) showing the following information for each highway structure:

1. Location (station and offset)
2. Structures on a skew should be surveyed parallel to the face of the structure and/or the toe of slope (data will be manually adjusted for hydraulic modeling as needed by the engineer).
3. Roadway profile (length) over the structure should include that portion over which the weir flow might occur during the 100-year flood.
4. Pipe or Bridge Data (Figure 5-7)
   - If a referenced monument is not used to establish a datum for an existing bridge, a point on the bridge should be selected. This point should be clearly marked and identified in the field and the survey notes to identify it as the datum for all elevations.
   - Measurement at the entrance and exit faces of the structure should provide the shape of the waterway opening (e.g., for an arch structure, data points should clearly provide the span shape). For multiple span bridges, the length of each span must be measured.
   - Referenced elevation of low chords, upstream and downstream.
   - Cross section and profile of bridge deck and approaches.
   - Type of top surface (e.g., concrete or steel/wooden girders).
   - Dimensions and elevations of wingwalls.
   - Material, type, size and width of the piers, including their alignment with respect to the road and referenced elevations of pile caps and pier caps.
   - Shape and dimensions of pier(s), and pier footings, if exposed. Material, type (e.g., semi-circular, triangular, flat), skew angle, widths perpendicular to abutment and piers and effective hydraulic width perpendicular to stream flow.
   - Depth and extent of scour holes at piers and abutments, and the presence of any debris.
   - Height, extent and type of parapets (grooved, solid, etc.) with appropriate referenced elevations.
   - Measurement of depth and extent of any deposition within spans or pipes.
5. Culvert Data (Figure 5-8)
   - Culvert description: type, size, material, invert elevations at both ends (not the top of sediment, but the bottom of structure).
   - Type of entrance (headwall, projecting end, mitered end, headwall with wing walls, including beveled, depression, etc.) and show the details, including elevation of top of headwalls and the station-offset data of wing walls' ends.
   - Skew angle.
   - Sediment depth at both ends (if any) and note if it is loose or compact. Survey the top of ground at both culvert ends and depth of any sediment within the culvert.

- Type of bottom surface (natural, or concrete in case of boxes, etc.).
- Presence of any debris and measurement of depth and extent of any deposition.

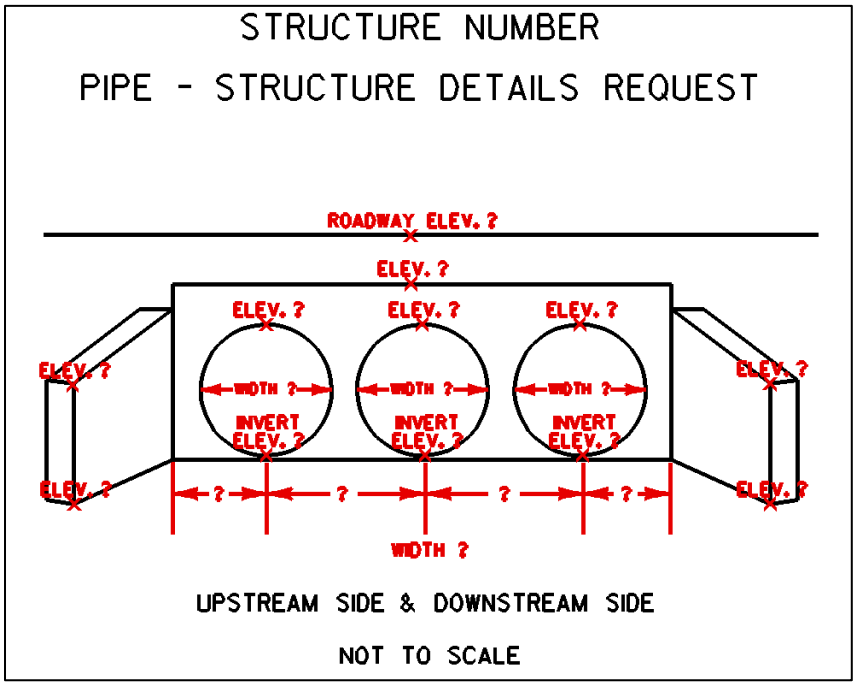


Figure 5-7. Survey Data Requirements for Pipe Structures

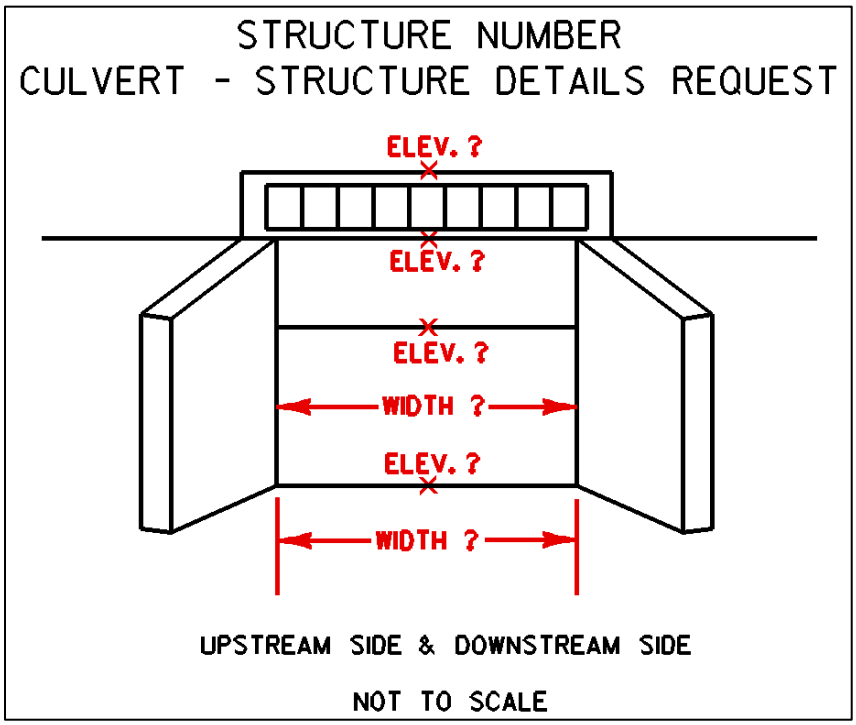


Figure 5-8. Survey Data Requirements for Culvert Structures