

APPENDIX C TOPOGRAPHIC DATA REQUIRED FOR CULVERT ANALYSIS

1.0 Introduction

This appendix discusses the field data that is required to conduct a hydraulic analysis of a culvert. This data is required for culvert replacements, culvert extensions, and new culvert crossings. The hydraulics designer should meet onsite with the survey party chief to go over the required cross section locations and other unique data requirements of the site. This will ensure that the survey will be cost effective, gather the necessary data and avoid repeat visits to the site by the surveyors to gather additional data.

2.0 Digital Terrain Model

A method of obtaining hydraulic survey data using cross-sections and profiles is described. An alternative to surveying individual cross-sections is to develop a digital terrain model (DTM) for the project site. If a DTM is developed for the project, the limits of the DTM should extend far enough to allow the required cross-sections and profiles to be “cut” from the DTM.

Experience shows that the DTM should extend far enough upstream and downstream to include the culvert construction, detour structures, access roads, erosion control features, and temporary water management. The area occupied by the pipe jacking or ramming pit should also be included for these trenchless installations. The terrain model is extremely valuable or essential when these features are designed.

Other features that should be included are right-of-way and easement boundaries, utilities, and trees and bushes to be preserved. Guidance on making these models is in the “structure” survey guidelines in the ODOT Highway Design Manual. Often a DTM is made of the project site and it is supplemented by individual cross-sections and profiles outside of the DTM limits. Care should be exercised to assure the individual cross-sections and profiles are compatible with the DTM. As an example, both surveys should use the same stream profile stationing and elevation datum.

The terrain at most culvert crossings is irregular and difficult to accurately model with a DTM. It is important to construct the DTM based on the original survey, and to plot the vicinity map,

cross-sections cut from the DTM, and the stream profiles. These drawings should be taken to the site and compared to the existing terrain. Often additional data points will be needed at critical locations, and the model will need to be adjusted so it represents actual conditions. These quality control steps should be completed before the model is submitted to the designers.

Note: These guidelines are for large culvert or fish passage culvert replacement, installation, or extension. Work on smaller culverts without fish passage concerns may require less survey data.

3.0 Required Field Data

3.1 General

- a. Vertical Reference should be identified. All brass disks within project limits should be referenced and identified. Surveys in FEMA floodplains need to tie the reference marks used in the Flood Insurance Study to the project survey. The hydraulics designer can supply the locations and descriptions of the reference marks. The preferred vertical reference hierarchy is:
 - known benchmark,
 - assumed datum (as shown on plans), or
 - other assumed datum.
- b. Site Sketch should be prepared. The sketch should include north arrow, stream alignment, highway alignment, cross-section locations, horizontal control and turning angles of cross-sections, hydraulic structure(s), skew angle of each hydraulic structure(s) with respect to flow, buildings, and other unique features at the site. The sketch should show right-of-way and easement boundaries, utilities, and bushes and trees to be preserved.
- c. Photographs. Each photograph should include a description of the item(s) shown. Record the name and address of the photographer and the date the photos were taken. Take photographs, either film or digital, of:
 - Existing culvert. Take a photo of the inlet and outlet of the culvert.
 - Overflow or structure(s). This photo should show the waterway opening provided by the structure(s). If the overflow structure is a culvert, take a photo of the inlet and outlet.

- Channel upstream and downstream from the culvert. Take a photo looking upstream and a photo looking downstream while standing on roadway. Other photos of the channel further upstream and downstream from the culvert are also helpful.
 - Overflow channels upstream and downstream from the overflow structure(s). Take a photo looking upstream and a photo looking downstream while standing on the overflow structure.
 - Floodplain upstream and downstream from the culvert.
 - Roadway overflow areas.
 - Erosion or scour problem areas.
 - Take a photo looking ahead on line and a photo looking back on line from the culvert.
 - Locations where floor elevations are obtained.
 - Hydraulic controls such as rock outcrops, rock ledges, weirs, dams, etc. (See chapter text.)
 - Developed property in or adjacent to the waterway, such as pump intakes, retaining walls, fences, pedestrian bridges, structures, etc. These photos will record the condition of the facilities before the project is constructed. They may be valuable if there is future litigation.
 - Ordinary High Water elevation marks. Usually these elevations are located and staked by the biologist or the hydraulics designer.
- d. Describe significant debris accumulation near the culvert or in the channel within project limits.
- e. Obtain floor elevation and location of upstream houses and buildings.

3.2 Highway

- a. Obtain a profile of the highway. The profile should reflect the highest part of the roadway. If the highway is subject to overtopping, the profile must also define the overtopping limits.

Water will overtop at other locations than the road centerline at many sites. A profile is needed across the apex of the location where the water starts to overflow. An example is a culvert on a roadway with a constant grade. Overtopping occurs adjacent to the inlet, it flows down the roadside ditch to a sag several hundred feet away, then it crosses the road in the sag. A profile would be needed across the high point in the roadside ditch near the culvert inlet where the overtopping initially occurs.

- b. Cross-section of the highway along the centerline of the culvert alignment. This section may be skewed relative to the highway centerline.

3.3 Existing Culvert

- a. The following data is needed for projects that are replacing or extending an existing culvert. Most of this data may be available from existing roadway and/or bridge plans, but it should be field verified. If a culvert is proposed to replace an existing bridge, then the data requirements for the existing bridge described in Appendix D must be obtained.
- b. Type of culvert (i.e., box culvert, circular, pipe-arch, etc.)
- c. Culvert material (i.e., concrete, metal, or plastic)
- d. Size
- e. Length
- f. End treatment (i.e., sloped, mitered, or projecting ends, headwall with wingwalls, etc.)
- g. Top of barrel, water surface, invert, and ground surface elevations at the inlet and outlet. If the culvert is partially full of sediment, the flow line elevation of the culvert barrel and the elevation of the sediment must be obtained. If the culvert end is undermined, elevations are needed of the invert and the groundline under the invert.
- h. The Culvert Inspection Form in Appendix D is required for all culverts within the project limits. Culverts in poor condition may need to be either replaced or rehabilitated.

3.4 Cross-Sections

- a. Width. The cross-section should extend across the full valley width, which includes the channel and adjacent floodplain.
- b. Obtain multiple channel ground points, including underwater ground points, sufficient to accurately define the channel bottom.
- c. Should be taken perpendicular to the direction of flow. Note that perpendicular to the flow in the floodplain may differ from perpendicular to the flow in the channel in which case the section will have a “dogleg” and the direction of the section in floodplain will be different than in the channel. Left and right for the cross-sections are defined by looking downstream.
- d. Should define limits of vegetation types. Note where vegetation changes from grass to brush, etc. This can be identified in the cross-section notes.

- e. Should be taken at locations shown in Figure 1. If significant upstream ponding is likely, additional sections may be necessary to determine the storage capacity upstream of the culvert. Likewise, additional downstream sections may be necessary to establish downstream controls that will influence the tailwater elevation. Highly irregular channels may require additional up- and downstream cross sections.

3.5 Stream Profile

- a. The profile should extend a sufficient distance upstream and downstream from the project site to accurately determine the slope of the channel.
- b. Profile upstream and downstream from the culvert centerline the distances listed in 6.4.4.2. Additional profile length may be needed to satisfy 5a. Elevations should be located along the channel thalweg (lowest point in channel) and be taken every 50 feet and at significant channel bottom grade breaks.
- c. Include the stream bottom profile and the water surface profile at the time of the survey.
- d. Include past flood profiles if evidence from previous high water is apparent.
- e. Include ordinary high water elevations. These elevations are usually staked in the field by the biologist or the hydraulic designer.

3.6 Miscellaneous Structures

- a. Obtain elevations, dimensions, and profiles of other roadway crossings within 500 feet of project. Enough information needs to be obtained to include the crossing in the hydraulic model developed for the project.
- b. Obtain elevations and dimensions of miscellaneous structures such as irrigation dams or weirs within 500 feet of project.

3.7 Local Knowledge of Past Floods

- a. Source of historic flood information is from local residents or maintenance personnel. If local knowledge is obtained, give name and phone number of contact, otherwise give name and phone number of people that can be contacted later.
- b. Highest water elevation and date of occurrence. If a high-water elevation is available, the exact location and elevation of the high-water mark should be surveyed.

- c. Is roadway overtopped? If so, obtain depth of water over road and length of roadway overtopped.
- d. Any debris or ice problem?
- e. Photos of past floods?
- f. Sediment problem?

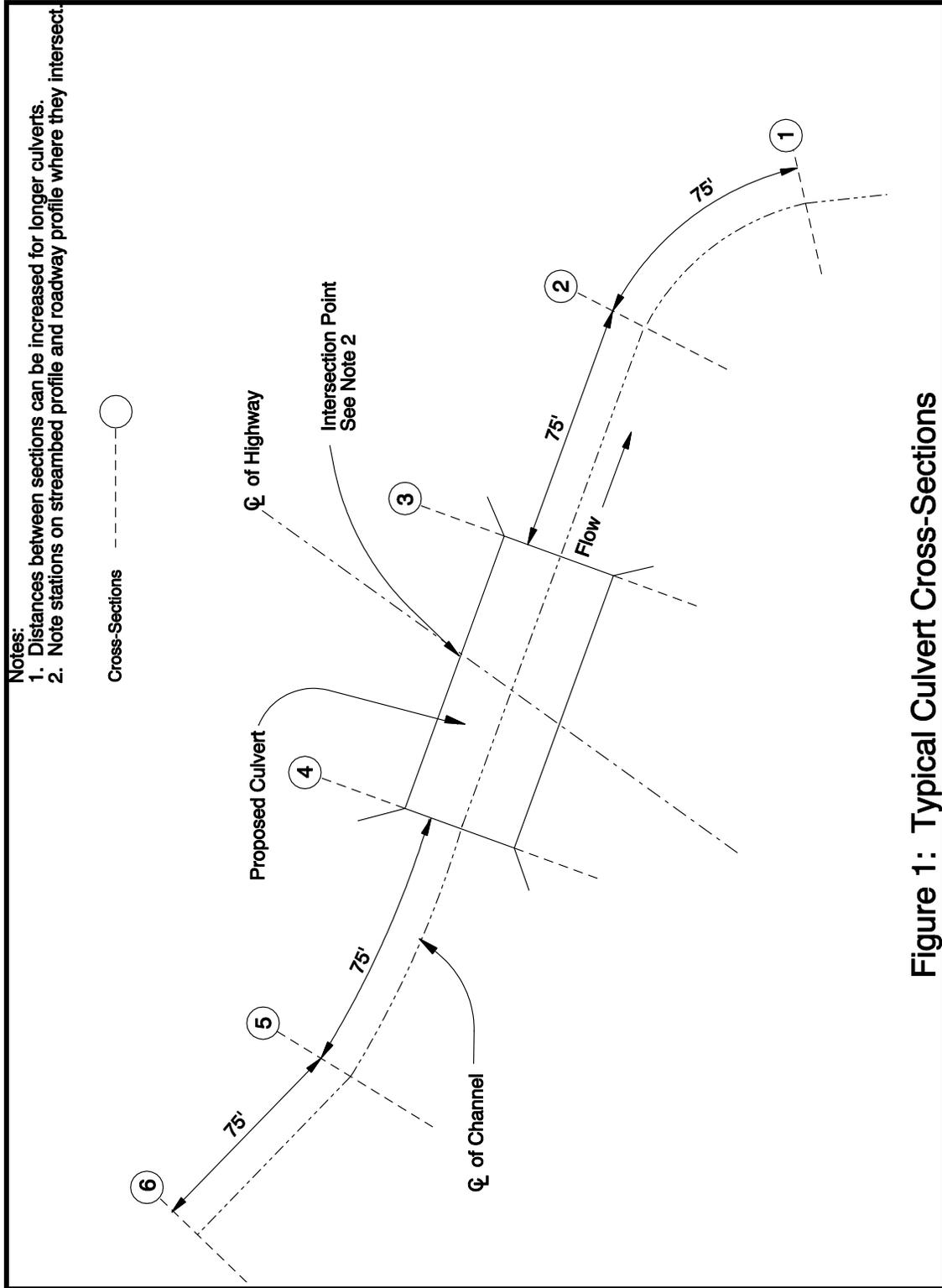


Figure 1: Typical Culvert Cross-Sections