CHAPTER 7

HYDRAULIC SURVEYS

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Sec. 7.01 **Introduction**

One of the most significant input parameters for any design activity is the survey data. The importance of complete information cannot be over emphasized. It is the responsibility of the District Survey Manager to insure that the data is complete and accurate when the initial survey data is sent into the Central Office or transmitted to the District Structure & Bridge Engineer.

The amount and detail of survey data to be collected should be commensurate with the complexity of the hydraulics of the site, stream stability and the importance and/or classification of the highway facility. The individual directing the field hydraulic survey should have a general knowledge of the design activity that will use the data. Surveys for unusual or complex situations and flood plain surveys for major structures shall be coordinated with the hydraulics designer.

For the purpose of this chapter, all facilities employed to convey or retain water will be classified as "hydraulic and drainage structures, or bridges". Culverts with a diameter less than three feet **(3 ft)** or clear span and ditches with a top width less than ten feet **(10 ft)** shall be considered "small drainage structures". Culverts with a diameter or clear span of three feet **(3 ft)** to twenty feet **(20 ft)** and channels with a top width equal to or greater than ten feet **(10 ft)** shall be considered "large drainage structures". Structures with a clear span or diameter greater than twenty feet **(20 ft)** shall be considered major drainage structures.

Sec. 7.02 **General**

Sufficient data shall be obtained to accurately determine the drainage requirements. Any existing structure if not built in accordance with a standard plan or for which there are no bridge plans on file, shall be carefully measured with details shown by sketches. Existing fee right-of-way, property line data and prescriptive easements will be shown on all hydraulic and drainage structures, or bridges surveys. ◊

Where a structure in place is not functioning properly and/or is to be replaced, all data required for new sites shall be obtained.

Where the location parallels an existing road, as in the case of a survey for a dual lane road, locate all pipes and culverts under the existing road. Give accurate invert elevations at the inlet and outlet ends. Extend the profile of the streambed up and downstream beyond each respective lane a sufficient distance to determine the profile of the stream. This is most important as the pipes and culverts under the new lane must be designed to function with the existing structure. DTM readings should be extended a minimum of 50 feet beyond the construction limits of the existing road, at each existing culvert, to accurately define the terrain near the culvert.

At times survey data is secured only on one side of an existing road where a parallel lane is to be constructed. In these cases, it is necessary to secure complete drainage data on both sides of the existing lane.

◊ March 3, 2014

In the case of a location paralleling a railroad, secure all information required above for a location paralleling an existing road. Right of entry must be secured to survey on railroad property.

At all ponds or lakes that will affect or may be affected by the proposed construction, the following is to be secured:

1. Outline (perimeter) of lake
2. Elevation of normal and high water
3. Detailed description at normal spillway works including dimensions and elevations
4. Detailed description of emergency spillway works including dimensions and elevations
5. Description of adjustable gates or other control devices
6. Profile along top of the dam and a typical cross-section of the dam
7. Determine the use of the pond, (stock water, fish, recreation, etc.)
8. Note the existing conditions of the pond as to turbidity and silt

Sec. 7.03 **Topographic Features**

The survey should provide sufficient information for the location engineer and the designer to select the location of the structure and make the necessary hydraulic and impact studies for all significant physical and cultural features that would be adversely affected by the construction. Features such as residences, commercial or industrial facilities, crop lands, roadways, railroads, utilities, wells and other facilities can influence design and their locations and elevations should be established by the survey.

Backwater may extend a considerable distance upstream in streams with relatively flat slopes. Structures, features, and buildings that may be affected by backwater should be located and elevations collected on the finished floors of buildings.

The following survey data must be secured:

1. The location and elevation of pertinent points of all buildings and other valuable structures situated on the upstream side of a proposed or existing highway that would be flooded in the event high waters were to inundate the proposed or existing highway.

2. A description of all buildings, structures, land and activities in the area that would be flooded in the event the proposed or existing drainage structure caused the low point in the highway grade to become inundated.

3. Make note of any buildings or other property previously flooded or closely located to previously known flood stages.

Sec. 7.04 **Channel Characteristics**

The physical characteristics of existing channels, natural or man-made, can best be described by the field survey. The type of material in the bed and banks (i.e., clay, gravel, cobbles, etc.) should be noted as well as any evidence of erosion or deposition along the streambed and banks. **(See Table 7.1)** The type and extent of vegetal cover and classification of debris should be noted. **(See Table 7.2)**

Table 7-1

Particle Size (Mean Diameter)		*Standard Designation*
<0.0003 ft.		Silt
0.0003 ft.	to 0.0015 ft.	Fine Sand
0.0015 ft.	to 0.007 ft.	Course Sand
0.007 ft.	to 0.20 ft.	Gravel
0.20 ft.	to 0.80 ft.	Cobbles
	>0.80 ft.	Boulders

Table 7-2

Debris Classification	*Description*
Light floating debris	Small limbs, pruning and refuse
Medium floating debris	Limbs and large sticks
Heavy floating debris	Logs and trees

Sec. 7.05 **Water Level Information**

The survey should identify various water levels (i.e., normal water, high water, tide levels, etc.) as described in **Section 7.09.3.** This data is used to calibrate engineering calculations and is correlated with other sources of water data.

Normal water data should reflect the average water surface elevation the majority of the time. A line on the stream bank established by the fluctuations of the water or indicated by physical characteristics can be a good indicator of the high water mark elevation. Physical characteristics that indicate the high water mark can be a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

The frequency of high and low water is a "best estimate" and is not intended as a precise quantification that results from a detailed hydrologic analysis.

Reliable high water data can be invaluable information for establishing the stage and discharge of past floods, locating hydraulic controls and establishing highway profiles. Several high water marks along the traverse are required to compute the flood discharge by the slope area indirect method.

If possible, high water elevations for the same flood event should be obtained at points upstream, at the structure site and downstream of the site. When wide flood plains are encountered, elevations are desirable along the edge of the flood plain in addition to those along the stream. Most important, each high water elevation given should be a confirmed sighting, never obtained by paralleling a given elevation up or downstream. The exact location at which the elevation was taken should be referenced to the traverse because the water surface elevation is seldom flat or level either longitudinally or transversely.

Personnel experienced in identifying high water marks are extremely important because the apparent quality of evidence of high water can be deceiving. Evidence of high water on the upstream side of a tree or building will reflect a stage higher than the true high water and marks taken within the drawdown area of a structure or another obstruction will reflect a lower than normal stage than existed. Stages affected by ice, logjams, confluence, varying land use (such as forested areas subsequently cleared), aggrading or degrading channels, and railroad or highway structures can be misleading if the abnormal stage is not recognized.

Information on high water elevations can be obtained by observing seed and mud lines on tree trunks and bridge abutments, wash lines and fine debris lines on banks, wisps of grass or hay lodged in tree limbs and fences, and evidence of erosion and scour. Interviews with residents, commercial and school bus drivers, mail carriers, law enforcement officers, highway and railroad maintenance personnel, and others who might have reason to observe unusual floods will yield additional information. The date of the flood occurrence, the name, address, and phone number of the observer and the stage and location of the observation should be recorded. It is desirable to obtain high water marks from several sources for the same flood event as a cross-reference on the information. The observed frequency of occurrence should be noted since reliable information that a stream reaches a certain elevation every two or three years provides important frequency information for the designer. A few hours spent in interviewing several people who are familiar with the flood history of a stream can result in substantial savings in construction cost, liability, and future maintenance costs through improvements in the design.

The collection of high water data after any significant flood event is very important. The District Hydraulic Unit in each district is responsible for coordinating this data collection program.

A considerable period of time usually elapses between the initial survey for a highway project and actual construction. During this period, additional information should be collected if a reasonably large flood event occurs. This requires preparation in advance of the flood so that resources can be quickly mobilized when a flood occurs.

Correlation of stage at the structure site with discharge relationship by providing one or more known points on a rating curve that otherwise might be used entirely on computations. Data should be collected for as many past flood events as possible in order to aid both the hydrologic and hydraulic analysis.

Sec. 7.06 **Small Drainage Structures**

(Culverts less than 3 feet in diameter and ditches with top span less than 10 feet)

The following survey data is required for small drainage structures with the exception of roadside cut or toe ditches:

1. Stream traverse and profile taken a sufficient distance up and downstream of the anticipated construction area (not less than 100 feet beyond the construction area) to define the alignment and grade of the stream or swale (the traverse is not necessary on sites covered by aerial mapping).

2. Description of channel characteristics **(Sec. 7.04)**

3. Information pertaining to the past hydraulic performance of the existing stream, culvert, etc. to the extent practical. This may include maintenance observations by local citizens.

Sec. 7.07 **Large Drainage Structures**

(Culverts with diameter 3 feet to 20 feet and channel top width greater than 10 feet)

The following survey data is required for large drainage structures:

1. The stream DTMs and topo should be extended 500 feet ± upstream and downstream of the anticipated right-of-way line. The DTM should be taken at intervals not to exceed 50 feet **(50 ft)** and should extend each way from the existing channel to points that are above known or anticipated high water levels. The stream traverse shall begin upstream of the structure and run downstream through the structure to the downstream limits of the survey.

2. Description of channel characteristics. **(Sec. 7.04)**

3. High water elevations, date, source of information, point of measurement. **(Sec. 7.05)**

4. Maximum elevation of headwater permissible at the proposed structure without causing flood damage to developed upstream property.

5. When structures are in place at the proposed site or within one thousand feet **(1000 ft)** up or downstream, the following information is required:
   a. Description of structure, date of construction
   b. Dates and high water elevations for major floods that have occurred since construction
   c. Performance during past floods
   d. Evidence of scour or erosion

e. Location of overflow areas
f. Appurtenance structures (i.e., energy dissipaters rip rap, etc.)

6. Note significance, if any, of stream ecology and/or wildlife habitat.

Sec. 7.08 **Storm Sewers**

When the survey includes an existing storm sewer system, invert elevations should be determined on all pipes, drop inlets, catch basins, manholes, etc. It is essential that all utilities in the area of the existing be located and their elevations given in order to avoid conflicts between the existing utilities and future storm sewer system. This information should be extended well beyond the limits of the proposed project, both laterally and longitudinally, at least to the next access structure. The invert elevation of each pipe entering and leaving a drop inlet and/or manhole must be shown. The location of storm sewer outfalls should be determined. This data should conform to applicable items of **Sec. 7.06** and **Sec. 7.07.**

Sec. 7.09 **Major Structures Over Waterways and Major Flood Plain Surveys**

(Structures with clear span or diameter greater than 20 feet)

The purpose of a survey is to provide an accurate picture of the site conditions. The quality of the final design is heavily dependent on the accuracy and thoroughness of the survey data. This is particularly true in the case of major structures where the cost and the consequence of error can be quite significant.

All surveys for major structures must be coordinated with the District Hydraulic Unit. This will ensure that all needed data is obtained and, in many cases, will eliminate certain standard survey requirements that are not needed for the particular site.

Each item of requested information described in this section is needed for a specific reason. While the survey party must exercise some discretion in securing the requested information, they should endeavor to fully comply with the instructions in this section as modified through coordination with the District Hydraulic Unit.

Sec. 7.09.1 **General Considerations**

A reconnaissance of the stream should be made in order to select the most desirable structure site. The best location is a point where the flood plain is narrowest and where a reasonable foundation is available at a favorable elevation. Skewed crossings should be avoided when possible, but where skewed crossings are unavoidable, they should not exceed 45° unless conditions make other angles imperative.

Alignment should be adjusted to avoid horizontal curvature and transitions on bridges. When this cannot be done, it is usually preferable to place the entire structure on a horizontal curve with transitions beyond the end of the bridge. Structure locations that would involve a heavy gradient on the structure should also be avoided, when possible.

When crossings are necessary near bends and meanders, the trend of the meander should be noted. If erosion around the bend is evident, a comment so stating the conditions should be included in the survey notes.

Sec. 7.09.2 **Site Surveys**

The survey manager or supervisor shall meet with the hydraulic design unit, the bridge design unit, and roadway designer to determine the topographic, DTM, contour, and profile needs. The bridge site survey will use a combination of the sUPC, suUPC, scrUPC, sbUPC, and as necessary the spoUPC file, which the bridge designer can plot as he or she desires. The survey section will not provide a 1" =10' bridge situation file on grid. The topography, contours, and profiles files will be provided so they can be appropriately referenced together in Microstation. LD-23 document will be in a separate document file. These survey requirements shall be contained in the survey authorization at the time the site survey is begun.

There are three (3) classes of site surveys. Any deviation from or addition to these classes must be explained in the survey authorization.

Class I Site Survey - Standard Bridge Situation Survey

This class of survey is required for all bridge sites and major culvert installations where the data is needed to perform a detailed hydraulic analysis. All of the information described in **Section 7.09.3** "Survey Data" shall be obtained. The bridge design unit will specify its choice between contours (Option 1) at the site or profiles (Option 2) along each edge of shoulder. **It is imperative that consultation between the District Hydraulic Unit, the Bridge Design Unit and the District Survey Manager prior to the survey taking place to identify the need for a full Class I Bridge Situation Survey. It may be necessary or beneficial to revert to a Modified Class I Site Survey.**

Modified Class I Site Survey

There are situations when only portions of the Class I Survey are required (i.e., only the flood plain cross-sections or only a single flood plain cross-section at the structure site). All requested data shall be obtained in accordance with **Section 7.09.3**. **It is imperative that consultation between the District Hydraulic Unit and the District Survey Manager, prior to the survey taking place, occurs, to identify the special cases and the specific requirements for the particular survey.**

Class II Site Survey - Abbreviated Bridge Situation Survey

This class of survey is required for all bridge sites and major culvert installations where the data needed for a detailed hydraulic study is available from another source.

All of the information pertaining to the existing that is described in **Section 7.09.3** "Survey Data" shall be obtained. The stream profile, flood plain cross-sections and high water data are

omitted. The bridge design unit will specify its choice between contours (Option 1) at the site or profiles (Option 2) along each edge of shoulder. The location of the stream channel shall be identified between a point two hundred feet **(200 ft)** downstream of the structure and a point two hundred feet **(200 ft)** upstream of the structure. **Consultation between the District Hydraulic Unit and the District Survey Manager is required and will be documented prior to the survey to identify exactly what data is needed for the given situation.**

Class III Site Survey - Longitudinal Encroachments

Cross-sections shall be obtained for the full width of the flood plain. They shall be located at 200 feet ± intervals from a point 500 feet ± downstream of the anticipated encroachment to a point 500 feet ± upstream of the anticipated encroachment. A continuous channel bed profile is required through the area that is cross-sectioned.

Sec. 7.09.3 **Site Data**

The CADD file should show the following from left to right:

1. Title Block - Route, Project, Date, Legend, Utility Owners, etc.

2. The profiles of the site area will be plotted under the site plan unless modified, if modified the profiles will be plotted to the right of the location survey.

3. The stream traverse (i.e. streambed, normal water, etc.), grade separation or railroad profiles will be plotted to the right of the profiles of the situation portion.

4. Flood plain cross-sections, when necessary, will be plotted to the right of the stream centerline and grade separation profiles.

5. Sketches, when needed, will be plotted to the right of the flood plain cross-sections and/or stream traverse profiles.

6. Sketches or photos will be placed in a separate file.

Contours (Option 1) - the contours or DTM's should be extended along the existing roadway centerline to cover all of the area under high water, unless high water extends at rather shallow depths over a considerable area not likely to be bridged. Normally, the contours or DTM's are extended to cover an area fifty feet (**50 ft**) each side of the edge of pavement at the proposed location. However, in some cases, such as a proposed four-lane divided route, it may be necessary to extend them more than fifty feet (**50 ft**).

The contour interval is to be shown on the bridge situation plan by note at the beginning of the plan. The contours are to be labeled at sufficient intervals so that lower or higher elevations can be determined.

A north arrow, bearings on centerline or baseline, all topography within the area to contoured, the name of the stream and direction of flow are to be shown on the contour portion of the plan. The edges of the stream shall be designated by a dash and three-dot symbol (— — · · · — —

)(custom line style WA). The high water line within the limits of the situation plan shall be designated by a dash and dot (□·) symbol and obscured contours shall be shown as a broken line (— — —).

In this case, obscured contours are those that pass under a bridge or structure and are not visible when viewed in plan. No contour shall cross itself or another contour and no contour shall fork or split. The elevation and description on the benchmarks on which the bridge situation is based must be shown. The datum of the benchmarks should always be given whether it is that of the NGVD 29, NAVD 88, or assumed. The agency (N.G.S., U.S.G.S., VDOT or other) should also be noted. Most importantly, assumed vertical datum should be noted as such. **In all cases the elevation for bridge surveys must be referred to the datum used for the roadway survey.**

When the stream is of sufficient width and depth to prevent contours from being readily secured across its bed, three (3) profiles shall be taken across the stream, one on the centerline and one on each side of and parallel to the proposed location. These locations can be noted or written directly on the contour section of the plan.

Centerline profile - The profile must, in all cases, extend along the existing roadway to cover and define the high water spread area and, where practical, to cover an area at least two feet **(2 ft)** above high water. Where there is a nearby existing structure, the clear water way opening as well as the entire length of approach roadway inundated at high water must be defined by running levels and plotting a profile to delineate this area.

The profile on centerline shall be plotted to a scale of one inch equals ten feet (1”=10’) both vertically and horizontally.

The Materials Division will secure foundation determinations. The elevation of normal water, low water and extreme high water should be plotted with the profile. The month and year of high water and the name of the individual furnishing the information must be noted on the situation plan. High water data is of great importance in the hydraulic analysis. The Survey Party Manager should verify that the instructions in **Section 7.05** were followed in the acquisition and presentation of this data. Where tidal streams are encountered, the elevation of normal low tide, normal high tide, extreme low tide and extreme high tide should be determined. The month and year of extreme high tide and the name of the individual furnishing information must also be shown.

Edge of shoulder profiles (Option 2) - Profiles shall be plotted from DTM data. These cross-sections shall be secured to cover the edge of shoulder left and right of the roadway centerline. For an existing structure these readings shall be located along the outer faces of the structure. For a proposed structure on new location these readings shall be located along the anticipated outer faces of the structure as supplied by the bridge design unit or 15 feet ± from the roadway centerline.

The length of the area cross-sectioned shall conform to the instructions, as described in the preceding subsection for the extent of contour coverage along the centerline. Where these cross-sections encounter an existing approach roadway embankment, readings shall be taken along the edge of shoulder and along the toe of the embankment.

Stream Traverse sbUPC#.dgn- All Flood Plain Cross-Sections shall be shown on the site plan. A traverse of the stream for a distance one thousand feet **(1000 ft)** minimum on each side of the location centerline shall be secured and shown so that its course can be determined. The traverse must be run from upstream to downstream to facilitate the direct transfer of data electronically from the data collector to engineering application software. Five hundred feet **(500 ft)** stations should be labeled clearly. A profile of the streambed and the normal water surface for a minimum distance of one thousand feet **(1000 ft)** each side of the location centerline shall be secured. This profile shall be continued until at least two feet **(2 ft)** above high water is reached, or until profile is run for a total of two thousand feet **(2000 ft)** on each side of the location centerline. If the proposed centerline is several hundred feet removed from an existing structure, the traverse shall extend from a point one thousand feet **(1000 ft)** from the downstream centerline to a point one thousand feet **(1000 ft)** from the upstream centerline.

For any dam located in the vicinity of the bridge site, a profile should be secured along the top of the dam from the extreme edges of high water. A detailed description of all spillway arrangements should be obtained, similar to the outline in **Section 7.02** the dam should be located on the site plan.

On all surveys for navigable streams, the channel and bridge fender systems that are in place must be accurately located and shown. The channel alignment is usually referenced to buoys or permanent markers on the shoreline. This information can be secured from the United States Coast Guard and must be tied into survey centerline and recorded in the notes.

On all surveys made for bridges in tidal areas, the Survey Supervisor should determine whether there are oyster beds in the vicinity of the proposed bridge, and, if so, accurately locate.

Existing Structures - Where an existing bridge is to be widened and as built plans are on file, field measurements shall be made of all accessible outlines of the substructure. Also, all outside dimensions of superstructure, complete layout dimensions and elevations of all bridge seats, top of basic floor, both immediately above the bridge seats and on top of the roadway surfacing, shall be field measured. These measurements shall be shown in a sketch and saved in Falcon. When an existing bridge is close enough to the location centerline that the proposed structure might overlap the existing bridge, accurate outlines of the existing structure must be shown on plan views.

Structures near a proposed bridge may have experienced unusual historical floods or major flooding, large enough to provide useful information for the design of the proposed bridge. Information on historical floods or major flooding, which have occurred since construction of the existing bridge, may be obtained from highway agency personnel and maintenance files, residents of the area and from high water marks. This data should be noted on the Bridge Data Sheet.

Data at existing structures should include as much of the following as is available or can be obtained. (Note: Much of this information should be obtained from the District Bridge Office or the District Hydraulic Unit).

1. Date of construction
2. Location relative to proposed structure
3. Cross-section under bridge from as-built plans
4. Present cross-section under bridge
5. Type and size of materials in streambed and banks
6. Condition of structure
7. Scour, erosion and sediment deposits
8. Evidence of head cutting in stream
9. Major flood events since construction and dates of occurrence.
10. Flood elevation upstream and downstream of the bridge with horizontal location of such elevations
11. Observed differences in water surface elevations upstream and downstream of the embankment at as many locations as the information is available
12. Direction of flow relative to piers and the low water channel
13. Observed drift size and quantities
14. Clearance and freeboard
15. Duration of flooding
16. Damage of the high way, bridge and other property
17. The road profile should be carried to a point ± two feet **(2 ft)** above the high water elevation.
18. Photographs of the structure in flood events, stream, and any other feature that will aid in the design of the bridge

Flood Plain Cross-Sections - A cross-section shall be taken at right angles to the flood flow of the stream at the proposed bridge site and shall extend far enough to cover all the area under high water. And where practical, the stream cross-section shall extend to cover an area at least two feet **(2 ft)** above high water. The stream cross-section shall be plotted in the sUPCb#.dgn to the same scale as the centerline profile. A solid line representing the location of this cross-section shall be drawn on the site plan.

DTM readings or Cross-sections, which can provide a representative description of the flood plain, shall be taken throughout the area covered by the stream traverse. These sections should be located at points of major change in cross-sectional area of the flood plain. Major changes in cross-sectional area can be described as: narrowest point; widest point; points of major change in stream gradient (more than 5% change); the beginning and end of significant bends in the flood plain; points of confluence of two streams and at points that may cause a backwater effect (a dam, a road). As a general guideline, sections should be taken ± one hundred feet **(100 ft)** upstream and downstream of all structures (proposed and existing), ± one hundred feet **(100 ft)** and ± one thousand feet **(1000 ft)** downstream of the proposed roadway centerline, and ± five hundred feet **(500 ft)** and ± one thousand feet **(1000 ft)** upstream of the proposed roadway centerline. These cross-sections shall be taken, as nearly as practical, at right angles (90º) to the direction of flood flow. The cross-sections shall be collected left to right, as you are looking downstream. They shall

extend far enough to cover the area under the high water elevation and, if practical, shall cover an area two feet **(2 ft)** above high water. In the case of wide flood plains, the precise definition of minor variations in elevation ± one foot **(1 ft)** may be omitted and average elevations over longer horizontal distances may be employed. **The Hydraulic Design Unit reserves the right to determine the spacing between the cross-sections.**

All flood plain cross-sections shall be referenced by station and angle to the stream traverse and shall be plotted in the sUPCb#.dgn file. It is imperative that the location of these cross-sections be referenced to some base data. The left and right side of all cross-sections (looking downstream) shall be clearly referenced.

Cross-sections should be plotted at a scale that will permit realistic definition of detail without occupying excessive area on the situation survey roll. In all cases, the horizontal and vertical scale will be clearly indicated.

The location and description of the land cover for each subsection shall be shown for each cross-section. The description shall be in sufficient detail to permit the designer to differentiate between the degrees of cover within a given category, i.e., tall trees with dense undergrowth, light woods, dense woods - not just woods.

When flood plain cross-sections are obtained for a longitudinal encroachment, they shall span the entire flood plain below the high water elevation, and, when practical, shall be carried two feet **(2 ft)** above the high water elevation. They shall be carried horizontally and vertically to the centerline of the existing roadway or horizontally to the centerline of the proposed roadway if there is no existing roadway.

High water elevations and topographic data shall be obtained, as much as practical, conforming to the preceding flood plain cross-section instructions.

Station and angle to the roadway centerline or a traverse line shall reference cross-sections for a longitudinal encroachment. This survey data may be shown as part of the highway survey or it may be reported independently. If the latter course is taken, sufficient correlation with the highway survey should be indicated.

Sec. 7.10 **Environmental Data**

The need for environmental data in the engineering analysis of a stream crossing stems from the obligation to investigate and mitigate possible impacts due to specific design configurations. In those cases where an environmental assessment has been completed earlier in project development, part or all of this evaluation may already have been accomplished. Where an environmental assessment has not been made, the data developed for planning and location of the crossing is often of value in the engineering-environmental analysis.

While much of the information noted in the following paragraphs is not within the scope of V.D.O.T. field surveys, it is presented to (1) provide the survey party with an awareness of such data requirements and (2) to suggest that the survey party obtain any part of the required data that is accessible to them.

The designer needs information on existing water quality, present and future water uses and the water quality standards for the stream. Some of this information is available in the water quality standards and criteria published by the State Department of Environmental Quality in fulfilling part of the requirements of PL-92-500. Physical, chemical and biological data for many streams are also available from State and Federal water pollution control agencies, the U.S. Geological Survey and from municipalities, water districts and industries which use the stream as a source of supply.

A description of existing water circulation patterns and the definition of the types and extent of potentially affected wetlands is necessary for the designer to assess the effects of each structure-fill configuration. Data on circulation, tides, water velocity, water quality and wetlands is available from the National Geodetic Survey, the U.S. Coast Guard, the Army Corps of Engineers, universities, Marine institutes as well as other state, federal, and local agencies and organizations.

Information on fish and fish habitat is often necessary in order to evaluate proposed channel modifications and to design replacement habitat. Fish and fish habitat information is available from State and Federal Fish and Game Agencies.

Sediment analysis of the material in the streambed and banks as well as proposed fill materials may be essential data for projects in critical water use areas such as near municipal or industrial water supply intakes.

Information on sediment transport is also vital in defining the suitability of a stream for most beneficial uses including fish habitat, recreation and water supply. Potential changes in the sediment transport rate resulting from construction must be thoroughly investigated for environmental impacts as well as channel stability.

It may be necessary for the highway agency to collect data at critical sites, if the required information is unavailable from other sources.

Data needs may be summarized as follows:

1. Information necessary to define the environmental sensitivity of the crossing, e.g., water use, water quality and standards and wetlands information.

2. Information necessary to determine the most environmentally compatible design, e.g., circulation patterns and sediment transport data.

3. Information necessary to define the need for and design of mitigation measures, e.g., fish habitat sediment analysis and water use and quality standards.

Sec. 7.11 **Bridge Data Sheets (Form LD-23, See Figure 7-A)**

The bridge data sheet should be prepared on all proposed special design bridges and should be completed giving all of the pertinent information required on the sheet. Elevations of normal water and extreme high and low water should be given. The dates of extreme high water and sources of information are also required. For navigable streams the mean or average high and low tide should be determined, and care should be taken to ensure these levels check with the datum of the U.S. Geological or National Geodetic Survey. An estimate of the velocity of current in feet per second at high water and normal water should be made. In navigable streams, the velocity of current at mid flood and mid ebb tide should be obtained by the use of rods or floats. The character of the soil of the bed of the stream is often an index of the velocity during maximum flood conditions. This should always be noted.

Any evidence of erosion along the banks should be recorded, as such evidence affects the layout of the structure. The amount and character of drift and ice should be determined and noted. At locations over tidal streams, it is important to know the degree of brackishness of the water.

It will usually be necessary for the Survey Supervisor to have the assistance of the District Material Engineer in securing this data, but it should be shown in the "Remarks" at all tidal crossings. The "Remarks" should include a brief description of the current usage of the stream for navigation, by small boats, etc.

Emphasis should be placed on the importance of each and every item on the data sheet. This is often the only information available to design a costly structure and the time and effort expended to accurately determine all values is well spent.

Certain data required on bridge data sheets for stream and road crossings is superfluous for railroad grade separation structures and certain data for railroad crossings is needed that is not required on stream and road crossings. Only that portion applicable to the site plan being taken should be completed. This form is shown on **Figure 7-A.**

On all bridge site surveys for bridges over navigable waters, a statement must be included on the bridge situation roll as to whether the proposed bridge and approaches to the bridge will require the use of any land from a public park, recreation area, wildlife and waterfowl refuge or historical site.

Sec. 7-12 **Securing and Storing High Water Information**

The Department established a procedure during the 1960's and 70's for securing and storing high water data immediately after a flood event. This program was implemented to assist both the surveyor and the designer for use at a later date when a bridge site survey was needed. In some cases, it has eliminated the need for a bridge site survey.

It is imperative the survey parties retrieve any data in this program when a bridge site survey is needed. The Survey Party Manager will request this data from the District Hydraulic Unit prior making a bridge site survey.

The data can be requested and retrieved by the following systems:

1. District - All data for District
2. County - All data for County
3. Route - All data for Route in District
4. Route over called river - All data for route over river in District
5. River in called county - All data for river in County
6. River in called District - All data for river in District

All high water data will be submitted to the District Hydraulic Unit by memorandum, when the bridge site plans and data sheets are transmitted to the Central Office, or for secondary roads, when sent to the District Bridge Unit. The District Hydraulic Unit will then input the data into the program.

LD-23 Figure7-A

Link: http://vdotforms.vdot.virginia.gov/SearchResults.aspx?strFormNumber=LD-023

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DEPARTMENT OF TRANSPORTATION
LOCATION AND DESIGN
STRUCTURE AND BRIDGE DATA SHEET

Project: _____ City/County: _____
Federal Route Base No. _____ Situation data for design of bridge on Route _____
over _____
Plane Coordinates or Latitude and Longitude from Transportation Department County Map
_____
Date of Survey: _____ Location (Nearest Town, etc. _____

GENERAL INSTRUCTIONS

Fill out all blanks carefully, giving information on all points. High water data is especially important and should be thoroughly investigated. Comments on any item covered in Survey Instruction Manual which are not covered below should be noted on an attached sheet.

HYDRAULIC SURVEY

1. EXISTING STRUCTURE

Existing structure is any structure at, upstream, or downstream from the proposed site having comparable drainage area.
Date of original construction: _____
Was present bridge in place at time of extreme high water? _____
Has bridge ever been washed out? _____ Date _____ Mo. _____ Yr. _____
Explain what portion of bridge or approaches that have been washed out: _____
_____
Elevation of maximum high water:
Upstream side of existing structure _____
Downstream side of existing structure _____
_____ Ft. upstream of existing structure _____
_____ Ft. downstream of existing structure _____
At other locations on the flood plain (describe)
_____
_____
Date of maximum high water: _____ Mo. _____ Yr. _____ Source of information
_____

2. STREAM FLOW DATA AT PROPOSED SITE

Elevation of maximum high water of this stream at proposed location if different from data for existing site:
_____ Ft. on upstream side of proposed _____
_____ Ft. on downstream side of proposed _____
At other locations on the flood plain (describe) _____
_____
Date: _____ Mo. _____ Yr. _____ Source of information _____
_____
Elevations of highest backwater caused by another stream _____
Date: _____ Stream Name _____
Source of information _____

Elev. of normal water: _____ (Average) Elev. of extreme low water _____
Date: _____ Mo. _____ Yr. _____
Source of information _____
Velocity of current at high water: _____ ft./sec. Velocity of current at normal water _____ ft./sec.

3. SITE CONDITIONS

Amount and character of drift during a freshet or flood:

_____

Amount and character of ice: _____
Do banks or bed show scour? _____
Description and location of scour?

_____

Bed of stream consists mainly of: mud, silt, clay, sand, gravel, cobbles, boulders, soft solid rock, stratified rock, hard rock, silt sedimentation, deposition of large stones. Is this material loose or well compacted?

_____

Comments on stream ecology and wildlife habitat:

_____

4. INFLUENCE AND CONTROL OF SITE

Location and condition of dams upstream or downstream that will affect high water or discharge at this site:

_____

Location and description of any water-gaging stations in the immediate vicinity: _____

_____

_____

Elevation _____ on gage corresponds to elev. _____
_____ on survey datum.
Extent to which sink-holes affect runoff, etc.: _____

_____

Brief description of usage of stream for navigational purposes. By small boats, etc.

_____

_____

_____

Railroad Grade Separation Structure Site Data

Railroad milepost _____ No. of tracks _____
Situation data for design of bridge on _____ over _____
Type of construction: _____ New structure
_____ Replacement of existing structure
_____ Remodeling of existing structure
_____ Paralleling existing structure

Owner of existing structure _____ .
Owner of grade crossing to be eliminated _____ .

Date of original construction of any railroad structure being replaced or within approximately 500 feet of the site of proposed overpass

_____ .

Conditions of existing cut slopes, whether stable, eroded, et cetera .
Are ditches open, maintained, et cetera _____ .

NOTE - Show cross-section of existing railroad bed at right angles to centerline crossing, with all dimensions, on bridge situation plan. This cross-section should extend from top of cut to toe of fill.

REMARKS -
(Information on significant features not listed, et cetera)

_____
_____
_____
_____

Survey by _____