5.3 Site Characteristics

5.3.1 Introduction

A complete understanding of the physical nature of the natural channel or stream reach is of prime importance to a good hydraulic design. Any work being performed, proposed, or completed, that changes the hydraulic efficiency of a stream reach must be studied to determine its effect on the stream flow. The designer should be aware of plans for channel modifications, and any other changes which might effect the facility design. The stream may be classified as:

- rural or urban
- improved or unimproved
- narrow or wide
- rapid or sluggish flow
- stable, transitional, or unstable
- sinuous, straight, braided, alluvial, or incised

Geomorphological data are important in the analysis of channel stability and scour. Types of needed data are:

- sediment transport and related data
- stability of form over time (braided, meandering, etc.)
- scour history/evidence of scour
- bed and bank material identification

5.3.2 Roughness Coefficients

Roughness coefficients, ordinarily in the form of Manning's "n" values, shall be estimated for the entire flood limits of the stream. Report No. FHWA-TS-84-204, "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains," should be consulted for determining the appropriate "n" values. It is advisable to take still pictures of the flood plain to document the "n" values selected.

5.3.3 Stream Profile

Obtain stream bed profile data to determine the average slope and to encompass any proposed construction. These data should extend sufficiently upstream and downstream. Limits will be established by the hydraulic engineer. Identification of "headcuts" which could migrate to the site under consideration is particularly important.

5.3.4 Stream Cross-Sections

Stream cross-section data shall be obtained that will represent the typical conditions at the structure site as well as other locations where stage-discharge and related calculations will be necessary. The location and extent of cross-sections will be determined by the hydraulic engineer. See Chapter 9, Bridges, for additional guidance in determining the location of stream cross sections.

5.3.5 Existing Structures

Secure the location, size, description, condition, observed flood stages, and channel section relative to existing structures on the stream reach and near the site in order to determine their capacity and effect on the stream flow. Investigate structures, downstream or upstream within the area of influence, which may cause backwater or retard stream flow. Note the manner in which existing structures have been functioning with regard to such things as scour, overtopping, debris and ice passage, fish passage, etc. For bridges, include span lengths, type of piers, and substructure orientation which usually can be obtained from existing structure plans. Other necessary culvert data includes size, inlet and outlet geometry, slope, end treatment, culvert material, and flow line profile. Photographs and highwater profiles or marks of flood events at the structure and past flood scour data can be valuable in assessing the hydraulic performance of the existing facility.

5.3.6 Acceptable Flood Levels

Improvements, property use, and other developments adjacent to the proposed site both upstream and downstream may determine acceptable flood levels. Note incipient inundation elevations of these improvements or fixtures. In the absence of upstream development, acceptable flood levels may be based on freeboard requirements to the highway itself. In these instances, the presence of downstream development becomes particularly important as it relates to potential overflow points along the road grade.

5.3.7 Flood History

The history of past floods is a valuable tool for sizing structures. Historical flood data is also utilized in the development of flood hazard evaluation studies. Information may be obtained from newspaper accounts, local residents, flood marks or other positive evidence of the height of historical floods. Evaluate changes in channel and watershed conditions since the occurrence of the flood in relating historical floods to present conditions. (See Chapter 6 – Appendix E – Major Flood Events in Connecticut since 1927).

Recorded flood data may be available from agencies such as U.S. Army Corps of Engineers, U.S.G.S., ConnDEP, NRCS, and ConnDOT.

5.3.8 Debris and Ice

Investigate the potential quantity and size of debris, ice, etc. available for transport by a stream during flood events. The effect of backwater from debris and ice jams on recorded flood heights should be considered when using stream flow records.

5.3.9 Scour Potential

Scour potential is an important consideration relative to the stability of the structure over time. Scour potential is a function of a combination of the stability of the natural materials at the facility site, tractive shear force exerted by the stream, sediment transport characteristics of the stream and relative floodplain/channel conveyance characteristics. Data on natural materials may be obtained from the Department or by tests at the site.

Collect enough bed and bank material samples for classifying channel type, stability and gradations. A geotechnical study will be required to determine the substrata if scour studies are needed. Also, these data are needed to determine the presence of bed forms so that a reliable Manning's "n" and bed form scour can be estimated.

5.3.10 Controls Affecting Design

Many controls will affect the final design of drainage structures. These include allowable headwater level, allowable flood level, allowable velocities, and resulting scour and other site specific considerations. Data and information related to such controls can be obtained from Federal, State and local regulatory agencies, and site investigations to determine what natural or man-made controls should be considered in the design. In addition, there may be downstream and upstream controls which should be documented.

5.3.11 Downstream Control

Any ponds or reservoirs, along with their spillway elevations and design levels of operation, shall be noted. Also, channel constrictions or points of abrupt grade changes should be identified. Their effect on backwater and/or streambed aggradation may directly influence the proposed structure. Also, any downstream confluence of two or more streams shall be studied to determine the effects of backwater or streambed change resulting from that confluence.

5.3.12 Upstream Control

Upstream control of runoff in the watershed shall be noted. Conservation and/or flood control reservoirs in the watershed may effectively reduce peak discharges at the site and may also retain some of the watershed runoff. Obtain capacities and operation designs for these features. The NRCS, Corps of Engineers, Bureau of Reclamation, consulting engineers and other reservoir sponsors often have complete reports concerning the operation and design of proposed or existing conservation and/or flood control reservoirs.

The redirection of flood waters can significantly affect the hydraulic performance of a site. Some actions that redirect flows are debris jams, mud flows and highways or railroads.

5.3.13 Survey Requirements

Complete and accurate survey information is necessary to develop a design that will best serve the requirements of a site. The amount of survey data gathered shall be commensurate with the importance of the proposed structure and the expected flood hazard.

At many sites photogrammetry is an excellent method of securing the topographical components of drainage surveys. Planimetric and topographic data covering a wide area are available in many locations. A supplemental field survey may be required to provide data in areas obscured on the aerial photos (underwater, under trees, etc.).

Data collection shall be as complete as possible during the initial survey in order to avoid repeat visits. Thus, data needs must be identified and tailored to satisfy the requirements of the specific location and size of the project early in the project design phase. Coordination between the project engineer and surveyor before the initial field work is begun will help insure the acquisition of sufficient, but not excessive survey data.

5.3.14 Field Review

Field reviews shall be made in order for the designer to become familiar with the site. The most complete survey data cannot adequately depict all site conditions or substitute for personal inspection by someone experienced in drainage design. Visit the project site before any detailed drainage/hydraulic design is undertaken. Factors that most often need to be confirmed by field inspection are:

- identification of apparent environmental concerns
- selection of roughness coefficients
- evaluation of apparent flow direction and diversions
- flow concentration
- observation of land use and related flood hazards
- geomorphic relationships
- highwater marks or profiles and related frequencies
- adequacy or suitability of existing and proposed drainage outlets

Before making the field visit, determine what kind of equipment is needed and, most importantly, the critical items at the site. Take photographs. As a minimum, looking upstream and downstream from the site as well as along the contemplated highway centerline in both directions. Details of the stream bed and banks should also be photographed along with structures in the vicinity both upstream and downstream. Take close up photographs complete with a scale or grid to facilitate estimates of the stream bed gradation.