Appendix 14-B: Evaluation of Soil and Bed Load Materials for Scour Studies

Selection of the appropriate D50 particle size is an important aspect of the scour evaluation study. As a general rule, the description of channel bed materials should be included in the geomorphology report along with an evaluation as to whether the type of scour used for scour analysis should be clear-water or live-bed scour.

The extent of scour to be expected at a bridge foundation is dependent on the surface and subsurface materials in the stream channel and its flood plain. The engineer needs to evaluate, among other matters, the types of scour (clear water or live-bed) that may occur at the bridge. If there is a significant sediment bed load passing through the structure at flood stage, use the live bed scour equation developed by Laursen to estimate the extent of contraction scour at the bridge. The scour depth at the bridge is computed using the ratio of the unit flow through the bridge to the unit flow in the upstream channel as described in Chapter 11 of the H&H Manual. Use of this equation also assumes that the material in the channel bed is the same upstream of the bridge as it is under the bridge. This is rarely the case.

If there is an insignificant bed load transported to the bridge from the upstream sediment supply reach, use the clear water scour equations developed by Neill (and modified by the Office of Structures as incorporated in the ABSCOUR 9 Program) to estimate the extent of contraction scour. This method uses the D_{50} particle size of the bed material under the bridge and the velocity and depth of flow through the bridge to estimate the contraction scour depth.

Alluvial streams in flood stage will normally carry some sediment load. Stream morphology studies conducted to date in Maryland indicate that the sediment supply for many non-tidal streams is limited and that the scour mode is more likely to be clear water than live bed. Therefore, for many scour evaluations there will be no clear-cut resolution of the scour type (live bed or clear water) that causes the deepest scour to occur.

The engineer needs to use judgment in the evaluation of both types of scour to determine the most reasonable estimate for the contraction scour depth for a given flood flow. Information obtained during the stream morphology study, along with the bridge borings, will serve as the sources of the data used to make this judgment. The following guidance is provided for the collection and evaluation of this information.

Observations and/or representative soil samples should be taken and careful observations made at the location of the structure crossing and at the upstream approach section to the bridge as indicated in Figure 14B-1. If the location of the approach section has not been identified by SHA, select an upstream section typical of the channel and flood plain, located two or more bridge lengths above the crossing site. The objective is to select a cross-section that is representative of the approach reach above the bridge.

Approach Section

The purpose of the evaluation of the approach section (Locations 1, 2 and 3) is to evaluate the nature of the sediment transport in the reach above the bridge. Essentially, the question to be answered is whether the flood flow will be carrying a significant bed load.

Locations 1 and 3 should be selected on the flood plain within the active flood plain which carries overbank flow. At locations 1 and 3, describe in detail the nature of the vegetative cover. Flood flows on the flood plain generally have low velocities. If there is a heavy protective cover

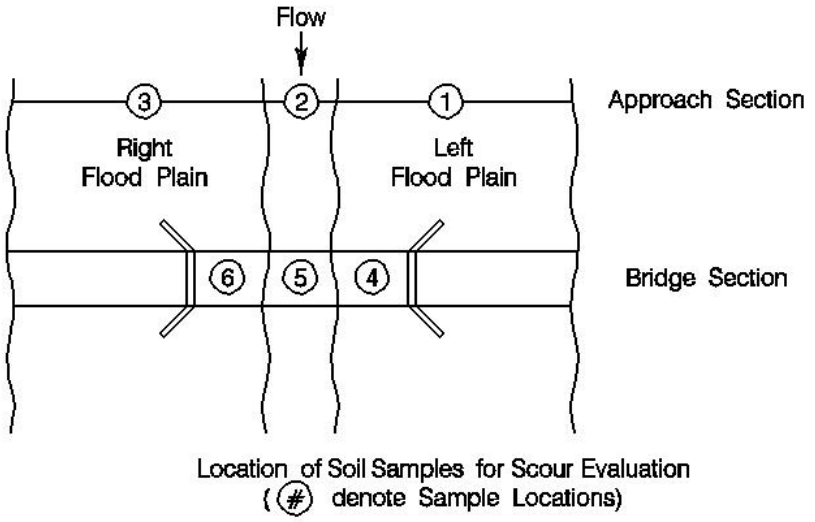

Figure 14B-1

on the flood plain, it is likely that the surface soils will not be mobilized and that the flood plain flow approaching the bridge will be clear water. Describe the nature of the surface material, as to whether it is sand, gravel cobbles or a mixture of sizes. If sand, make a note as to whether it is fine or coarse sand. For other materials, take a representative pebble count as appropriate at each location 1 and 3 and include this information in the preliminary report. Note the D_{50} size.

Take photos of the general flood plain area and its vegetation and of specific areas in which the pebble counts and soil observations are made.

For Location 2, the upstream channel, the following actions should be taken:

- Take a pebble count of the channel bed material. Ideally, this sample should be taken on a riffle upstream of the bridge. This information will be helpful in determining whether the stream will mobilize the bed material in the riffle during flood flows
- Sample the upstream bars using the procedures discussed elsewhere in Chapter 14, and determine particle size distribution plots for this material. This material will normally be carried by flood flows as a part of the sediment load.
- Take photos of the channel reach in which the measurements and observations were made.
- Review the information obtained from the stream morphology report to evaluate the nature and magnitude of the sediment load in the supply reach above the bridge.

The above information will be used in the scour studies to estimate the type of sediment load moving through the bridge for the hydraulic conditions used in the scour estimate.

Bridge Section

Information on surface and subsurface soils is needed at the bridge section (Locations 4, 5 and 6 in Figure 14B-1) for use in the scour evaluation. Essentially the information needed is a description of the surface soil characteristics, including the D_{50} particle size, of the material comprising the channel and flood plain under the bridge. The engineer leading the morphology study will need to determine the best location to obtain these samples for the particular site crossing, and to determine whether this material is characteristic of the sediment load passing through the structure waterway opening.

The engineer leading the morphology study can also provide valuable information on surface soils and make informed judgments about the shallower subsurface soils using the following methods and observations as appropriate:

1. Description of surface soils in the flood plain and channel, using pebble counts. If the flood plain consists of sand or cohesive materials, describe the material in the preliminary report as sand, silt or clay using the following as a guide.

Class	**D_{50} Size**
Coarse or Medium Sand	0.25 to 2 mm
Fine Sand	0.06 to 0.25 mm
Silt	Visual observation/field tests
Clay	Visual observation/field tests

1. Observe the channel banks to assess the nature of the shallow subsurface flood plain material.
2. Make a note of the existence of rock or rock outcroppings in the vicinity of the bridge crossing.
3. Take photos of the locations where measurements and observations were made.

Include the findings of these investigations in the preliminary and detailed morphology reports in a section entitled "Evaluating Soil and Bed Load Materials for Scour Studies."

Borings

Since scour depths can approach 20 feet or more at some structures, information on the variation of subsurface soils or rock with depth will be important to the accuracy of the scour estimates. Borings will serve to provide this information for deeper subsurface soils.

- One or more borings should be taken at each foundation element. In addition, at least one boring should be taken in the channel at the bridge location.
- Depths reported on the standard borings log sheet should be tied in to survey information so that the elevations can be related to the water surface, channel bottom and foundation design elements.

- The material removed from the boring should be classified as to whether it is clay, silt sand, gravel, etc. using standard procedures. For cohesive materials, classify the soils accordingly. Take Shelby Tube samples of each cohesive soil layer encountered.
- For cohesionless soils take samples and run a particle size distribution of the sample. Use the standard Maryland DOT forms to list and plot the various sample sizes. As a minimum, the sample particle size report should include the D50 median grain size, the 84% finer and the 95% finer grain sizes
- If there is a significant change in the composition of the soil, note the elevation where the change occurs. Take additional samples of the soil below the change, gathering the same information as that discussed above.
- Note the elevation of the soil/rock interface. Record the standard data on rock characteristics including RQD, elevations, depths recovery, etc.
- The rock cores should be reviewed with an SHA geologist to determine whether the rock is scourable or scour-resistant.