Guidelines For Water Course Surveys In Undesignated Or FEMA Zone A Floodplains

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Guidelines For Water Course Surveys In Undesignated Or FEMA Zone A Floodplains

The purpose of this presentation is to provide surveying guidelines that will lead to a Base Flood Elevation (BFE), and/or a floodplain determination on a limited reach of a floodplain, that will likely be acceptable to most local communities and FEMA.

The accuracy of a BFE determination or the delineation of a 100 year floodplain is very dependent upon the planning and implementation of the field survey.

Cross sections are the backbone of any hydraulic model used for determining BFE's or delineating floodplains.

Guidelines For Water Course Surveys In Undesignated Or FEMA Zone A Floodplains

Important aspects of a water course survey are:

- the use of the appropriate Datum
- the identification of a registered Benchmark
- the location and orientation of the cross sections, including water course changes, bridges, and other obstructions
- the proper format of the data to be submitted

Benchmarks and Datums

Topographic data must be referenced to one or more accepted benchmarks tied into the National Geodetic Survey (NGS) National Spatial Reference System (NSRS).

The NGS Permanent Identifier (PID), or unique identifier assigned by the maintainer of the benchmark, for any benchmark utilized must be provided.

For GPS surveys, indicate the benchmark used for the base station, the Continuously Operation Reference Stations (CORS) sites used for the On-line Positioning User Service (OPUS) solution (also attach the OPUS report), or the name of the Real Time Network used.

Benchmarks and Datums

Monuments used for GPS base stations must have Horizontal Order, Vertical Order and/or Ellipsoid Order, and Stability C or better.

Horizontal Control must be NGS Second Order or better.

Vertical Control must be 5 centimeters or better for GPS, or Third Order differential leveling.

Other benchmarks may be used provided supporting documentation is submitted which supports a tie back to a previously recognized benchmark.

Benchmarks and Datums

Either the National Geodetic Vertical Datum 1929 (NGVD 29) or the North American Vertical Datum 1988 (NAVD 88) must be used. No mixing of datum's is allowed.

The datum utilized for the survey must match the FEMA Flood Insurance Study (FIS) datum.

If the survey is near a USGS Stream Gage Station, it's datum should be used and tied into the FIS datum. Flow rate and depth information from the gage from the day of the survey should also be recorded.

Survey Reach Identification

Cross section surveys required for hydraulic computer models are different from those needed for highways and other projects. Therefore a pre-survey site visit and discussion involving the engineer and the surveyor is necessary.

Cross section location and orientation is very important to the hydraulic modeling process.

The required reach length is very dependent on channel slope, the channel and overbank roughness, channel shape, obstructions, and flow depth.

Survey Reach Identification

Limiting the reach length to the shortest useful distance is important in keeping the cost of the field surveying reasonable.

From a hydraulic modeling standpoint, the more cross sections the better, however improperly placed cross section are useless.

A good balance of cross sectional data and reasonable costs is imperative. Therefore, consultation with the engineer, and a pre-survey site visit is highly recommended.

Location of Cross Sections

Cross section data should be taken from left to right across the valley with the left end or starting point being defined by looking downstream.

Insure that the cross sections span the entire floodplain width and fully describe the total area likely to be flooded by the 100-year flood.

A uniformly shaped channel will require fewer cross section than a channel that has constant changes in size, shape, slope, and roughness.

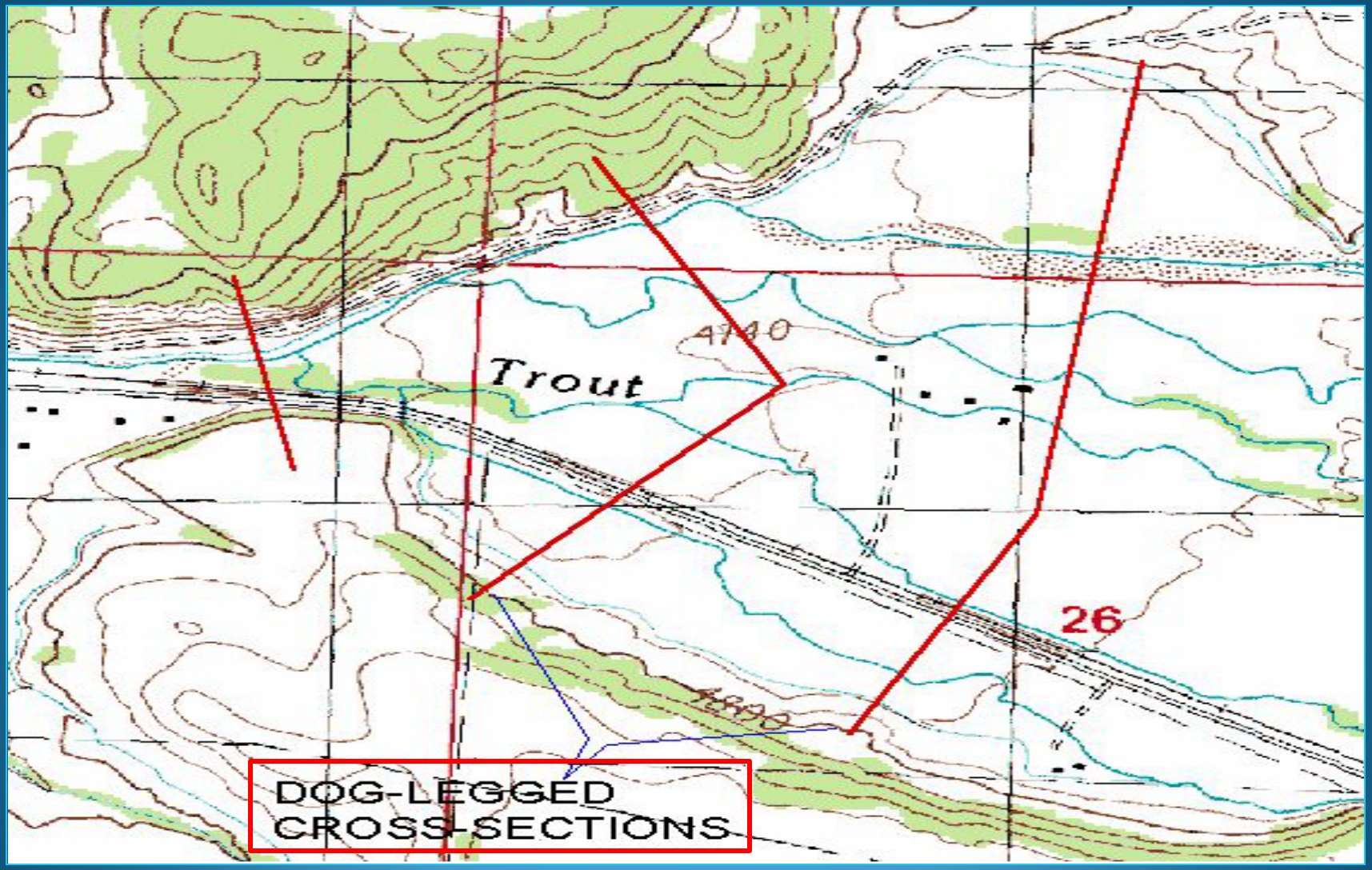
Location of Cross Sections

Cross sections should be placed at intervals which will divide the channel reach into sections that are as uniform in size, shape, slope, and roughness as possible.

Select each cross-section location so that it represents the typical conditions for that subreach and it represents the channel and floodplain geometry ½ way to the next cross section in both the upstream and downstream direction. .

Cross section alignment should be perpendicular to the general flow of the watercourse (generally perpendicular to the contour lines). Wide floodplains may require a dog-leg alignment to be perpendicular to the flow paths.

Location of Cross Sections

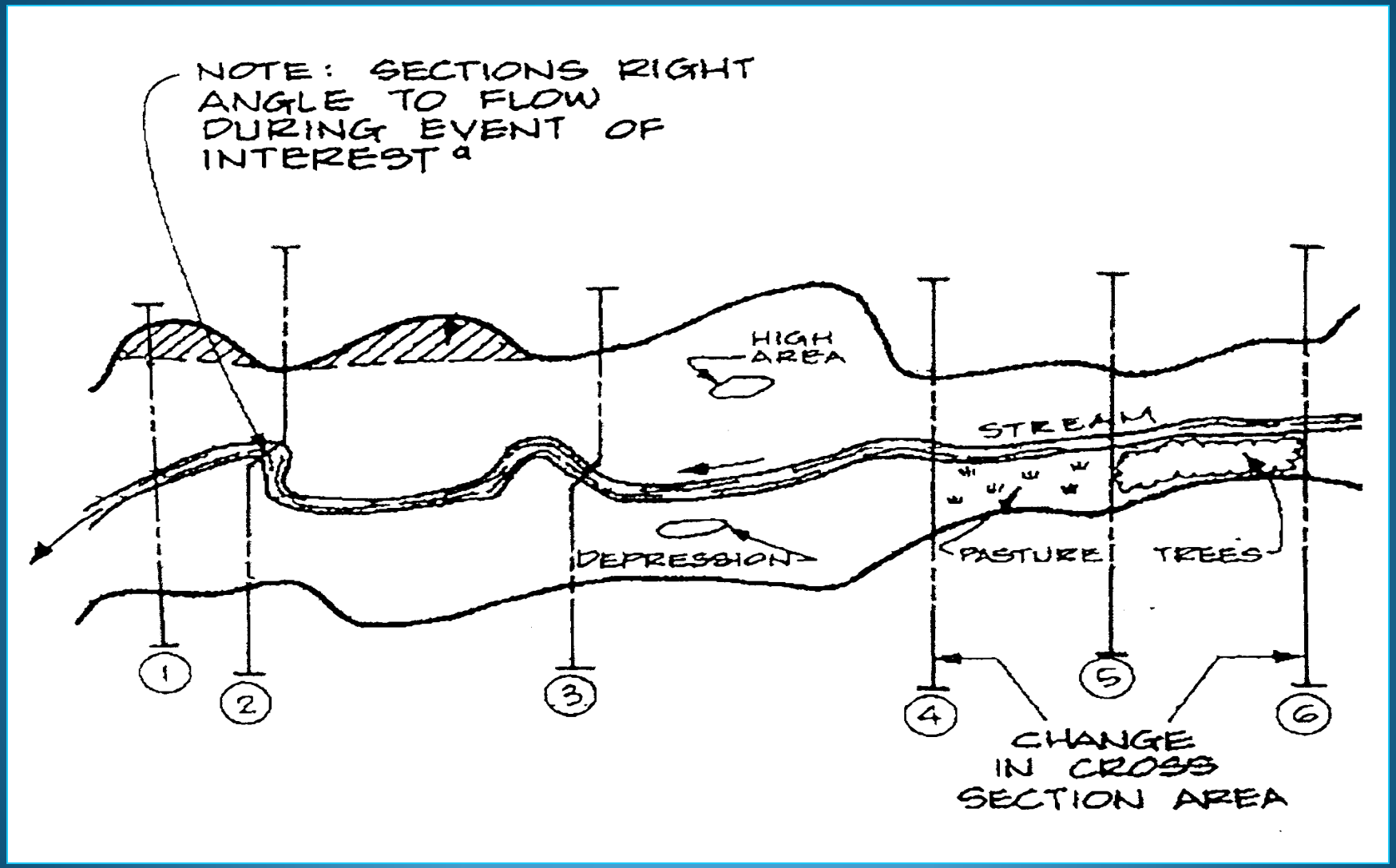


Location of Cross Sections

Cross sections should be located at:

- changes in the floodplain/channel bed slope
- changes in the floodplain/channel widths
- changes in floodplain/channel depths
- changes in floodplain/channel roughness (i.e. points where ground cover or channel substrate significantly changes)
- significant obstructions (i.e. bridges, diversions, dams)

Location of Cross Sections



Location of Cross Sections

Based upon an engineers recommendation, one (1) cross section can be used to determine the BFE at a single cross section, if the flow characteristics of the channel are uniform in both the upstream and downstream directions.

A minimum of three (3) cross sections are required in order for a one dimensional hydraulic model like HEC-RAS to be constructed.

These types of limited information flood studies can only be used to determine elevations within the immediate vicinity of the single cross section, or the upper two (2) cross section of the HEC-RAS model.

Location of Cross Sections

A minimum of five (5) cross sections are required for a reasonable delineation of limited reach of a 100 yr. floodplain (the type of delineation usually required for a subdivision).

At least one cross section should be located downstream of the property boundary, or at a minimum at the property boundary. (See Table 1)

At least two cross sections must be located on the property where BFE elevations are desired.

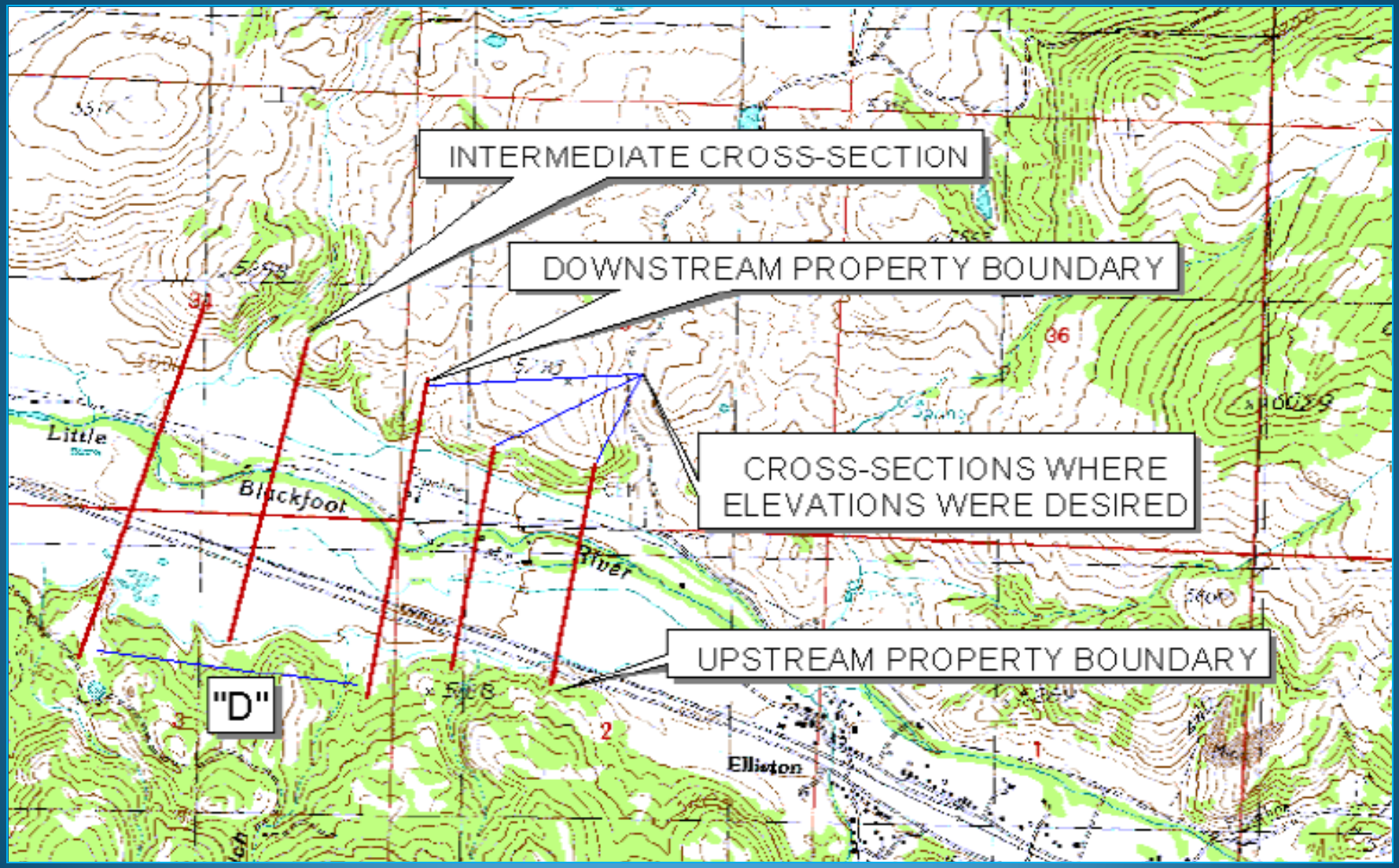
The furthest upstream section should be at the upstream property boundary, or above if possible.

Location of Cross Sections

TABLE 1	
Channel Slope (ft/ft) (As determined by the average water course slope from USGS quadrangle topographic maps)	Maximum Distance Between Cross Sections (Ft.) (or from the downstream property boundary to the furthest downstream cross section)
< 0.001	3000
0.001 – 0.0049	1500
0.005 – 0.01	500
> 0.01	100

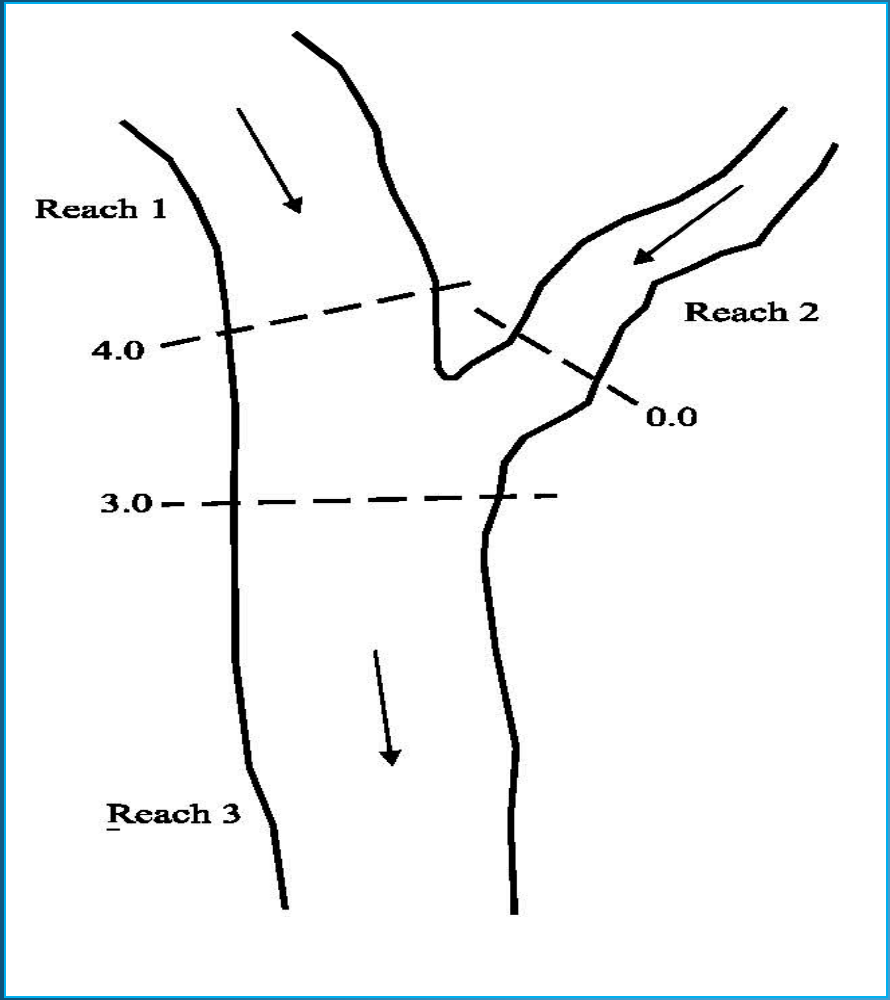
*The maximum distance between cross sections should be the approximate width of the floodplain, or as per FEMA guidelines.

Location of Cross Sections



Location of Cross Sections

Tributaries

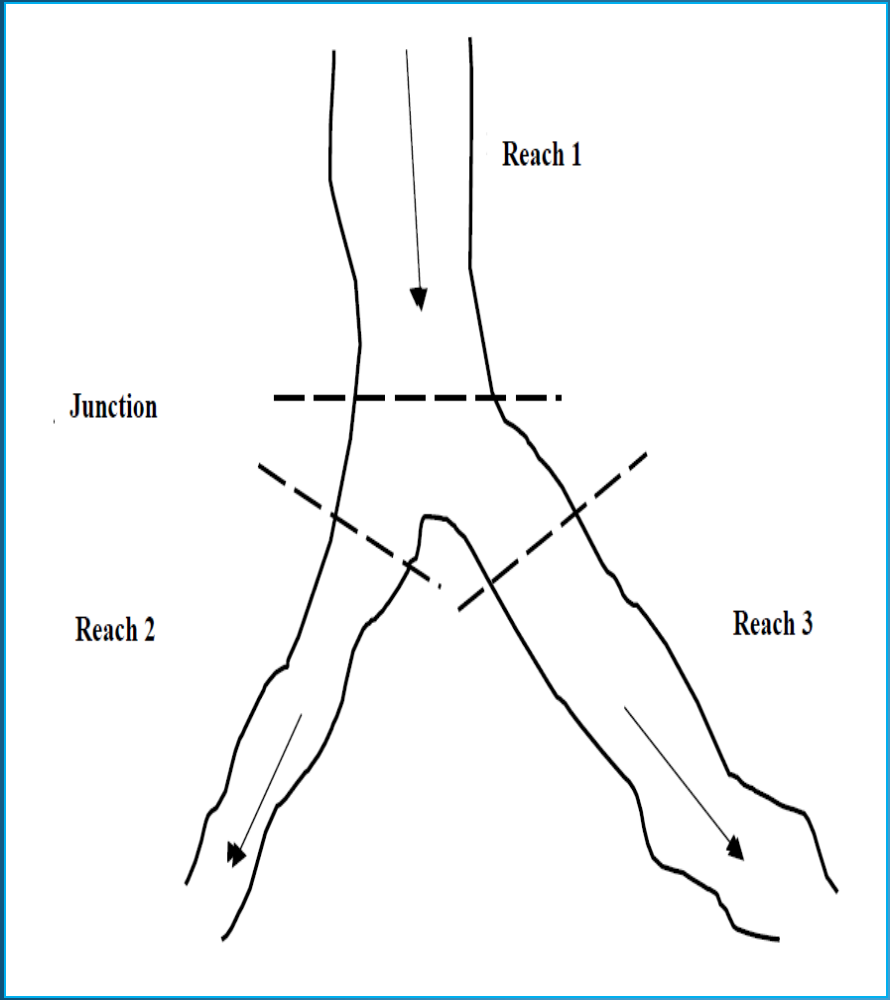


If the tributary is not going to be modeled the cross section should be located near the confluence (Use cross section #3 only).

If the tributary is to be modeled the cross sections should be placed as near as possible to the confluence, taking care that the cross section lines do not cross.

Location of Cross Sections

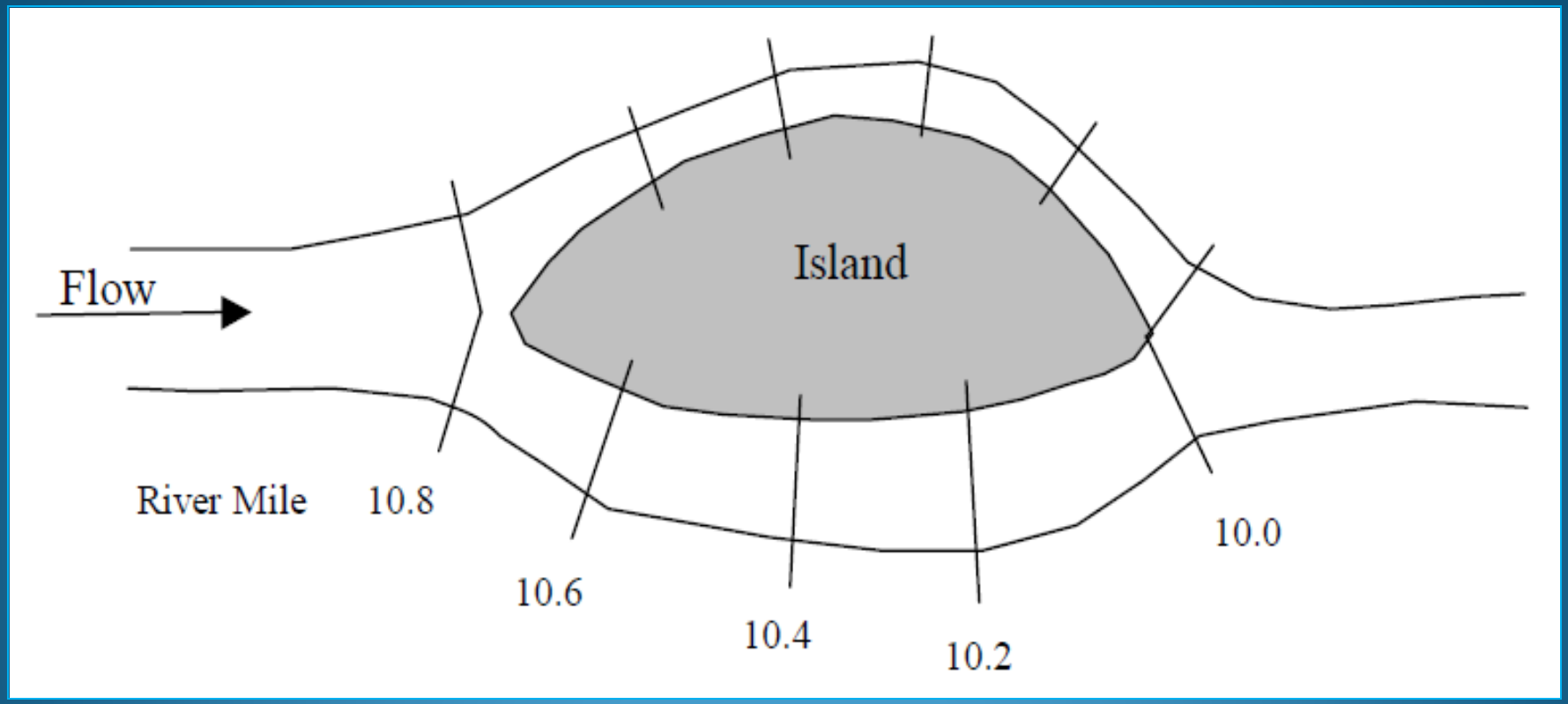
Junctions



If the split flows are to be modeled the cross sections should be placed as near as possible to the junction, taking care that the cross section lines do not cross.

Location of Cross Sections

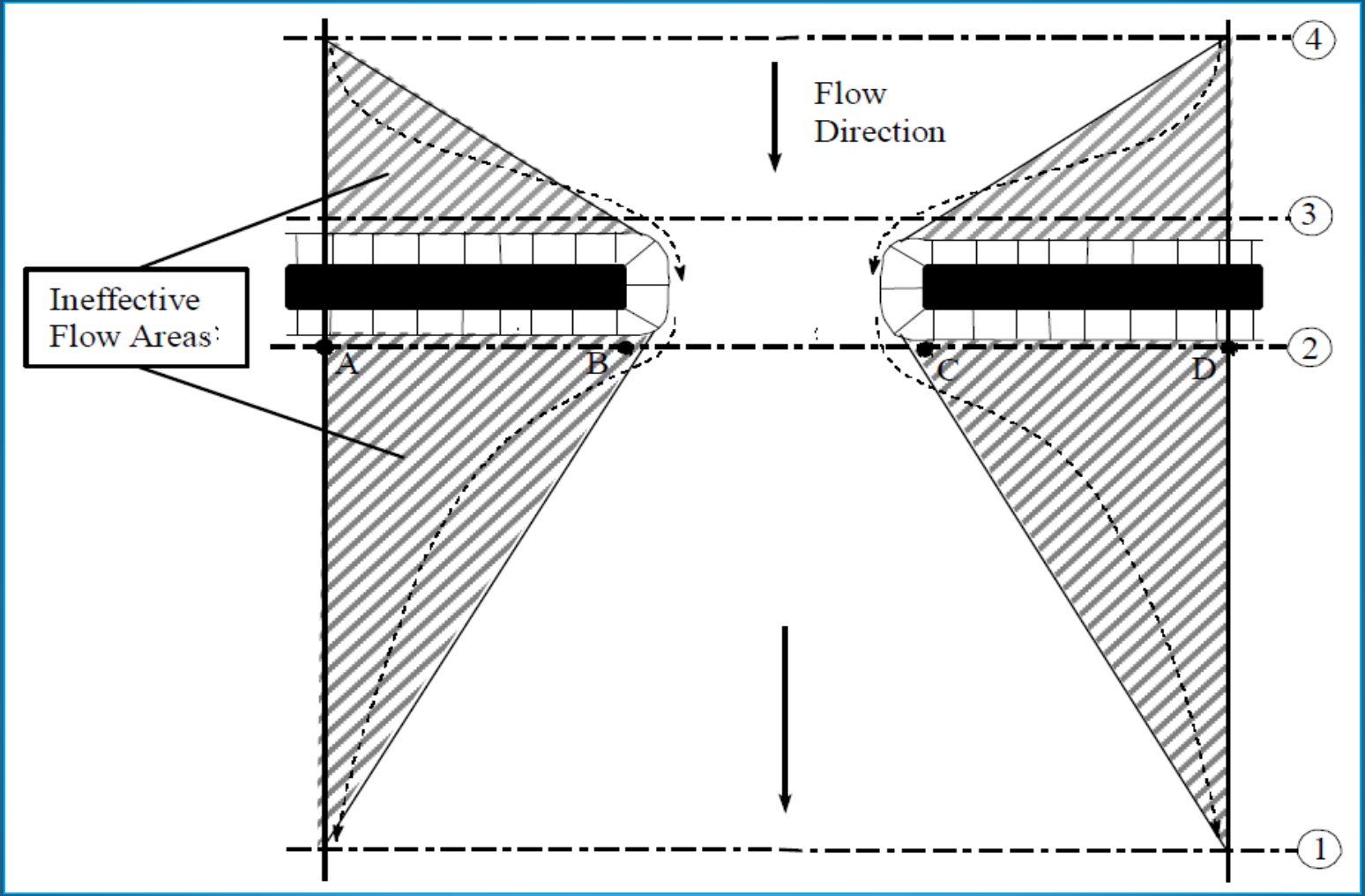
Islands



Generally, cross sections should span islands located within a channel, unless the island is very large and Lidar or 2 ft. contour data is available.

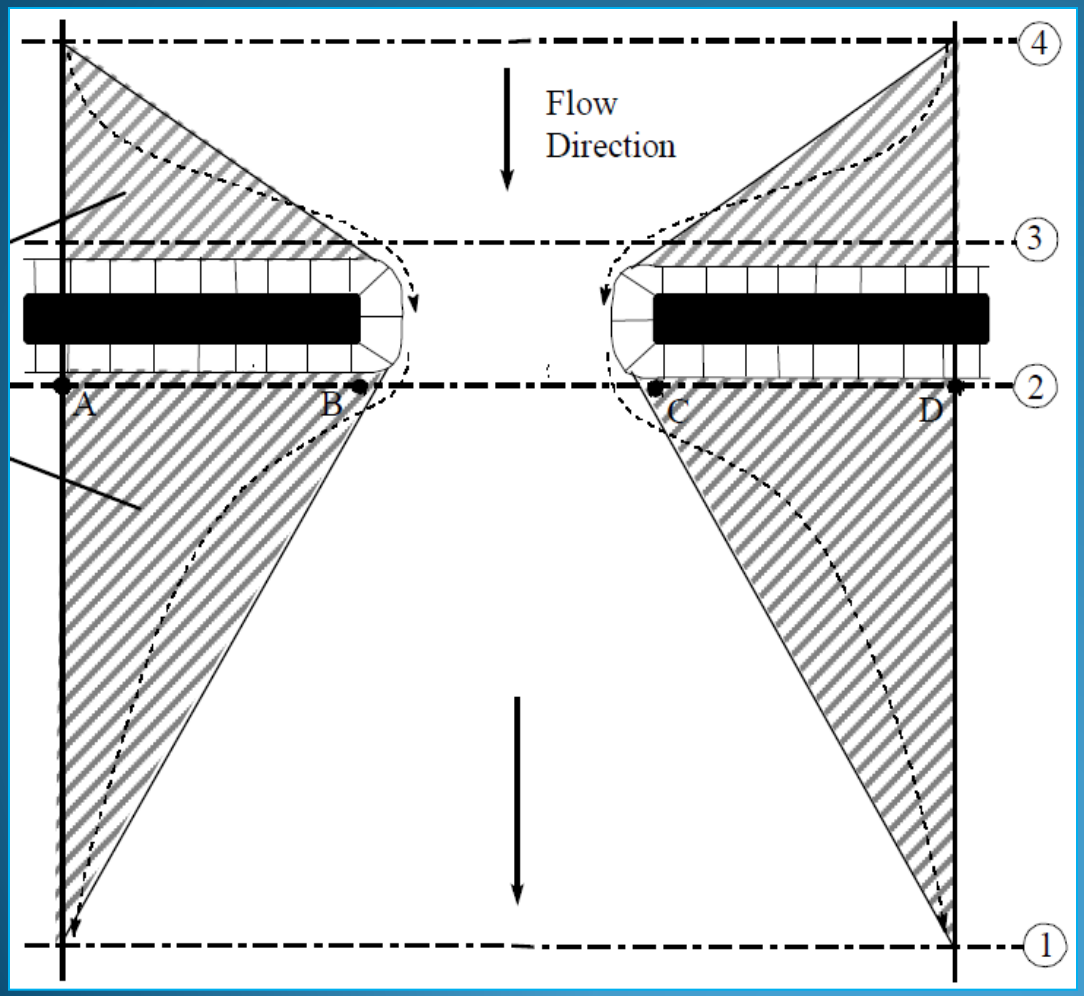
Location of Cross Sections

Bridges



Location of Cross Sections

Bridges

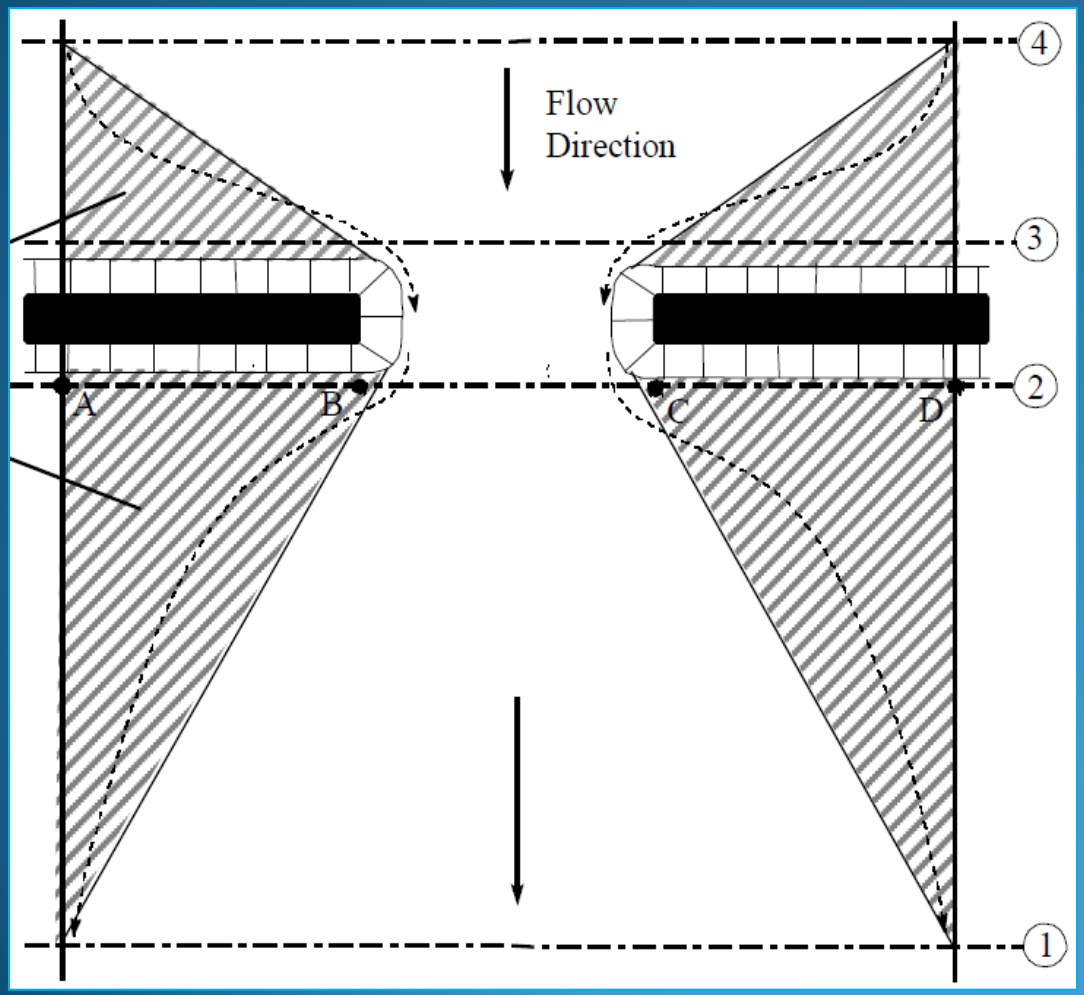


Bridges should be defined with four (4) cross sections.

Bridges and bridge openings need to be defined by enough survey points to create a “Connect-the-Dots” 3-D picture of the entire structure.

Location of Cross Sections

Bridges

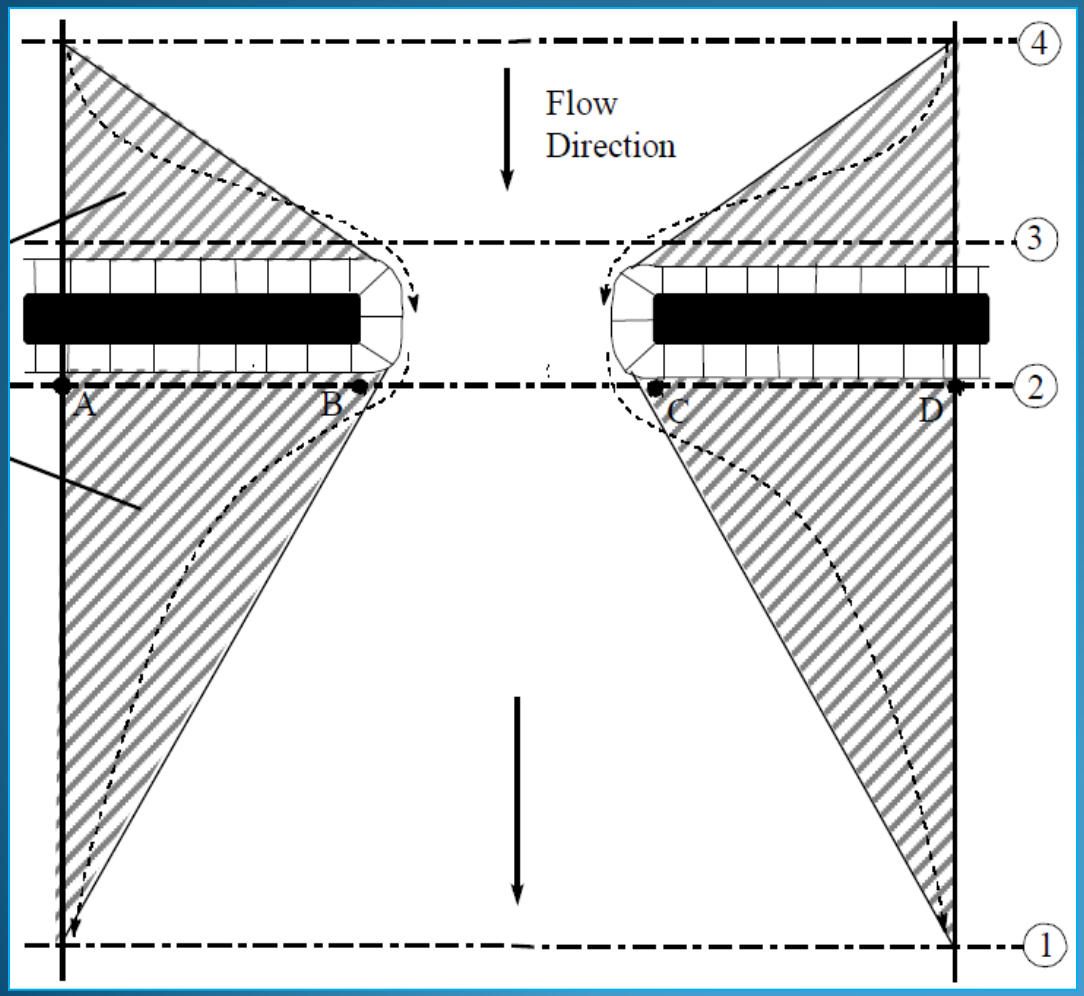


Horizontal stationing at a bridge must be consistent with the upstream and downstream cross sections.

The roadway profile is usually along the crown of the road unless there is curb and gutter, then it is used.

Location of Cross Sections

Bridges

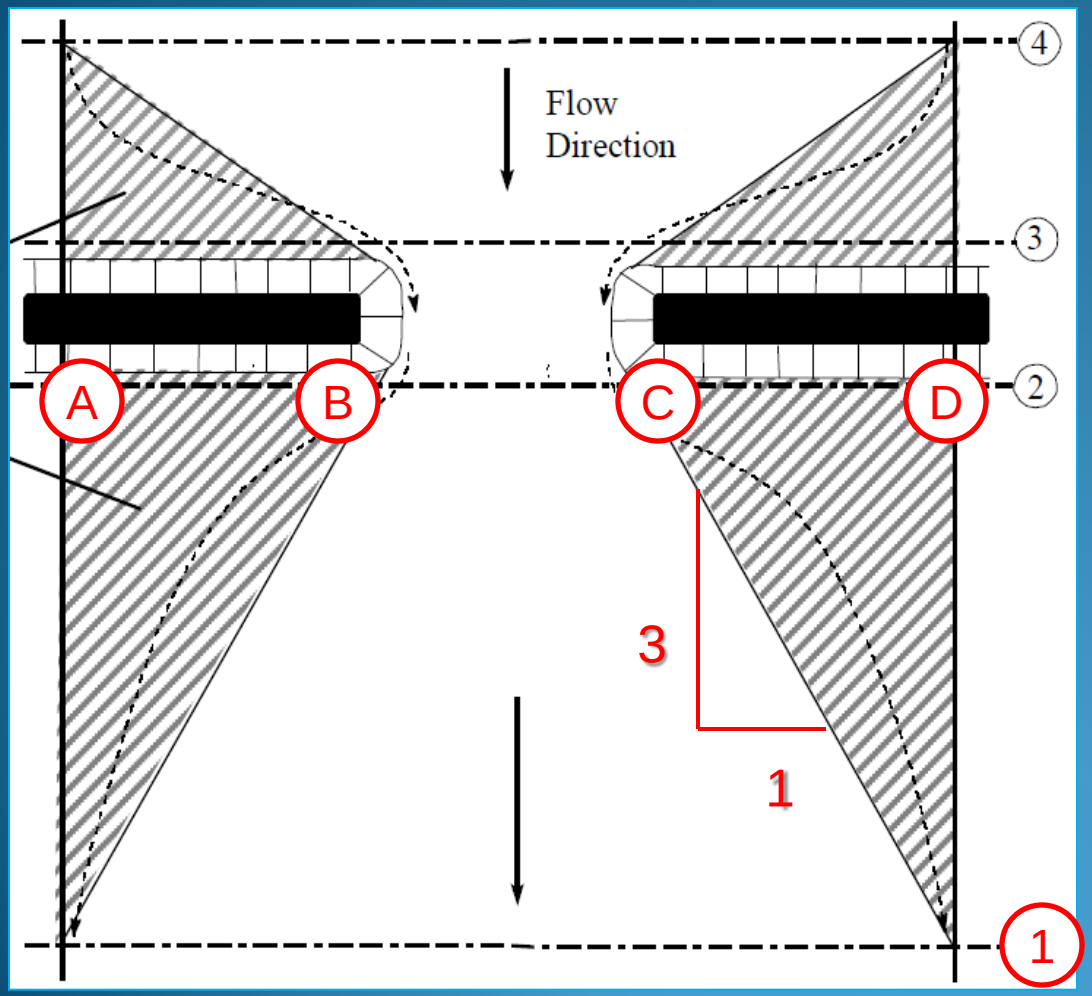


Note if the bridge or piers are skewed and provide an estimate of the skew angle.

Pictures of the bridge taken from the upstream and downstream views are recommended.

Location of Cross Sections

Bridges

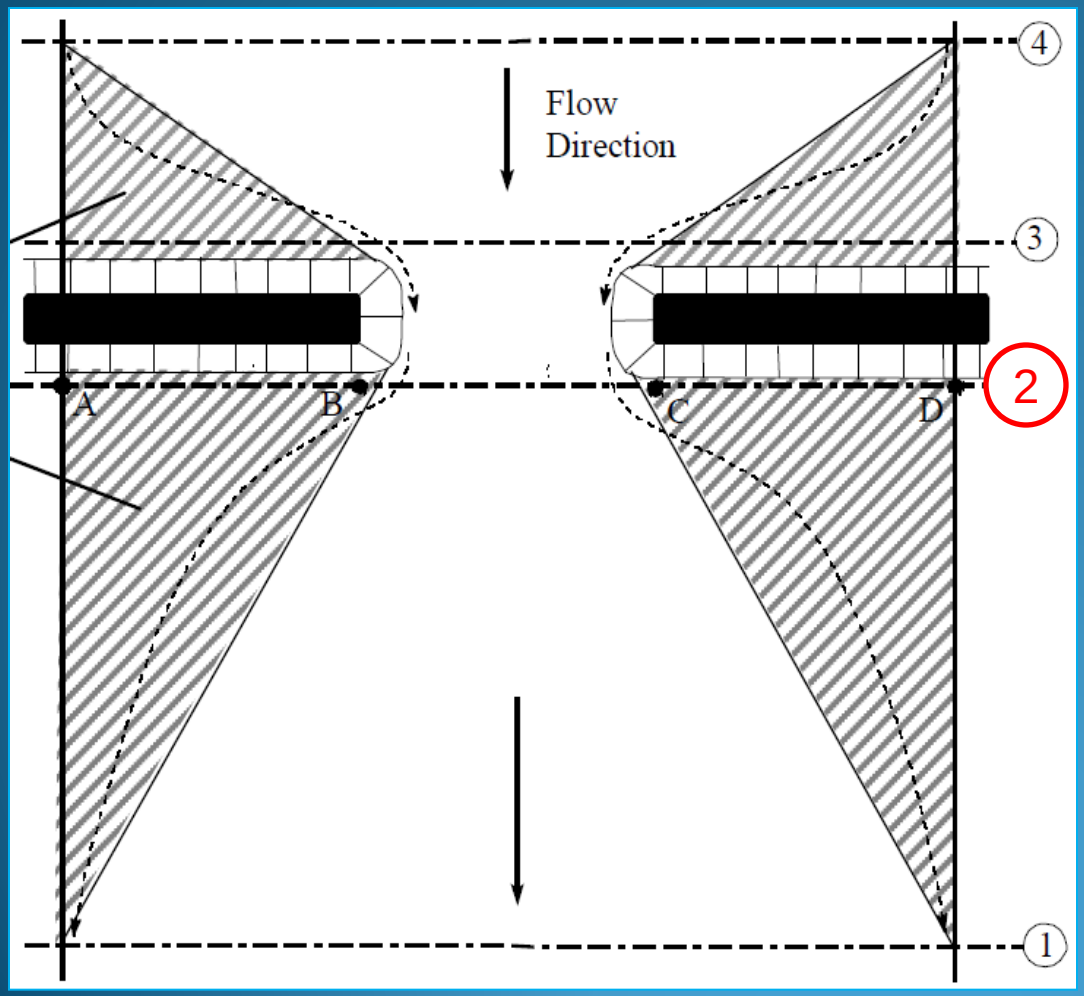


Cross Section 1 is located far enough downstream so that the flow is not affected by the structure and the flow has expanded to full channel width.

A general rule of thumb is 3 times the average abutment length downstream.

Location of Cross Sections

Bridges

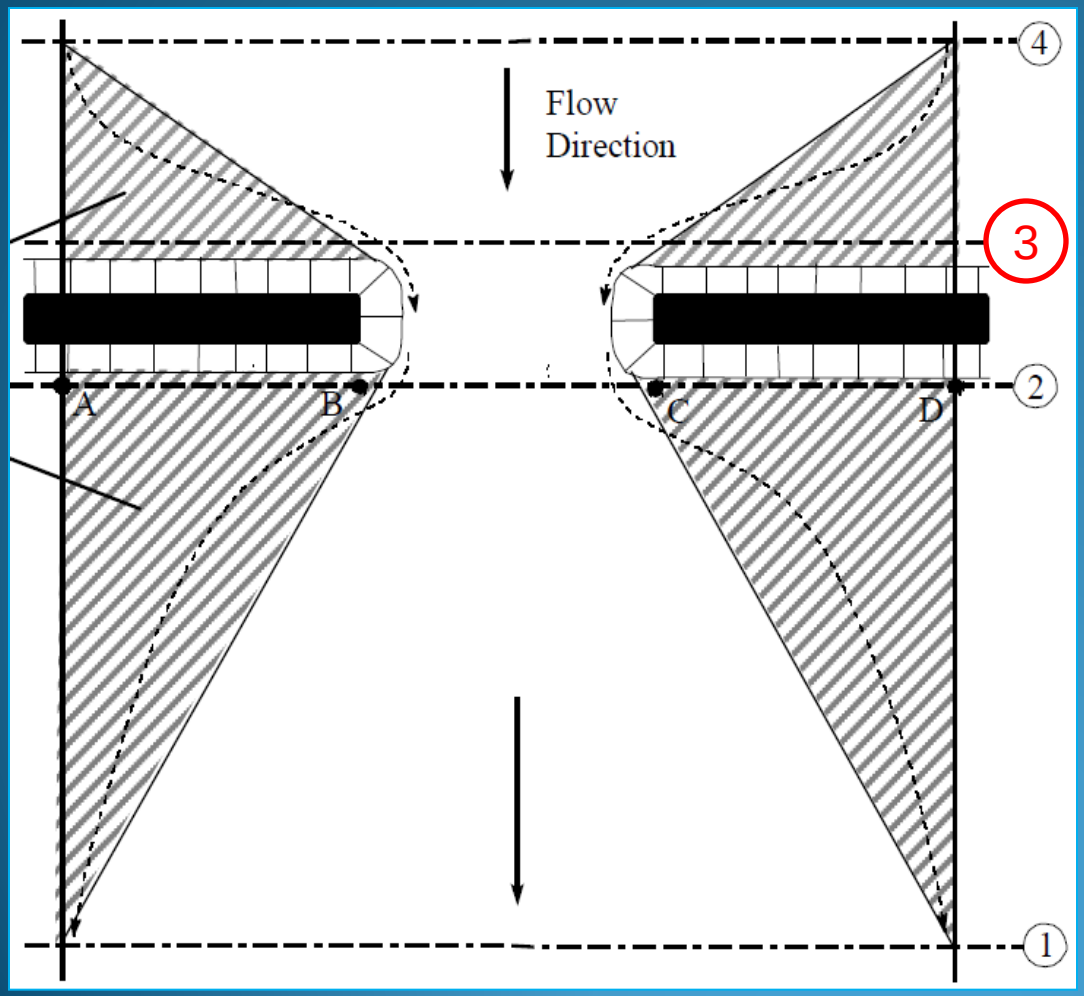


Cross Section 2 is located a short distance downstream of the bridge and should represent the effective flow area of the bridge.

Usually placed at the downstream toe of the road embankment.

Location of Cross Sections

Bridges

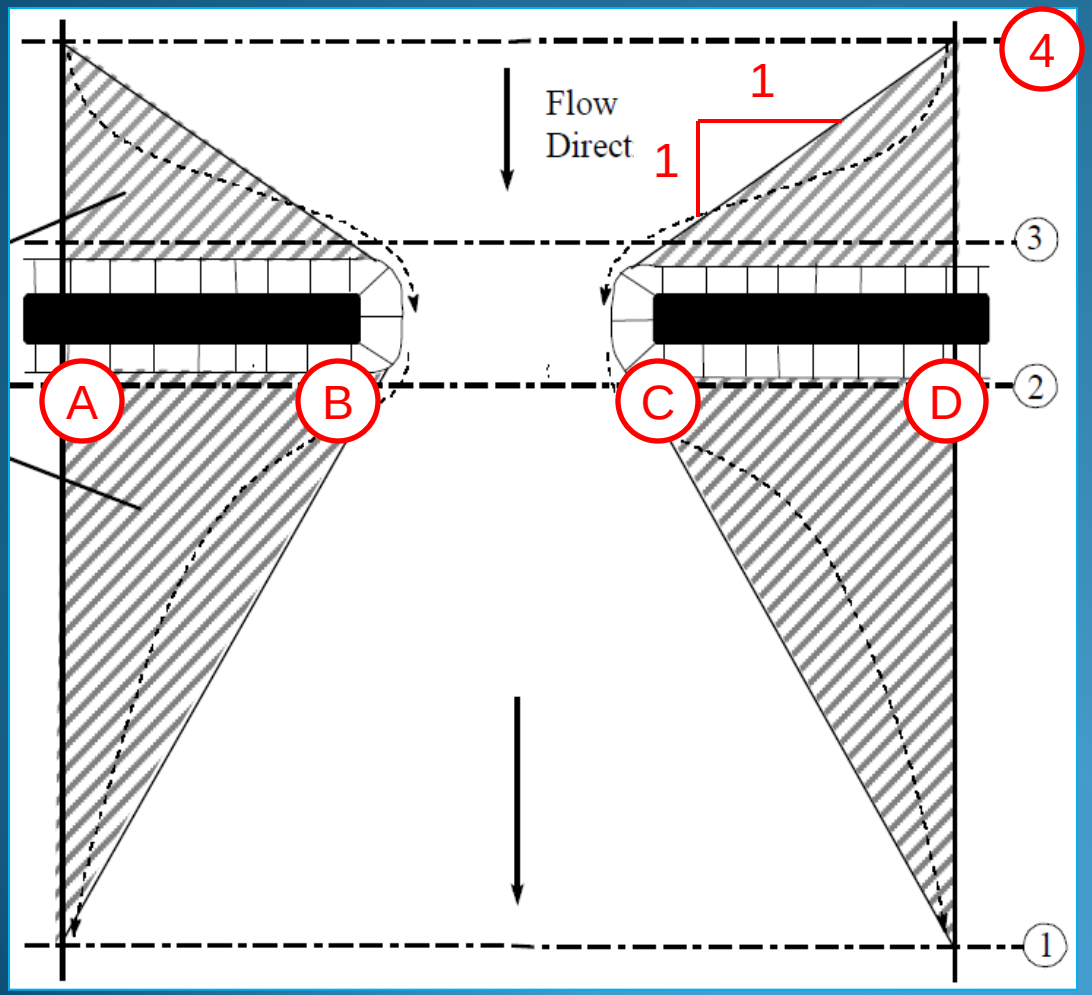


Cross Section 3 is located a short distance upstream of the bridge and should represent the effective flow area of the bridge.

Usually placed at the upstream toe of the road embankment.

Location of Cross Sections

Bridges



Cross Section 4 is located far enough upstream so that the flow is not affected by the structure and the flow is occupying the full channel width.

A general rule of thumb is 1 times the average abutment length downstream.

Location of Cross Sections

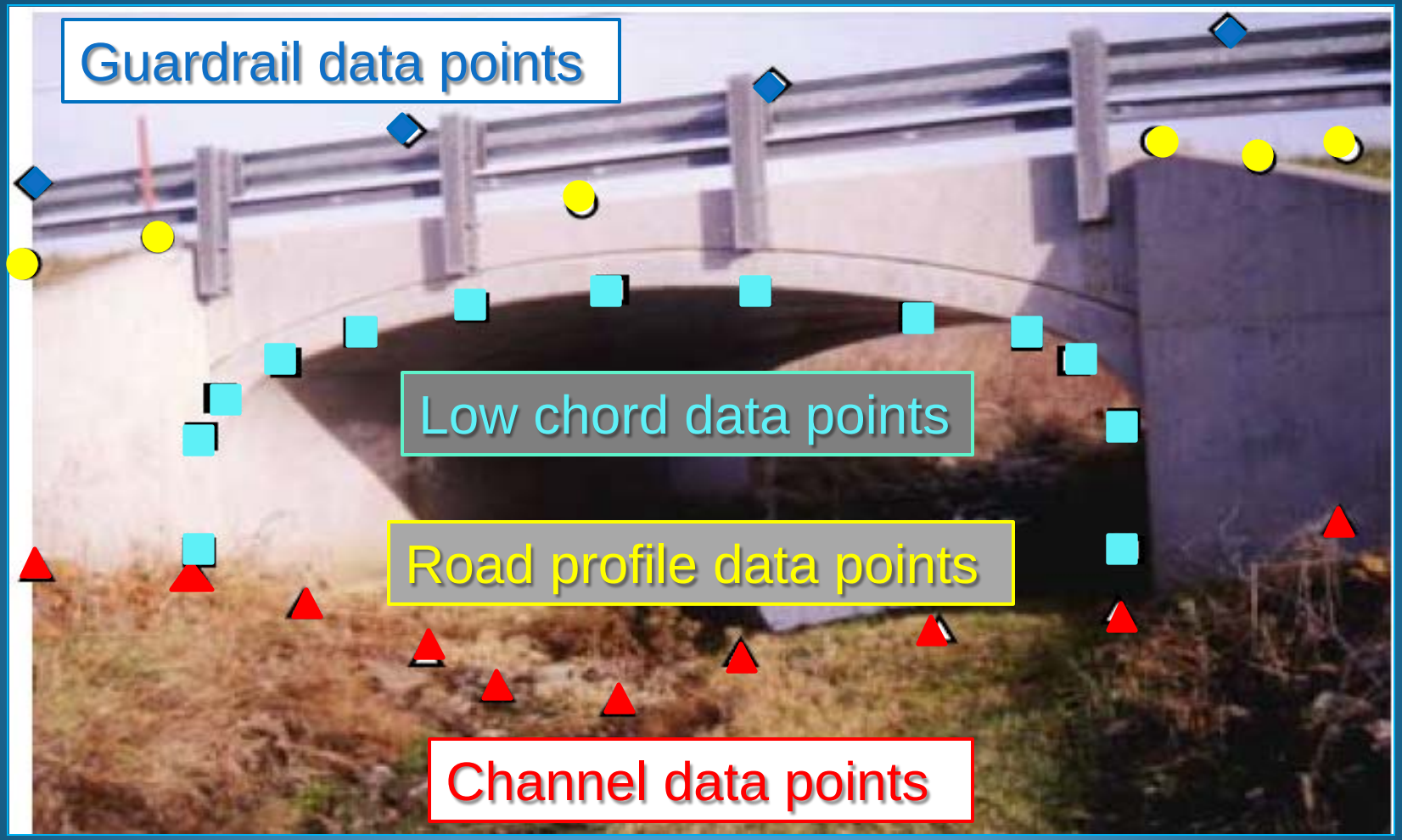
Bridge Openings

The bridge geometry for both the upstream and downstream faces should consist of:

- the approach roadway, include width and side slopes
- the bridge deck, include width
- roadway crown and deck centerline
- curbs, gutters, and railings (i.e. open or closed)
- bridge deck thickness, and bottom of the “low chord”
- abutments, including wing walls
- piers
- upstream and downstream channel shape and inverts

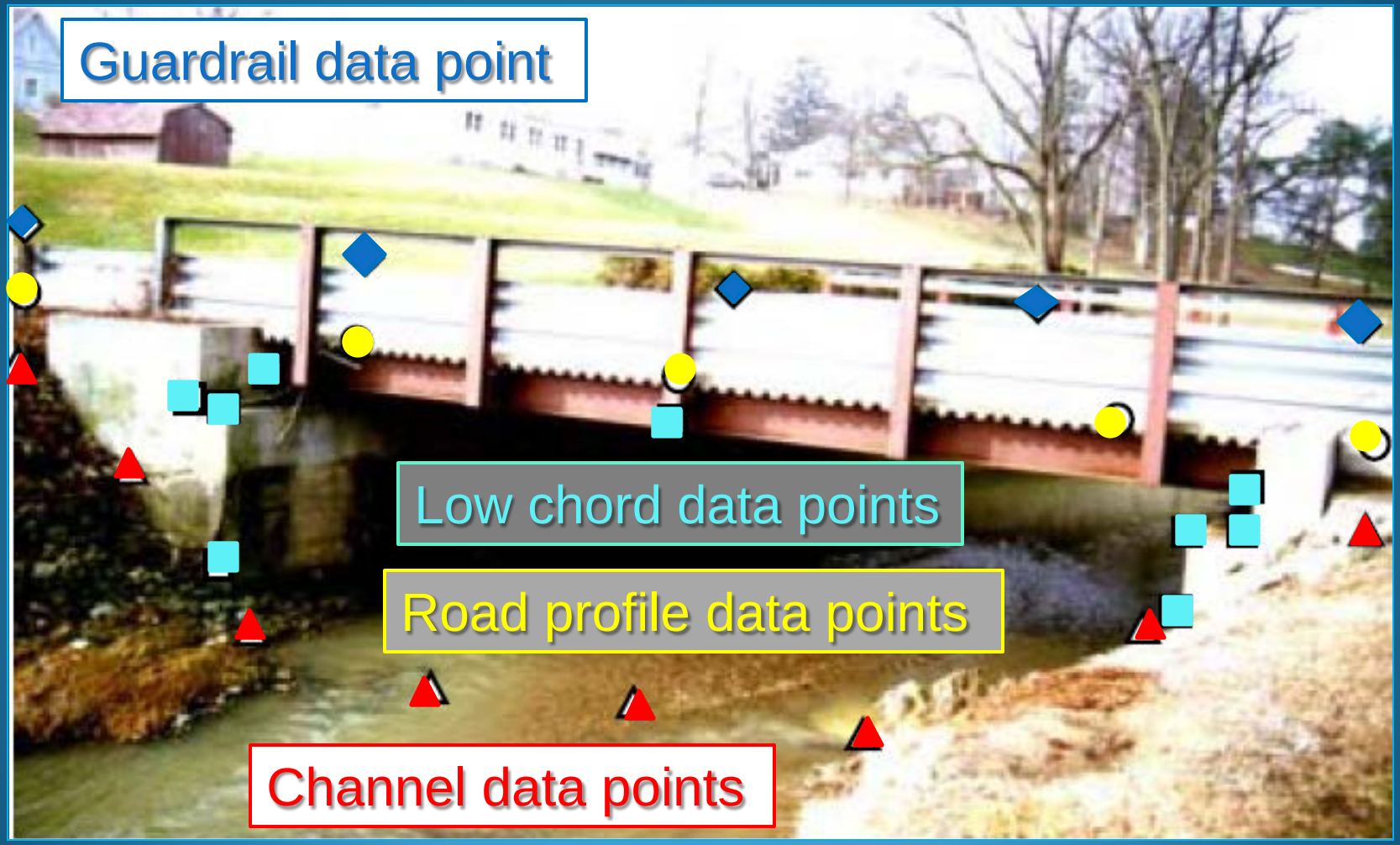
Location of Cross Sections

Bridge Openings



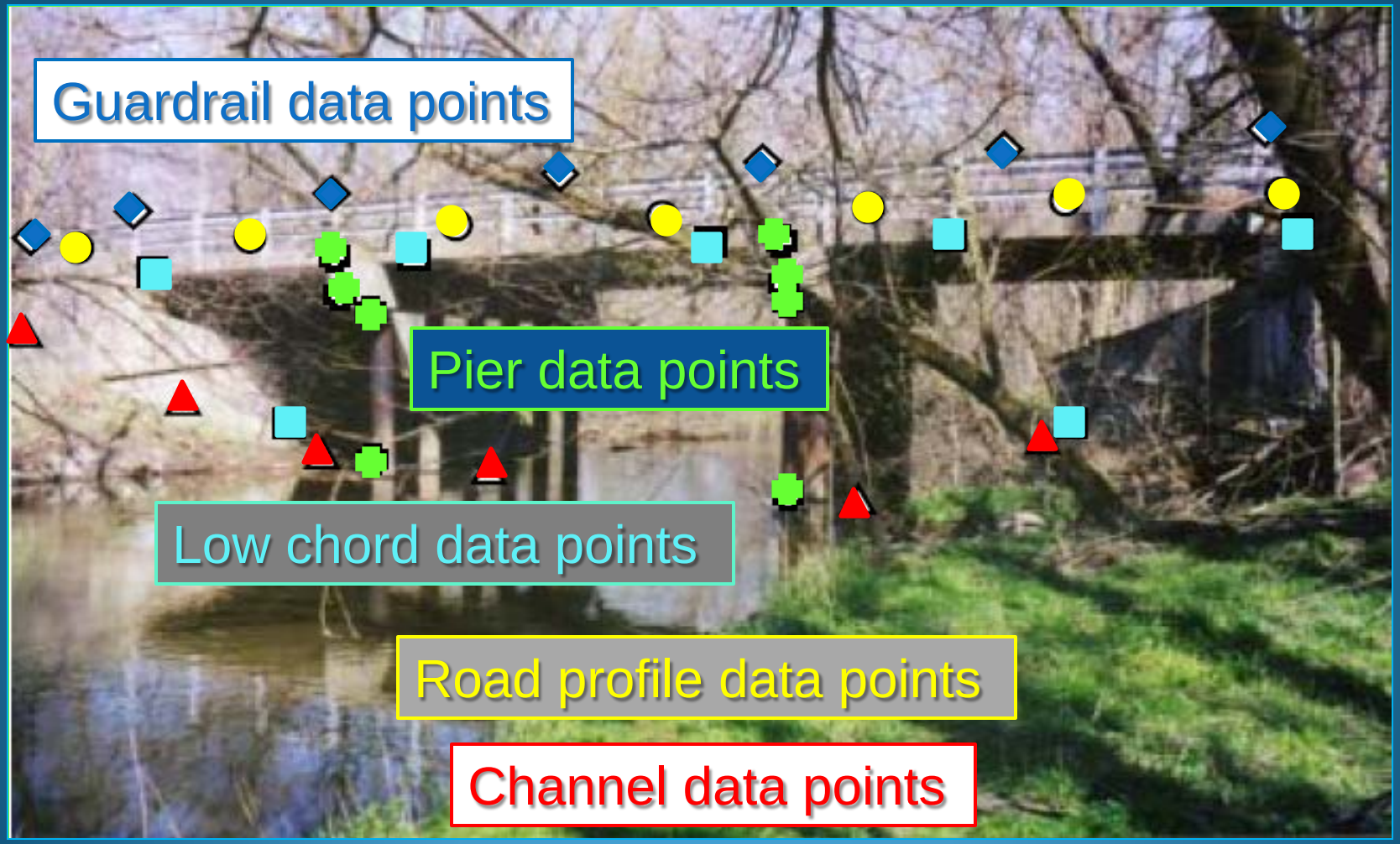
Location of Cross Sections

Bridge Openings



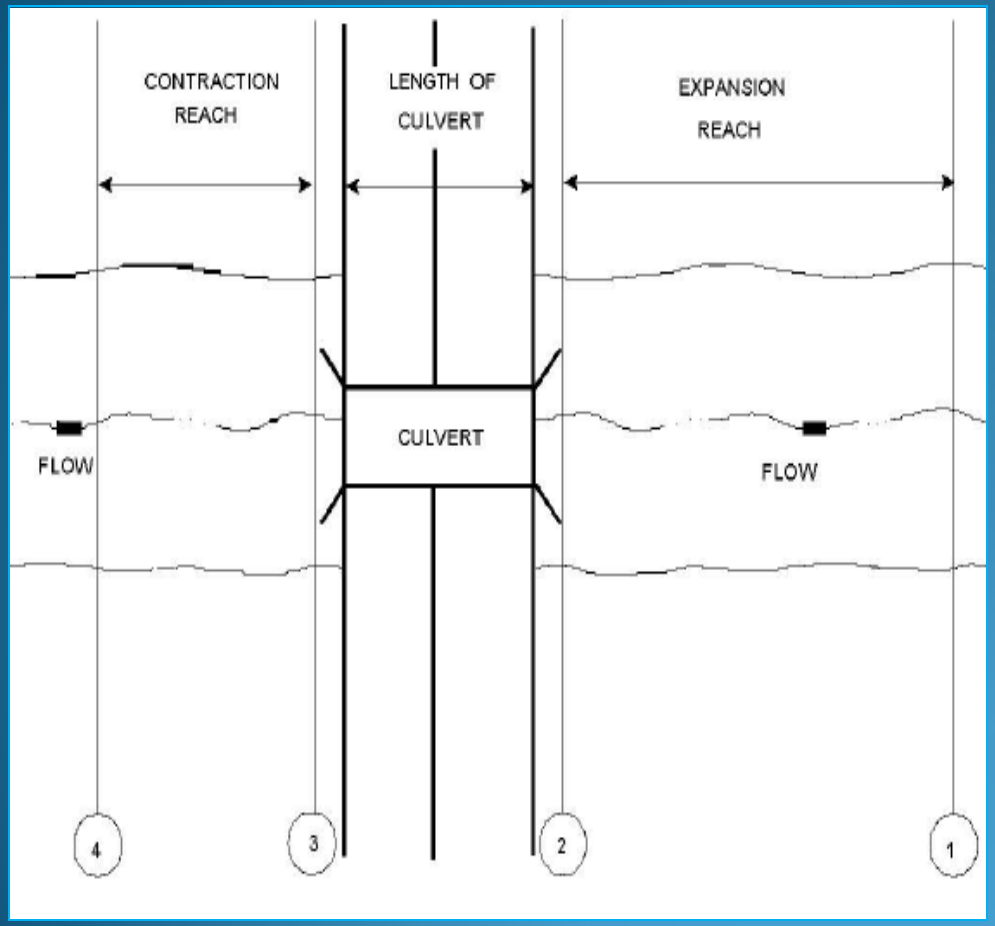
Location of Cross Sections

Bridge Openings



Location of Cross Sections

Culverts

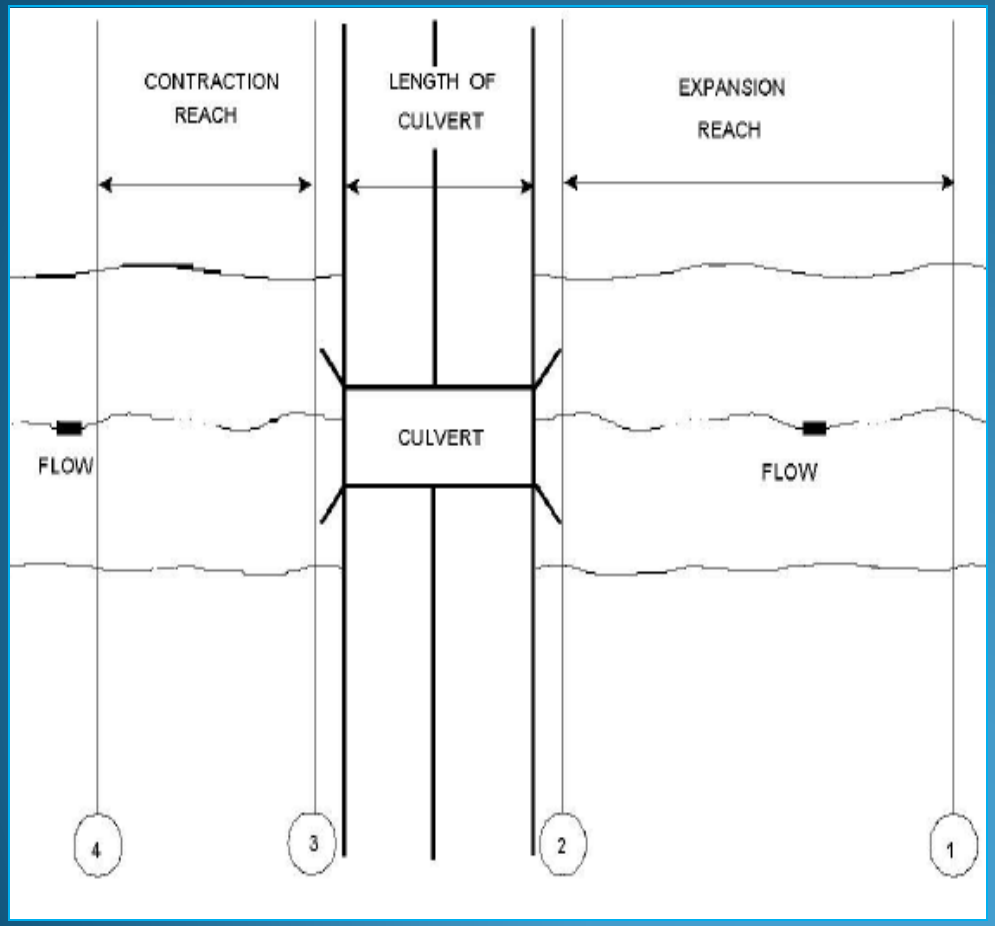


Culverts should be defined with four (4) cross sections.

Culverts and road crossings need to be defined by enough survey points to create a “Connect-the-Dots” 3-D picture of the entire structure.

Location of Cross Sections

Culverts

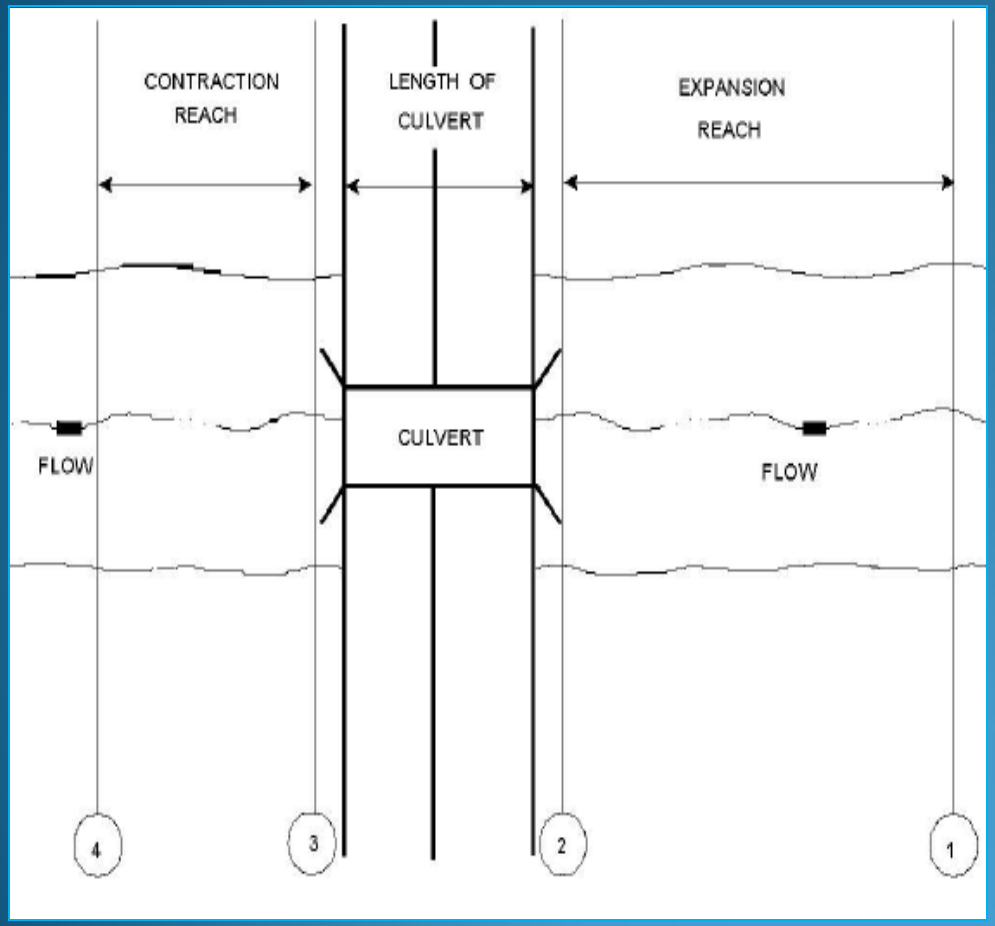


The culvert shape, size, length, and composition material should all be recorded.

The culvert entrance configuration (i.e. projecting from fill, wing walls, flush with head wall, or mitered to embankment) should be noted.

Location of Cross Sections

Culverts

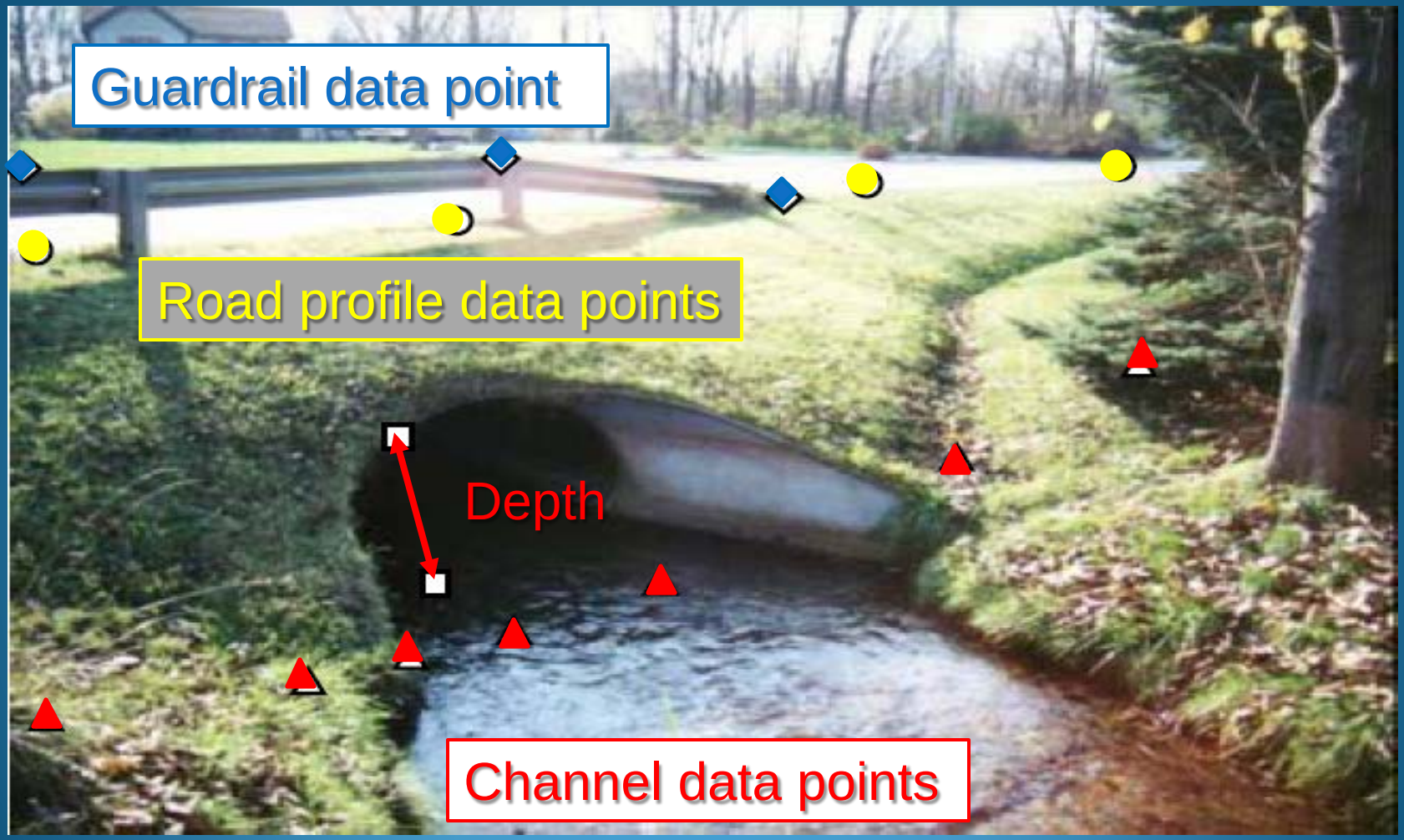


Identify the amount of sediment in the bottom of both the upstream and downstream ends of the culvert.

Pictures of the culvert taken from the upstream and downstream views are very helpful.

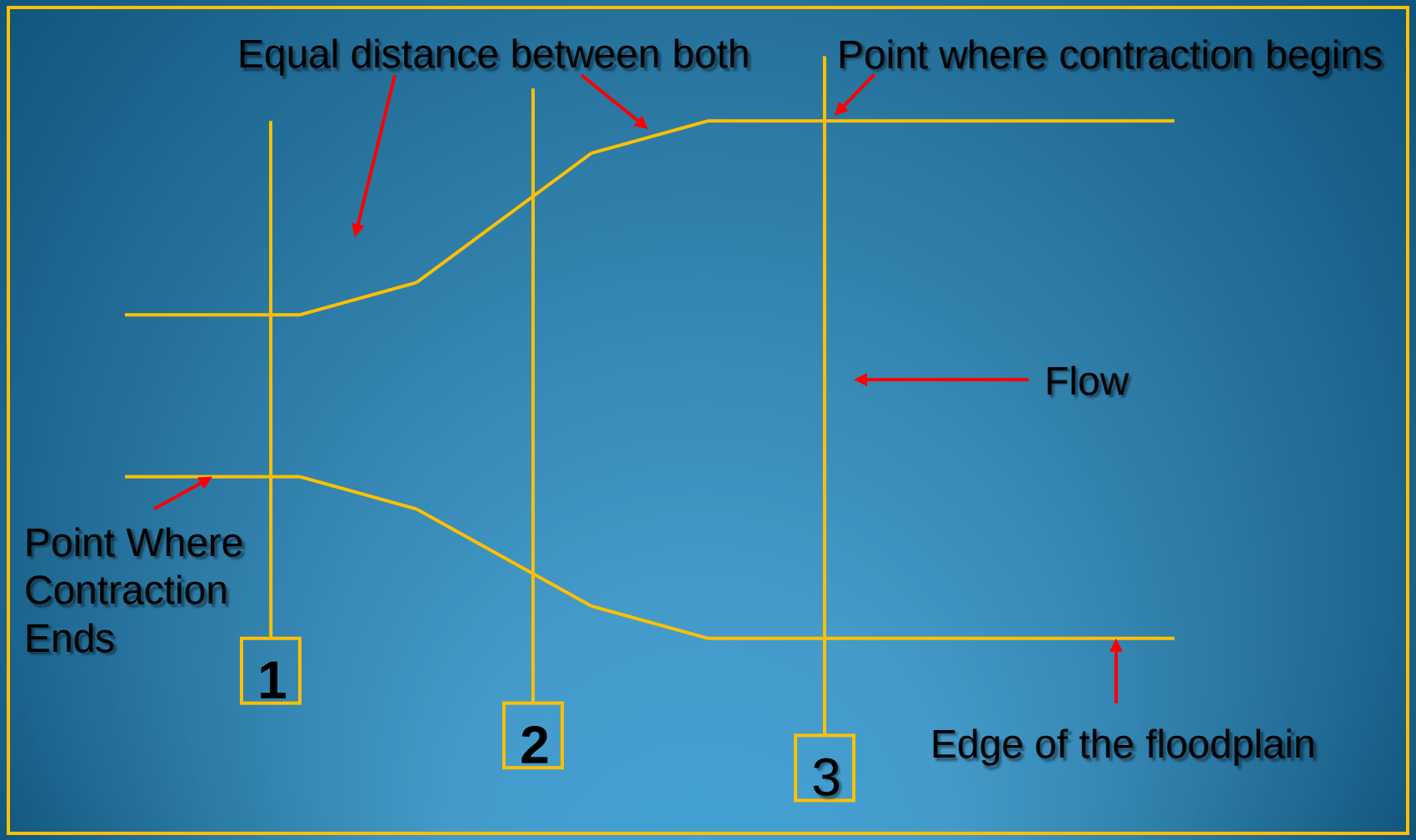
Location of Cross Sections

Culverts



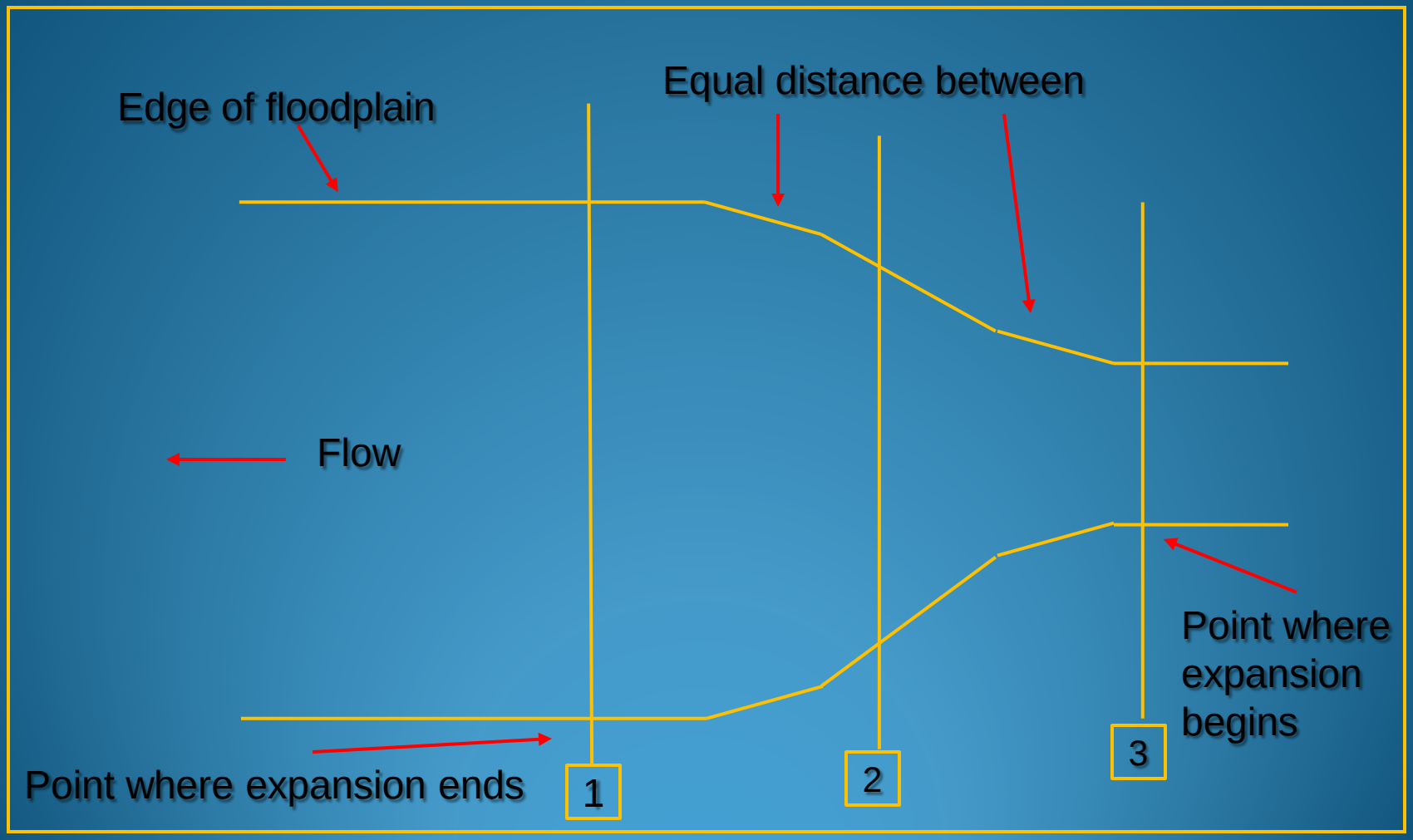
Location of Cross Sections

Contractions



Location of Cross Sections

Expansions



Cross Section Attributes

All cross sections must be comprised of straight line segments, no arcs.

Cross sections must be aligned perpendicular to the flow direction across their entire length. Therefore, flow patterns may require dog-legged cross section.

Cross sections can not cross over each other within the boundary of the channel or floodplain.

Cross sections cannot share common data points.

Cross Section Attributes

Distance/Elevation ground station data points should be located:

- at significant breaks in ground slopes outside of and above the channel
- at the waters edge
- at significant breaks in ground slopes below the water level (bathymetric measurements)
- the channel invert at it's deepest point.
- at locations where significant changes occur in the hydraulic characteristics or roughness (i.e., ground cover changes from rocky to smooth to brushy)

Submittals

A plan view of the project area and survey reach should be submitted.

The plan should be prepared under the supervision of a land surveyor or engineer with knowledge of generally accepted survey principles.

Certification by a licensed surveyor or registered professional engineer is required.

Submittals

The plan view must include:

- North arrow and flow direction
- Scale in both the numeric and graphic format
- Horizontal and vertical control benchmarks used
- Datum identifier (must match FIS datum)
- Property location and limits
- Streets and roads
- Existing and proposed structures and features

Submittals

The plan view must include:

- Cross section locations with reference labels
- Rivers, streams, and other water features
- The location of any channel or floodplain constrictions, expansions, or obstructions
- Bridges, road crossings, culverts, and dams
- Any significant diversions of water
- All cross sections must be labeled in the downstream to upstream direction

Submittals

Photographs should be labeled identifying date, subject matter, direction of view, and any additional information that will help to further describe the photograph subject matter.

A copy of the field notes and any descriptions of the cross section conditions (i.e., vegetative cover, change in channel geometry, etc.)

Station-elevation data for each cross section should be submitted in tabular and graphical form (cross-section plots).

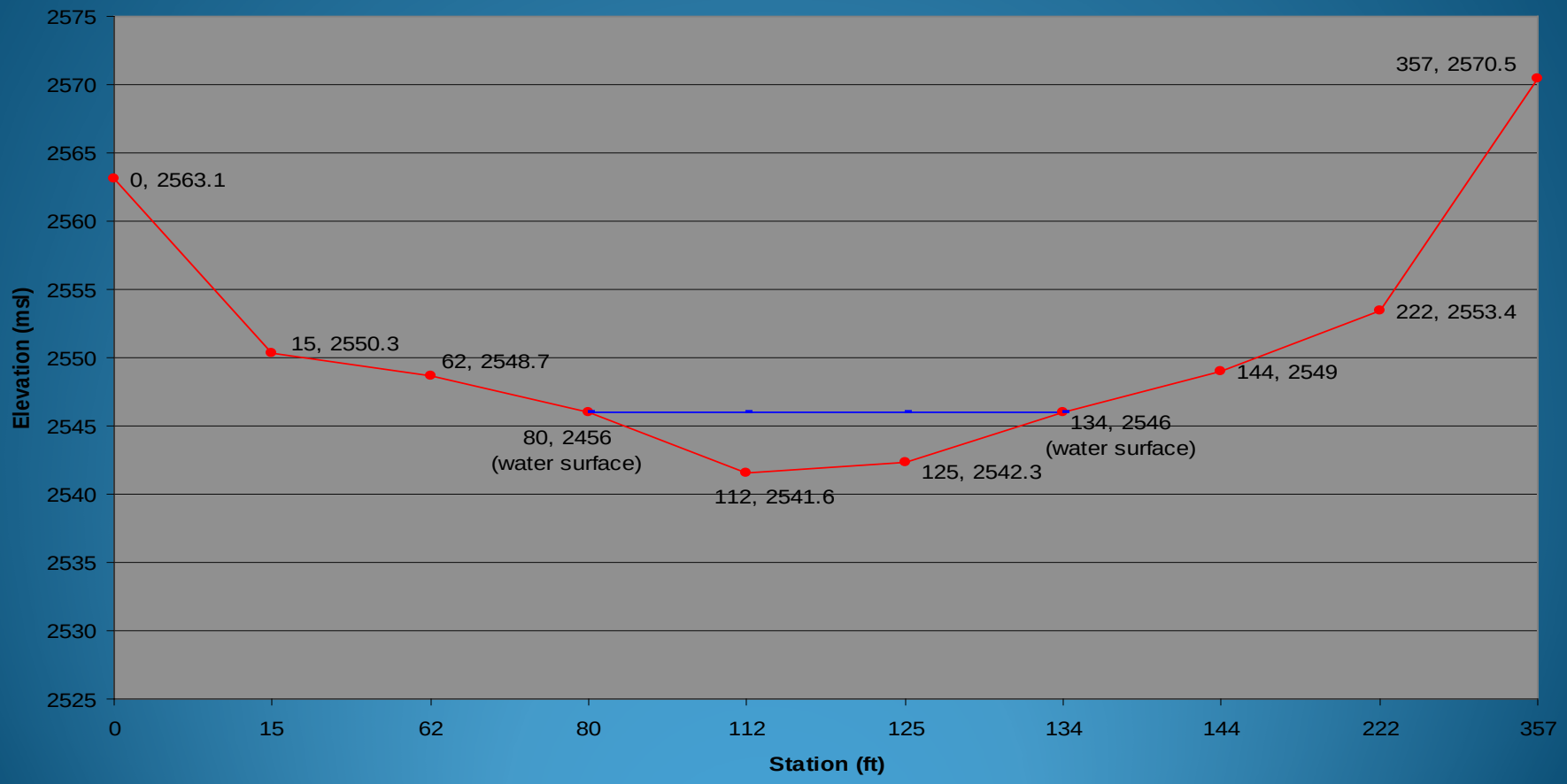
For each surveyed point defining the cross section, the cross-section table should indicate distance and elevation data referenced to the FIS datum.

Submittals

Sample Cross-Section Data			
Cross Section 2345			
Station	Elevation	Station	Elevation
(Left Side) 0	2563.1	125	2542.3
15	2550.3	134	2546.0 (w.s.)
62	2548.7	144	2549.0
80	2546.0 (w.s.)	222	2553.4
112	2541.6	(Right Side) 357	2570.5

Submittals

Cross Section 2345



Questions?