17. Hydrologic and River Morphology Data. For feasibility and specifications designs, hydrologic, sediment transport, geomorphic, and water quality data may be acquired for the project. Hydrologic data may include precipitation rates and basin areas, flow gauge records, staff gauge records, ground water well data, Federal Emergency Management Agency flood reports, studies on probable maximum flow, and freezeup, breakup and ice thickness records. Sediment transport data may include suspended or total load measurements, bed material sampling, cross section data, LiDAR or ortho-photography surface mapping, and field observations of aggradation, incision, bank erosion and existing revetment treatments. In addition to the data listed above, morphologic data could include historic or current aerial photography, river profile surveys, vegetation data, debris history, and icing and freezeup data. Water quality data could include temperature, suspended sediment and testing for metal and chemical compositions.

This information is acquired for analysis, design and successful operation and maintenance of diverse projects with elements including reservoir filling and draining studies, spillway capacities, reservoir capacities, channel conveyance systems, culvert and bridge passage requirements, water quality construction concerns, pumping plant intake systems, effects of a powerplant tailrace, water surface and floodway studies, dam safety, structure erosion maintenance, minimalization of aggradation/degradation impacts, bank stabilization, river morphology and channel change, habitat protection, reservoir sedimentation maintenance, stable channel design, dam removals, and river restoration work. The data required will be specific to the project needs. For feasibility studies, the critical design data items should be identified and receive maximum attention.

The design data and design criteria for a structure or facility should be documented in a report. For specifications designs, the data will be updated based on any additional information developed since the feasibility designs. The specifications design data submittal shall reference the feasibility data document and, thus, eliminate the need to repeat the information enumerated below. If, for any reason, the information enumerated below is not contained in the report prepared for the feasibility design, this information should be provided for the specifications design. Examples of hydrologic design criteria include design flows and recurrence intervals for specific features, maximum changes in water surface and probable maximum flood (pmf). Information to be included in the feasibility or specifications data report or memorandum, if pertinent to the project, are listed below.

A. **General:**

(1) The operational impacts of the project that require alternative designs (e.g., outlet works and downstream river temperature, spillways and gas supersaturation, increased channel scour, and downstream channel protection, etc.).

(2) Flood protection requirements.

(3) Operational data on upstream and downstream dams, diversions, pumping plants, and reservoirs. Discuss if dams appear to be hydraulically inadequate.

B. **Hydrology:**

(1) Source of water being transported.

(2) Data used/required to estimate flows and hydrographs:

(a) Precipitation and runoff records.

(b) Location of gauging station at or near the site, gauge number if it is a USGS gauge, and the dates for which hydrographs should be prepared. Copies of the daily discharge record should be supplied for stations with unpublished records.

(c) Drainage area located upstream from the site. Shape, size, slope, and character of each catchment area, probable rainfall intensity as required, and method used for the flow computation.

(d) Discuss if upstream dams appear to be structurally or hydraulically inadequate.

(3) Flows and recurrence intervals required to be estimated including normal flows, floodflows, peak flows, and minimum flows. The flow estimate requirements will depend on the type of facility being constructed and the required frequency of the design storm.

(4) Peak design flow discharges for minor drainage areas. Assess ponding upstream or up-gradient of the feature and if temporary ponding in these areas is possible then hydrographs of the design storms should be submitted, and topography should extend upstream and above the feature a sufficient distance to cover the temporarily inundated area.

(5) Surface drainage facilities:

(a) Location of any existing intersecting facilities, watercourses, or other physical features affecting the proposed facility.

(b) Natural surface drainage, flood history, and channel locations and characteristics.

(c) Location and description of protective dikes and ditches.

(d) Preliminary plan for surface and subsurface drain systems, including types of drains to be provided.

(e) Suggested correlation and integration of project drain systems with farm drains, canals, laterals, flood control facilities, and nonproject protective works.

(f) Permissible additional capacity of natural channels which will convey drain water and stability, including an assessment of future conditions of sediment transport, of natural channels receiving drain flows.

C. **Reservoir Hydrology:**

(1) Inflow design flood and possible preceding and recurring flood hydrographs with recommended routing criteria. For a diversion dam involving little or no storage, normally a probability curve of flood peak discharges up to the 100-year point will be sufficient. However, if the structure is judged to pose a significant threat to a downstream population, the design flow may be based on a longer recurrence interval.

(2) Area capacity curves and/or tables to at least the dam crest elevation.

(3) For features such as water treatment plants, potential location for and volume of reservoir(s) suitable for leveling of daily or annual fluctuation in flow or salinity of water source.

(4) Annual periodic fluctuations of reservoir levels shown by tables or charts, summarizing reservoir operation studies:

(a) With the expected initial reservoir level for flood routing studies.

(b) For the critical and normal climatic periods. Include any annual reservoir drawdowns for operation and maintenance purposes.

(5) Storage allocations and corresponding elevations.

(6) Reservoir operation criteria for flood control, maximum permissible releases, and the estimated safe discharge capacity downstream of the dam site.

(7) Physical, economic, or legal limitations to maximum reservoir water surface.

(8) Extent of anticipated wave action, including a discussion of wind fetch.

(9) Reservoir backwater curves, including the effect of sediment deltas if upstream right-of-way will be critically affected or damaged.

(10) Required outlet and sluiceway capacities for respective reservoir water surfaces, and sill elevations. Give type and purpose of reservoir releases and the time of year to be made. Include the minimum release during winter and other seasons. If temperature or water quality control of releases is anticipated, the degree and purpose of the control should be included.

(11) Use and allocation of water (downstream habitat, irrigation, municipal, and industrial).

(12) Annual net evaporation and distribution.

D. **Sediment Transport and River Morphology:**

(1) Data collection for assessing the morphology of the river and sediment transport concerns, such as occurrences of degradation or aggradation, bank erosion, changes in the river alignment or condition of the stream channel, and general channel stability can include:

(a) Repeated surveys of river cross sections at established locations.

(b) Surveyed longitudinal profile of the river.

(c) Information on existing natural or constructed, vertical or horizontal controls, especially those affecting tailwater. Include location, distance, physical dimensions, and characteristics of the controls.

(d) Bathymetry surveys of the submerged channel bed, pond, or reservoir.

(e) Bed and bank samples providing gradations of the channel materials, or pebble counts for larger bed materials.

(f) Records of bank stratigraphy and height at cut banks.

(g) Suspended sediment measurements or grab samples in conjunction with a discharge measurement or gage reading.

(h) Turbidity measurements in conjunction with discharge.

(i) Bedload measurements using samplers or traps in conjunction with discharge.

(j) Surveys or bank pins for measuring rate of bank retreat.

(k) Photos at established locations to note changes in deposition, bar features, and bank erosion.

(l) Mounted video recorders for capturing time lapse photography of bed, bank, and bar changes during high flow events or other increments

(2) To help assess the ongoing river processes and potential for future changes, research historical records on the river including:

(a) Hydrologic data for geomorphic concerns including maximum, mean, minimum, and 1.5-year flows in natural streams, and recorded flood stage elevations at major drainage and river crossings (bridges, pipelines, etc.).

(b) Aerial photographs of the river, often available back to the 1930s

(c) Mapping by Land Office in the 1800s or from the USGS sometimes available back to the late 1800s

(d) Historical surveys by the USGS, U.S. Army Corps of Engineers (Reports to the War Office), road departments, railroads, water delivery districts, and other entities.

(e) Historical sediment samples and longitudinal profiles.

(f) The degree of exposure of bridge abutment and footing foundations and foundations of other structures, along with the age of the bridge and maintenance record, can provide telling data on both scour and river degradation.

(g) Ice potential and effect on channel including the possible flooding from jams, channel avulsions, or the scour of vegetation in channels.

(h) Previous reports on geomorphic and sediment transport conditions or professional journal articles.

(i) Construction and maintenance records from government groups and private entities including records of structural failures and recurring maintenance actions, tailwater curves, and USGS repeat surveys for adjustments to gage station rating curves.

(j) Narrative descriptions of the river including journals or compilations from early explorers, travelers, scientific expeditions and settlers, and accounts from newspapers.

(3) Concerns and issues for specific types of structures could include:

(a) Identifying downstream of structures the height and location of any stream headcuts or kickpoints and their approximate rate of upstream migration.

(b) Measurements of local scour and constriction scour data on bridge foundations and other structures in the stream.

(c) Estimate the incision and channel change downstream of a reservoir or large pond, estimate the aggradation in the reservoir, and the aggradation and change in alignment upstream of the reservoir or pond inlet for sediment transport studies.

(d) Identify deposition potential and potential for channel migration at intake structures.

(e) Consider the anticipated occurrence and amounts of sediment, ice (thickness) and flooding from ice jams, and drift (trash), and possible effect on facilities such as reservoir outlets, water intakes, spillways, fish screens, etc.

(f) Channel and bank protection requirements and allowable materials and potential alternative solutions that allow for natural channel processes.

(g) Describe imposed conditions resulting from project construction that contribute to river instability and address concerns (e.g., increased channel bed or bank erosion, downstream channel protection; removing natural vertical control, replacing with constructed control; etc.).

(h) The expected volume of sediment which would be taken into the canal or other features and/or accumulated upstream of a facility, and plans for addressing concern.

E. **Water Quality:**

(1) Published guidelines and regulations for water quality standards.

(2) Recommendations for maintenance of water quality standards such as suppression of nitrogen, adequate oxygen levels, and temperature control and control for turbidity during construction.

(3) Water temperature, including seasonal variations.

(4) Analysis of water for intakes or other purposes as required for chemical and physical characteristics and biological quality.