

**Forest Service Handbook
National Headquarters – Washington Office
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**Forest Service Handbook 7709.56b – Transportation Structures Handbook
Chapter 30 - Site Surveys**

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Approved by: Gregory Smith, Acting Associate Deputy Chief, NFS

Date approved: November 18, 2014

Responsible Staff:

Explanation of changes: Following is an explanation of the changes throughout the directive by section.

7709.56b: The entire Handbook has been revised; refer to the digest for a summary of the revisions.

Zero Code: Makes minor technical and editorial changes, removes obsolete direction and terminology, and updates the coding system by changing from the one-digit to the two-digit coding system.

10: Recodes, reorganizes, and updates direction throughout the chapter. Makes minor technical and editorial changes, removes obsolete directions, and updates the coding system by changing from the one-digit to the two-digit coding system.

11: Recodes, reorganizes, and updates this section in its entirety. Replaces discussion of forest plans, ecosystem management, and least total cost method decisions with subsections on travel analysis and travel management decisions. Updates direction on road management to include direction on Trail Management Objectives and recodes the direction to section 11.3. Reduces scope of direction on alternatives to stay within limits of travel management decisions and the Road and Trail Management Objectives and recodes the direction to section 11.4. Recodes the remainder of the section to new section 11.5 entitled, “Project Development Process.”

13: Sets forth new direction on inspection reports for existing structures and evaluation of load-carrying capacity of existing structures to listing of required design information.

20: Makes minor technical and editorial changes, removes obsolete direction, adds direction to meet Road and Trail Management Objectives, and updates the coding system by changing from the one-digit to the two-digit coding system throughout the chapter.

23: Adds direction to consider roadway widening needed to accommodate off-tracking of large trucks when curves are constructed close to bridges, to consider construction access to both sides of a stream, and to consider measures needed to maintain existing road traffic when replacing existing bridges.

30: Makes minor technical and editorial changes, removes obsolete direction, and updates the coding system by changing from the one-digit to the two-digit coding throughout the chapter.

34: Revises direction to conform to stream simulation requirements and to reference chapter 60.

35.4: Adds direction for identification of construction staging areas.

40: Makes minor technical and editorial changes and updates the coding system by changing from the one-digit to the two-digit coding throughout the chapter. Removes obsolete direction referencing economic analysis methods and flood insurance.

43.5: Updates direction to allow previously used materials only when they have been inspected, determined to be structurally adequate, economical and approved by the Regional Director of Engineering.

50: Changes chapter caption from “Hydrology” to “Hydrology and Geomorphology” and adds direction to require stream simulation and aquatic organism passage. Makes minor technical

and editorial changes and updates the coding system by changing from the one-digit to the two-digit coding system.

60: Changes chapter caption from “Hydraulics” to “Hydraulics and Watershed Protection” and adds direction to require stream simulation and aquatic organism passage. Makes minor technical and editorial changes and updates the coding system by changing from the one-digit to the two-digit coding system throughout the chapter. Removes obsolete direction.

70: Changes chapter caption from “Structural Design” to “Road Bridge Design” and updates the coding system by changing from the one-digit to the two-digit coding system throughout the chapter. Adds new direction and revises, reorganizes, and recodes direction throughout the entire chapter. Changes various section captions to be applicable for road bridge designs and sets forth new direction throughout the chapter. Removes obsolete direction.

80: Changes chapter caption from “Operations” to “Trail Bridge Design” and updates the coding system by changing from the one-digit to the two-digit coding system throughout the chapter. Sets forth direction for planning, design, and construction of trail bridges and other engineered trail structures.

90: Changes chapter caption from “Construction” to “Road Bridge Operation” and updates the coding system by changing from the one-digit to the two-digit coding system throughout the chapter. Revises, reorganizes, and recodes entire chapter. Major changes are: 1) removes the distinction and inspection requirements between bridges formerly known as NBIS and non-NBIS (National Bridge Inspection Standards), 2) removes all trail bridge references and guidance and 3) incorporates culvert guidance.

100: Establishes code, chapter “Trail Bridge Operation”, and sets forth direction for maintenance, inventorying, and operation of trail bridges and other engineered trail structures.

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30.2 - Objectives

To conduct site surveys, including foundation investigations, site reconnaissance, preparation of topographic maps, and stream channel surveys, and to secure other pertinent data related to preparing adequate structure design information.

30.3 - Policy

Conduct a site survey for all bridges, arches, and long span arches. Conduct a site survey for large culverts as needed. Make the site survey commensurate with the complexity of the site and the proposed structure.

31 - Foundation Investigations

Conduct a foundation investigation for all structures. Vary the amount and type of investigation effort dependent upon a number of factors, such as structure type; site characteristics, including foundation conditions; access; availability of equipment; economics; and available time.

Consider structure type and foundation conditions as the primary elements that determine the type and degree of foundation investigative effort needed. Coordinate the evaluation of these factors for each site with the geotechnical personnel who will conduct or coordinate the investigation effort and with involved project and Forest Management personnel.

Consider a variety of methods for foundation investigation work, dependent upon the conditions outlined above. Investigations may range from visual observation of site conditions and mapping of geological conditions to test pits or extensive soil borings over several alternate sites. Where necessary, supplement these investigations with other geophysical or remote sensing techniques.

Where rock outcrops are present and drilling is not necessary to determine the extent of rock or its quality, perform limited geologic mapping of abutment and pier footing sites to describe and display foundation conditions. Where appropriate, for sites that will use relatively shallow footing depths, excavate properly logged test pits.

Where time permits and conditions warrant, conduct the bridge foundation investigation effort in three phases:

Phase 1. Conduct field reconnaissance work to identify geotechnical investigation needs and to assist in selecting the specific crossing site and/or the bridge type.

Phase 2. Conduct preliminary investigation work to identify subsurface conditions at the crossing site.

Phase 3. Conduct final investigation work to obtain data for specific abutment and/or pier designs. At less complex sites, only phases 1 and 2 may be appropriate.

31.1 - Field Reconnaissance

Coordinate with the Regional Bridge Engineer and the Regional or Forest Geotechnical Engineer to determine project scope and complexity.

Review known or recorded information for the structure site, such as previous designs, available soil and geological studies, and aerial photographs.

Conduct a site visit with appropriate personnel to classify soil and rock types, to determine their condition and stability, and to obtain information on topographic features, natural flora and fauna, evidence of subsurface water, and any manmade features. Inspect natural lakes and adjacent slopes in the area and study the natural drainage patterns.

Develop a soil profile (field cross section) that depicts the anticipated subsurface conditions, including the distance to bedrock for use in the preliminary design and planning and in conducting the investigation.

31.2 - Preliminary Investigation

Conduct a foundation investigation based on the recommendations of the designer and the materials and Geotechnical Engineering Specialists. Use a preliminary design drawing, depicting bridge location and tentative substructure locations and types, as a guide for the investigation and location of drill sites at the proposed location of piers and abutments.

Use seismic or resistivity investigations only in conjunction with borings or test piles, or where subsurface conditions are predictable, based on knowledge of local geology and adjacent structures.

Perform borings or dig test holes to locate ground water.

Investigate sites for short, simple structures, generally those less than 20 feet long, and trail bridge sites thoroughly enough to determine the capacity of soils for design of the abutments.

Investigate the general area around the proposed bridge site to determine the need for subsurface drainage systems.

31.3 - Foundation Investigation Report

The Geotechnical Engineer should analyze the information obtained from the field investigations and summarize all findings in a report that includes the following:

1. Description of the field investigation procedures, location of test borings, and other tests performed. Provide a log of the test borings.
2. Narrative of laboratory tests and results.
3. Analysis and description of soil and site conditions.

4. Analysis of channel stability conditions.
5. Recommended design parameters for the foundation types, including soil capacities and recommended bridge substructure type(s).
6. Recommended stream bank protection measures.
7. Recommended excavation and dewatering requirements at the site during construction.

Maintain a copy of the foundation investigation report in the permanent bridge design file.

31.4 - Final Investigation

Conduct additional investigation work at specific abutment and/or pier sites when the foundation data from the preliminary investigation is incomplete or insufficient for performing an adequate bridge design. Coordinate with the Design Office to determine the specific data that are needed before initiating final investigation efforts.

32 - Guidelines for Preparing Topographic Maps

Prepare the topographic map using either conventional, on-the-ground survey and mapping procedures or photogrammetric methods, as appropriate. Make sure the area covered in the topographic map is sufficient to design and detail the structure, the approaches, and related improvements such as dikes, channel improvements, bank protection measures, detour structures, and flood stage overflow channels. Generally, this work encompasses the total width of the flood plain.

Follow these guidelines for preparing the map:

1. Establish a horizontal and vertical geometric control point commensurate with the structure. For most bridges and culverts do the following:
 - a. Use the same horizontal and vertical geometric control point for the bridge site survey as used for the overall road project. Do not use different elevation datum, especially where two structures are affected by the same storm flow and interact in passing that flow.
 - b. Show bench mark locations, descriptions, and elevations. Establish vertical geometric control by using primary bench marks, intermediate bench marks, and elevations of appropriate stakes/hubs and traverse stations. Temporary bench marks used for obtaining contours and cross sections should be to the nearest 0.1 foot. Establish elevations of all construction bench marks to 0.01 foot. Close all level circuits for accuracy checks.
 - c. Establish horizontal geometric control by using preliminary (P) or final (L) line survey points and stationing. Install reference points and run traverses along the

- stream to establish base lines for dikes or channel changes. Measure the centerline of any existing bridge and substructure units to 0.01 foot. For existing structures, show elevations to the nearest 0.01 foot at both ends of all bridge seats, including piers. Measure angles to the nearest 30 seconds. Obtain closure across the stream for all sites either by direct measurement or by triangulation.
- d. When Global Positioning System (GPS)/Global Navigation Satellite System (GNSS) equipment is available, collect and record latitude and longitude data at a point on each end of the proposed structure.
2. Prepare the site survey map on a reproducible material that is durable and dimensionally stable. Alternatively, use electronic media or computer software to transmit site survey data in a suitable format, with electronic data showing a real world (1:1) scale.
 3. Use a scale of either 1 inch = 10 feet or 1 inch = 20 feet and a maximum contour interval of 2 feet to display site survey data on a site plan. Use a dimensionless ratio for scale when using metric measurements.
 4. Show the location and identify all subsurface explorations, such as drill holes and test pits.
 5. Show true "north" arrow and road data, including the road name and number and distance to the nearest town. Indicate existing roads and structures with dashed lines. Orient the map so that road stationing is from left to right.
 6. Identify section corners, land lines, and right-of-way limits if they are within the area of the topographic map. Give the Forest and Ranger District name and legal land survey description as is customary for legal land descriptions in the State where the project is located. In areas with the Public Land Survey System (PLSS), provide the legal land subdivision part (such as NW1/4SE1/4...), the land parcel (such as section or protraction block) number, township number, range number, and principal meridian name, as well as the State and local governmental unit name (county, township, parish, borough) In States without a PLSS, provide a legal land description consistent with State land surveying and land description standards and requirements.
 7. Show GPS/GNSS coordinate information when available.
 8. Show stream name and direction of flow.
 9. Locate and identify stream banks, types of ground cover in the approach areas, edge of stream, islands, rock outcrops, large boulders, gravel and sand bars, debris jams, overflow channels, side streams, old channels, scour areas, backwater areas, high-water marks (date, where possible), ground water elevation, and other items important to the location of the structure.

10. Locate existing constructed features such as buildings, fences, ditches, pipelines, and utility lines. Indicate vertical clearances of overhead facilities.

11. Provide a title block on the map for names or initials of individuals preparing the map and checking it. Include survey date, map completion date, Forest, District, road number and name, bridge number and name, and related data.

32.1 - Use of Photogrammetry

Consider using photogrammetry in developing topographic maps for sites that are in relatively open country (less than 50 percent crown cover). Specify aerial photography that will provide photogrammetric measurements at a reasonable level of accuracy, indicated by the root-mean-square error method for geometric control. Contact the Geometronics staff for specific information.

Consider using existing resource photography and using high-altitude photo data as the geometric control.

Consider ground-based photography where there are overhangs that cannot be mapped with vertical photography or where sites are too hazardous to map with ground methods. This method may also be used for small sites for which aerial photography may not be economical.

33 - Route Design Information

Obtain the plan and profile sheet for the section of road or trail encompassing the bridge site. Show stations and angle of intersection between the centerline of the proposed route and the centerline of any intersecting roads, railroads, or trails at the bridge site.

Plot the ground profile along the proposed roadway centerline using the same scale as the topographic map. Do not exaggerate the vertical scale. Extend the profile 100 to 150 feet beyond the extreme limits of the proposed bridge or to the limits of the flood plain, whichever is greater. Make sure the ground profile agrees with the topographic map.

Prepare a typical cross-section sheet showing sections of the proposed route and any existing roads or trails that will remain in place or that will be reconstructed. Show the relationship of the ground profile to the centerline and edges of the proposed route on the cross-sections. Consider the need for additional width to permit proper installation of guardrails on the approaches to bridges.

34 - Stream Channel Survey

See U.S. Department of Agriculture, Forest Service. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (sec. 60.8).

Include survey data, description of stream and physical ground characteristics, estimates of engineering data needed for hydraulic design, and photographs of the site.

Establish a base line and a beginning cross-section location for the drainage channel.

Show the stream survey geometric control line, including traverse stations, elevations, and cross-section locations on the topographic map. Extend the geometric control line an adequate distance up and downstream especially where data will be used to perform in-depth hydraulic analyses using hydraulic engineering software. Provide cross-sections taken at 25-50 foot intervals and at all angle points along the geometric control line.

Include stream cross-sections taken at all critical stream sections, such as locations of stream ends, sand and gravel bars, debris points, rapids, points of stream gradient changes, points where the channel is restricted, and at the intersection of the road and stream centerlines. Show on the stream cross-section, locations of stream bottom, water's edge, high water mark (if visible or known), top of bank, breaks in the ground, and location of significant vegetation. Length of cross-sections should include the entire flood plain.

Obtain dates of previous floods and information on drift, ice conditions, and other pertinent events.

Classify streambed material by the percentages and sizes of sand, gravel, cobbles, and/or boulders, and specify vegetative cover for hydraulic calculations. Include an estimate of Manning's "n" value (channel roughness factor), a description of any debris and/or ice problems, bank cutting, scour or stream degradation or aggradations. Take photographs to indicate the streambed conditions and materials. Make an estimate ("straw test") of the velocity of the stream when possible. Include records from stream gauges near the site when available.

35 - Additional Data

35.1 - Information on Existing Structure

If a replacement structure is involved, recommend whether elements of the existing substructure can be considered for use in the new structure, or whether they may serve as false work during construction of the new structure. If so, include measurements of the existing substructure and copies of the original or as-built plans, if available.

35.2 - Information on Nearby Structures

Obtain information on any existing structure(s) in the vicinity of the proposed structure, including foundation type, waterway opening, overtopping, and flood damage history. Include upstream and downstream distances from the proposed structure to the existing structure(s).

35.3 - Photographs

Provide photographs that accurately depict all pertinent site conditions, including road or trail approach views, views of the flood plain, upstream and downstream views, streambed material and condition, rock outcrops, foundation material, and existing facilities. Show the centerline and stationing of the traveled way. Indicate on the topographic map the point and direction from which the photographs were taken.

35.4 - Staging Area Information

Locate areas near the bridge site that may be suitable for staging of manpower, equipment, and materials during construction. Provide photographs and measurements of these sites and measurements of the distance from the sites to the bridge location. Include estimates of any mitigation measures that may be necessary for use of the sites to meet resource management objectives and environmental protection requirements.