



U.S. Department  
of Transportation  
Federal Highway  
Administration

# Memorandum

Subject: **ACTION**: Technical Guidance for Bridges  
over Waterways with Unknown Foundations  
*/s/ Original Signed by*

Date: January 9, 2008

From: King W. Gee  
Associate Administrator for Infrastructure

In Reply Refer To: HIBT-20

To: Associate Administrator for RD&T  
Associate Administrator for  
Federal Lands Highway Program  
Directors of Field Services  
Resource Center Director  
Division Administrators

The purpose of this memorandum is to provide technical guidance on a process that should be considered by Federal, State and local agencies (referenced herein as bridge owners) to identify foundation characteristics such as width, depth and length for bridge foundations identified as unknown. The goal of this process is to reduce or eliminate the population of bridges over waterways identified as having unknown foundations, which in turn would allow bridge owners to evaluate these bridges for their scour vulnerability.

## **Background:**

The term “unknown foundations” has been traditionally associated with examining the population of existing bridges over waterways (riverine and tidal) where foundation details are unknown and therefore, foundations could not be evaluated against the hydraulic hazards related to scour. Most of the bridges having unknown foundations were identified by owners while screening their bridges over waterways (riverine and tidal) for their scour vulnerability. These bridges received a Code U for Item 113 of the FHWA’s Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges (Coding Guide).

The FHWA exempted this population of bridges from being evaluated for their scour vulnerability due to the lack of a process and guidance that would have allowed bridge owners to determine their foundation characteristics and therefore, evaluate these bridges. This exemption did not apply to bridges on Interstate designated routes for which FHWA recommended bridge owners to consider technology available to determine their foundation characteristics and evaluate their scour vulnerability. The use of geophysics technology such as non-destructive testing (NDT) has been available for quite some time; however, cost and reliability of results may be the leading reason for their limited use for determining foundation characteristics.

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The National Bridge Inspection Standards (NBIS) regulation, [23 CFR 650.313.e.3](#), requires that bridge owners develop a plan of action (POA) for bridges identified as scour critical bridges. We are concerned that some bridges within the unknown foundation population may be scour critical and as such need to have a POA as required by the NBIS regulation.

An additional growing concern, primarily related to our aging bridge population and increasing load and performance demand on all bridges, is our limited “body of knowledge” to assess the structural and geotechnical load capacity and deterioration mechanisms of foundation elements in both the short and long-term. When examining the “body of knowledge” from a broader view point, a more global definition of unknown foundations appears to be appropriate as we have to consider the potential of having another population of unknown foundations on land bridges currently reported in the Coding Guide. In general, the topic of unknown foundations presents a broad based challenge to bridge owners, which warrants FHWA’s attention.

### **Status of Bridges with Unknown Foundations:**

As of September 2007, the National Bridge Inventory (NBI) data showed that bridge owners reported 67,240 bridges over waterways as having unknown foundations. Table 1 presents the number of bridges over waterways on the National Highway System (NHS) and the non-NHS with unknown foundations by Federal, State and local agencies. It is important to highlight that the NHS population of unknown foundation bridges presented in Table 1 includes 144 bridges with Interstate designation. The number of bridges over waterways having unknown foundations is presented by bridge owner in Attachment A.

<b>Table 1 – Number of Bridges over Waterways Coded U (Unknown Foundations) for Item 113 of the NBI</b>			
<b>Agency</b>	<b>NHS</b>	<b>Non-NHS</b>	<b>Total</b>
Federal	0	238	238
State	1,155*	12,864	14,019
Local	324	52,577	52,901
Other Bridge Owners	2	80	82
Total	1,481	65,759	67,240

\* Includes 144 bridges with Interstate designation

### **Guidance on Process for Reducing the Number of Bridges with Unknown Foundations:**

The following steps outline a process developed by the FHWA Office of Bridge Technology’s Hydraulics and Geotechnical Team that bridge owners may consider to reduce or eliminate the population of bridges over waterways identify as having unknown foundations:

1. Screen all bridges coded U to ensure that they are correctly coded as having unknown foundations. In addition, bridges with unknown foundations that may have been coded 6 for

Item 113 should be recoded as U and undergo a screening as well. Bridge owners that assigned a Code 6 to Interstate bridges with unknown foundations based on the current definition of Code U should keep these bridges with a Code 6 and follow the guidance presented in this process. Direct and specific communication between bridge inspection and bridge design and construction units should expedite and improve the results of this activity.

- Most bridge owners may have some form of historical technical inventory of project plans, standard sheets, construction specifications, and design guidance. A concerted effort to “mine” this historical data by cross referencing coded U bridges construction dates should yield valuable preliminary information regarding foundation practices in that period. This information could also be coupled with knowledge on bridges with known foundations constructed in the same time period. Similar to current foundation practices, historical practices were very repetitive and rather simple in concept.
2. For bridges over waterways that are determined to be correctly identified as having unknown foundations:
- Prioritize these bridges based on their functional classification. We recommend that this prioritization be as follows: Principal Arterial – Interstate; Principal Arterial – Other Freeways or Expressways; Other Principal Arterial; Minor Arterial, Major Collector; Minor Collector.
  - Consider using the following criteria for determining, with a reasonable accuracy, foundation characteristics:
    - a) Collect and document historical knowledge of foundation design and construction practices for the period of original construction.
    - b) Consider geologic, subsurface conditions, bridge standards, and information that may be available from nearby bridges.
    - c) Consider applying “proven” surface and subsurface NDT tools to confirm foundation type and determine foundation length.
      1. NCHRP 21-05(2) “Determination of Unknown Subsurface Bridge Foundations” specifically examined NDT tools for the application. The unedited final report and accompanying guideline document can be obtained for loan by contacting NCHRP at [NCHRP@nas.edu](mailto:NCHRP@nas.edu). More information on this project is available at <http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=667>.
      - a) Pertinent results of this study are summarized in FHWA’s Geotechnical Notebook Issuance No. 16 (GT-16) of the same title, which is available at <http://www.fhwa.dot.gov/engineering/geotech/policymemo/gt-16.pdf>.
      - b) Since the completion of project NCHRP 21-05(2) further advancements in computer software and hardware have greatly advanced to provide improved result reliability. The current state of knowledge is such that the combined suite of surface and subsurface NDT tools has limitations based on foundation access (surface or down-hole) foundation material type and dimension and the best results require the user to consider each situation for undertaking a testing program.
  - Conduct a scour evaluation based on this determination and consider recoding the bridge for Item 113 according to the outcome of the evaluation.

- a) A risk-based prioritized schedule for conducting the scour evaluations of these bridges may be considered.
    1. Factors other than functional classification, such as the amount and reliability of the determined information should be considered in a risk-based prioritization schedule in order to target the scour evaluation of the bridges most in need of attention.
    2. It is likely that only partial foundation information may be determined on some bridges and that some information may be qualitative rather than quantitative resulting in some uncertainty in the scour evaluations for that population.
    3. Several projects funded by the NCHRP have addressed the topic of unknown foundations and produced valuable though limited information and guidance. The concept of a risk based approach was addressed in the NCHRP project 24-25, Risk-based Management Guidelines for Scour at Bridges with Unknown Foundations (Web-only document 107). This project advanced a template for a risk-based approach and computer software. While this project might not meet the needs of all bridge owners, it provides a protocol of how a risk-based approach could be structured to manage bridges with unknown foundations. We encourage bridge owners to consider this product as a beginning draft to develop their own risk based approach. The Web-only document 107 could be downloaded at: [http://www.trb.org/news/blurb\\_detail.asp?id=8000](http://www.trb.org/news/blurb_detail.asp?id=8000).
3. For bridges that were previously coded as U for Item 113 of the NBI and whose foundations are completely and accurately identified after completing the screening:
- Conduct scour evaluations following the guidance presented in the FHWA publication Hydraulic Engineering Circular No. 18, Evaluating Scour at Highway Bridges, Fourth Edition dated May 2001.
    - a) Prioritize the scour evaluation of these bridges based on the functional classification previously recommended.
  - Code Item 113 according to the outcome of the evaluation.

We request that your appropriate staff disseminate and discuss this technical guidance with their appropriate Federal and State department of transportation management official. We plan to monitor the progress made by bridge owners towards reducing their number of bridges with unknown foundations by reviewing the NBI data every year in April. November 2010 is the target date for eliminating the number of bridges with unknown foundations from the NBI. We are contemplating amending the NBIS regulations so that any remaining bridge reported as having unknown foundations after November 2010 would be kept with a Code U for Item 113, considered scour critical and subject to the plan of action requirement of the NBIS regulation, [23 CFR 650.313\(e\)\(3\)](#), until properly designed countermeasures are installed to protect the bridge foundations or until the bridge is replaced.

If you have any questions please do not hesitate to contact Mr. Jorge E. Pagán-Ortiz, Principal Bridge Engineer – Hydraulics at (202) 366-4604 ([jorge.pagan@dot.gov](mailto:jorge.pagan@dot.gov)), or Jerry DiMaggio, Principal Bridge Engineer – Geotechnical at (202) 366-1569 ([jerome.dimaggio@dot.gov](mailto:jerome.dimaggio@dot.gov)).

Attachment

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## Attachment A

## Number of State, Local and Other Bridge Owner Bridges Coded U (Unknown Foundations) for Item 113

	State		Local		Other Bridge Owners		Interstate*	Total
	NHS	NNHS	NHS	NNHS	NHS	NNHS		
AL	67	159	4	3,419	0	0	0	3,649
AK	33	65	0	45	0	0	8	143
AZ	0	0	0	87	0	0	0	87
AR	7	909	0	3,478	0	0	0	4,394
CA	30	122	0	1,694	0	0	4	1,846
CO	10	24	0	1	0	0	2	35
CT	0	0	0	0	0	0	0	0
DE	0	0	0	0	0	0	0	0
DC	3	3	0	1	0	0	1	7
FL	122	280	12	2,018	0	7	13	2,439
GA	429	1,087	4	3,804	0	0	3	5,324
HI	0	0	2	5	0	3	0	10
ID	2	9	0	480	0	1	0	492
IL	0	1	0	0	0	0	0	1
IN	0	9	0	1,350	0	1	0	1,360
IA	0	0	0	3,073	0	17	0	3,090
KS	1	26	0	13	0	0	0	40
KY	0	1	0	3	0	0	0	4
LA	18	1,465	5	3,444	0	11	7	4,943
ME	12	41	0	50	0	1	10	104
MD	8	35	2	311	0	0	9	356
MA	27	51	6	271	0	0	2	355
MI	53	60	2	549	0	0	7	664
MN	0	6	0	183	0	4	0	193
MS	15	102	0	6,291	0	5	0	6,413
MO	0	2	0	0	0	0	0	2
MT	3	7	0	1,667	0	0	2	1,677
NE	1	26	0	3,183	0	0	0	3,210
NV	1	3	0	35	0	4	0	43
NH	0	7	1	28	0	0	0	36
NJ	8	4	0	73	0	1	0	86
NM	13	101	4	296	0	0	1	414
NY	1	0	2	34	0	1	0	38
NC	38	4,943	0	246	0	0	0	5,227
ND	0	5	0	1,936	0	0	0	1,941
OH	6	6	4	321	0	0	4	337
OK	10	6	0	11	0	0	1	27
OR	75	121	2	1,635	0	5	20	1,838
PA	11	30	0	5	0	4	5	50
RI	0	6	0	1	0	0	0	7
SC	82	2,615	0	709	0	0	27	3,406
SD	0	0	0	0	0	0	0	0
TN	14	114	0	973	0	0	4	1,101
TX	30	253	258	8,468	2	14	5	9,025
UT	2	6	0	8	0	0	0	16
VT	1	22	2	216	0	0	0	241
VA	0	0	0	0	0	0	0	0
WA	1	1	12	201	0	0	1	215
WV	0	0	0	0	0	0	0	0
WI	18	34	2	1,546	0	1	5	1,601
WY	0	8	0	393	0	0	0	401
PR	3	89	0	22	0	0	3	114
TOTALS	1,155	12,864	324	52,577	2	80	144	67,002

\* Included under State NHS

Attachment A			
Federal Bridges Coded U (Unknown Foundations) for Item 113			
	NHS Fed	Non NHS Fed	All Fed
ALABAMA	0	0	0
ALASKA	0	2	2
ARIZONA	0	0	0
ARKANSAS	0	2	2
CALIFORNIA	0	4	4
COLORADO	0	13	13
CONNECTICUT	0	0	0
DELAWARE	0	0	0
DIST. OF COL.	0	5	5
FLORIDA	0	30	30
GEORGIA	0	6	6
HAWAII	0	0	0
IDAHO	0	0	0
ILLINOIS	0	1	1
INDIANA	0	0	0
IOWA	0	5	5
KANSAS	0	7	7
KENTUCKY	0	0	0
LOUISIANA	0	0	0
MAINE	0	0	0
MARYLAND	0	7	7
MASSACHUSETTS	0	0	0
MICHIGAN	0	1	1
MINNESOTA	0	0	0
MISSISSIPPI	0	69	69
MISSOURI	0	1	1
MONTANA	0	1	1
NEBRASKA	0	1	1
NEVADA	0	0	0
NEW HAMPSHIRE	0	0	0
NEW JERSEY	0	4	4
NEW MEXICO	0	1	1
NEW YORK	0	4	4
NORTH CAROLINA	0	12	12
NORTH DAKOTA	0	1	1
OHIO	0	0	0
OKLAHOMA	0	1	1
OREGON	0	1	1
PENNSYLVANIA	0	6	6
RHODE ISLAND	0	0	0
SOUTH CAROLINA	0	0	0
SOUTH DAKOTA	0	0	0
TENNESSEE	0	4	4
TEXAS	0	23	23
UTAH	0	1	1
VERMONT	0	0	0
VIRGINIA	0	13	13
WASHINGTON	0	6	6
WEST VIRGINIA	0	0	0
WISCONSIN	0	3	3
WYOMING	0	3	3
PUERTO RICO	0	0	0
TOTALS	0	238	238