

ADOT

Bridge Inspection Guidelines



	2
Table of Contents	
CHAPTER 1	4
INTRODUCTION	4
1.1 INTRODUCTION	4
1.2 APPLICABLE REFERENCE MATERIALS	4
1.3 ADOT BRIDGE INSPECTION SECTION	5
1.4 SELF INSPECTING LOCAL PUBLIC AGENCIES (LPAs)	5
1.5 BRIDGE INVENTORY DATABASE	5
1.5.1 Structure Numbering System	5
1.5.2 New Structure Number Request Procedures	6
CHAPTER 2	9
TYPES OF BRIDGE INSPECTION AND FREQUENCIES	9
2.1 INITIAL INSPECTIONS	9
2.2 ROUTINE INSPECTIONS	9
2.3 SPECIAL / INTERIM INSPECTIONS	9
2.4 IN DEPTH INSPECTIONS	10
2.5 FRACTURE CRITICAL INSPECTIONS	10
2.6 DAMAGE INSPECTIONS	11
2.7 UNDERWATER INSPECTIONS	11
2.8 INSPECTION FREQUENCY	12
CHAPTER 3	14
BRIDGE INSPECTION PROCEDURES	14
3.1 INTRODUCTION	14
3.2 BRIDGE INSPECTION PLANNING	14
3.2.1 Construction Zones and Traffic Restriction Review	14
3.2.2 Traffic Control Plans	14
3.2.3 Record Drawing Updates	16
3.2.4 Railroad Permits	16
3.2.5 Canal Bridge Inspection	16
3.2.6 Border Bridges	16
3.2.7 Safety Compliance	16
3.3 FIELD INSPECTION	17
3.4 CHARACTERIZATION OF CONCRETE DETERIORATION	18
3.5 BRIDGE INSPECTION LIFECYCLE	19
3.6 CRITICAL FINDINGS	19
3.6.1 Definition, Purpose and Reporting Responsibilities	19
3.6.2 Critical Finding Applicability	20
3.6.3 Critical Finding Procedures	20
3.7 COMPLEX BRIDGES	20

<i>Fig. 3.3 – SAMPLE OF LOAD RATING REPORT</i>	24
CHAPTER 4	25
4.1 STRUCTURE INVENTORY AND APPRAISAL (SI&A) REPORT	25
4.1.1 General Requirements	25
4.1.2 Data to be Updated by Bridge Technical Section (BTS)	26
4.1.3 Data to be Updated by Bridge Hydraulics Section (BHS)	26
4.1.4 Common Data Entry Errors	26
4.2 INSPECTION REPORT	27
4.2.1 General Requirements	27
4.2.2 NBI Bridge Condition Ratings	27
4.2.3 Sufficiency Ratings	27
4.2.4 Orientation and Elements Numbering	27
4.2.5 Structure Component Rating	28
4.2.6 Contents of Inspection Notes and Element Notes of AASHTOWare BrM	30
4.3 REPAIR REPORT / LIST OF MAINTENANCE ITEMS	32
4.4 CLEARANCE DIAGRAM	33
4.5 VERTICAL CLEARANCE SIGN	33
4.6 CHANNEL PROFILE DIAGRAM	34
4.7 SKETCHES	35
4.8 INSPECTION PHOTOGRAPHS	35
4.8.1 General	35
4.8.2 Guidance for Inspection Photographs	35
4.8.3 Digital Photograph Naming Convention	36
4.8.4 Other Naming Conventions for Documents stored in BrM	37
CHAPTER 5	40
QUALITY CONTROL AND QUALITY ASSURANCE	40
5.1 INTRODUCTION	40
5.2 QUALITY CONTROL ENGINEER / QUALITY ASSURANCE ENGINEER	40
5.3 REVIEW SELECTION ON INSPECTION DOCUMENTS	40
5.4 REVIEW INSPECTION DOCUMENTS	40
5.5 REVIEW COMMENT CORRECTION	41
5.6 FIELD INSPECTION REVIEW	42
5.7 TRAINING WORKSHOP	42
Chapter 6. Tunnel Inspection	
6.1 Introduction	
6.1.1 History	
6.1.2 Purpose	
6.2 Inspection	
6.2.1 Introduction	
6.2.2 Inspection Types and Frequencies	
6.2.2.1 Inspection Types	
6.2.2.1.1 Initial Inspection	
6.2.2.1.2 Routine Inspection	
6.2.2.1.3 Damage Inspection	

6.2.2.1.4	In-depth Inspection
6.2.2.1.5	Special Inspection
6.2.2.2	Inspection Frequencies
6.2.3	Inspector Qualifications
6.2.3.1	Program Manager
6.2.3.2	Team Leader
6.2.3.3	Inspection Assistance from Discipline Specific Specialist and Field Inspectors
6.2.4	Inspection Procedures
6.2.4.1	Structural Materials
6.2.4.1.1	Steel Structures
6.2.4.1.2	Concrete Structures
6.2.4.1.3	Timber Structures
6.2.4.1.4	Masonry Structures
6.2.4.2	Structural Elements
6.2.4.2.1	Liners
6.2.4.2.1.1	Steel Liners
6.2.4.2.1.2	Concrete Liners
6.2.4.2.1.3	Timber Liners
6.2.4.2.1.4	Masonry Liners
6.2.4.2.1.5	Unlined Tunnels in Hard Rock
6.2.4.2.2	Segmental Rings
6.2.4.2.3	Roof Girders
6.2.4.2.4	Columns and Piles
6.2.4.2.5	Emergency Corridors
6.2.4.2.6	Interior Walls
6.2.4.2.7	Portals
6.2.4.2.8	Tunnel Ceiling Structures
6.2.4.2.9	Tunnel Invert Structures
6.2.4.2.10	Joints and Gaskets
6.2.4.3	Miscellaneous Structural Elements
6.2.4.3.1	Structural Connections
6.2.4.3.2	Doors
6.2.4.3.3	Windows and Frames
6.2.4.3.4	Staircases
6.2.4.3.4.1	Concrete Staircases
6.2.4.3.4.2	Steel Staircases
6.2.4.3.5	Roof
6.2.4.3.6	Floors
6.2.4.3.7	Brackets and Supports
6.2.4.3.8	Machinery Pedestals
6.2.4.3.9	Structural Finishes
6.2.4.4	Civil Elements
6.2.4.4.1	Wearing surfaces
6.2.4.4.2	Traffic Barriers
6.2.4.4.3	Pedestrian Railings
6.2.4.4.4	Miscellaneous Civil items
6.2.4.5	Functional Systems
6.2.4.5.1	Tunnel Drainage

		5
6.2.5	Inspection Report	
6.2.5.1	Repair Priorities	
6.2.5.2	Inspection Report Packet.....	
6.2.6	Quality Control and Quality Assurance	
6.3	Critical Finding and Condition State Ratings	
6.3.1	Critical Findings	
	<i>APPENDIX A – SAMPLE OF BRIDGE INSPECTION DOCUMENTS</i>	45
	<i>APPENDIX B – SAMPLE OF PLAN OF ACTION REPORT</i>	61
	<i>APPENDIX C – FRACTURE CRITICAL DOCUMENTS</i>	67
	<i>APPENDIX D – ARIZONA ITEMS</i>	73
	<i>APPENDIX E – CRITICAL FINDINGS PROCEDURE</i>	93
	<i>APPENDIX F – CRITICAL FINDINGS REPORT</i>	
	<i>Appendix G – TUNNEL INSPECTION CODING</i>	98

CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

The Arizona Department of Transportation (ADOT) Bridge Inspection Guidelines are intended to describe bridge inspection procedures that must be followed in Arizona and to provide uniform interpretation of the various nationally available inspection and coding guides. These guidelines provide for consistency of bridge inspection throughout the state. Any deviation of these guidelines requires approval of the ADOT Bridge Inspection Program Manager.

The National Bridge Inspection Standards (NBIS) are published in the Code of Federal Regulations, 23 CFR 650, Subpart C. The NBIS set the national standard for the proper safety inspection and evaluation of bridges and applies to all structures defined as highway bridges located on all public roads. ADOT Bridge Inspection Guidelines detail Arizona's policies and procedures for safety inspection of in-service bridges.

These guidelines cover the majority of issues that may be encountered while performing and documenting a bridge inspection in Arizona; however, they are intended neither to be exhaustive nor to replace bridge inspection textbooks and manuals. Adhering to these guidelines does not relieve bridge inspection personnel from the responsibility of applying sound engineering principles and judgment throughout the bridge inspection process. In the event of conflicting information or requirements between these Guidelines and the NBIS, the NBIS will govern. If a conflict is discovered, please notify Bridge Inspection Program Manager immediately.

1.2 APPLICABLE REFERENCE MATERIALS

The proper reference material to be used by the bridge inspection personnel must be the latest editions of the following:

- National Bridge Inspection Standards (NBIS), Code of Federal Regulations, Title 23, Part 650, Subpart C
- Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (FHWA)
- Bridge Inspector's Reference Manual (FHWA)
- Inspection of Fracture Critical Bridge Members (FHWA)
- Culvert Inspection Manual (FHWA)
- Manual on Uniform Traffic Control Devices (FHWA)
- AASHTO LRFD Bridge Design Specifications
- AASHTO Manual for Bridge Evaluation
- AASHTO Manual for Bridge Element Inspection
- ADOT Safety Policies

1.3 ADOT BRIDGE INSPECTION SECTION

ADOT Bridge Inspection Section (BIS), an organizational unit within the Bridge Group, is responsible for bridge inspection program in Arizona. It employs in-house and consultant bridge inspection teams to perform safety bridge inspections on most of Arizona's publicly owned bridges. These include all of the bridges on the state highway system and the majority of the bridges that are owned or operated by Arizona Local Public Agencies (LPAs).

1.4 SELF INSPECTING LOCAL PUBLIC AGENCIES (LPAs)

Some LPAs perform their own bridge inspections. In order for a bridge owning LPA to conduct its own bridge inspections, whether through in-house or consultant inspectors, it must demonstrate that it complies with the NBIS. Also it must submit written documentation to ADOT Bridge Inspection Program Manager, detailing its bridge inspection program, quality control, and quality assurance procedures. The documentation will be reviewed by ADOT and the Federal Highway Administration (FHWA) for compliance with national and state requirements prior to granting approval. After the initial submission and approval of this documentation, it shall be updated by LPAs as needed and it will be reviewed at least once every five years by ADOT and the FHWA. If ADOT and the FHWA determine that a LPA is not in compliance with the NBIS and/or the state requirements, the bridge inspection program may be taken over by the state.

All LPAs performing their own bridge inspections shall submit annual electronic National Bridge Inventory records complying with FHWA reporting guidelines to the ADOT Bridge Inspection Program Manager. In addition, any LPA that performs its own bridge inspections without ADOT-provided bridge inspection software shall submit quarterly progress reports to the ADOT Bridge Inspection Program Manager. A sample quarterly progress report is included in Fig 1.4.

1.5 BRIDGE INVENTORY DATABASE

ADOT BIS maintains the bridge inventory database of all NBI qualified bridges and culverts except for Federal owned structures in Arizona. NBI qualified bridges and culverts in the state requiring inspection have a folder identified with the bridge structure number

1.5.1 Structure Numbering System

Each structure, defined as a 'bridge' according to NBIS, has a unique identifying number assigned by the ADOT Bridge Inspection Section according to the group of numbers allotted to each ownership / maintenance responsibility as shown in table below:

Table 1.5.1

Structure Number	Ownership / Maintenance Responsibility Category
0001-2999	State jurisdiction bridges
3000-3999	Federal jurisdiction bridges
4000-7499	State jurisdiction culverts
7500-19999	Local Public Agency jurisdiction bridges and culverts
20000-29999	State jurisdiction bridges continued
30000-39999	State jurisdiction culverts continued
40000-989999	Reserved
990000 and above	Maricopa County non NBIS structures (N49: Structure Length<20 feet)

Structure Number Identification remains unique and permanent to each structure. Twin or parallel structures are numbered individually if there is an open median. The structure number will be retired only for structures totally removed, for one of the twin or parallel structures where the median is closed by subsequent construction or for transfer between state and local public agency jurisdiction. In that case, a new structure number must be assigned for the replacement or the transferred one. Transfer of structure's ownership / maintenance between local public agencies will not necessitate an assignment of a new structure number.

1.5.2 New Structure Number Request Procedures

Inspector / Bridge Owner should request a new structure number for a new / replaced bridge by filling out Structure Number Request Form (See Fig 1.5.2). A new structure number is not required for a rehabilitated / widened structure.

Fig. 1.4 – SAMPLE QUARTERLY PROGRESS REPORT FORM

Transmittal of Quarterly Bridge Inspection Information to ADOT Bridge Inspection Section

Agency Name:			
Name of Person Providing Information:			
Date Information Provided:			
	Quarter	Year ----)	
Please highlight the quarter being updated	1	January 1st to March 31st	
	2	April 1st to June 30th	
	3	July 1st to September 30th	
	4	October 1st to December 31st	
			Comments:
No. of bridges inspected during the quarter:			
No. of culverts inspected during the quarter:			
No. of overdue bridge inspections at end of the quarter:			
No. of overdue culvert inspections at end of the quarter:			
No. of new NBI bridges added to the inventory during the quarter: ^a			
No. of new NBI culverts added to the inventory during the quarter: ^b			
No. of bridges deleted from the inventory during the quarter: ^c			
No. of culverts deleted from the inventory during the quarter: ^d			
No. of critical findings during the quarter: ^e			
Total no. of bridges in the inventory at the end of quarter:			
Total no. of culverts in the inventory at the end of quarter:			
Provide a list of structure numbers that correspond to the above fields:			
a:			
b:			
c:			
d:			
e:			
Please send the form electronically to =====> BridgeInfo@azdot.gov Attention: Bridge Inspection Program Manager			
Alternatively mail to =====> ADOT Bridge Inspection Section, 205 South 17th Avenue, M/D 613E, Phoenix, AZ 85007			

Fig. 1.5.2 - Application for Structure Number Form



Arizona Department of Transportation

Infrastructure Delivery and Operations Division
 Bridge Inspection Section
 205 South 17th Ave., Mail Drop 635E Phoenix, Arizona 85007-3212
 Phone 602.712.8607 Fax 602.712.3056
 E-mail Address: vceleva@azdot.gov

APPLICATION FOR STRUCTURE NUMBERS

All structures conform to National Bridge Inspection Standards definition are required to have a structure number. The number (NBI Item 8 ~ Structure Number) will be assigned and monitored by the Bridge Management Section of ADOT to ensure that the assigned numbers for State, Local and Federal bridges are unique. Normally the number is retired and a new number is assigned when the structure is replaced. For newly design structures, apply for the structure number at the final structural design phase.

Instructions: E-mail or FAX this application to: [Verna Celeva](mailto:vceleva@azdot.gov)

Please provide the following data for each **new** structure:

Data Item	Description
Structure Name	
Culvert/RCB Dimensions	
Responsible Agency	
Feature Under Structure	
Road or Street on Structure	
Route Number	
Milepost	
Is it a twin/parallel structure?	YES <input type="checkbox"/> NO <input type="checkbox"/>
If YES, give clear distance between the two	
Year Built (or future est.)	
TRACS Number	
Project Number	
Project Station	
If there is an existing structure being replaced, provide the current structure number(s).	
Requested by:	Date:
FAX No.:	Phone No.:
	E-Mail:

Please provide the following data for each **new** structure:

Data Item	Description
Structure Name	
Culvert/RCB Dimensions	
Responsible Agency	
Feature Under Structure	
Road or Street on Structure	
Route Number	
Milepost	
Is it a twin/parallel structure?	YES <input type="checkbox"/> NO <input type="checkbox"/>
If YES, give clear distance between the two	
Year Built (or future est.)	
TRACS Number	
Project Number	
Project Station	
If there is an existing structure being replaced, provide the current structure number(s).	
Requested by:	Date:
FAX No.:	Phone No.:
	E-Mail:

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Revised November 5, 2014

CHAPTER 2

TYPES OF BRIDGE INSPECTION AND FREQUENCIES

2.1 INITIAL INSPECTIONS

Initial Inspection is the first inspection of a new structure, that is, when it becomes part of the bridge inventory. The Initial Inspection is to include a coding of the analytical determination of load carrying capacity and scour critical determination. The purpose of the Initial Inspection is to verify the safety of a bridge, in accordance with the NBIS and Department standards, before it is put into service. It also serves to provide required inventory information of the as-built structure type, size, and location for Bridge Management System and National Bridge Inventory, and to document its structural and functional condition.

The inspection should be performed for each new structure after construction is essentially complete and before the bridge is put into service.

2.2 ROUTINE INSPECTIONS

Routine Inspections provide documentation of the existing physical and functional conditions of the structure. All changes to NBI items that have occurred since the previous inspection are also to be documented and updated. The purpose of routine inspections is to comply with NBIS and to satisfy the Department standards. The inspections are also served to determine the need for improvement, maintenance, and establishing or revising a weight restriction on the bridge, to ensure that the structure continues to satisfy present service and safety requirements and to identify and list concerns of future conditions. Load capacity analysis is reevaluated only if changes in structural conditions or pertinent site conditions have occurred since the previous analysis.

2.2.1. Typical Structures - Routine Inspection of typical structures such as bridges over roadways, dry washes, drainage channels, intermittent or shallow streams and rivers should provide documentation of the existing physical and functional conditions of the structure. All changes to NBI items that have occurred since the previous inspection are also to be documented and updated. The purpose of routine inspections is to assure public safety, comply with NBIS and to satisfy the Department standards. The inspections are also served to determine the need for improvement, maintenance, and establishing or revising a weight restriction on the bridge, to ensure that the structure continues to satisfy present service and safety requirements and to identify and list concerns of future conditions. Load capacity analysis is reevaluated only if changes in structural conditions or pertinent site conditions have occurred since the previous analysis. Visual inspection is the key to start of any inspection. In particular, it may apply to underside of deck, superstructure/substructure units under the deck. For a bridge with substructure units in the water, after visual evaluation of all elements, it is necessary to evaluate physical condition of the bridge's elements that may not be visible. This evaluation may include sounding of structural surfaces with a hammer to detect delamination under the surfaces or use of probing /sounding rods to detect any hidden scour at bottom of the substructure units. When the abutments are hidden behind bank protection, the probing should be applied to the toe of the bank protection.

2.2.2. Canals with access - When a single-span bridge over canals with flowing water allows access to under the bridge, e.g. a walkway exists over the abutment under bridge in each side, the

inspector can apply probing techniques from the top of the walkways to detect any delamination under abutment surfaces or scour at toe of the abutments or bank protection units. In this case, the inspection can be scheduled at any time as needed.

2.2.3. Canals without access - When there is no access to underside of the bridge, other factors and remedies have to be considered for scheduling and conducting routine inspections.

2.2.3.1 Irrigation Canals - Majority of water canals in Arizona are used for irrigation with the exception of a few for drinking purposes. When the use of water is mainly for irrigation of plants and trees, the water flows full in the canal during growing season and then is reduced to low flow or dry conditions in the off season. This allows for inspection of bridges during dry-up periods with or without waders. The inspector should apply probing techniques to detect any scour at toe of the abutments or bank protection units. When the channel bottom adjacent to the substructure elements is soft or slippery, extra care must be taken in wading the water regardless of the water depth.

2.2.3.2. Drinking Water Canals - The canals conveying drinking water usually flow full year-round except for periodic dry-ups for maintenance purposes. Routine inspection interval of bridges is once every 24 months. That means the inspection date almost always coincides with water being present at full depth in the canal which necessitates utilization of a boat to access the parts under bridge. The inspector can apply visual and physical probing techniques from a boat to detect any defects including scour at toe of the abutments, piers, or bank protection units.

2.2.3.3. Water Canals - Other factors to consider are the canals having conditions such as high depth, velocity, and turbidity that make the routine inspection under bridge difficult or unsafe even with waders or a boat. Every effort should be made to schedule routine inspections of bridges over these canals in the low flow or maintenance periods. In the event low flow or maintenance intervals exceed 60 months, the routine inspection should be conducted every 24 months carefully, with safety of the inspection team in mind, followed by an underwater inspection every 60 months. See Section 2.7 regarding underwater inspections.

2.3 SPECIAL / INTERIM INSPECTIONS

Special Inspections as defined in the MBE are also called Interim Inspections in the state of Arizona. This inspection type is scheduled when

- The need to monitor a particular known or suspected deficiency between the routine inspections or the fracture critical inspections.
- The need to satisfy regular inspection frequency when the steel in-depth inspection could not be performed on the scheduled month due to the accessibility issue or other safety concerns.
- The need to optimize scheduling with other bridges in the same geographical area.
- The need to update the bridge condition rating after bridge rehabilitation before the scheduled routine inspection.

Bridges or culverts should be considered for an interim inspection if the NBI Superstructure, Substructure or Culvert code is equal to or less than 3.

The inspection interval may vary depending on the type of deficiency or the inspection situation. The inspection typically occurs between regularly scheduled inspections.

2.4 IN-DEPTH INSPECTIONS

An in-depth inspection is a close-up, hands-on inspection of all steel members above the water or below the water level to identify any deficiency not readily detectable using but not limited to routine inspection procedures. The purpose of in-depth inspections is served to collect and document data to a sufficient detail needed to ascertain the physical condition of a bridge. This data may not be able to obtain during the routine inspections due to limited available resources and access. Non-destructive field tests and/or material tests may be performed to fully ascertain the existence of or the extent of any deficiency. The cracking of the main members and connection welds may be illustrated in sketches for better description and reporting. Load capacity analysis is reevaluated only if changes in structural conditions or pertinent site conditions have occurred since the previous analysis.

In-depth Inspections for Arizona bridges are currently scheduled for all the steel bridges in the entire bridge inventory of Arizona (State and LPAs) every 48 months due to the vulnerability and unpredictability of fatigue nature in steel.

An in-depth inspection that includes all elements of the structure will satisfy the NBIS and take the place of the routine inspection for that cycle.

2.5 FRACTURE CRITICAL INSPECTIONS

Fracture Critical Bridges must have at least one fracture critical member (FCM) in order to be deemed as a fracture critical bridge. A FCM must meet the following three criteria:

- a) Must be steel
- b) Must be in tension
- c) The loss of the FCM would result in a partial or total loss of the structure

An important aspect of steel bridge inspection is the determination for potential fatigue and / or fracture. Fatigue cracks are developed at stresses well below the material's yield point stress. Fatigue and fracture can lead to premature and possibly sudden failure of a portion of the bridge or of the entire bridge.

Each bridge with FCM(s) must have an FCM Inspection Plan with an inspection field sheet attached made available to the Bridge Inspector. The plan must include highlighted locations of FCM with locations of the tension zone and typical fatigue prone details (E and E') listed in AASHTO fatigue prone categories in the member, discussion of bridge site location, access as well as traffic control, recommended methods of testing in FCMs and qualifications of inspector. The attached field inspection sheet(s) are prepared for recording notes / sketches of all the FCMs identified in the plan during inspection and the feedback comments after the inspection.

Fracture critical inspections must be scheduled within 24 month frequency in accordance with the NBIS.

FCM Inspection is required to have all steel members including FCMs and other bridge elements to

be in-depth inspected in Arizona. It satisfies NBIS and takes the place of the In-Depth Inspection as well as the Routine Inspection for that cycle.

2.6 DAMAGE INSPECTIONS

Damage Inspection is an unscheduled inspection to assess the structural damage resulting from environmental factors or human actions. Damage Inspections are performed following extreme weather-related events (major storm with flash flood), earthquakes, vandalism, and vehicular / train / plane traffic crashes, as requested by the District Maintenance Engineer.

For state bridges, the extent of damage and repair recommendations should be reported to the District Maintenance Engineer and Risk Management Section. When major damage has occurred, the inspectors will need to evaluate fractured or failed members, determine the extent of damage including the amount of section loss, take measurements for misalignment of members, check for any loss of foundation support, etc. The damage inspection report of the damage bridge will be in a special report format illustrated in an example in Fig 2.5.

The Damage Inspection is performed on as-needed basis. It does not require a complete bridge inspection and cannot be substituted for the routine inspection. Draft special inspection reports must be forwarded to Bridge Inspection Program Manager for review.

2.7 UNDERWATER INSPECTIONS

The purpose of underwater Inspection is to provide information on under water portions of a bridge to evaluate its overall safety and to assess the risk of failure due to scour. Every effort should be made to conduct bridge inspection during periods of low flow where underwater members either can be inspected visually by wading boots or by using other hand tools such as probing rods, sounding lines, and wading gear. This is especially true with the single span/barrel bridges and culverts. When inspecting bridges and culverts with more than one span or barrel, the inspector may not be able to determine visually or by using the other tools the physical condition of the substructure members or the integrity of their foundations, due to high water level, high flow, turbidity, etc. In such cases, inspection by NBIS-qualified divers is required. New technology, including ground sensing radar, ultrasonic techniques, remote video recorders, and others are useful aids for underwater inspections of substructure foundations for limited situations. Key information to be determined in every underwater inspection is the top of streambed relative to the elevation of the substructure foundations. Since scour can vary significantly from one end of a footing to the other, a single probing reading is not sufficient. Baseline streambed conditions should be established by waterway opening cross sections and by grid pattern of probing readings around the face of a substructure unit. The baseline information is essential for future monitoring and assessment. The current streambed conditions and changes since the last inspection are critical inputs to the bridge scour assessment. Each bridge should have local benchmarks established near each substructure unit to enable inspectors to quickly and accurately determine the depth of adjacent scour. These benchmarks can be as simple as a painted line or PK survey nail driver into the wall in a place visible during high water. The location of these scour-monitoring benchmarks should be referenced in the inspection records and bridge file. Use previously established benchmarks when possible to provide a consistent long term record of scour conditions. If new benchmarks need to be established, provide conversion from new to old datum. Underwater Inspections by divers are required at least once every 60 months for structures with water depths typically greater than 4

feet or due to other unfavorable conditions such as darkness, turbidity, high velocity flow, etc. in a perennial stream (channel).

2.8 INSPECTION FREQUENCY

Routine inspections for bridge structures are to be performed at regular intervals not to exceed 24 months. Routine inspections for culvert structures are to be performed at regular intervals not to exceed 48 months unless circumstances arise that will require the frequency to be reduced to 24 months.

In-depth inspections are to be performed at regular intervals not to exceed 48 months. It is to be scheduled at the same time the routine inspection is performed unless circumstances arise that will require the inspection date to be adjusted.

Fracture Critical Inspections are to be performed at regular intervals not to exceed 24 months.

Underwater Inspections are to be performed at regular intervals not to exceed 60 months.

Bridge inspection must be completed during the month in which the inspection is due. The due month is determined by the date of the previous inspection and the frequency for the inspection type.

If a bridge inspection cannot be completed in the month it is due then the inspection team leader must notify Bridge Inspection Program Manager, and document the reason for the delay in the inspection report.

Table 2.8 below shows a summary of normal inspection frequencies for the types of structure inspections.

Table 2.8 - Normal frequencies of structure inspection types

Type of Inspection	Normal Frequency of Inspection in Months
Routine - Bridge	24
Routine - Culvert	48
In-Depth	48
Fracture Critical Member	24
Underwater	60
Damage / Special / Interim	N. A.

Figure 2.5 - Damage Inspection Form

ARIZONA DEPARTMENT OF TRANSPORTATION		
BRIDGE GROUP		
Special Bridge Inspection Report		
Special Inspection Report Type: Damage	<div style="border: 1px solid black; width: 100%; height: 100%;"></div> <p style="text-align: center; margin-top: 5px;">P.E. Seal</p>	
Structure Number: Route: MP:		
Structure Name:		
Inspected By: Inspection Date:		
Agency: ADOT District: Org. No.:		
Incident description:		
Structure description:		
Damaged areas:		
Recommendations:		
Relevant photos of the damage locations are attached to the e-mail carrying this special report.		

CHAPTER 3 BRIDGE INSPECTION PROCEDURES

3.1 INTRODUCTION

All bridge inspections shall comply with NBIS and must be performed by personnel who qualify as bridge inspector under NBIS regulations with appropriate refresher training per ADOT Bridge Inspection Guidelines. ADOT requires all inspectors take a refresher training course FHWA-NHI-130053

Bridge Inspection Refresher Training every five years

Figure 3.1a displays a flowchart that details the bridge inspection process. The submittal package should include the following documents as described in Table 3.1 and in the order shown below:

- Bridge Inspection Cycle Form (Figure 3.1b)
- Summary of Bridges Inspected List (Figure 3.1c)
- Structure Inventory and Appraisal (SI&A) Report
- Inspection Report
- Repair Report (if applicable)
- List of Maintenance Items (if applicable)
- Vertical and Horizontal Clearance Diagram (if applicable)
- Channel Profile Diagram (if applicable)
- Sketches (if applicable)
- Inspection Photographs

3.2 BRIDGE INSPECTION PLANNING

Inspection personnel should contact ADOT district maintenance organizations or appropriate LPA personnel prior to inspecting bridges that are located within the jurisdiction of these entities. ADOT district maintenance organizations or LPA personnel should be encouraged to accompany the bridge inspection team during the field inspections. They could provide valuable information about on-going maintenance issues, flooding history, previous repair projects, and planned future projects. Moreover, in the case of LPAs, they may identify structures that need to be added or deleted from the NBI.

3.2.1 Construction Zones and Traffic Restriction Review

When planning bridge inspections, websites that display information on traffic restrictions caused by construction must be consulted. Inspection personnel must coordinate bridge inspection activities in construction zones with resident engineers.

3.2.2 Traffic Control Plans

When required, traffic control plans for bridge inspections should be prepared in consultation with ADOT District or LPA personnel. They must be submitted at least two weeks prior to the inspections and must be approved by the District or the LPA that have jurisdiction over the bridge. The approved traffic control plans should be sent to BIS for recordkeeping.

Table 3.1 - Description and Purpose of Various Documents

Document name	Description	Purpose
Bridge Inspection Cycle Form	Form with a reference number describing inspection of several structures by a given inspection team in a given time frame such as a week	Tracking of bridge inspection packet lifecycle (see section 3.5)
Summary of Bridges Inspected List	Listing of several structures inspected in a packet	Informs BIS of the task completed, repairs / maintenance items recommended and distribution of copies of the report to various stakeholders
Structure Inventory and Appraisal (SI&A) Report	Form including all coded NBI items and Arizona Items	Quick review of all structure information in coded form
Inspection Report	Key part of inspection documents with element condition rating and notes	Review of all structure member conditions
Repair Report	List of applicable repairs recommended with assigned priorities	Informs the structure owner of the needed repair items and priorities.
List of Maintenance Items	List of applicable maintenance items recommended.	Informs District maintenance units / structure owners of the needed maintenances.
Vertical and Horizontal Clearance Diagram	A drawing of plan and elevation views of a bridge with vertical and horizontal clearance measurements provided for vehicular or RR traffic.	Advises Class C Permits and informs traveling public via posting of clearance signs
Channel Profile Diagram	This diagram graphically and numerically documents the cross-section profile underneath the bridge.	For bridge hydraulics or scour evaluation.
Sketches	Prepare whenever they are needed.	To better illustrate a condition encountered during the field inspection.
Inspection Photographs	Photos taken of the structure and its components during an inspection	The photos include some standard photos and others showing a defect supporting the inspection and repair/maintenance reports.

For more details, see Chapter 4.

3.2.3 Record Drawing Updates

Bridge inspectors should gather all missing bridge documentation such as record drawings for existing and new structures and determine if any structure was retrofitted, repaired or rehabilitated and include project plans in the bridge file. The plan information on the inside cover of the inspection folder should be updated accordingly. If the structure was replaced, a new folder and a set of plans must be obtained, in addition to the request for a new structure number as well as retiring the replaced structure.

3.2.4 Railroad Permits

Prior to inspecting bridges which carry or cross over railroad tracks, a permit may need to be obtained from the railroad company. For routine inspections, ADOT has obtained a systemic permit from railroad companies to inspect those bridges. Bridge inspectors should check the availability of such permits. In general, when the bridge carries the railroad tracks, the railroad company would be the bridge owner (NBI item N22 = 27). When the bridge spans over the railroad tracks, both ownership and maintenance responsibility belong to the state or the LPA, and NBI items N21 and N22 should be coded accordingly.

3.2.5 Canal Bridge Inspection

Inspections of canal bridges are best performed during canal dry out periods. Inspection personnel should contact the canal owner for these periods prior to inspections and strive to schedule inspections of canal bridges during dry out periods.

3.2.6 Border Bridges

Jointly owned border bridges with California, City of Needles, and Nevada are inspected by Caltrans or NDOT under the terms of Intergovernmental Agreements between Arizona and these entities. Inspection reports and data must be obtained and documented in Arizona bridge inventory.

3.2.7 Safety Compliance

It is imperative that bridge inspection personnel, whether ADOT or consultants, comply with all of ADOT safety policies at all times including but not limited to, wearing hard hats, steel toed boots and safety vests.

3.3 FIELD INSPECTION

During a Field Inspection, team members should adhere to the following:

- Remain within the limits of the right of way.
- When specifying traffic directions on the state highway system, the highway's cardinal direction should always be used instead of the compass direction. For example, I-10 from Phoenix to Tucson is EB (cardinal) direction although actually it is in north to south compass direction.

Compass directions should be used when specifying all locations other than the state highway system.

- In the event of the discovery of a new structure that qualifies for the NBIS, inspection personnel should perform an initial inspection of that structure while in the field. Afterwards, the BIS office technician should be informed of existence of the new structure. A new structure number will be assigned and a skeleton record will be created in the database. At this point, the inspection team shall update the database with the information gathered in the field and generate all necessary inspection documents.
- When inspecting a structure with no record drawings, inspection personnel should prepare elevation, plan, and cross-section details for conducting a load rating analysis in addition to obtaining all required NBI information.
- The inspector must alert Bridge Inspection Program Manager whenever a bridge element has deteriorated or has been damaged to an extent where a new load rating must be performed. A review of Load Rating Report could provide valuable information about critical bridge elements and locations. An increase in overlay thickness could also justify the need for a new load rating. See Figure 3.3 for Load Rating Summary Sheet.
- In the event that a scour plan of action (POA) does not reflect field current conditions, the inspector must alert Bridge Inspection Program Manager. See Appendix B for a sample POA.

3.4 CHARACTERIZATION OF CONCRETE DETERIORATION

Use the following terms, which are found in the FHWA Bridge Inspector's Reference Manual, when describing crack width, scaling or spalling of concrete elements:

Crack Widths:

Describing cracks should include length, width, location, and intensity (few, numerous, etc.). To maintain consistency, it is essential to document crack width in the inspection notes using the following table:

Table 3.4.1 – Crack Size in Reinforced / Pre-stressed Concrete

Crack Size	Crack Width, inches - Reinforced	Crack Width, inches - Pre-Stressed
Insignificant	<0.012	<0.004
Moderate	0.012 - 0.05	0.004 - 0.009
Wide	>0.05	>0.009

Concrete Scaling:

Scaling is the condition of concrete with gradual and continuing loss of mortar and aggregate over an area due to the chemical breakdown of the cement bond. Scaling is classified according to the following table:

Table 3.4.2 – Concrete Scaling Categories

Scaling	Loss Depth, inches	Description
Light/Minor	1/4	surface exposure of coarse aggregates
Medium	1/4 to 1/2	mortar loss between the coarse aggregates
Heavy	1/2 - 1	clearly exposed coarse aggregates
Severe	>1	reinforcing steel is usually exposed

Concrete Spalling and Pop-out:

A Spall is a circular or oval depression in concrete caused by separation of a portion of the concrete surface. A Pop-out is usually a funnel-shaped cavity found in a horizontal concrete surface that occurs after a near-surface aggregate particle has expanded, then fractured. Spalls and Pop-outs are classified in the following table:

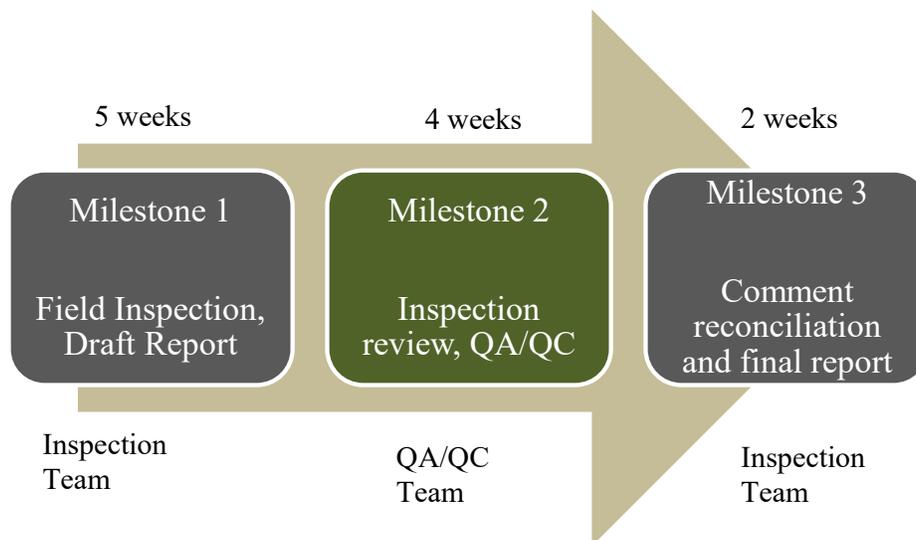
Table 3.4.3 Concrete Spalling and Pop-out

Defect	Depth, inches	Diameter, inches
--------	---------------	------------------

Pop-out	Near surface	From <0.5 to several
Spalling - Small	1/4	≤6
Spalling - Large	1/4 to 1/2	>6

3.5 BRIDGE INSPECTION LIFECYCLE

When planning an inspection, inspection teams shall assemble bridges into packets. The lifecycle of a packet consists of the following milestones:



The completion of the field inspection of the first bridge in a packet marks the beginning of the 11-week lifecycle of a bridge inspection packet. This lifecycle procedure applies to all inspections, whether performed by in-house staff or consultants, and shall be observed unless an exemption is granted by Bridge Inspection Program Manager.

3.6 CRITICAL FINDINGS

3.6.1 Definition, Purpose and Reporting Responsibilities

Critical Findings are defined as a structural or safety related deficiency that is discovered during a routine, in-depth or fracture critical bridge inspection which requires immediate follow-up inspection or action of the bridge. The main purpose of Critical Finding is to bring those deficiencies to the attention of responsible parties and cause actions are undertaken immediately to restore service on that bridge or safeguard the travelling public using it.

It is the responsibility of the bridge inspector to note, evaluate, and notify. It is the responsibility of

the bridge owner to respond, protect the public and fix the deficiency in a proper and timely manner. The bridge owner must notify FHWA of the situation and actions taken to resolve problems including monitoring of the critical findings. The bridge owner, if a self-inspecting LPA, must inform ADOT of such findings and monitoring or actions taken to remedy the situation. The bridge owner must also periodically update FHWA of the progress made until the deficiency is removed.

3.6.2 Critical Finding Applicability

Critical findings shall be issued when, as a minimum but not limited by one of the following conditions exists:

For a bridge or a culvert:

- a. A partial or complete bridge collapse
- b. Structural or other defects posing a definite and immediate public safety hazard
- c. A condition rating of 2 or less for NBI item 61 (*channel and bank protection*)
- d. An appraisal item 113 (*scour critical*) rating of 2 or less
- e. A load rating (NBI item 66) of less than 3 tons

For a bridge:

- f. A condition rating of 2 or less for any of the following bridge components: NBI items 58 (*deck*), 59 (*superstructure*), and 60 (*substructure*)

For a culvert:

- g. A condition rating of 2 or less for culvert component 62

These conditions may require closure or partial closure of a bridge for the immediate follow-up measures to be taken.

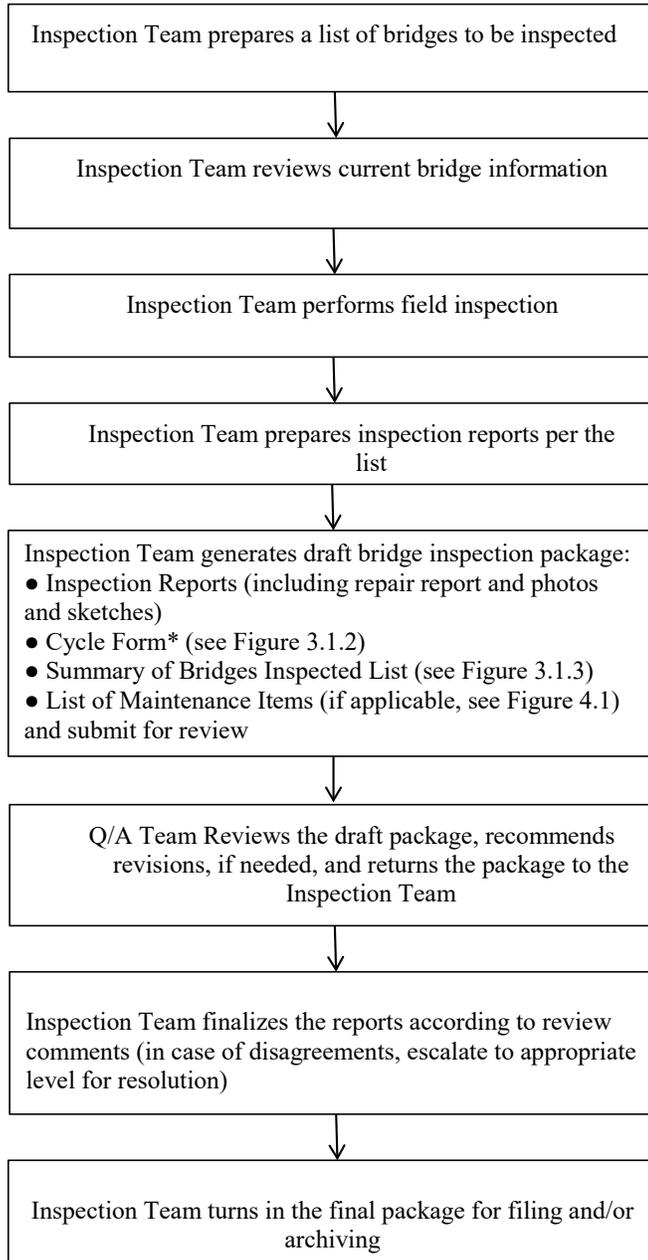
3.6.3 Critical Finding Procedures

1. The inspector discovering the critical finding shall immediately report the finding to Bridge Inspection Program Manager and notify responsible ADOT Maintenance District or bridge owner to immediately close the bridge or partially barricade the bridge, pending a closer inspection results.
2. The inspector shall complete the bridge damage inspection report describing the critical findings and submit a copy to Bridge Inspection Program Manager and responsible Maintenance District or bridge owner within 48 hours of the findings.

3.7 COMPLEX BRIDGES

The National Bridge Inspection Standards (NBIS) defines complex bridges as movable, suspension, cable stayed, and other bridges with unusual characteristics. There aren't any Complex Bridges in Arizona at current time.

Figure 3.1a – ADOT Bridge Inspection Flowchart



*Cycle Forms shall always be prepared by ADOT staff.

Figure 3.1b – Bridge Inspection Cycle Form

BRIDGE INSPECTION CYCLE			
TEAM: <input style="width: 40px;" type="text"/>	MAINT ORG: <input style="width: 40px;" type="text"/>	PACKET NUMBER: <input style="width: 40px;" type="text"/>	
ROUTE NUMBER: <input style="width: 40px;" type="text"/>		NO. OF FILES IN PACKET: <input style="width: 40px;" type="text"/>	
Begin MP <input style="width: 40px;" type="text"/>	End MP: <input style="width: 40px;" type="text"/>	AGENCY NAME: <input style="width: 80px;" type="text"/>	
<input type="checkbox"/> Check here if this is a partial local agency packet: <input type="checkbox"/> Check here if location map included:			
PHASE I			
1. FILE CHECK OUT DATE: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
PHASE II			
2. FIELD INSPECTION DONE: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
3. FILE ASSEMBLY, PHOTOS DONE: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
4. FORWARD PACKET FOR REVIEW: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
PHASE III			
5. REVIEW COMPLETION DATE: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
6. RETURN TO TEAM FOR CORRECTIONS: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
7. TEAM REVISIONS COMPLETION DATE: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
PHASE IV			
8. RETURN FILES TO FILE SYSTEM: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
9. PREPARE TRANSMITTALS: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
10. TRANSMIT REPORTS TO CUSTOMER: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
PHASE V			
11. ADD TO BG-IDMS: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
12. REVIEW OF BG-IDMS DOCUMENTS ADDED: <input style="width: 40px;" type="text"/>	BY: <input style="width: 40px;" type="text"/>		
REMARKS:			

Notes:

1. Cycle Forms and Summary of Bridges Inspected Lists should list the same bridges.
2. Each Cycle Form should contain bridges owned by only one Agency. For State Bridges, Cycle Forms should be generated by single Maintenance Organization number and bridges should be listed in Remarks section by ascending milepost order. Local Agency bridges will be listed in Remarks section in sequential order of bridge number. Cycle Forms will be created by in-house teams having responsibility over the region where the bridges are located. Generally, no more than 15 bridges should be listed on one Cycle Form (this also applies to Summary of Bridges Inspected List).
3. Initial Inspections should not be mixed with other inspections and are commonly listed in a separate Cycle Form.
4. Remarks of Cycle Form should contain the type of inspection and the name of the inspectors.

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Fig. 3.3 – SAMPLE OF LOAD RATING REPORT

ARIZONA DEPARTMENT OF TRANSPORTATION
BRIDGE GROUP
Bridge Technical Section
Bridge Rating Report



I. General Information

Structure No. 515	Structure Name: Fine Wash Bridge	Rated By: Masudur Rahman, PE
Route: US70	Location: 34.60 mi W of Jct US191	Date of Rating: 03/03/09
Mile Post: 304.85	Owner: ADOT	QA/QC By: M. Amin Islam, Ph.D., P.E.
District: Safford	Year Built: 1932	Date of QA/QC: 03/31/09
County: Graham	Year of Reconst.: 1958	

II. Rating Data

Structure Length: 112 feet	Deck/Slab Thickness: 17.50 inches
Structure Type, Main: 1 01; Concrete Slab	Deck Concrete Strength: 2.60 ksi
Original Design Vehicle: HS20-44	Deck Reinforcing Steel: 40.00 ksi
Rating Vehicle: HS20-44	Prestress Strands: NA

Rating Method	Inventory Rating				Operating Rating			
	Factor	NBI Code N66	Location from Begin of Str. (feet)	Limit State	Factor	NBI Code N64	Location from Begin of Str. (feet)	Limit State
LFD	0.93	2 - 33	11.00	Ult. Moment	1.55	2 - 66	11.00	Ult. Moment
ASD		2-17	From BMS File			2-35	From BMS File	

III Computer Program

Software Used: **Virtis 6.0.0** Data Base File: **VirtisBridges9_60.db** Structure Model ID: **515**

IV. Comments

AC Overlay: 5 inches;

Bridge Span Configuration: **5 Spans: 5 @ 22' - 0**

CHAPTER 4 BRIDGE INSPECTION DOCUMENTS

Bridge Inspection Documents must be written using appropriate technical terminology. They should not contain abbreviated text. Inspectors' personal notebooks may contain those abbreviations; however, inspectors should refrain from using any abbreviation in all formal documents that is associated with the bridge inspection. Common acronyms may be used.

The following bridge inspection documents are normally produced as a result of an inspection:

- Structure Inventory and Appraisal (SI&A) Report
- Inspection Report
- Inspection Photographs
- Repair Report (if applicable)
- List of Maintenance Items (if applicable), see Figure 4.1
- Vertical and Horizontal Clearance Diagram (if applicable)
- Channel Profile Diagram (if applicable)
- Sketches (if applicable)

A description of each of the above documents follows. In addition, a sample of each of these documents is included in Appendix A.

4.1 STRUCTURE INVENTORY AND APPRAISAL (SI&A) REPORT

The SI&A document is a collection of bridge data that includes a large portion of the fields which constitute the NBI items. ADOT customized this NBIS required report by grouping like data together and adding Arizona Agency Items to it.

4.1.1 General Requirements

- When a dropdown list is provided within the inspection software, the user shall select the appropriate entry from the list. In the event that the list is missing an appropriate entry, the user shall notify the database administrator, in BMS, so that the list would be updated accordingly.
- NBI items N13a and N13b, LRS Inventory Route and Sub-route, are globally populated by the database administrator.
- When coding NBI item N28a (lanes on), count and record lanes that carry actual traffic only. A temporarily closed lane, i.e., for construction purposes, shall be counted. Lanes that are not in use, including median lanes, shall not be counted.
- Arizona item A207 (inspection quarter field) shall not be altered. Arizona item A228 (next inspection due date) should be equal to NBI item N90 (current inspection date) plus NBI item N91 (inspection frequency).

- Arizona item A235 must only be set to “Active” after the initial inspection has been reviewed and finalized.
- During the initial inspection of a structure that was replaced, Arizona item A300 must contain a reference to the number of the retired (replaced) structure. Also, prior to designating the replaced structure as “Retired” under Arizona item A235, item A300 must contain a reference to the new structure number.

4.1.2 Data to be updated by Bridge Management Section (BMS)

- Inventory – NBI and Agency Items
 - NBI item N31, Design Load
 - NBI item N63, Method Used for Operating Rating
 - NBI item N64, Operating Load Rating
 - NBI item N65, Method Used for Inventory Rating
 - NBI item N66, Inventory Load Rating
 - NBI item N70, Bridge Posting
 - Arizona item A222, Load Rating Date and Initials

4.1.3 Data to be updated by Bridge Hydraulics Section (BHS)

- Appraisal
 - NBI item N113, Scour Critical
- Inventory – Agency Items
 - Arizona item A221abc, Scour Countermeasure (Flow-Floor-Bank)

4.1.4 Common Data Entry Errors

- NBI item N5d, Inventory Route Number, is a 5-digit long numerical field and should start with leading zeros as needed. For example, use “00008” for I-8, “00010” for I-10, “00089” for 89A, “00101” for Loop 101, etc.
- Proposed Project Information, NBI items N75a, N75b, N76, N94, N95, N96 and N97, must be coded for any structure with a Sufficiency Rating of 80 or less; NBI item N97 shall indicate a date within 8 years from the current inspection year. Otherwise, the inspector must update this item.
- When a required posted weight limit sign is missing, NBI item N41 (structure open, posted, or closed traffic) shall be coded as “B”. A new repair recommendation to replace the missing sign should be created.

NBI item N49, Structure Length, should be 20 feet or greater when NBI item N112 (NBIS bridge length) is coded “Long enough”.

4.2 INSPECTION REPORT

4.2.1 General Requirements

The Bridge Inspection Report documents all of the observations that are made during the field inspection. Bridge inspection reports must be sealed and signed by a certified NBIS bridge inspection team leader who is a Professional Engineer licensed in civil or structural engineering by Arizona Board of Technical Registration.

4.2.2 NBI Bridge Condition Ratings

Condition Ratings shall be assigned based on the overall condition of the bridge element and not on a localized area. Any one point increase or decrease in condition ratings should be documented in the related element notes section. Element quantities and condition states must be updated accordingly, to maintain consistency between the two rating methods.

Inspection personnel should consult with a Bridge Inspection Program Manager whenever a condition rating is being modified by two points or more.

The Bridge Inspection Program Manager must be notified when an overall condition rating is 4 or less.

When bridge elements are not visible, inspectors should maintain previously documented condition ratings unless actions were taken to improve the condition of the element since the last inspection. Those actions must be documented in the inspection report and bridge file. A note clarifying that the element is not visible or accessible should also be added. A common example is when a bridge deck is asphalt overlaid since the last inspection.

The condition rating of 9 should only be used when describing excellent element conditions for newly built structures.

4.2.3 Sufficiency Ratings

Appropriate justification is needed in the event that:

1. The sufficiency rating significantly changes;
2. The structure is no longer classified as structurally deficient or functionally obsolete; or
3. The structure gains a structurally deficient or functionally obsolete classification.

4.2.4 Orientation and Elements Numbering

Piers and spans are usually numbered sequentially in the direction of increasing stations. Note that the first substructure element is referred to as abutment number 1 followed by piers numbered from 1 to the last pier ending in the last substructure element, abutment number 2. Therefore, span number 1 located between abutment number 1 and pier number 1 and span number 2 located between pier number 1 and pier number 2 and so on. Girders are numbered from left to right while looking towards increasing stations. This information should be consistent with record drawings.

The inspector should note that some existing bridge inspection documentation may not have

followed the convention stated above. In those cases, bridge inspectors should follow the existing convention for numbering abutments, piers, spans and girders to maintain consistency with past inspections. However, this inconsistency should be documented in the report for future reference.

4.2.5 Structure Component Rating

Additional guidance is provided below when documenting structure components.

4.2.5.1 Deck

- NBI item N58, Deck Condition Rating, shall be based on the deck top and the deck undersurface condition. The condition of asphalt or other type of overlays at the deck top should not be considered in the rating. Also, N58 coding should not be influenced by the condition of sidewalks, bridge railings, or deck joints.
- For culvert structures (NBI item N43b = 19), Deck Condition Rating, NBI item N58, shall always be “N”, regardless of fill height.
- NBI item N108 (Wearing Surface / Protective System), Arizona item A201 (Wearing Surface Thickness), and the inspection element protection items, such as Element 510, must be coded consistently. If applicable, inspection personnel should verify the measurement of the overlay thickness in the field. These items also apply to culverts with fill height < 2’.
- The condition of joints between approach slabs and roadway pavement should be documented under the joint element notes section.
- Deck Condition Rating of 4 or less should trigger a repair recommendation.

4.2.5.2 Superstructure

- For slab bridges, Superstructure Condition Rating (NBI item N59) shall match Deck Condition Rating (NBI item N58).
 - Overhead cable lines crossing over the structure should be documented under the inspection notes section. If applicable, the coding of NBI items N10 and N53, Minimum Vertical Clearance items, must be in accordance with the existence of such overhead utilities.
 - Pre-stressed concrete and reinforced concrete voided slabs /adjacent box beams or box girders shall be inventoried under elements 104 & 105 respectively. Reinforced concrete top flange (Element 16) shall be coded additionally for the top flange where traffic rides directly on the structural element regardless of the wearing surface or protection system used. See Figures 4.2.5.2a and 4.2.5.2b.
- Pre-stressed concrete segmental box girders shall be inventoried under element 104. Pre-stressed concrete top flange (Element 15) shall be coded additionally for the top flange where traffic rides directly on the structural element regardless of the wearing surface or protection system used.

4.2.5.3 Substructure

- Reinforced concrete abutment length (Element 215) shall be inventoried excluding any integral wing walls. See Figure 4.2.5.3.
- For non-waterway bridges, if the abutment slopes are armored, they shall be evaluated as slope protection. For waterway bridges, armored slope protection shall be evaluated as bank protection.

4.2.5.4 Waterway

- If scour around pier or abutment is discovered during the inspection, the inspector should notify Bridge Hydraulics Section by checking the “Copy to BHS” box on Summary of Bridges Inspected List, See Fig 3.1c. Therefore, any repair recommendation should be deferred to BHS and only a maintenance item should be recommended by the inspector. Bridge Hydraulics Section will determine whether the coding of NBI item N113 needs to be changed and prioritize any needed remedial actions.
- For all Scour Critical Structures (NBI item N113 = 3), the inspector should review the scour Plan of Action (POA). Bridge Inspection Program Manager shall be notified immediately in the event that a copy of the POA is missing from the bridge file or the POA needs to be updated.
- Comments relating to channel stability should refer to the comparison of current and historical measurements as documented on channel profile diagrams.

4.2.5.5 Roadway

- Erosion caused by roadway drainage must be documented. If it is significant, BHS should be notified.
- Settlement of approach slab must be documented. If it is equal or over ½ inch, BGS, Bridge Geotechnical Sections should be notified.
- Measured vertical under clearances must be shown on the vertical and horizontal clearance diagram. The minimum vertical under clearance, in each driving direction, must be noted under the inspection notes section.

4.2.5.6 Culverts

- NBI item N58 (Deck Condition Rating) shall always be coded as “N”.
- NBI item N36a, b, c, d, (Railings and Rail Transition / Approach Rail) should be coded as “N” unless the fill height is less than 2 feet.
- Culverts’ structure length, NBI item N49, should be measured parallel to the roadway centerline, regardless of the skew of the headwalls. The measurement should be made between the inside faces of the exterior end walls.

- NBI items N50a, N50b, N51, and N52, should be set to “0” unless the fill height is less than 2 feet.

4.2.6 Contents of Inspection Notes and Element Notes of AASHTOWare BrM

There are two types of note sections in AASHTOWare BrM for bridge inspectors to record the inspection observations made for each structure. One type of note section is Element Notes, and the other type is Inspection Notes.

Element Notes are a note section that is limited to a 4000-character length dedicated to condition states of each element based on observations and measurements in the field. Each element also can be documented for several potential defects and protection sub-elements, and each of them has its own note section of 4000-character length. Inspectors should accurately describe the element and concisely record the necessary information so that it leads to a proper evaluation of condition states of the element.

Inspection Notes is a note section that is limited to a 4000-character length, which includes specified items not covered by the Element Notes.

The specified items in Inspection Notes for **Bridges** are as follows:

1. Additional notes for deck, superstructure and substructure
 - Describe main and approach span superstructures, main and secondary members if applicable.
 - Describe substructure wing walls and slope protection.
 - List utility attachments, if applicable.
2. Waterway notes
 - Describe channel/bank protection condition and flow direction.
 - Describe scour countermeasures, such as aprons, flumes, dikes, etc., if applicable.
3. Roadway / Safety notes
 - List traffic signs, such as speed limit sign, weight limit sign, vertical clearance sign, etc.
 - Include vertical clearance measurement notes if applicable.
4. Miscellaneous notes
 - Describe the number and status of previous repair recommendations, and the number of current recommended repairs when it is applicable.
 - Describe the number and status of previous maintenance items, and the number of current recommended maintenance items when it is applicable.
 - For steel in-depth / fracture critical inspections, describe the access method, traffic control type and specialized equipment used.
 - List Photos taken for the inspection report.

The specified items in Inspection Notes for **Culverts** are as follows:

1. Additional notes for the culvert structure
 - Describe wing walls, headwalls, if applicable.
 - List utility attachments, if applicable.
2. Waterway notes
 - Describe channel/bank protection condition and flow direction.
 - Describe scour countermeasures, such as aprons, flumes, dikes, etc., if applicable.
 - Describe Inlet and outlet percent openings, and high water mark measurement below ceiling at inlet.
3. Roadway / Safety notes
 - List traffic signs, such as speed limit sign, weight limit sign, etc.
4. Miscellaneous notes
 - Describe the number and status of previous repair recommendations, and the number of current recommended repairs when it is applicable.
 - Describe the number and status of previous maintenance items, and the number of current recommended maintenance items when it is applicable.
 - List Photos taken for the inspection report.

4.2.7 Bridge Element Condition States

All bridge AASHTO elements are provided with a list of potential defects. In addition, protective systems such as asphaltic concrete on concrete deck, cathodic protection of rebar, and paint/oxide on steel elements are introduced as "sub-elements" with their own potential defects and condition state ratings.

The description of condition states for all elements, "sub-elements" and defects are provided in the following table:

Condition State	Description
1	Good
2	Fair
3	Poor
4	Severe

The condition ratings of all applicable NBI items or components are shown in the following table with their descriptions:

Condition Rating	Description
9	Excellent
8	Very Good
7	Good
6	Satisfactory
5	Fair
4	Poor
3	Serious
2	Critical

1	Imminent Failure
0	Failed
N	Not Applicable

Rating of bridge element condition states should be according to current AASHTO Manual for Bridge Element Inspection, and to the extent possible, be consistent with NBI item Condition Ratings.

4.3 REPAIR REPORT / LIST OF MAINTENANCE ITEMS

Repair recommendations should only be issued for valid and practical items that need to be repaired. Inspection personnel should keep in mind that they are performing safety inspection of bridges / culverts, and that repair recommendations that qualify under this criterion should be issued. Therefore, a repair recommendation to patch a spall that does not affect the structural integrity of a given bridge element should not be made. Likewise, a repair recommendation dealing with aesthetic treatment should not be made. Both of these examples should be noted as observations in the appropriate inspection notes section of the inspection report.

A repair recommendation should not be created for the following maintenance items:

- Protruding joint angles*
- Drainage grates, manhole and junction box covers*
- Tree branches, vegetation, or other obstruction protruding over bridge decks*
- Exposed wires, cables, etc.*
- Approach slab settlements
- Potholes in roadway approach or on bridge decks
- Joints between approach roadway and approach slabs
- Missing joint seals
- Damage to chain link and pedestrian fences
- Minor concrete spalls on bridge elements
- Damage to roadway drainage appurtenances
- Clogged drains
- Damage to roadway approach guardrail and end treatment
- Minor damage to bridge railings
- Cleaning debris around bearings
- Lighting fixtures, utility lines or casings
- Bird netting damage
- Cleaning of channel debris, vegetation growth, sediments, etc.
- Cleaning debris and sedimentation from culverts
- Graffiti removal
- Weed removal
- Irrigation system repair
- Minor erosion
- Minor damage to bank protection elements such as rail-banks, gabions, etc.

* This item may require immediate maintenance personnel notification depending on field conditions.

Maintenance items such as the ones listed above should be summarized in the List of Maintenance Items form. An example of this form is included in Appendix A. This list provides maintenance personnel with a summary of the maintenance items so that a thorough reading of the inspection report is not required. These maintenance items shall be also listed under the Inspection Notes section of the inspection report.

The inspector should consult with Bridge Inspection Program Manager prior to issuing a repair recommendation with a high repair task priority. In the event that the bridge must be closed, the inspector should contact the appropriate District or Local Agency depending on structure ownership. Then Bridge Inspection Program Manager should be informed.

Previously issued repair recommendations that were not implemented and are in accordance with these guidelines should be repeated. The inspector should not refer back to previous recommendations; instead new repair recommendations corresponding to the current inspection must be created.

4.4 CLEARANCE DIAGRAM

The clearance diagram shall graphically and numerically document lateral and vertical clearance measurements, locations, and posted vertical clearance signs. Measurements should be coded in the database in feet including decimal points; for example, 16.5 would be the correct coding for a 16'-6" measurement.

The following should be adhered to when preparing clearance diagrams:

- Vertical clearances shall be measured from items attached to the superstructure such as lights and signs if they result in lower vertical clearances. If measurements were copied from record drawings, the inspector must document same with a note below the diagram.
- Lateral under-clearance should be measured from edge of travel lane to:
 - The face of a rigid obstruction such as pier column or wall, abutment wall, faces of concrete barrier/parapet for relatively flat ground.
 - The toe of slopes steeper than 1:3.
- When updating previous measurements, and in the event those are different, the inspector should cross-out the existing value and write the updated value next to it. If certain measurements cannot be taken due to inaccessibility or other reasons, previous values should be transferred to the new diagram and should be clearly labeled.
- The inspector should create a new clearance diagram whenever the existing diagram becomes crowded or difficult to read.

4.5 VERTICAL CLEARANCE SIGN

Vertical Clearance Signs are required if the measured minimum vertical clearance is equal or less than 16'-3". A repair recommendation should be created stating that a vertical clearance sign is needed and specifying the clearance as the measurement minus 3". The 3 inch is a buffer zone accounting for vehicle bounce.

When a new Vertical Clearance Sign measurement conflicts with an existing posted sign, the inspector should consult with Bridge Inspection Program Manager prior to issuing a repair recommendation.

When a Vertical Clearance Sign is required for a structure that spans over both traffic directions, one of the two following cases shall apply:

1. No raised median: posted signs in both direction of traffic should reflect the same minimum vertical clearance.
2. Raised median: each direction of traffic may have a different vertical clearance sign.

Posting a Vertical Clearance Sign, where two or more structures are located along the same road in parallel and close to each other is governed by the lowest vertical clearance measurements amongst the structures. In this case, the inspector must clearly document the structure that controls the vertical clearance on all structures diagrams, and address this fact in the inspection notes section. It may be noted that in case of several parallel structures, a vertical clearance sign may be posted on a structure not because it has the lowest vertical clearance, but due to its location at one end of the parallel structures.

4.6 CHANNEL PROFILE DIAGRAM

This diagram shall graphically and numerically document the cross-section profile underneath the bridge. The diagram is not required for concrete lined channels.

The following should be adhered to when preparing channel diagrams:

- The inspector should make every effort to maintain up to five successive inspection records of the same points on the same sheet to allow for a better understanding of changes in the channel profile over time.
- Vertical measurements under bridge should be taken at intervals of quarter spans and should be from the lowest member of the superstructure to the channel bottom. For spans shorter than 40 feet, the inspector may omit quarter and three-quarter point measurements.
- If measurement is not possible under the bridge usually due to inaccessibility, inspectors can measure from the top of the deck by subtracting the depth of the superstructure from the measured value.
- Typically, these measurements should be taken at the upstream or downstream side of the bridge, depending on the condition of channel in the field, and the chosen side should be noted on the diagram. It is important to consistently take measurements on the same side of the bridge for a better understanding of changes in the channel profile over time.

The inspector should create a new Channel Profile Diagram whenever the existing diagram becomes difficult to read or has no space to record new profile measurements.

4.7 SKETCHES

Sketches should be prepared whenever they are needed to better illustrate a condition encountered during the field inspection. A field condition that cannot be appropriately documented with photographs and written observations would require a sketch to be generated. An example of a needed sketch is when the inspector is trying to report deteriorated areas of a bridge deck. A sketch could delineate and show dimensions of all affected areas. Another situation that may require a sketch is collision damage to a girder. A sketch could show location of multiple damaged areas.

Appendix A has an example of an inspection sketch.

4.8 INSPECTION PHOTOGRAPHS

4.8.1 General

Photographs shall be obtained identifying the bridge roadway (Roadway ID), bridge elevation (Elevation ID), typical deck top condition (including culverts with less than 2 feet of fill height), typical soffit condition, typical expansion or hinge joints if applicable, bridge elements requiring repair or maintenance, and any additional necessary features (such as weight limit signs, vertical clearance signs, etc.). The first five photographs are referred as the standard required photographs for all bridges.

Previously recommended repairs that were completed since the last inspection should also be documented through photographs.

Inspection personnel must not include excessive number of photographs in the inspection reports. For example, a single typical photograph of similar cracks would suffice.

4.8.2 Guidance for Inspection Photographs

1. Inspection personnel should strive to obtain the best possible photographs with utmost clarity and exposure.
2. With the exception of standard required photos, other photographs should not be included unless they are being referenced in the inspection report.
3. When taking a photograph documenting the roadway or the elevation, it is useful to select an opposite direction to the previous inspection photograph.
4. Roadway photographs should clearly show all lanes on the structure wearing surface. If there are two directions of travel, then the photograph should show both directions on the structure. For unusually wide structures, a separate photograph for each direction of travel may be taken instead and appropriately labeled.
5. Inspectors should not refer to photographs taken during previous inspections. Instead, new photographs should be taken.
6. Whenever an element requires repair, a photograph should be taken and referred to in the text of the repair recommendation as well as the inspection report.

7. If the structure is posted for weight limit signs, vertical clearance signs or other restrictions, include photographs from both approaches showing said restrictions.
8. Whenever a previously suggested repair is complete, a photograph must be taken to document said completion. In addition, the inspector should document said completion with a statement in the inspection report.
9. A list of all photographs that were taken during the inspection shall be included as a last item under the inspection notes section of the inspection report. The list should be sequential and should contain the description of each photograph.

4.8.3 Digital Photograph Naming Convention

All photograph file names must contain 24 digits/characters plus “.jpg”. The first 5 digits should indicate the structure number including leading zeros (type the number “0” not the letter “O”). The 7th through 16th digits should indicate the inspection date. The 24th and 25th digits use of letters of the alphabet is being replaced with sequential numbers (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,....., 26, 27, 28, 99). Utilize category INSPECTION option from Multimedia – Context of BrM software for linking photographs to a given inspection date.

Examples:

- During the November 15th, 2019 inspection of structure number 1280 (4 digits), five photographs were taken. The five file names should be:

01280-2019-11-15-Photo-1.jpg
 01280-2019-11-15-Photo-2.jpg
 01280-2019-11-15-Photo-3.jpg
 01280-2019-11-14-Photo-4.jpg
 01280-2019-11-14-Photo-5.jpg

- During the December 18th, 2019 inspection of structure number 25 (2 digits), thirty photographs were taken. The thirty file names should be:

00025-2019-12-18-Photo-1.jpg
 00025-2019-12-18-Photo-2.jpg
 00025-2019-12-18-Photo-3.jpg
 00025-2019-12-18-Photo-4.jpg
 00025-2019-12-18-Photo-5.jpg
 00025-2019-12-18-Photo-6.jpg
 00025-2019-12-18-Photo-7.jpg
 00025-2019-12-18-Photo-8.jpg
 00025-2019-12-18-Photo-9.jpg
 00025-2019-12-18-Photo-10.jpg
 00025-2019-12-18-Photo-11.jpg

 00025-2019-12-18-Photo-28.jpg
 00025-2019-12-18-Photo-29.jpg
 00025-2019-12-18-Photo-30.jpg

- During the January 8th, 2020 inspection of structure number 20001 (5 digits), four photographs were taken. The four file names should be:

20001-2020-01-08-Photo-1.jpg

20001-2020-01-08-Photo-2.jpg

20001-2020-01-08-Photo-3.jpg

20001-2020-01-08-Photo-4.jpg

4.8.4 Other Naming Conventions for Documents stored in BrM

All file names must contain first 16 digits/characters of digital photograph naming convention (structure number plus date) plus category plus “.pdf”. This assumes all these documents are saved as a pdf file. Do not use underline character (_) for dash (-).

4.8.4.1 Category INSPECTION option from Multimedia in BrM software

This is intended for documents belonging to a particular inspection date. See the following example of documents and their related naming conventions:

For January 14th, 2015 inspection of structure #869:

- Camera location sketch was prepared. The file name should be:
00869-2015-01-14-Sketch.pdf
- Channel profile was prepared. The file name should be:
00869-2015-01-14-Channel Profile.pdf
- Clearance Diagram was prepared. The file name should be:
00869-2015-01-14-Clearance Diagram.pdf
- Report supplement was prepared. The file name should be:
00869-2015-01-14-Report Supplement.pdf
- Miscellaneous (any document other than above). The file name should be:
00869-2015-01-14-Miscellaneous.pdf

4.8.4.2 Category BRIDGE option from Multimedia in BrM software

This is intended for documents belonging to the life of a bridge. See the following example of documents and their related naming conventions:

For May 10th, 2010 inspection of structure number 869:

- Construction Plans were prepared. The file name should be:
00869-2010-05-10-Plans-Record Drawing-Original Construction.pdf
- Bridge Load Rating Summary was prepared. The file name should be:
00869-2010-05-10-Load Rating.pdf
- Fracture Critical Inspection Procedure was prepared. The file name should be:

00869-2010-05-10-Fracture Critical Procedure.pdf

- Plan of Action for Scour Vulnerable Bridges was prepared. The file name should be:
00869-2010-05-10-POA for Scour.pdf
- Miscellaneous (any document other than above). The file name should be:
00869-2010-05-10-Miscellaneous.pdf

Figure 4.1 – List of Maintenance Items

**Arizona Department of Transportation
Bridge Group
List of Maintenance Items**

Str. No.	Structure Name	Rt.	MP	Description of Maintenance Items

District/LPA:		Org. Number:		Packet Number:	
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Inspected by:	Date:
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Procedure for Some Superstructure and Substructure Elements

Superstructure

- Pre-stressed concrete and reinforced concrete voided slabs shall be inventoried under elements 104 & 105 respectively. Reinforced concrete top flange (Element 16) shall be coded where traffic rides directly on the structural element regardless of the wearing surface or protection system used.

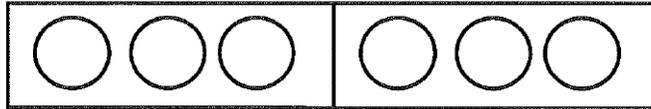


Figure 4.2.5.2a - Reinforced Concrete / Pre-stressed Concrete Voided Slab

- Reinforced Concrete Top flange (Element 16) shall be coded for all pre-stressed & RC concrete girders where traffic rides directly on the structural element regardless of the wearing surface or protection system used. Pre-stressed Concrete Top flange (Element 15) shall be coded only for segmental pre-stressed concrete girders.

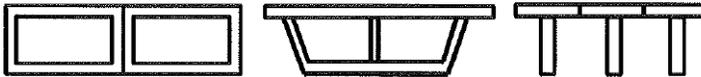


Figure 4.2.5.2b - Reinforced Concrete / Pre-stressed Concrete Girders

Substructure

- Reinforced concrete abutment (Element 215) length shall be inventoried without wingwalls regardless of connection type (integral or jointed).

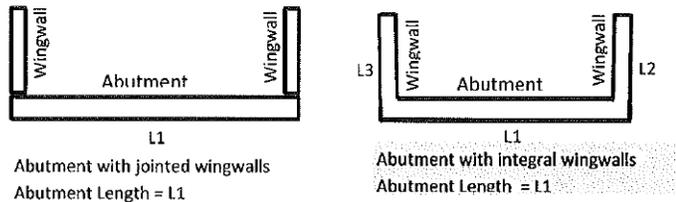


Figure 4.2.5.3 - Reinforced Concrete Abutment Walls & Wingwalls

CHAPTER 5

QUALITY CONTROL AND QUALITY ASSURANCE

5.1 INTRODUCTION

Quality Control and Quality Assurance are integrated into all aspects of bridge inspection. They contain the essential requirements to demonstrate that care, skill, and diligence is used in the preparation of bridge inspection report.

The quality of the bridge inspection program will be controlled through regularly scheduled training workshops, random office review of inspection documents, independent and concurrent field review of inspections, and independent field inspection conducted specifically for calibration purposes. In addition, the FHWA conducts an annual review of the bridge inspection program.

5.2 QUALITY CONTROL ENGINEER / QUALITY ASSURANCE ENGINEER

The quality control engineer's responsibilities include but not limited to the review of the inspection reports, review of inspection methods in field, and performing quality assurance work. Quality control engineer should not be the same person as the team leader being reviewed. Quality control engineer should have extensive experience in the bridge safety inspection area and should be familiar with inspection procedures and requirements.

The quality assurance engineer is responsible for ensuring that the defined quality control procedures are enforced.

5.3 REVIEW SELECTION ON INSPECTION DOCUMENTS

Independent office review of bridge inspection documents will be performed to enhance quality assurance. Quality control engineers must select at least 10% of each packet of bridges to be reviewed. All inspection packets shall be reviewed regardless of bridge ownership and whether ADOT personnel or consultants performed the inspections. The following are some of the criteria that shall be used when selecting inspections to be reviewed:

- Initial Bridge Inspections
- Bridges designated as Structurally Deficient
- Bridges with Fracture Critical Members
- Bridges with one or more condition rating that changed by 2 points or more
- Change in sufficiency rating prefix (i.e., from blank to S or F, or vice versa)
- Change in vertical or horizontal clearance that may affect NBI items
- Bridges in need of changing vertical clearance signs
- Bridge inspections that include repair recommendations

5.4 REVIEW INSPECTION DOCUMENTS

Quality control engineers shall indicate on the draft inspection report any incorrect coding and corrections found. In case of on-call consultants, quality control engineers shall summarize findings from the reviews into a document, and return the document to the inspectors for

correction. See the example in Figure 5.4. Quality control engineers shall summarize findings from the review, and assist the bridge inspection program manager in developing a training plan which will ensure these errors will not be repeated.

The quality control engineer's review includes but not limited to the following:

1. Overall review of the inspection report to ensure that the correct structure is identified. This includes a check that correct bridge has been identified through examination of information such as structure number, structure name, route, mile post, and location. Further detail review should assure all required information has been entered correctly in accordance with the FHWA coding Guide. This review includes but not limited to a check those proper coding conventions, formats, correct significant digits and units have been used.
2. Check the condition ratings of items 58 through 62 for consistency with the element ratings. The element inputs should be reviewed for accuracy, including elements numbers, units and quantities under different condition states.
3. Check all photographs and/or sketches for proper cross referencing to the inspection report.
4. Check consistency of information between the current inspection report and pervious inspection reports, load rating report, plan of action, and/or the fracture critical inspection plan/field sheet, if applicable.
5. Review all items in the SI&A to check they have been properly and correctly entered.
6. Check the inventory data on the SI&A against the record drawing to ensure that the data is consistent.

5.5 REVIEW COMMENT CORRECTION

Bridge inspection personnel are reminded that assuring quality during their field inspection and throughout their documentation is their responsibility.

The independent office review of bridge inspections is provided to maintain consistency throughout the state and shall not replace the due diligence that an inspector must exercise while performing and documenting each bridge inspection.

Review corrections should be implemented prior to sealing and signing reports. Inspection personnel should strive to maintain objectivity and factual reporting of field observations. While some relevant comments with professional judgment are desirable and made to pinpoint source of a potential problem area, subjective reporting and editorializing of review comments are not acceptable.

Special attention should be accorded to pattern errors. Since the review may not entail every inspection report in a submitted packet, some errors may be repeated in non-reviewed reports. Therefore, the inspector must correct non-reviewed reports for similar types of comments.

5.6 FIELD INSPECTION REVIEW

At least once every year, the Bridge Inspection Program Manager and the quality control engineer should randomly choose at least five structures to review in the field for each inspection team. The composition of these structures shall represent a cross-section of bridge types inspected.

The quality control engineer shall keep a logbook of the dates, review team, and Bridge Inspection Quality Assurance Review Form (See Figure 5.6) and shall have the logbook available to present to FHWA on the occasion of FHWA annual review.

5.7 TRAINING WORKSHOP

To minimize common mistakes and omissions from structure inspections, at least once every year, Bridge Inspection Program Manager should establish a training workshop to all bridge inspection personnel by utilizing the training plan developed in consultation with quality control engineers.

The plan should address concerns and not be limited to the following:

- Changes to the coding guide
- Changes to the element coding
- Changes to the bridge management software
- Changes to structures inspection scheduling
- Common errors or problems occurring due to inspectors' inputs or the software

The Training Workshop should include inspectors' views and observations in the field which may help to improve quality of the inspection reports.

Figure 5.4 - On-call consultant review comments

RETURNED FOR CORRECTIONS

Team No.	4	Inspection Week	7/2/15	Packet No.	7313
Review Comments By & Date	HS	7/7/15	Date Returned to Team	7/7/15	
Corrections Completed By			Date Returned to Office		
Local Government	City of Yuma		Maintenance ORG No.		
Route	Milepost	To	No. of Files	1	

GENERAL NOTE: While inspecting structures, please remember to take photo for each repair item and refer to the photo when preparing inspection reports.

Structure No.	COMMENTS
8533	<p>SI & A None</p> <p>Inspection Report: <u>Comments above elements</u> Comment 3, 1st sentence: No evidence of testing of pins provided other than noting it was tested (when and by who not documented). See general note above. Comment 3, 2nd sentence: one new repair if abutment undermining is counted. Comment 8: Refer to maintenance item. Previous inspection maintenance item (removing debris from lower chord of deck truss) is not mentioned.</p> <p><u>Comments for Elements</u> FCM should be identified. Element 161: Refer to the pin tests if they were done for this inspection. Element 215, Comment 3: Since abutment is away from the river flow, it is preferred that its undermining does get described as erosion and not scour. Last sentence refers to a repair item which is not seen in the repair</p>

CHAPTER 6 INTRODUCTION

6.1— Introduction

6.1.1—History

Following the tragic ceiling collapse in the Interstate 90 Connector Tunnel in Boston, Massachusetts on July 10, 2006, the National Transportation Safety Board's Highway Accident Report, NTSB Number HAR-07/02, identified several safety issues including, "*Inadequate regulatory requirements for tunnel inspections*". On July 6, 2012, the President signed the Moving Ahead for Progress in the 21st Century Act (MAP-21), which requires the Secretary to establish national standards for tunnel inspections.

Specifications for the National Tunnel Inventory (SNTI) document was published in July 2015 by FHWA in coordination with the National Tunnel Inspection Standards (NTIS) regulation 23 CFR 650 Subpart E and the Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual.

Tunnel is defined per SNTI as "an enclosed roadway for motor vehicular traffic with vehicle access limited to portals, regardless of type of structure or method of construction. Tunnels do not include bridges or culverts inspected under the National Bridge Inspection Standards (23 CFR 650 – Subpart C – National Bridge Inspection Standards). Tunnels are structures that require, based on owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity."

ADOT currently has 4 active tunnels meeting the above definition in its tunnel inventory database. It is expected that this number will increase with passage of time.

6.1.2—Purpose

The tunnel database includes items that can be used to meet Federal reporting requirements, as well as part of the States' needs.

6.2—Inspection

6.2.1 - Introduction

Prior to 2015, ADOT inspected its tunnels as a bridge with N43b (Main Structure Type, Design) coded as “18” (Tunnel). Since then, they have been inspected with appropriate tunnel elements under 2015 NTIS. ADOT currently collects and maintains tunnel inventory and inspection data, addresses critical findings, and maintains a registry of certified tunnel inspectors within its jurisdiction. Reports and electronic files are generated to document the actions taken in response to the inspection findings. Health and safety procedures are in-place to protect the inspection team, tunnel facility personnel, and the users of the tunnel facility.

Some of the responsibilities of ADOT tunnel inspection program include:

- Establishing written policies and procedures.
- Maintaining tunnel inventory and inspection data.
- Regularly reporting NTI data to the FHWA.
- Maintaining qualification records of personnel including national inspector certification.
- Establishing an effective quality control and quality assurance program.

6.2.2 - Inspection Types and Frequencies

6.2.2.1 - Inspection Types

NTIS identifies several types of inspections that are regularly performed on highway tunnels similar to bridge inspection program. These inspections include initial, routine, damage, in-depth, and special inspections for tunnels. See Table 6.2.2.1.1 for tunnel inspection types.

6.2.2.1.1 Initial Inspection

An initial inspection should be performed on existing highway tunnels within the interval specified in the NTIS. On new tunnels, the initial inspection should be conducted after the completion of construction activities and the testing of functional systems but prior to opening the tunnel to traffic. At a minimum, the initial inspection should consist of a sufficient number of observations and measurements to determine the physical and functional condition of the tunnel. These inspections are intended to be comprehensive covering the structural, civil, mechanical, electrical and lighting, fire and life safety, security, signs, and protective systems. The results are to be recorded in accordance with the instructions contained in the SNTI. The initial tunnel inspection establishes the baseline conditions of the tunnel; and it is used to field verify the initial tunnel inventory data. The baseline results can be used to evaluate changes over time to the tunnel systems and to help identify trends.

6.2.2.1.2 Routine Inspection

Following the initial inspection, routine inspections are conducted within the intervals specified in the NTIS. Routine inspections are regularly scheduled inspections that help to ensure continued safe, reliable, and efficient service. These inspections are similar in scope to the initial inspection. Routine tunnel inspections record the changes to the tunnel over time and can be used to help identify trends and predict

future life expectancy of components. At a minimum, routine inspections consist of a sufficient number of observations and measurements that can be used to determine the physical and functional condition of the tunnel. These inspections are intended to be comprehensive covering the structural, civil, mechanical, electrical and lighting, fire and life safety, security, signs, and protective systems. The results are to be recorded in accordance with the instructions contained in the SNTI.

6.2.2.1.3 Damage Inspection

Damage inspections are performed in response to natural disasters or human activities that damage the tunnel. Damage may occur by motor vehicle impact, fire, flood, earthquake, vandalism or explosions. When severe damage occurs, the tunnel should remain closed until a damage inspection has been completed. Structural analysis and follow-up emergency repairs may be needed. Structural materials may need further evaluation as identified in the Manual for Bridge Evaluation (MBE). Safety is of paramount importance after an incident. Devices such as breathing apparatus, protective clothing, and specialized equipment may be necessary. Inspection work should be coordinated with emergency responders. It is important that the tunnel inspection organization develop detailed plans and conduct training exercises with tunnel facility personnel in advance of these events.

6.2.2.1.4 In-depth Inspection

In-depth inspections are close-up, hand-on inspections conducted on one, several, or all of the elements or functional systems. These inspections are used to identify deficiencies that are not readily detectable during initial, routine, or damage inspections. In-depth inspections may involve testing of tunnel system, components, and materials. More extensive disassembly and cleaning of equipment parts may occur. This type of inspection may be used to support a structural analysis or a functional system evaluation where more information is needed. In-depth inspections are scheduled based on the needs of the tunnel facility, inspection findings, and established written procedures.

6.2.2.1.5 Special Inspection

A special inspection is typically performed after an initial, routine, damage or in-depth inspection when significant deficiencies have been discovered and need to be monitored. Special inspections are scheduled based on the needs of the tunnel facility, inspection findings, and established written procedures. These types of inspections continue, but perhaps at adjusted intervals or durations, until the deficiency is repaired, the component is removed from service, or further study determines that the conditions are no longer deteriorating at accelerated levels. For example, a light fixture built of dissimilar metals and installed over traffic might have problems with excessive corrosion. As such, this light fixture may be monitored on a regular basis to ensure that it remains securely anchored and safe until repairs can be made.

Table 6.2.2.1.1 – Types of highway tunnel inspections

Inspection Type	Purpose
Initial	Establish the inspection file record and the baseline conditions for the tunnel.
Routine	Comprehensive observations and measurements performed at regular intervals.
Damage	Assess damage from events such as impact, fire, flood, seismic, and blasts.

In-Depth	Identify hard-to-detect deficiencies using close up inspection techniques.
Special	Monitor defects and deficiencies related to safety or critical findings.

Source: Tunnel Operations, Maintenance, Inspection, and Evaluation (TOMIE) Manual

6.2.2.2 - Inspection Frequencies

The interval requirements for initial inspection and routine inspections are contained in the NTIS. Table 6.2.2.2.1 summarizes these requirements. ADOT is responsible for establishing the inspection intervals for in-depth inspections based on the particular needs of the tunnel facility. Special and damage inspections are performed on as needed basis.

Table 6.2.2.2.1 – Interval period contained in the National Tunnel Inspection Standards

Inspection Type	Application	Interval
Initial	New tunnel Prior to opening to traffic to the public.	Existing tunnel Within 24 months of NTIS effective date.
Routine	Default condition	Every 24 months over lifetime of the tunnel.
	Approved written justification	Possibly allow extension up to 48 months.
In-depth	Complex tunnels and for certain structural and functional systems.	Level and frequency to be established by the program manager.

Source: Tunnel Operations, Maintenance, Inspection, and Evaluation (TOMIE) Manual

6.2.3 - Inspector Qualifications

The program manager and the team leader are specifically identified in the NTIS; other inspection personnel have been discussed in this chapter to include discipline specific specialists and field inspectors. ADOT may use specialized contract inspectors to assist with complicated or sophisticated tunnel systems. In accordance with the NTIS, an independent assessment is desired; therefore, the operating and maintenance personnel should not be used for inspection purposes.

6.2.3.1- Program Manager

The program manager is the individual in charge of the tunnel inspection program for State of Arizona that currently has four active tunnels in its inventory database. This person must be capable of leading the tunnel inspection organization and ensuring that the requirements of the NTIS are fulfilled. The program manager may delegate duties and responsibilities to qualified delegates who take charge of a particular subset of tunnels; however, the program manager remains responsible for ensuring compliance. The program manager develops written procedures, schedules inspections, procures inspection and safety equipment, coordinates with tunnel facility staff, and advises the team leader as necessary. Ideally, the program manager should have a general understanding of all aspects of tunnel engineering including design, construction, operation, maintenance, inspection, evaluation, load rating, and rehabilitation. Good judgment is essential for this position in order to respond appropriately to safety and structural concerns

within the tunnel. Refer to the NTIS for the complete requirements of this position. The program manager must be a registered professional engineer or have at least 10 years of tunnel or bridge inspection experience. This individual must also be a nationally certified tunnel inspector, which requires comprehensive training, end-of-course assessment, and periodic refresher training.

6.2.3.2 - Team Leader

The team leader is the person on-site who is in charge of the inspection team. This person is responsible for inspection planning, preparing, performing and reporting to include coordinating the field work. Refer to the NTIS for the complete requirements. The team leader is responsible for evaluating the deficiencies, quality checking of the inspection data, and making sure that the inspection reports are complete, accurate, and legible. The team leader should also conduct safety briefings as needed. The team leader should be able to provide recommendations for the repair of defective items and must initiate appropriate actions when critical findings are discovered. A team leader must be a nationally certified tunnel inspector. Additionally, the team leader is expected to meet at least one of the following:

- Registered professional engineer and at least 6 months of tunnel or bridge inspection experience.
- 5 years of tunnel or bridge inspection experience.
- Appropriate combination of education and experience as described in the NTIS.

In addition to the minimum requirements stated above, the team leader should be a professional engineer when the tunnel is complex or if it has distinctive features or functions. Team leaders must be on site at all times for initial inspections, routine inspections, and in-depth inspections.

6.2.3.3 - Inspection Assistance from Discipline Specific Specialist and Field Inspectors

Discipline Specific Specialist: When complex civil/structural, mechanical, or electrical systems need to be inspected, the team leader should assign discipline specific specialists with suitable training and experience to help conduct these inspections. Ideally, these specialist individuals should be registered professional engineers or at least engineers-in-training.

Field Inspectors: Field inspectors assist the team leader with the inspection work. Some duties of the field inspector include carrying inspection equipment, filling out inspection forms, taking photographs, and making sketches. Ideally, the field inspectors would have an engineering background with education, training, and experience within their respective fields of practice.

Discipline specific specialists and field inspectors should:

- Be knowledgeable of tunnel components and understand their function.
- Be able to climb and/or use equipment to access various areas of the tunnel.
- Be able to use equipment or apply appropriate test methods.
- Be able to print legibly and draw accurate sketches.
- Be able to read and interpret drawings.
- Be able to use appropriate technology as required for data collection.

6.2.4 – Inspection Procedures for Highway Tunnels

Qualified tunnel inspectors should conduct tunnel inspections and when needed, use assistance from qualified inspectors in other disciplines to complete the inspection tasks. The inspectors should be equipped with appropriate gear, e.g. hard hat, steel toe boots, and safety vests and other necessary equipment to access the tunnel elements. The inspectors should understand how defects impact the function and capacity of tunnel systems. They also should be able to recognize the common deficiencies that impact the structural, civil, and functional systems. The observations and measurements used to carry out the inspection should provide information on the overall safety and reliability of the NTI database regarding structural (elements, miscellaneous elements, and materials), civil, and functional systems.

ADOT will develop written inspection procedures for inspecting the elements defined by the SNTI per AASHTO Manual for Bridge Element Inspection (MBE). A number of material evaluation techniques are covered in the MBE. These include various field tests, material sampling, and laboratory tests. The MBE discusses field tests for concrete, steel, and timber.

Visual inspection is the first and the most important method. Once a defect or its indicator is observed, e.g. a crack or rust stain, other tests should be utilized to estimate size or confirm presence of the defect. General inspection techniques are discussed below for common structural materials (e.g., steel, concrete, timber, and masonry).

6.2.4.1– Structural Materials: Structural elements are comprised of materials like steel, concrete, timber, and masonry.

6.2.4.1.1 Steel Structures

Steel structures are affected by corrosion, cracks, buckles and kinks. Other defects may also be present such as leaks and protective system failures. Inspectors should be concerned with any crack in the steel member as serious. It should be reported right away and evaluated by an engineer. Look for cracks radiating from holes, cuts, notches, and welds. The inspectors also should be concerned with corrosion and pitting in the steel member as the end result. The inspectors should look for any buckles and kinks which can be attributed to damage from collision, fire, or soil interaction. Steel is impermeable; however, leaks can occur where water is able to penetrate through joints, cracks, or holes in the steel. The joints, joint seals, gasket materials, and welds should be checked to determine if they are defective.

Steel used nowadays is often protected by paint, galvanizing, or weatherized. Paint systems fail by peeling, cracking, corrosion pimples, and excessive chalking. Galvanizing is done typically by applying molten zinc to form a tightly bonded alloy coating. Flaking and chipping are common defects.

6.2.4.1.2 Concrete Structures

Some common concrete defects include scaling, cracking, delamination, spalling, pop-outs, mud balls, efflorescence, staining, honeycombing, and leakage.

Scaling is gradual and continual loss of mortar and aggregate of a finished surface of hardened concrete. The scaling is considered light when the coarse aggregate below the surface is not exposed; however, the scaling is considered severe when the coarse aggregate is clearly exposed.

A crack is a linear fracture in the concrete. Cracks can occur due to poor curing (non-structural shrinkage cracks), settling, or over loads (structural cracks). Cracks may extend partially or completely through the concrete member. The direction of the crack relative to axis of structure should be observed and measured. The location, width, length, depth, and the spacing between cracks should be measured and recorded. Based on various observations and measurements, the cracks can be classified. The common types of cracks found in tunnels include longitudinal, transverse, vertical, diagonal, pattern/map, D-cracks and random cracks. As the concrete hardens, water and air that is trapped below the surface can develop into subsurface voids or delamination. These types of voids eventually lead to concrete spalling.

Delamination is one area of the concrete surface that produces a hollow sound when struck by a hammer. Determine the extent of these areas and document them.

Spalling is the detachment of hardened concrete fragments that leave shallow, roughly circular or oval shaped depression in the concrete surface. Spall can also develop as an elongated depression along an expansion, contraction, or construction joint. Steel reinforcement may also be exposed where the spalling is severe. The inspector should record the location, width, length, and depth of the spalled area and note any exposed reinforcing.

Pop-outs are conical fragments that break out at the surface of the concrete and leave a small hole. A shattered aggregate particle will often be found at the bottom of this hole adhering to the small end of the pop-out cone. Pop-outs should be noted for size, depth, location, etc.

Mud balls are small holes that are created in the surface by the dissolution of clay balls or soft shale particles that were introduced into the concrete mix. Mud balls should be noted for size, depth, location, etc.

Efflorescence is a deposit of water-soluble calcium hydroxide that forms on the concrete surface. It is usually white and emerges from the concrete as solution materials crystallize as salts. Efflorescence may also occur because of contaminants in the ground water or de-icing salts. Salt crystal stalactites can form on tunnel ceilings from severe efflorescence.

Staining is a discoloration of the concrete surface due to emergence of water containing dissolved materials through cracks after water evaporates. Although staining can be of any color, brown staining usually signifies that corrosion is occurring in the underlying steel reinforcing.

Honeycombing occurs in concrete when the mortar does not completely fill the voids between coarse aggregate particles.

Leakage occurs in regions of the concrete surface where water has penetrated through cracks, joints, or other imperfections in the concrete. It is important to note the temperature when checking for leaks. The full effect of leakage might not be known when temperatures are below freezing since ice can mask the effects of leaks. The portions of the concrete structure that are below the water table should be carefully checked at joints for leaks.

6.2.4.1.3 Timber Structures

Some common timber defects include decay by fungi /insects, checks /splits, and fires.

Decay by fungi is the primary cause of timber deterioration. it is produced by living fungi that feed on the cell walls of timber. Molds, stains, soft rot (least severe), and brown or white rot (most severe) are

common types of fungi that cause decay in timber materials. With heavy decay, timber may become discolored and soft, and section loss may occur. The amount of decay and section loss should always be noted in the inspection report.

Decay by wood eating insects: Termites and carpenter ants are common types of insects that can cause timber deterioration. The presence of insect infestation should be noted in the inspection records and the type of insect should be recorded if known. An insect may be placed into a container or a picture taken for later identification. Saw dust or powdered dust on or around the timber members could indicate the presence of wood eating insects, and this dust should be noted. Photographs of the insect mounds may be used to document the extent of damage.

Checks are cracks in timber, which extend partially through the timber member; the percentage of penetration through the members should be identified with checks. Checks result from shrinkage after drying or from seasoning of the timber and should be noted in the inspection report.

Splits are cracks that extend completely through the member. Splits result from shrinkage after drying or from seasoning of the timber and should be noted in the inspection report.

Fires can blacken and char timber and cause appreciable section loss. Fire damage is easily evaluated on most timber structures, but it can be a time consuming process. The best way to ascertain the extent of damage is to chip away at the charred remains in several locations and then measure the section remaining in the undamaged timber. The greatest section loss often occurs where two or more members have been fastened together.

A hollow area usually indicates either advanced decay in the interior of a timber or the presence of wood eating insects. Hollow areas should be noted in the inspection report to show the size, location, and extent of damage in the area hollowed. Leaks occur in timber where water is penetrating through a joint, check, split, or some other defect in the timber such as a knot.

6.2.4.1.4 Masonry Structures

The individual stones, bricks, or blocks of masonry structures should be checked for displaced, cracked, broken, crushed, or missing units. Some types of masonry surfaces are susceptible to deterioration or weathering. The mortar should be checked to ensure that it is effectively bonded to the masonry unit at the joint. It is particularly important to note cracked, deteriorated, or missing mortar. Masonry arches are primarily used in compression applications; flattened curvature, bulges in walls, or other shape deformations may indicate unstable conditions with tension cracks. The vertical and horizontal alignment of the masonry should be checked visually. Plumb bobs and lasers may be useful tools for assessing these conditions. Leaks often occur in regions of the masonry where water penetrates through joints, cracks, or other imperfection. Efflorescence accumulations might help locate areas with active leaks.

6.2.4.2– Structural Elements

Structural elements for tunnels include liners, segmental rings, roof girders, columns and piles, cross passageways, interior walls, portals, ceiling slabs, ceiling girders, hangers and anchorages, ceiling panels, invert slabs, slabs on grade, invert girders, joints, and gaskets.

6.2.4.2.1 Liners

The tunnel liner supports the ground around the tunnel and restricts groundwater infiltration into the tunnel. Many tunnels have a two-pass liner system consisting of an initial liner (or temporary support) and a final liner (or permanent support). Initial support is typically provided by shotcrete and rock bolts, ribs and lagging, and slurry walls. The final liner is usually made of either cast-in-place concrete liners or bolted and assembled precast concrete segments.

6.2.4.2.1.1 Steel Liners

Structural steel is not typically used as a final liner material due to its relatively high cost, fabrication requirements, and susceptibility to corrosion. Many rock tunnels in mountains have exposed steel liner plate above the spring-line to prevent rocks from falling onto the roadway. Older tunnels in soft ground, hard rock, or under water may have incorporated steel components as part of their initial support. Common temporary liner components include liner plates, steel ribs, columns, beams, and prefabricated shell elements. Many of these steel elements were not designed to be part of the permanent structural load-carrying component of the tunnel and were not sufficiently protected against corrosion. Typically, the temporary steel elements were covered or encased in concrete final liners. If structural steel components have been incorporated into the tunnel liner, then these steel elements should be inspected as structural steel materials.

6.2.4.2.1.2 Concrete Liners

Concrete Liners and Shotcrete – Precast concrete liners and cast-in-place concrete liner make up the bulk of all permanent final lining systems installed in highway tunnels. Because of its availability, ease-of-use, durability, and relatively low cost, concrete liners have been installed in all types of tunnel projects. Shotcrete, also referred to as pneumatically sprayed concrete, is commonly used for temporary support and as final liners in lightly loaded structures such as a rock tunnel that supports only the loose rock that could fall onto the roadway. Concrete liners should be inspected using the methods previously described for structural concrete materials. Many concrete tunnel liners are covered by an architectural finish such as ceramic tiles or metal panels. When inspecting these surfaces, it is recommended that the inspector sound the finish surface. This should be done at multiple locations throughout the tunnel, and it should be done near known defects or when defects are suspected to determine the limits of the defective areas. Visually inspect cracks for moisture, leakage, corrosion, staining, and efflorescence. Record the amount of active leakage in number of drips per minute or estimate the continuous rate of flow.

6.2.4.2.1.3 Timber Liners

Timber liners have been installed in some mountain tunnels to prevent loose rock from falling onto the roadway. The timber liner may be composed of roof or ceiling sections with or without wall elements. Timber liners should be inspected using the methods previously described under structural timber materials.

6.2.4.2.1.4 Masonry Liners

Masonry tunnel liners have not seen much use for highway tunnels since this method was largely supplanted by concrete technology that came into existence before many highway tunnels were built. Nevertheless, masonry structures are quite common at tunnel portals and other ancillary buildings. Masonry materials should be inspected using the methods previously described under structural masonry materials.

6.2.4.2.1.5 Unlined Tunnels in Hard Rock

Tunnels may be unlined in some hard rock applications; however, these tunnels typically need reinforcing to prevent loose rock from falling into the roadway. Rock bolts and dowels are often used for this purpose. Support from timbers, steel plates, or shotcrete may also be used in limited areas of unlined tunnels to prevent rocks from falling onto the roadway. Unlined tunnels are self-supported by the competent rock. A qualified geologist or geotechnical engineer should assist the inspection team when inspecting self-supported tunnels in rock. Identify the deficiencies in the rock mass that could potentially pose safety and stability problems or nuisance issues for maintenance of traffic. The cross-sectional shape of the tunnel should be monitored for potential changes by taking measurements at predetermined intervals (approximately 200 ft. intervals). The distances between the spring line and vertical sidewalls should also be measured at specific points; the locations should be permanently marked.

6.2.4.2.2 Segmental Rings

When inspecting precast concrete tunnel segments, the concrete should be inspected using the techniques previously discussed. The joints of the precast concrete liners should be inspected for cracks and leaks. Joint hardware such as end plates, bolts, and gaskets should also be inspected for each segment for discoloration due to moisture and humidity conditions in the tunnel. This condition does not downgrade the structural capacity of the bolt. Particular attention should always be given to bolts in regions of water leaks to check for loss of section. If losses in the section are observed, then this should be noted in the inspection report. The cross-sectional shape should be compared against the shape shown in the drawings to evaluate possible changes in cross section.

6.2.4.2.3 Roof Girders

A roof girder is the main horizontal support for a flat tunnel roof. The roof girders support the tunnel roof and the loads from the backfill, surcharge, and traffic above. Girders are used to support a deck system, and these girders can be steel or concrete. Inspect these elements using the methods previously described for structural concrete or steel materials.

6.2.4.2.4 Columns and Piles

Columns and piles are vertical load bearing elements that are usually comprised of concrete or steel components. Piles are embedded into the ground. Columns are free standing members located above the ground level. Lateral bracing may be incorporated to stiffen the columns. A typical set of columns may have a bent cap. Inspect these elements using the methods previously described for structural steel and concrete materials.

6.2.4.2.5 Emergency Corridors

Emergency corridors provide a means of escape from the tunnel. Parallel tunnels may be linked by cross passageways. In emergencies evacuees can move to safety through a cross passage and escape through an adjacent tunnel. Therefore, these evacuation passageways should not be cluttered with objects or debris, and doors should be operable. These areas should ideally be slightly pressurized to maintain positive air flow to prevent smoke from entering the escape route, which helps to maintain a tenable environment for evacuees and emergency responders. The inspector should check for cracks, delamination, and spalls in the concrete walls, ceilings, and floors. Check for leaks. Look for build-up of maintenance debris in the rooms. Examine the utilities, lights, and electrical conduit, and any safety systems for deterioration. If the

passageway is pressurized, an operational check of this system is required. Miscellaneous structural checks should be performed on all of the structural connections, doors, windows, frames, roofs, floors, curbs and walkways, staircases, brackets and supports, and structural finishes.

6.2.4.2.6 Interior Walls

The tunnel liner is in contact with the ground; whereas, interior walls are not. Interior walls are usually constructed using concrete materials. These walls separate opposing traffic, the travel way from the ventilation plenum, or the travel way from the emergency egress corridor. Written procedures should address the unique identification of interior walls and the survey control processes for reporting inspection findings. Concrete walls should be inspected using the methods previously described under structural concrete materials. Concrete walls should be inspected using a hammer to sound the substrate concrete or a rubber mallet to tap on the tile finish at random locations and at areas adjacent to defects. When hollow sounding areas are detected, the limits of these areas should be defined. Mark out these areas using keel or paint. Note the size, maximum depth, and location of the spalls; and note any exposed reinforcing steel. Check and document the percentage of section loss, if present, at exposed reinforcing steel. Document the length, width, depth, and location of cracks. Visually inspect for moisture, leakage, corrosion, staining, and efflorescence. Note any cracks with moisture penetration or corrosion staining. Record the amount of active leakage in number of drips per minute or measure the flow rate.

Architectural Finishes – Many concrete tunnel walls are not visible because they are covered by architectural finishes such as ceramic tiles or metal panels. Tile walls should be checked for cracked, delaminated, or missing tiles that could indicate defects in the underlying substrate concrete. Missing tiles may be the result of moisture and water penetration through the concrete substrate. Check the exposed substrate concrete for cracks, delamination, and spalls. Look for spalled concrete behind missing tiles and at construction joints between wall segments where reinforcement steel may be exposed. The degree of surface deterioration and condition of anchor bolts should be checked on metal panels. Note all conditions described above in the inspection report.

6.2.4.2.7 Portals

Tunnel portals are located at the entrances and exits of the tunnel. When inspecting the portal facades, it is important to consider the condition of the elements that are above the roadway since spalls or falling objects from above could impact the safety of tunnel users. It is also important to document the condition of material outside and above the portals, especially if there are concerns for landslides. A landslide could easily damage the portal façade or portal buildings. A qualified geotechnical engineer or geologist should assist the inspection team when evaluating the potential for landslides. Inspect the walls, ceilings and floors of the portal building for cracks, delamination, and spalls using the methods described for the appropriate structural material. Use a hammer to sound the walls at random locations and around defects. Look for build-up of debris in the rooms. Examine the utilities, lights, and electrical conduit within the rooms for deterioration. Miscellaneous structural checks should be performed on all of the structural connections, doors, windows, frames, roofs, floors, staircases, brackets and supports, and structural finishes within the portal buildings and auxiliary structures. Implement miscellaneous structural checks as appropriate.

6.2.4.2.8 Tunnel Ceiling Structures

Tunnel ceiling structures consist of slabs or panels that are supported by girders or hangers and anchorages. Many tunnels were installed with ceilings above the roadway to create space for ventilation. This space, commonly referred to as the upper plenum, is used to either exhaust or supply air to the tunnel. Sometimes the upper plenum also contains utilities. The configuration of the upper plenum depends on the shape of the tunnel. For example, a circular tunnel will have roughly a half moon shape, while a box tunnel will have a box-shaped plenum. The inspector should ensure that all air distribution diffusers, registers, and passages are in good condition and free of debris accumulation. The structural elements of tunnel ceilings include either reinforced concrete ceiling slabs or precast concrete ceiling panels that are supported by either girders or hangers and anchorages. These structural support systems carry loads from their own weight, ventilation pressures, live loads from personnel, wind pressure from trucks, and earthquakes. Many ceiling structures are relatively heavy, providing stability when large trucks pass through the tunnel and create air pressure waves between the truck and the ceiling. Because the ceilings are located directly above the roadway, the potential exists for these objects to fall onto the roadway below. When inspecting ceiling structures, it is critical to carefully and thoroughly examine each component of the ceiling support system to ensure that the ceiling loads are being transferred into the support members as intended. It is advised that detailed written inspection and maintenance procedures be fully developed and completely implemented when tunnels have heavy ceiling elements installed over traffic. Prior to conducting an inspection of ceiling elements, the inspector should review all pertinent drawings and procedures.

Hangers and Anchorages – If the ceiling structure is supported with hangers and anchorage held by adhesive epoxy anchors, then these anchorages should be repaired in accordance with FHWA’s Technical Advisory – Use and Inspection of Adhesive Anchors in Federal-Aid Projects. The inspector should refer to FHWA Technical Advisory T 5140.30, which superseded T 5140.26. A copy of this document is found at the link below:

<http://www.fhwa.dot.gov/bridge/t514030.cfm>

If anchors have pulled out or are loosening, the tunnel owner (mainly ADOT) should be immediately notified since this poses a significant safety concern. Remedial action may be necessary such as installing new supports that incorporate mechanical anchorages with the hanger rods, or a similar system that does not rely on epoxy in sustained tension. Exposed steel support system elements should be inspected for corrosion and section loss as well as for missing bolts at the connection points for the support beams or the hangers and anchorages. Document the locations of missing bolts, deteriorated beams, or hangers. Verify that the hanger connections are intact; and ensure that there is no vertical displacement in any of the embedded supports or exposed anchors. Visually inspect the hangers to determine if they are bowed. A bowed hanger possibly indicates that the ceiling slab was pushed up from either vehicle impact, air pressure, or other means. One method to verify hangers are in tension is by “ringing” each hanger. Ringing a hanger is done by lightly striking it with a mason’s hammer. A hanger in tension will vibrate or ring like a bell after being struck; while a hanger that is not loaded in tension because of a loose connection or other defect, will not ring. Rather, a dull thud will be heard. If the hanger does not ring, inspect the hanger carefully and verify that the ceiling system is structurally sound.

Tunnel Roof – If the tunnel has a ceiling support structure with hangers attached to the roof, check the connection locations of these supports at both ends (tunnel roof and ceiling slab or panel) for cracks, delamination, and spalls. Check the roof area in the vicinity of the hangers for cracks in the concrete,

delaminated concrete, and spalls to verify solid embedment. Use a hammer to sound random areas and areas suspected of concrete defects adjacent to the hangers.

Ceiling Girder – A ceiling girder is the main horizontal support for the ceiling panels or slabs. These structural elements are used in place of hangers and anchorages. Ceiling girders use various structural shapes. They are usually steel or concrete and should be inspected using the methods previously described for structural concrete and steel materials.

Ceiling Slabs and Panels – Slabs are cast-in-place concrete elements, whereas, panels are precast concrete elements. Both serve the same function in the ceiling system. The topside and underside of the ceiling should be inspected. Note the location of any cracked or deteriorated ceiling panels. Document the length, width and locations of cracks in the ceiling slab. Visually inspect for spalling. Note the size, maximum depth, location and any exposed reinforcing steel details at the locations of the spalls. Note the locations of cracks; look for moisture penetration and corrosion staining. At random locations and adjacent to all defects, a hammer should be used to sound the substrate concrete or a rubber mallet to tap the tile finish. The top side of the ceiling panels and the ceiling support system are often examined from within the upper plenum. Check the top side of the ceiling panels for cracks, corrosion stains, efflorescence, spalls, disintegrated concrete and evidence of moisture. Observe for displaced seals between the panels. Examine the ceiling support system for corrosion and section loss as well as missing bolts. At the bottom face of the ceiling panels, inspect concrete surfaces using the methods previously described for structural concrete. Focus on the inspection techniques for scaling, cracks, delamination, and spalling. Check for exposed reinforcing steel at any spalls and document the section loss. Visually inspect for moisture and corrosion staining at cracks; and note efflorescence at crack locations.

An architectural finish may be placed on the underside of the ceiling slabs or panels in some cases. If ceramic tiles, concrete-filled metal pans, or steel composite metal pans make up the underside finish, their condition is evaluated more rigorously than on the walls, since delaminated tiles can fall onto the roadway. Check the ceramic tile finish for cracked, delaminated or missing tiles, which could indicate defects in the substrate concrete. Examine any exposed substrate concrete for cracks, delamination, and spalls.

6.2.4.2.9 Tunnel Invert Structures

Slabs, Girders, and Slabs on Grade Tunnel invert structures consist of slabs that are supported by girders or on grade. When the roadway is a structurally supported slab, then the space below the supported roadway is used for ventilation and drainage. The supported invert slab acts like a bridge deck that carries traffic loads. When inspecting invert structures, the size and location of the defects should be documented. Check the concrete for cracks, delamination, and spalls; use a hammer to sound random areas of the invert for delaminated concrete and sound areas around cracks and spalls. Record the sizes and maximum depth of the spalls. Note any section loss for exposed reinforcing steel. If severe spalling is present, a sketch should be prepared to show the extent and location of the spalling. Note exposed reinforcing steel in the spalls and record any section loss. Cores may be needed to determine the chloride ion content prior to making recommendations for repair or replacement. Document the length, width, and location of all cracks and delamination. Check for signs of moisture penetration. Note all corrosion staining, dampness, map cracking, and efflorescence. Document the severity and locations of all other defects. Provide percentages of total invert area for map cracking, moisture penetration, efflorescence, and delamination. Check for excess debris accumulation resulting in standing water, and confirm that the lower plenum is draining into the sumps. **Invert Slab** – Inspect the topside and underside of the slab. The topside of the slab might be obscured by the wearing surface; nondestructive testing can supplement the inspection process.

The tight space below the slab could also preclude direct inspection from below the slab in the lower plenum; and robotic video inspection techniques can be used for inspecting tight spaces like these. Examine the concrete slabs for cracks, delamination, and spalls. Use a hammer to sound random areas of concrete for delamination, and sound the concrete adjacent to cracks and spalls. Note exposed reinforcing steel in the spalls and record any section loss. Check for signs of moisture penetration through the concrete. Also note corrosion staining, dampness, and efflorescence. Document the amount of active leakage in number of drips per minute or measure flow rate. Check for areas of potential localized failure due to punching shear at large spall locations and where large potholes occur. Invert Girder – An invert girder refers to the main horizontal support for the slabs. These steel or concrete girders should be inspected using the methods previously described for structural concrete and steel materials.

6.2.4.2.10 Joints and Gaskets

Joints are integral to many structural elements and are used to simplify construction or accommodate strains from thermal movements. Joints are typically sealed or have gaskets to keep out water. Joints – Examine joints for deterioration, efflorescence and moisture penetration. Check for joints at the transitions between segments, at the connections to ancillary buildings, and at auxiliary structures. Check the concrete around the joint for cracks, spalls and delamination. Use a hammer to sound the concrete adjacent to the joint. Check the position and condition of the joint material. Check the condition of sealants between precast panel members. Closely examine the alignment and check for any signs of differential settlement, which can lead to other serious defects. Document the locations and severity of moisture penetration or joint deterioration. Gaskets – There are many types of gaskets such as lead, mastic, or rubber. Gasket materials can become dislodged from the joint due to water infiltrating through the joint, loosening of fastening bolts, etc. Gaskets can also fail due to chemical or biological deterioration of the material. Structural movements of the liner can also tear or otherwise distort the gasket and cause it to leak. Differential settlement often leads to other defects. Extra time should be spent investigating transition areas such as where the tunnel support conditions change at connections to buildings. The location of these areas should be evident from existing as-built drawings. Note all gasket deficiencies including the length, width and locations of cracks, loose or broken fasteners, or leaks of any kind.

6.2.4.3– Miscellaneous Structural Elements

Miscellaneous structural elements that are not inventoried but should be inspected periodically to maintain safety include structural connections, doors, windows, frames, staircases, roofs, floors, brackets and supports, machinery pedestals, and structural finishes. These items should be included in the written inspection procedures developed by the tunnel owner.

6.2.4.3.1– Structural Connections

The connection bolts, rivets, and welds should be carefully checked. Bolts on precast concrete, steel, and cast iron liners may be discolored due to moisture and humidity conditions in the tunnel; however, the discoloration usually does not reduce the structural capacity of the bolt. Particular attention should be given to bolts in regions where leakage occurs as section loss might result. A bolt can be rung with a hammer to determine if it's tight, but it's preferable to use a wrench. Section loss and missing or loose bolts should be noted in the inspection report. Observe the condition of welds for cracks and tears. Dye penetrant inspection may be helpful for detecting cracks. Coatings may protect welds from corrosion.

6.2.4.3.2– Doors

During the inspection, all of the doors and windows encountered should be opened and closed to verify their operability. Some door components may be deteriorated, stuck, or inoperable. The door hardware should be checked to ensure that the latches sufficiently engage the door frame and that the door can be closed securely. The door and the frame might have corrosion, delamination, or section loss. Security sensors should also be checked to be sure they are operational.

6.2.4.3.3– Windows and Frames

Steel window frames may be corroded, deteriorated, or experience section loss. Some of these may be stuck or inoperable. When concrete window frames are inspected, check for cracks, delamination, and spalls in the concrete material. The condition of protective coatings should also be documented. Stairs – Stairs are typically built with either reinforced concrete or steel. Reinforced concrete stairs sometimes have steel tread plates incorporated in the concrete. Inspect the rails, posts, and railing anchorages for missing or broken sections, damage and deterioration, cracks or corrosion, and section loss. Inspect for cracked welds at the connections and for loose or missing bolts. Document the severity and location of any defects.

6.2.4.3.4– Staircases

Inspectors should check stairs and ladders for loss of the steps and supports. In addition, inspectors should make note of any separated or missing plates and connections.

6.2.4.3.4.1– Concrete Staircases

Inspectors should check concrete stairs for cracks, delamination, and spalls. Note exposed reinforcing steel in the spalls and record any observed section loss in the reinforcing steel. Check for signs of moisture penetration, corrosion staining, dampness, and efflorescence. Use a hammer to sound random areas of the stairs and check for delaminated concrete. Also sound areas adjacent to defects such as cracks and spalls. Document the length, width and location of all cracks and delamination. Record the area, maximum depth and location of all spalls along with the condition of exposed reinforcing steel. Document the severity and locations of all other defects including moisture penetration, efflorescence, and corrosion staining. Examine the steel tread plates, if present, for adjacent spalls and looseness. Use a rubber mallet to tap the tread plates and make note of any separated or missing plates.

6.2.4.3.4.2– Steel Staircases

Inspectors should check steel stairs and ladders for corrosion and section loss of the steps and supports. Examine for crevice corrosion between plates of the stairs. Document the severity and location of corrosion and section loss found. Note the length, location, and distance of spread of all crevice corrosion.

6.2.4.3.5– Roof

Check the roof of any Ancillary Buildings or Auxiliary Structures for any deterioration which would allow water to penetrate through the roof into the building. Check that the water drainage system is functioning properly and not clogged with debris. Check the drains in the roof and the overflow scuppers in the barriers for debris accumulation. Inspect the barriers around the perimeter of the roof for deterioration. If present, examine expansion joints in the roof for debris accumulation and deterioration of the joint material. Look at the exterior surface of the exhaust stacks for any defects or deteriorated materials. Note

the location and severity of any defects on the roof. Document any locations of water penetration. Record the condition of the roof coating material and the drainage system.

6.2.4.3.6– Floors

Check concrete floors for cracks, delamination, and spalls. Note exposed reinforcing steel in the spalled areas and record any section loss. Check for signs of moisture penetration, corrosion staining, dampness, map cracking, and efflorescence. Use a hammer to sound random areas of the floor and check for delaminated concrete. Also sound areas adjacent to defects to define the extent of the area. Examine the floors for evidence of distortion and settlement. Document the length, width, depth, and location of all cracks and delamination. Record the area, maximum depth and location of all spalls along with the condition of exposed reinforcing steel. Document the severity and locations of all other defects including moisture penetration, efflorescence, corrosion staining, and settlement.

6.2.4.3.7– Brackets and Supports

Brackets and supports are structural elements that are mounted against the ceiling or walls. They are used to support longitudinal ventilation fans, CCTV cameras, ITS signs, traffic signs, over-height detection signs, lighting supports, conduit supports, and fan or motor supports. Check for corrosion, dissimilar metals, cracks, buckles, and kinks. Dissimilar metals may promote corrosion at accelerated rates when not sufficiently insulated from stray electrical currents. Particular attention should be given to bolts in regions where leakage occurs to evaluate any section loss. A bolt can be rung with a hammer, but it's preferable to use a wrench for checking the tightness. Observe the condition of welds for cracks and tears. Dye penetrant inspection may be helpful for detecting cracks.

6.2.4.3.8– Machinery Pedestals

Check concrete pedestals for cracks, delamination, and spalls. Use a hammer to sound random areas of the pedestals to check for delaminated concrete, also sound areas adjacent to defects. Examine the floors for signs of settlement. Note exposed reinforcing steel in the spalls and record any section loss. Check for signs of moisture penetration, corrosion staining, dampness, map cracking, and efflorescence. Document the length, width, and location of all cracks and delamination. Record the area, maximum depth, and location of all spalls along with the condition of exposed reinforcing steel. Document the severity and locations of all other defects including moisture penetration, efflorescence, and corrosion staining.

6.2.4.3.9– Structural Finishes

Tiles should be checked to determine whether they pose a hazard to passing motorists since loose tiles can fall into the roadway. A good technique for inspecting tiles is to tap firmly on a select number of tiles in multiple locations using a rubber mallet. A scraper may facilitate removal or checking loose tiles.

6.2.4.4– Civil Elements

The civil elements included in the NTI database are roadway wearing surfaces, traffic barriers, and pedestrian railings. The SNTI defines condition states for invert wearing surface, traffic barriers, and pedestrian railing systems. Although drainage systems in NIT are discussed under mechanical systems and pumps, but the drainage itself, less pumps, will be discussed under Civil Elements. Miscellaneous civil elements are not contained in the NTI database but should be inspected periodically to maintain safety.

6.2.4.4.1 Wearing surfaces

Tunnel roadways have either bituminous or concrete wearing surfaces on the structural invert. When inspecting the wearing surface, examine the skid resistance of the surface, look for grooving or rutting in the wearing surface. A glossy or shiny surface or exposed polished aggregate may be indicators of wear. Check that water properly drains from these surfaces. When wearing surfaces are not properly drained, they can wear prematurely and develop holes and present safety hazards to motorists. The roadway surfaces on tunnel ramps can also be impacted by high groundwater levels. Concrete – Concrete wearing surfaces should be checked for potholes, cracking, scaling, and delamination. Look for exposed reinforcing steel. For spalls, document the size, maximum depth, and location. Also, document any exposed reinforcing steel, and identify section loss. Use a hammer to sound random locations of the concrete wearing surface and areas adjacent to cracks, delamination, and construction or expansion joints. Document the areas and locations of delaminated concrete. Areas of delaminated concrete may spall and present hazards to traffic. Provide an estimate of total crack length as well as the average length, width, location, and spacing.

Asphalt – Asphalt wearing surfaces should be checked for cracking, wheel path rutting, surface irregularities, and potholes. Use a hammer to sound random locations of the wearing surface. Note any dull thuds, which could be indicators of future potholes. Also, investigate whether the pavement is drying out, and verify a good seal between the wearing surface and the curbs.

6.2.4.4.2 Traffic Barriers

At roadway level the tunnel walls are typically protected from errant vehicles by concrete curbs and barriers. These barriers are usually concrete; however, their vertical surface may be covered with ceramic tiles. A concrete safety walkway is usually provided in the tunnel bore. Document the length, width, and location of all cracks and delamination. Record the area, maximum depth, and location of all spalls along with the condition of the reinforcing steel if it is exposed. Document the severity and locations of all other defects including moisture penetration, efflorescence, and corrosion staining.

6.2.4.4.3 Pedestrian Railings

Pedestrian railings are common where raised sidewalks are used. These are commonly constructed of tubular steel, stainless steel, or aluminum with posts spaced along the walkway to support the lateral railing, and it can be produced using pipe, W-beam, or other shapes. The railing members can be coated with a structural finish such as paint or galvanized metal. Railings are a safety measure to prevent personnel on top of the walkway from falling into vehicles in the adjacent traveled lane. All aspects of the railings should be inspected and deficiencies noted. During inspection, check the rails, posts and anchorages. Examine the railing for vertical and horizontal misalignment, missing or broken sections, impact damage and deterioration such as cracks or corrosion with section loss. Inspect for cracked welds at the connections and loose or missing bolts. Section loss can be found most commonly in the base of the posts and the anchor bolts, especially if debris accumulation is present. Evaluate the condition of the paint or galvanizing. Document the location and severity of any defects.

6.2.4.4.4 Miscellaneous Civil items

Although these items are not specifically reported to the FHWA, it is good practice to perform miscellaneous civil checks on all curbs and sidewalks in the tunnel, ancillary buildings, or ancillary structures. These items should be included in the written inspection procedures. Curbs and Safety

Walkways – Curbs and safety walkways protect the tunnel operation and maintenance staff and users who need to evacuate during emergency conditions.

Curbs – Curbs are typically constructed of concrete. Check the curbs for proper alignment. Improper alignment or a protruding curb section can become a safety hazard for vehicles. Visually examine these elements for any buildup of dirt or debris that may reduce their effectiveness to transport the surface runoff into the drainage system. Examine the curbs for cracks and spalls. Check spalled areas for exposed reinforcing steel and document any section loss in the steel. Walkways – The inspector should look for cracks, scaling, delamination, spalls, tripping hazards, debris accumulation, and ponding of water. Examine spalls for exposed reinforcing steel and report any section loss. Advanced cracks and spalls can undermine the structural integrity of the safety walkways. Document the size and locations of any defects found. Document the length, width and location of all cracks and delamination. Record the area, maximum depth and location of all spalls along with the condition of the reinforcing steel if it is exposed. Document the severity and locations of all other defects including moisture penetration, efflorescence, and corrosion staining.

Emergency Egress – The quality of the walking surface on every safety walkway or emergency egress should be examined. Under emergency conditions, these walkways may be used for self-rescue or by first responders. Check for locked or inoperable doors and access to refuge areas, considering that some users have reduced mobility. Note in the inspection documents any deficiencies found.

Maintenance walkways – Some of the more complex tunnels have concrete or steel maintenance walkways. Inspect these in accordance with procedures for other steel and concrete elements.

6.2.4.5– Functional Systems: The functional systems include the mechanical, electrical and lighting, fire and life safety, security, systems, sign, and protective systems. Only tunnel drainage with exclusion of pumps will be discussed here. For more details regarding functional systems, refer to TOMIE manual.

6.2.4.5.1 – Tunnel Drainage

The tunnel drainage system is designed to remove water from the roadway and is made up of grates, scuppers, piping, drainage troughs, and pumps. For information regarding pumps refer to NIT under mechanical systems and pumps. Check if the drain lines are clear of debris and flush with water to ensure that water drains freely. Look for ponded water. Check the inlet grates for deterioration or broken ribs. Ensure the roadway drain piping is in good condition and free of debris or leaks. Document the location and extent of the defects.

6.2.5 – Inspection Report

Inspection report is formal summaries of inspection findings for each element and system that was inspected. The report should be submitted in accordance with written procedures established by the tunnel inspection organization (ADOT) and the owner (mainly ADOT). The completed report should be furnished to the tunnel owner along with any repair recommendations.

6.2.5.1. Repair Priorities

Following are the repair priorities for defective elements in an inspection report:

- Critical Finding

Critical finding refers to defects that require “immediate” action including possible closure of the tunnel where safety or structural concerns are identified using criteria established in the NTIS.

- Priority Repair

Priority repair refers to conditions for which further investigations, design, and implementation of interim or long-term repairs should be undertaken on a priority basis, i.e., taking precedence over other scheduled work. These repairs will improve the durability and aesthetics of the structure or element and will reduce future maintenance costs. Elements that do not comply with code requirements are also priorities for repair.

- Routine Repair Routing repair refers to conditions requiring further investigation or remedial work. This work can be undertaken as part of a scheduled maintenance program, scheduled project, or routine facility maintenance. Items identified in the preventive maintenance program can be put in this category.

6.2.5.2. Inspection Report Packet

A. Draft Packet: When an inspection is completed, the inspector should enter the data and notes into the ADOT tunnel inventory database. This may include notes, measurements, photos, diagrams, sketches and additional information. Once the data entry task is complete, the inspector should print a copy of various reports associated with the inspection report packet and submit the packet through a submittal form. The submittal form identifies the tunnel inspected and accompanies the complete draft tunnel inspection report packet.

The inspection report packet may include the following sections and their descriptions for an inspection report:

- Table of Contents – This provides information to the reader on where to find information of a particular interest.
- List of Tables – Used to identify the title and location of any tables that were used.
- List of Figures, Drawings, and Sketches – Used to identify the title and location of any figures or drawings.
- List of Photographs – Used to identify the title and location of any photographs. These may be included as an appendix to the report.
- Executive Summary – Provides a concise summary of the inspection, findings, and recommended repairs.
- General Description – Provides a general description of the tunnel or tunnels that were inspected. This information could include the location of the tunnel(s), age, general geometry, and any other pertinent descriptive information.

- **General System Descriptions** – Provide general descriptions of the structural, civil, and functional systems inspected and the scope of the elements covered by the inspection. This should precede the detailed descriptions for the inspection findings of each element.

- **Inspection Procedures** – The procedures used to inspect the tunnel elements should be explained and illustrated. If extensive written procedures were followed, these may be included as an appendix to the report. Documentation of any specialized testing processes and outside expertise should be included.

- **Inspection Findings** – The condition state of all tunnel elements should be documented per instructions and guidelines in the SNTI.

- **Inspection Results** – A detailed description of the results of the inspection should be included for the various tunnel elements below

- o **Structural and Civil** – For structural and civil elements, the report should contain descriptions of the various deficiencies found, their locations and their severity. Any special testing, such as concrete strength, freeze-thaw analysis, or petrographic analysis, should be included with the findings for the record.

- o **Mechanical** – For the mechanical inspections, the general condition and operation of all equipment should be described and deficiencies noted. Specialized testing required to effectively determine the operational condition of the equipment, such as vibration testing and oil analyses, should be included for the record.

- o **Electrical** – For the electrical inspections, the general condition and operation of all equipment should be described and the deficiencies noted. Any specialized testing needed to effectively determine the operational condition of the equipment, such as power distribution and emergency power, should be included for the record. In addition, comparisons of light level measured to recommended levels should be provided to the owner. Remediation work that may accompany testing and inspection should be included.

- **Recommendations** – This section includes recommendations for minor work (maintenance), posting of clearance signs (repair) as well as substantial repair/ rehabilitation of the tunnel components found to be deficient or not meeting current code requirements. Substantial rehabilitation may require a life-cycle cost comparison of repair options. Repair and rehabilitation recommendations should be broken down for each of the main tunnel systems into the categories: critical finding, priority repair and routine repair.

- **Appendices** – The appendices can be used for detailed and extensive inspection summaries that are lengthy, highly technical and detailed (such as structural panel ratings and lighting illuminance levels), and reports from special testing agencies. Detailed information such as special permits, processes or qualifications can go in an appendix. An example of this would be a confined space entry permit. A summary of the inspection operation should be provided with a list of inspection personnel, identification of the team leader, the inspection tools used, the access equipment required, and the schedule maintained. This information is useful for planning future inspections as well as for documenting the inspection.

B. **Draft Review:** Once the draft report is submitted, it will be reviewed by the office review engineers for QA/QC purposes. The revisions are presented to the inspector for consideration.

C. **Final Packet:** Once corrections are made, a copy of the report packet is resubmitted as final inspection report.

6.2.6 – Quality Control and Quality Assurance

Quality Control (QC): Quality control refers to observations, monitoring, and performance testing to maintain the quality of the tunnel inspections; these practices are usually performed continuously by the teams performing the work.

Quality Assurance (QA): Quality assurance is associated with a systematic approach to improve the overall program effectiveness, verify the accuracy of the quality control procedures, and ensure that established standards are met.

QC/QA procedures are performed by an office team of professional bridge inspectors independent of the inspection and load rating teams performing the work.

Quality control and quality assurance programs are used to promote accuracy, ensure consistency, facilitate improvement, and help maintain a high level of reliability. Periodic field reviews of inspection team and their work, quality checks on data, and independent reviews of the inspection results is part of the program. The use of checklists is recommended.

6.3—Critical Finding and Condition State Ratings

Critical findings and condition state ratings are used to represent the condition of tunnel components. A critical finding is a significant safety or structural concern that must be acted upon and reported in accordance with the NTIS. Condition states are used to represent the condition of an element at the time it was inspected. Condition states as defined in the SNTI are: good, fair, poor, and severe. Structural and civil elements in severe condition usually warrant a structural review to determine if there are any impacts to strength or serviceability. For functional systems in severe condition, evaluate safety and serviceability of the element. Condition states are recorded in the inspection report and database and then submitted to the FHWA.

Critical findings require immediate attention in accordance with agency and NTIS requirements.

6.3.1 Critical Findings

Critical findings are defined in the NTIS. The owner (ADOT) is required to establish a procedure to ensure that critical findings are addressed in a timely manner and actions have been taken, are underway, or are planned to resolve the issue. The critical findings are to be reported to the FHWA within 24 hours. The FHWA should be updated regularly or as formally established as to the status of each critical finding until the issue is resolved. FHWA is to be provided with an annual summary report of the current status of each critical finding identified within the past year and each unresolved finding from a previous year. The tunnel inspection organization (ADOT), in consultation with the tunnel owner (mainly ADOT), should have established written procedures for dealing with critical findings prior to the inspection. It is imperative that the inspection team have communication protocols in place to ensure that immediate action can be taken to respond to a critical finding. Critical findings normally require one or more of the following actions to be taken in a timely manner:

- Close the tunnel until the severe defect is removed or repaired, if the such defect may impact users or user safety.
- Restrict the area from public access until the defect can be removed or repaired.
- Repair the structural member or address the functional or safety issue. Detailed descriptions and photographs should be provided that describes the safety or structural concern. Identify appropriate actions or follow-up inspections and maintain a record of the actions taken to resolve or monitor the critical finding. For example, with a large concrete spall that is on the verge of falling into the roadway, the inspection team or tunnel operations personnel can block off the traffic; and the maintenance personnel or a specialty contractor can take down and remove the spalled concrete.

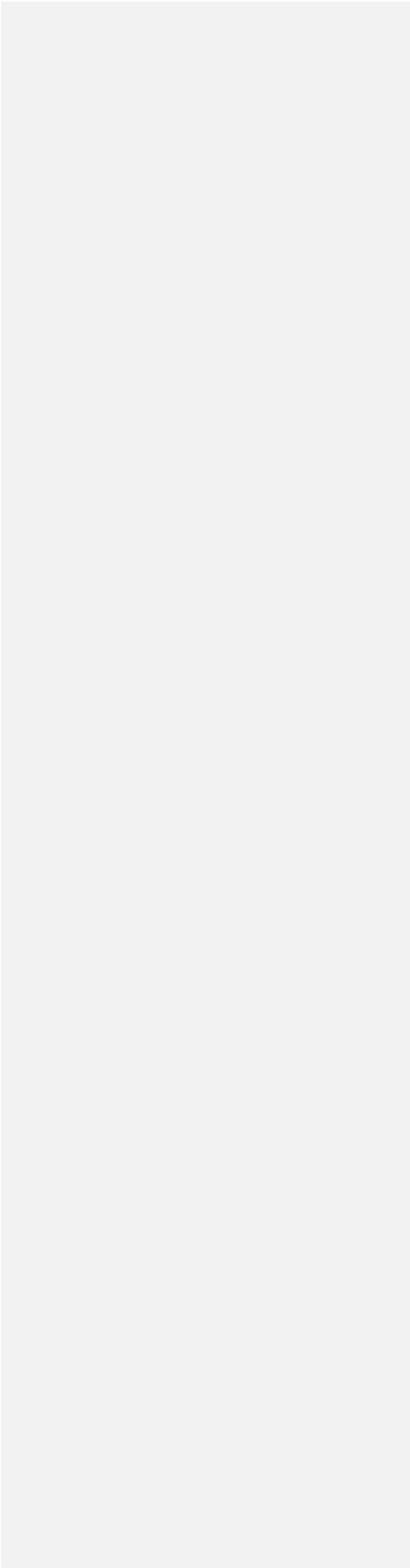
APPENDIX A – SAMPLE OF BRIDGE INSPECTION DOCUMENTS

This appendix contains samples of the following bridge inspection documents:

- Structure Inventory and Appraisal (SI&A) Report
- Repair Report
- List of Maintenance Items
- Inspection Report
- Vertical and Horizontal Clearance Diagram
- Channel Profile Diagram
- Sketches
- Inspection Photographs

These samples are provided to maintain consistency between inspection teams. They are not meant to restrict the individuality of each bridge inspection. They are intended to be used as guidance for a typical inspection of a typical Arizona bridge. Some of these documents were created for illustration purposes and are not based on actual inspections. Not all examples are related to the same bridge

SI and A Sheet



Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

BRIDGE GROUP

Structure Inventory and Appraisal

Structure Number: 00814		Structure Name: Chambers TI UP		Feature Under: I-40	
Route: 40		MP: 333.41		Road Name: US 191	
Agency: ADOT		Location: @ Jct US 191			

LOCATION INFORMATION		DIMENSIONS		PROPOSED IMPROVEMENTS	
N1-State Code:	049	N32-Appr Rdwy Width (feet):	30	N75-Type of Work:	
N2-State Hwy District:	Northwest	N46-Max Span Length (feet):	75	N75-Length of Str Imp (feet):	0
N3-County Code:	001	N49-Structure Length (feet):	245	N94-Br Improv Cost (x1000):	\$0
N4-Place Code:	00000	N50-LI Curb/Swik Width (feet):	0.0	N95-Rdwy Improv Cost (x1000):	\$0
N15-Latitude:	35 Deg 11 Min 25.31 Sec	N50-Rt Curb/Swik Width (feet):	0.0	N96-Total Project Cost (x1000):	\$0
N17-Longitude:	109 Deg 28 Min 9.42 Sec	N51-Br Width Curb-Curb (feet):	30.3	N97-Year of Cost Estimate:	
N98-Border St Code - % Reap:	0	N52-Deck Width Out-Out (feet):	33.2	CONSTRUCTION PROJECT DATA	
N99-Border Bridge Number:		N112-NBIS Br Length?	Y	N27-Year Built:	1996

INVENTORY ROUTE DATA		VERTICAL & HORIZONTAL CLEARANCE		CONSTRUCTION PROJECT DATA	
N19-Debour Length (miles):	12	N53-Min Vert Over Cr (feet):	99.99	N106-Year of Reconstruction:	2013
N20-Tot:	3	N54-Min Vert Under Cr (feet):	15.29	A204-Orig Project Number:	I-40-5(30)
ROADWAY RECORD		N55-Min Lat Under Cr Rt (feet):	H 9.5	A205-Orig Project Station:	1384+30.15
N5-Inv Rte:	1 2 1 00191 0 2 1 00040 0	N56-Min Lat Under Cr Lt (feet):	35.0	A223-TRACS Number:	
N23-Lanes:	2 4.00	SERVICE, TYPE, and SPAN INFORMATION		A225-Deck Area (sq feet):	8134
N10-Inv Rte Min Vert Cr (feet):	99.99 15.56	N42-Service Type:	5 1	INSPECTION	
N11-Inv Rte Milepoint:	375.33 333.41	N43-Str Type, Main:	4 2	N90-Inspection Date:	07/19/2016
N25-Functional Class:	07 01	N44-Str Type, Appr:	0 0	N91-Insap Freq (months):	24
N29-Avg Daily Traffic:	1026 15697	N45-Number of Main Spans:	4	A207-Inspection Quarter:	3
N30-Year of ADT:	2015 2015	N46-Number of Appr Spans:	0	Inspection Type:	Routine
N47-Inv Rte Tot Horiz Cr (feet):	30.3 72.50	CONDITION RATINGS		A225-Next Insap Date:	July 2018
N100-Defense Hwy:	0 1	N58-Deck:	7	CRITICAL FEATURES	
N101-Parallel Bridge:	N	N59-Superstructure:	8	N924-Fracture Critical:	N
N102-Direction of Traffic:	2 2	N60-Substructure:	7	N925-Underwater Insp:	N
N104-Hwy System:	0 1	N61-Channel:	N	N92C-Special Insp:	N
N109-Percent Truck Traffic:	11 43	N62-Culvert:	N	N93A-Date Fract Crit Insp:	
N110-National Truck Network:	0 1	APPRAISAL RATINGS		N93B-Date Underwater Insp:	
N114-Future ADT:	1036 15707	N67-Struct Evaluation:	7	N93C-Date Spec Insp:	
N115-Year of Future ADT:	2036 2036	N68-Deck Geometry:	5	A234-Steel In-Depth Insp Freq(months):	48
A200-Is NS the Princ. Rte?:	N Y	N69-Underclearance Rtg:	3	CULVERT INFORMATION	
RESPONSIBILITY		N71-Waterway Adequacy:	N	A217-Culv Barrel Height(feet):	0
N21-Maint Responsibility:	01	N72-Appr Rde Algn:	8	A218-Culv Length (feet):	0
N22-Bridge Owner:	01	N36-Traffic Safety Features:	1 N N N	A219-Culv Fill Height (feet):	0
A203-ADOT Org Number:	5236	BRIDGE SCOUR DATA		BRIDGE RAILING	
A229-Agency:	ADOT	N113-Scour Critical Rtg:	N	A209a,b,c- Bridge Rail Type:	911
NAVIGATION		A202-Foundation Type:	66	Geometric Conform, and Structural Conform:	
N35-Navigation Control:	N	A220-Found Embed (feet):	0	SUFFICIENCY RATING	
N39-Nav Vert cr (feet):	0.00	A221-Scour Countermeasure:		Sufficiency Rating:	90.20
N40-Nav Horiz Cr (feet):	0.00	LOAD, RATE, and POST		A300 - GENERAL COMMENTS	
N111-Nav Pier/Abut Prot:		N31-Design Loading:	A	Superstructure and deck replaced in 2013.	
N116-Nav Min Vert Cr (feet):		N41-Open, Post, Close:	A		
GENERAL DATA		N63-Method Used for Oper. Rtg:	1		
N33-Bridge Median:	0	N64-Operating Load Rtg/Factor:	66		
N34-Slew:	0	N65-Method Used for Inv. Rtg:	1		
N35-Structure Filled:	0	N66-Inventory Load Rtg/Factor:	52		
N37-Historical Significance:	5	N70-Bridge Posting:	5		
N107-Deck Str Type:	1	N103-Temp Str Designation:			
N108-Wear Surf Prot System:	1 0 1	A211-Posted Limit (Tons):			
A201-Wear Surf Thickness (Inches):	0	A222-Date of Load Rtg:	10/01/2014		
		A233-Posted Vert Cr NB/EB (ft-in):	0-0		
		A233-Posted Vert Cr SBWB (ft-in):	0-0		

Bridge Repair Report

Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 1 of 1

BRIDGE GROUP Bridge Repair Report

Structure Number:	00014	Structure Name:	Chambers TI UP	Inspected by:	[REDACTED]
Route:	40	Road Name:	US 191	Inspection Type:	Routine
MP:	333.41	Agency:	ADOT	Inspection Date:	Tuesday, July 19, 2016
ADOT District:	Northeast	District Org:	5236	Next Insp. Due By:	July 2018

<u>Work Candidate ID:</u>	00014-RAPX-000216-C5FDA57B1CED	<u>A216 - Actual Completion Cost:</u>	\$ [REDACTED]
<u>Action:</u>	1013 Bearings-Reset	<u>A216 - Completion Date:</u>	[REDACTED]
<u>Estimated Quantity:</u>			
<u>Estimated Cost:</u>			
<u>A212 - Repair Priority:</u>	3		
<u>Reinstall bearing pad for Beam 4 at south abutment.</u>			

List of Maintenance Items

Arizona Department of Transportation Bridge Group List of Maintenance Items

Str. No.	Structure Name	Rt.	MP	Description of Maintenance Items
771	Pinal Air Park TI UP Inspection #20	10	232.02	1. Repair the undermining of the spillway at NW corner. See Photo #13.
				2. Replace missing timber spacer blocks at SW approach rail. See Photo #15.
866	Ina Road TI OP EB Inspection #22	10	248.72	1. Repair broken light attached to pier cap #1 (see Photo #11).
867	Ina Road TI OP WB Inspection #22	10	248.72	1. Repair left turn signals at exterior of girder 9 that have impact damage. See photos # 7 and 8.
869	Orange Grove TI OP WB Inspection #20	10	250.04	1. Repair rail and replace wood blocks at the Southwest corner of the bridge. See photos #9.
				2. Repair spalls at the South and North abutment at girder 4. See photo #11.
873	Rathrauff Rd TI OP WB Inspection #22	10	252.43	1. Replace missing turn sign at exterior of girder 9. See photo #11.
		10		2. Replace broken timber posts at North West corner approach guard rail.
1107	Ajo Way OP EB Inspection #21	10	262.44	Repair guard rail and timber blocks at the following locations: 1. Southeast corner - broken timber blocks, detached guard rail due to collision. See Photo #14. 2. W-beam at midspan in the left shoulder. See photo #15. 3. Approach guard rail at Northeast corner. See photo #16.

List of Maintenance Items

PAGE 2

9/22/2015

1108	Ajo Way OP WB Inspection #23	10	262.44	Replace missing guardrail spacers at both abutment ends on right side. See photos #18 and 19.
1112	Country Club OP WB Inspection #22	10	263.82	Repair spill in AC overlay in right lane of span 3. See photo 3.
1217	Irvington Rd OP EB Inspection #21	10	264.27	Repair collision damage to north side thrie beam retrofit and bridge rail with missing rail sections at the northeast corner. See photo 8.
1218	Irvington Rd OP WB Inspection #21	10	264.27	1. Remove debris building on east shoulder. 2. Clean roadway drain on northeast corner of bridge. 3. Remove vegetation growth in spillway at northeast end. See photo 8.

District:	Tucson	Org. Number:	8150	Packet Number:	5380
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Inspected by:	John Doe	Date:	9/29/10
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Go\Everyone\Bridges\Forms

Revised 10/25/2010 vtc

Inspection Report - Page 1

Date Printed : 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 1 of 2

BRIDGE GROUP

Inspection Report

Structure No.: 00814	Structure Name: Chambers TI UP	Inspected by: [REDACTED]
Route : 40	Road Name: US 191	Inspection Type: Routine
MP : 333.41	Agency: ADOT	Inspection Date: Tuesday, July 18, 2016
ADOT District: Northeast	District Org: 5236	Next Insp. Due By: July 2018

NBI Condition Ratings

N58 Deck :	7 Good	N61 Channel:	N N/A (NBI)
N59 Superstructure :	8 Very Good	N62 Culvert :	N N/A (NBI)
N60 Substructure :	7 Good		

Appraisal Ratings

N57 Structural Evaluation:	7 Above Min Criteria	N71 Waterway Adequacy:	N Not applicable
N58 Deck Geometry:	5 Above Tolerable	N72 Approach Roadway Align.:	8 Equal Desirable Crit
N59 Vert. & Horiz. Clearances:	3 Intolerable - Correct	N113 Scour Critical:	N Not Over Waterway

Inspection Notes

Roadway/Safety:

1. Two-lane AC roadway has a few narrow to medium transverse and longitudinal cracks. Transitions are level.
2. Fills are in good condition.
3. Concrete barrier is at all 4 corners of bridge and has a few large spalls and vehicle scuff marks.
4. Minimum measured vertical underclearances = 16.39' (WB) and 16.29' (EB). Therefore, posting of vertical clearance is not required, per current ADOT signing policy.
5. US 191' signs are on exterior beams. Object markers are at both ends of Pier 2 column. Traffic / directional signs are at both ends of bridge, on top.

Superstructure:

1. Steel channel diaphragms (bolted to stiffeners) are at abutments, piers and intermediate span locations. Diaphragms are in very good condition.

Substructure:

1. Concrete slope paving at both abutments has narrow to medium horizontal and vertical cracks of moderate density (some sealed) and a few patches.

Miscellaneous Inspection Notes:

1. The one repair recommended in the previous inspection was not completed and is repeated. See repair report. No new repairs are recommended.
2. No previous maintenance items to verify and no new maintenance items are recommended.
3. Photos:
 - a. Roadway ID, looking S
 - b. Elevation ID, looking W
 - c. Deck top
 - d. Deck bottom
 - e. Joint, typ.
 - f. Beam 4 bearing pad, S abut.

Element No.	Element Description	Quantity	Units	Env.	Condition State			
					1	2	3	4
12	Re Concrete Deck	8134	sq feet	2	7634	500	0	0
1. Deck top has a few hairline transverse and random cracks. 2. Deck bottom has hairline transverse cracks of light density, a few with efflorescence on overhangs.								
107	Steel Opn Girder/Beam	974	feet	2	974	0	0	0
1. Description: 4- W36x160 rolled steel beams, 4 continuous spans. 2. Spans are numbered north to south and beams east to west, in accordance with plans. 3. Since this is a routine inspection, not all comments made in the last In-depth inspection were verified. However, they are retained and may be updated during the next In-depth inspection. Refer to inspection dated 10/1/14 for most recent In-depth inspection notes. 4. There are no fracture critical members on this structure. Fatigue prone details include welded vertical stiffeners and cover plates over piers. 5. Beams are in good condition.								
616	Steel Protective Coating	8561	sq feet	2	8561	0	0	0
1. Description: Tan paint (no lead).								
205	Re Conc Column	3	each	2	3	0	0	0
1. Description: Reinforced concrete columns on CIP YN-16 piles. 2. Pier columns have minor hairline vertical cracks.								
215	Re Conc Abutment	66	feet	2	66	0	0	0
1. Description: Reinforced concrete stubs on CIP YN-16 piles. 2. Abutments are in good condition. Backwalls have light to moderate scaling and hairline random cracks.								

Inspection Report - Page 2

Date Printed : 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 2 of 2

BRIDGE GROUP

Inspection Report

Structure No. : 00614	Structure Name : Chambers TI UP	Inspected by : [REDACTED]
Route : 40	Road Name : US 191	Inspection Type: Routine
MP : 333.41	Agency : ADOT	Inspection Date : Tuesday, July 19, 2016
ADOT District: Northaast	District Org: 5236	Next Insp. Due By : July 2018

Element No.	Element Description	Quantity	Units	Env.	Condition State			
					1	2	3	4
234	Re Conc Pier Cap	85	feet	2	85	0	0	0
1. Description: Reinforced concrete hammerhead pier caps. 2. Pier caps have minor hairline vertical cracks.								
302	Compression Joint Seal	56	feet	2	56	0	0	0
1. Description: Compression seal joints at abutments. 2. Joint openings at 90 deg. F: N abut. = 1-1/2" (E), 1-3/8" (W); S abut. = 1-3/8" (E), 1-1/2" (W). Joints are partially filled with debris.								
310	Elastomeric Bearing	16	each	2	15	0	1	0
1. Description: Elastomeric bearing pads at abutments and Piers 1 and 3. 2. Bearing pads are in new condition. Bearing pad for Beam 4 at south abutment has partially moved out from under beam. Approximately 58% of pad is still in contact with sole plate. See Photo 7 and repair report.								
313	Fixed Bearing	4	each	2	4	0	0	0
1. Description: Fixed steel bearings at Pier 2.								
616	Steel Protective Coating	4	sq feet	2	4	0	0	0
1. Description: Tan paint.								
321	Re Conc Approach Slab	420	sq feet	2	420	0	0	0
1. Approach slabs have a few hairline to narrow longitudinal cracks.								
331	Re Conc Bridge Railing	490	feet	2	490	0	0	0
1. Description: 34" F-shaped concrete barrier, both sides of bridge.								

Vertical and Horizontal Clearance Diagram

ARIZONA DEPARTMENT OF TRANSPORTATION

BRIDGE GROUP SUPPLEMENTAL PAGE TO BRIDGE INSPECTION REPORT VERTICAL & HORIZONTAL CLEARANCE DIAGRAM

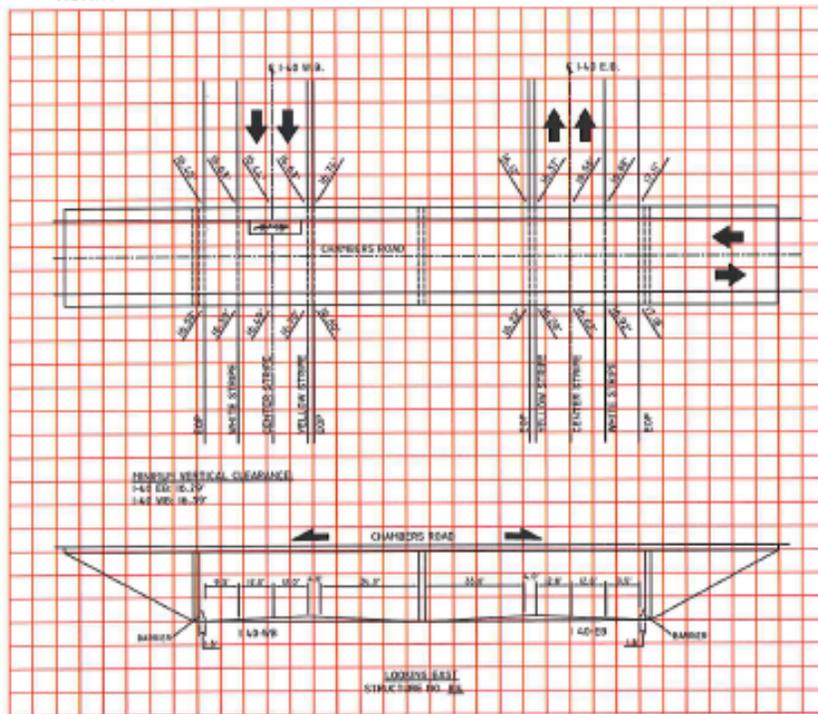
STRUCTURE NAME

STRUCTURE NO.

LOCATION ROUTE MILEPOST

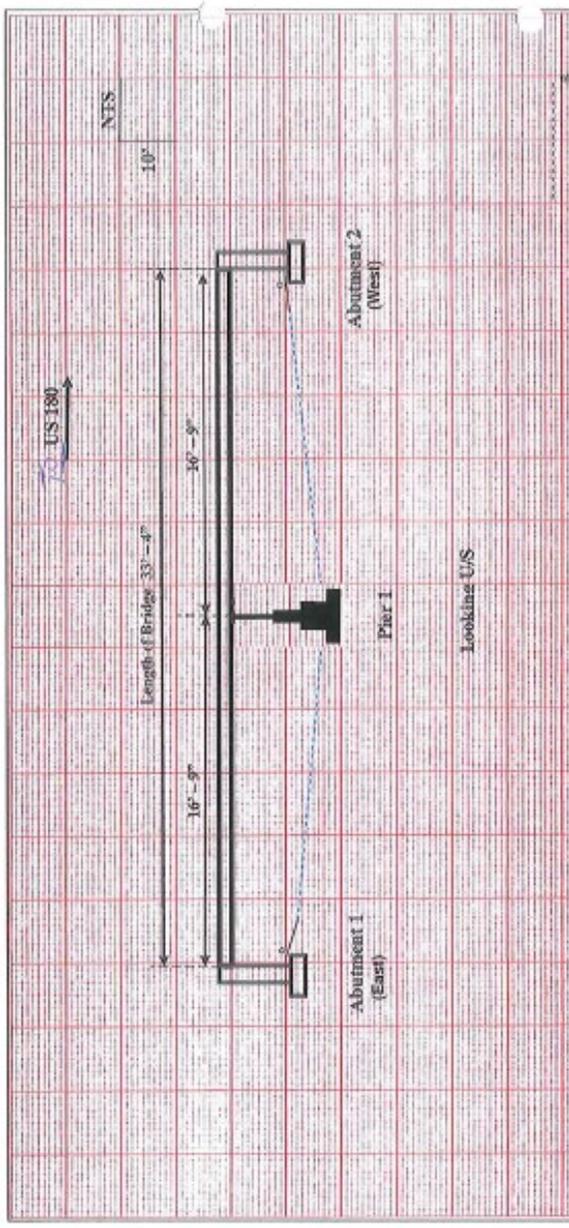


INSPECTION	23	24		
DATE	10/1/04	7/6/16		
INITIAL				
NEW/REVISED DIAGRAM	REV.	NSC		



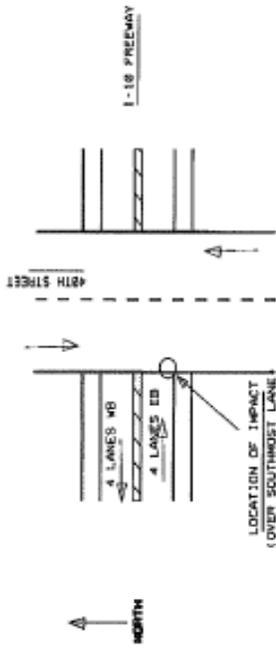
Channel Profile Diagram

Name of Structure: Little Colorado River Br.
 Structure No. 5777
 Location: Route MP _____ Springerville Globe



Insp. No.	Insp. Date	Inspector's Initial	Channel Profile Location (US or DS)	Depth at Abut. 'A1' face or at Support, 2' (HS)	Depth at 1/4 span	Depth at mid span	Depth at 3/4 span	Depth at the left side of Support 2-1	Depth at the right side of Support 2-1	Depth at 1/4 span	Depth at mid span	Depth at 3/4 span	Depth at Abut. 'A2' face or at Support, 2' (HS)
17	5/31/14		DS	9.50'				Water					9.31'
18	9/23/14		DS	9.50'				Water					9.35'

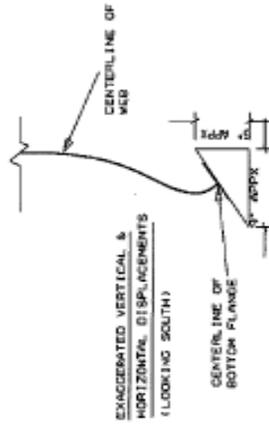
**DAMAGE TO EASTMOST STEEL GIRDER AND ASSOCIATED ELEMENTS
(STRUCTURE -2190 AT I-10 AND 40TH STREET)
ELEMENTS NOT TO SCALE**



SECTION OF APPROXIMATE TORSIONAL
DISPLACEMENT - LOOKING SOUTH



ABOUT 10 FEET LENGTH OF LONGITUDINAL
DISTORTION WAS OBSERVED IN THE
IMMEDIATE VICINITY OF SOUTHWEST LANE



An Example of a sketch

Inspection Photographs – Roadway ID

Date Printed : 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 1 of 6

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00814	Structure Name :	Chambers TI UP	Inspected by :	██████████
Route :	40	Road Name :	US 191	Inspection Type :	Routine
MP :	333.41	Agency :	ADOT	Inspection Date :	Tuesday, July 19, 2016
ADOT District :	Northeast	District Org :	5236	Next Insp. Due By :	07/19/2018



File Name : 00814-2016-07-19-Photo-a.jpg
Description : Roadway ID, looking S

Inspection Photographs – Elevation ID

Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 2 of 6

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00814	Structure Name :	Chambers TI UP	Inspected by :	[REDACTED]
Route :	40	Road Name :	US 191	Inspection Type :	Routine
MP :	333.41	Agency :	ADOT	Inspection Date :	Tuesday, July 19, 2016
ADOT District :	Northeast	District Org :	5236	Next Insp. Due By :	07/19/2018



File Name : 00814-2016-07-19-Photo-b.jpg
Description : Elevation ID, looking W

Inspection Photographs – Deck Top Condition

Date Printed : 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 3 of 8

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00954	Structure Name :	Chambers T1 UP	Inspected by :	
Route :	40	Road Name :	US 191	Inspection Type :	Routine
MP :	333.41	Agency :	ADOT	Inspection Date :	Tuesday, July 19, 2016
ADOT District:	Northeast	District Orig:	6236	Next Insp. Due By :	07/19/2018



File Name : 00914-2016-07-19-Photo-c.jpg
Description : Deck top

Inspection Photographs – Soffit View

Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 4 of 8

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number:	00814	Structure Name:	Chambers Tr UP	Inspected by:	[REDACTED]
Route:	40	Road Name:	US 181	Inspection Type:	Routine
MP:	333.41	Agency:	ADOT	Inspection Date:	Tuesday, July 19, 2016
ADOT District:	Northeast	District Org:	5236	Next Insp. Due By:	07/19/2018



File Name: 00814-2016-07-19-Photo-d.jpg
Description: Deck bottom

Inspection Photographs – Deck Joint

Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 5 of 6

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00014	Structure Name :	Chambers TI UP	Inspected by :	
Route :	40	Road Name :	US 191	Inspection Type :	Routine
MP :	333.41	Agency :	ADOT	Inspection Date :	Tuesday, July 18, 2018
ADOT District :	Northeast	District Org :	6236	Next Insp. Due By :	07/19/2018



File Name : 00014-2018-07-18-Photo4.jpg
Description : Joint, typ

Inspection Photographs – Bearing Condition

Date Printed: 12/11/2017

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 6 of 6

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00814	Structure Name :	Chambers TI UP	Inspected by :	
Route :	40	Road Name :	US 191	Inspection Type:	Routine
MP :	333.41	Agency :	ADOT	Inspection Date :	Tuesday, July 19, 2016
ADOT District:	Northaast	District Org:	5236	Next Insp. Due By :	07/19/2018



File Name : 00814-2016-07-19-Photo-4.jpg
Description : Beam 4 bearing pad, S abut.

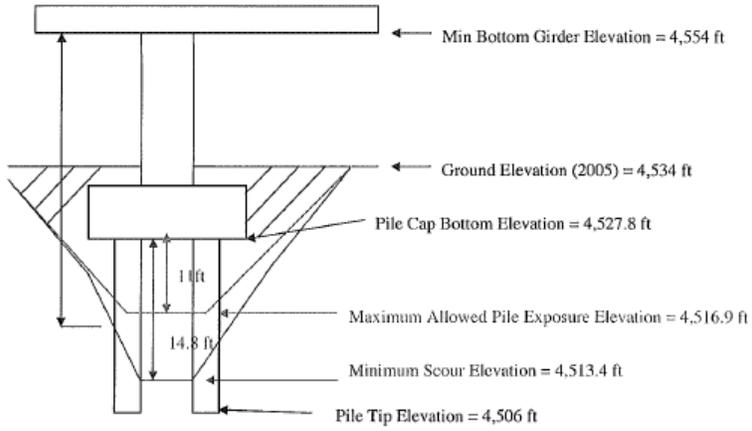
APPENDIX B – SAMPLE OF PLAN OF ACTION REPORT

<u>PLAN OF ACTION FOR SCOUR VULNERABLE BRIDGES- BRIDGE HYDRAULICS SECTION</u>	
<i>Prepared By:</i> SB	<i>Approved By:</i> <i>Date:</i>
	<i>Approved By:</i> <i>Date:</i>

- 1. Bridge Identification:** Name: Agua Fria River Bridge Str. No.: 1371 District: Prescott Route: SR 169
Mile Post: 0.25 Year Built: 1969 ADT/Year: 9700/2005
- 2a. Foundation Type:** Round concrete column piers on steel H-piles; abutments are concrete on steel H-piles.
- 2b. Foundation Soils:** The soil consists mostly of silty clay. Deeper layers contain gravel, sand and cobbles.
- 3. Sources of Scour Rating:** Pier scour calculations, dated August 29th, 1996, by Bridge Drainage Section, have classified the bridge in this location as scour vulnerable. The site indicates signs of general scour at the piers.
- 4. Comments about Rating:** The predicted local pier scour depth of 20.6 ft is based on the 50 year design flow at this location (discharge: 13,640 cfs; calculated high water elevation: 4,541.9 ft). In this scenario less than half of the embedment remains. The piles were not driven into bedrock. The new bridge will not be scour vulnerable.
- 5. Inspecting Details:** The channel appears to be relatively stable. Minor vegetation can be found in the channel due to moderate flow velocities (12 fps).
- 6a. Monitoring if any:** No scour monitor was installed.
- 6b. Criteria for Inspecting:** If any item in 7b is noticeable during a storm event by District Maintenance personnel, report to Bridge Management Section-602 712 8605 or Bridge Group office 602 712 7481.
- 7a. Closure Plan:** The Bridge must be closed following proper Traffic Control Guidelines by ADOT or DPS personnel notices the cases listed in item 7b and must report to the District Engineer.
- 7b. Criteria for Closure:** 1) Any distress of the deck or barrier at the pier location is visually noticeable or 2) If the piles are exposed more than 11 ft from the bottom of the pile cap.
- 8. Flooding Potential:** The high water for the 50 year event was found to be about 6 ft below the roadway surface. There is about 2 ft freeboard in this high water event. Chances for deck overtopping are minimal.
- 9. Detour Details:** SR 69 and I 17, see attached detour plan, can be utilized for detour purposes. The proposed detour is 35 miles longer than the regular distance on the SR 169.
- 10 Criteria for Reopening:** The DE or his representative must be convinced that items listed under 7b are no longer a concern or have been rectified.
- 11a. Follow up Action:** Gabion boxes can be used as protection against further scour. Concrete armoring can be used for more durable protection.
- 11b. Str. Replacement Plans:** Replacement project is in construction phase.

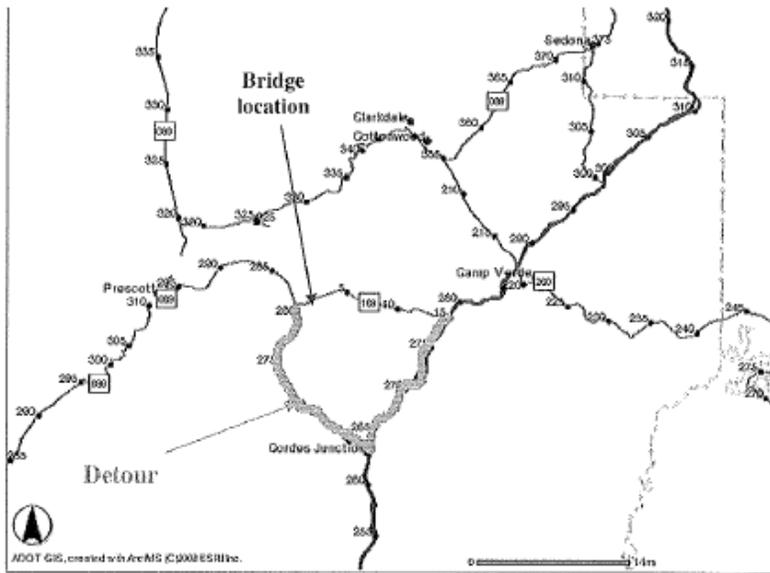
Str. No.: 1371

Minimum scour elevation shown below is based on the 50 year storm event.



8/29/2008

Detour Map for structure 1371
Milepost 0.25
SR 169



APPENDIX C – FRACTURE CRITICAL DOCUMENTS:

- 1. Inspection Plan**
- 2. Field Sheets**
- 3. Drawings**

ADOT Bridge Group

Inspection Methods:

1. Visual Inspection (VT)

Visual inspections will be conducted in accordance with NBIS Code of Federal Regulation 23 CFR Part 650, The inspection procedure recommendation in the FHWA NHI 03-001 "Bridge Inspection Reference Manual," 2006 and AASHTO "Manual for Condition Evaluation of Bridges," 1994, second edition and the "Inspection of Fracture Critical Bridge Members" FHWA Report No. FHWA-IP-86-26 will be followed. These inspections shall be hands-on with the inspector being within arm length of the component. Critical areas shall be specially cleaned prior to the inspections and additional lighting and magnification shall be used.

2. Liquid (Dye) Penetrant Testing (PT)

The testing will be performed by a Certified ASNT Level II inspector from a selected ADOT qualified on-call inspection company in accordance to ANSI/ASNT Testing Specifications. Refer also to: *Inspection of Fracture Critical Bridge Members*, FHWA Report No. IP-86-26.

Special inspection Needs:

1. Inspection Access Method Discussion

The bridge spans over Hereford River on Hereford Road in Cochise County with a narrow single-lane roadway and no shoulders. The channel is relatively flat and has spread wider than the center span. The low-flow channel runs through the center span west of the east pier. The berm on either side of the low-flow is approximately 15' from the lower truss chords which are about 25' above the water surface of the low-flow. The truss members above deck can be inspected with bucket truck, ladders or ropes. Lower truss chords and floor beams can be reached by ladders or ropes. Temporary bridge closure may be required if bucket truck is used.

2. Traffic Control Plan

The selected ADOT qualified on-call inspection company shall coordinate with Cochise County.

3. Equipment

The selected ADOT qualified on-call inspection company shall equip with the tools necessary to perform the In-depth inspection for this bridge.

Revised by: _____

Date: _____

Revised by: _____

Date: _____

Approved by: _____

Date: _____

ADOT Bridge Group

Fracture Critical Members In-Depth Inspection
Field Sheet

Structure #: 10597
 Bridge Name: Hereford Rd Bridge
 Route: Cochise County
 Facility Carried: Hereford Road
 Location: 8.3 mi East of SR 92

Bridge Description

Hereford Road Bridge has three simple spans of steel through pony trusses with a concrete deck supported by multiple steel rolled stringers and floor beams attached to the truss bottom chords.

Fracture Critical Members: (see FCM Plan and Drawings in bridge file)

1. Tension members of the north and south steel trusses in span 1, 2, & 3.
2. Floor beams in span 1, 2, & 3.

Members and Details that require Inspection

-Spans and panel points are numbered from west to east. Span 1 and 3 are numbered with bottom chords from L1 to L11 and top chords from U2 to U10. Span 2 is numbered with bottom chords from L1 to L17 and top chords from U2 to U16.

-Inspection methods listed are required for that member. Any other method(s) used in conjunction with these should be noted.

SPAN	FRACTURE CRITICAL MEMBERS	INSPECTION METHODS USED	INSPECTION COMPLETED	
			Yes	No
All Spans	Tension stress areas in the floor beams at panel points	VT/PT		
<u>Comments:</u>				
NORTH TRUSSES				
Span 1	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11	VT/PT		
<u>Comments:</u>				
Span 1	Diagonal members: U2-L3, U4-L5, U8-L7, U10-L9	VT/PT		
<u>Comments:</u>				
Span 2	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11, L11-L13, L13-L15, L15-L17	VT/PT		
<u>Comments:</u>				

ADOT Bridge Group

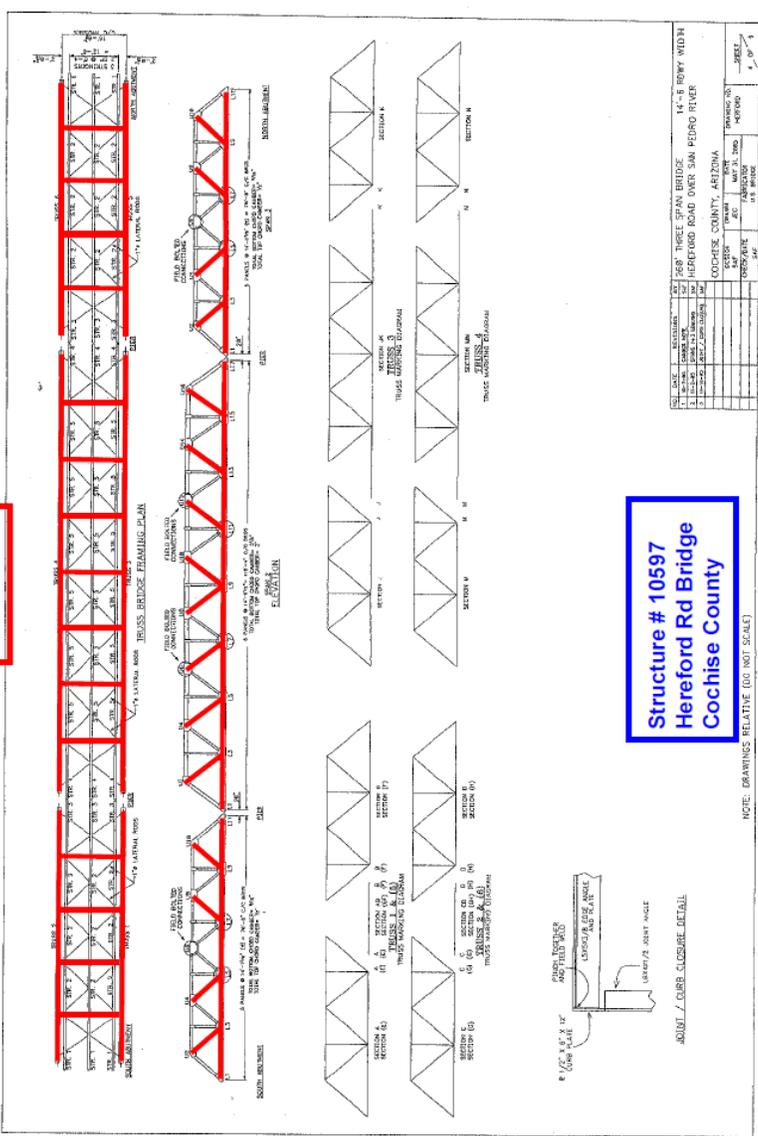
SPAN	FRACTURE CRITICAL MEMBERS	INSPECTION METHODS USED	INSPECTION COMPLETED	
			Yes	No
Span 2	Diagonal members: U2-L3, U4-L5, U6-L7, U8-L9, U10-L9, U12-L11, U14-L13, U16-L15	VT/PT		
<u>Comments:</u>				
Span 3	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11	VT/PT		
<u>Comments:</u>				
Span 3	Diagonal members: U2-L3, U4-L5, U8-L7, U10-L9	VT/PT		
<u>Comments:</u>				
SOUTH TRUSSES				
Span 1	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11	VT/PT		
<u>Comments:</u>				
Span 1	Diagonal members: U2-L3, U4-L5, U8-L7, U10-L9	VT/PT		
<u>Comments:</u>				
Span 2	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11, L11-L13, L13-L15, L15-L17	VT/PT		
<u>Comments:</u>				
Span 2	Diagonal members: U2-L3, U4-L5, U6-L7, U8-L9, U10-L9, U12-L11, U14-L13, U16-L15	VT/PT		
<u>Comments:</u>				
Span 3	Lower chord members: L1-L3, L3-L5, L5-L7, L7-L9, L9-L11	VT/PT		
<u>Comments:</u>				
Span 3	Diagonal members: U2-L3, U4-L5, U8-L7, U10-L9	VT/PT		

ADOT Bridge Group

Comments:
-VT = Visual Inspection Test; PT = Dye Penetrant Test; Note: The tension stresses are distributed over the member cross sections as follows: - Bottom flange and lower 1/2 of the web of steel floor beams in the positive moment regions - Top flange and upper 1/2 of the web of steel floor beams in the negative moment regions - The engineer shall choose PT for FCM inspection whereas VT is not applicable.

Additional Comments/Observations:

— = FCM



**Structure # 10597
Hereford Rd Bridge
Cochise County**

NO.	DATE	REVISIONS	BY	CHKD.	DESCRIPTION
1	10/1/20	1	JMS	JMS	ISSUE FOR PERMIT
2	10/1/20	2	JMS	JMS	ISSUE FOR PERMIT
3	10/1/20	3	JMS	JMS	ISSUE FOR PERMIT
4	10/1/20	4	JMS	JMS	ISSUE FOR PERMIT
5	10/1/20	5	JMS	JMS	ISSUE FOR PERMIT
6	10/1/20	6	JMS	JMS	ISSUE FOR PERMIT
7	10/1/20	7	JMS	JMS	ISSUE FOR PERMIT
8	10/1/20	8	JMS	JMS	ISSUE FOR PERMIT
9	10/1/20	9	JMS	JMS	ISSUE FOR PERMIT
10	10/1/20	10	JMS	JMS	ISSUE FOR PERMIT
11	10/1/20	11	JMS	JMS	ISSUE FOR PERMIT
12	10/1/20	12	JMS	JMS	ISSUE FOR PERMIT
13	10/1/20	13	JMS	JMS	ISSUE FOR PERMIT
14	10/1/20	14	JMS	JMS	ISSUE FOR PERMIT
15	10/1/20	15	JMS	JMS	ISSUE FOR PERMIT
16	10/1/20	16	JMS	JMS	ISSUE FOR PERMIT
17	10/1/20	17	JMS	JMS	ISSUE FOR PERMIT
18	10/1/20	18	JMS	JMS	ISSUE FOR PERMIT
19	10/1/20	19	JMS	JMS	ISSUE FOR PERMIT
20	10/1/20	20	JMS	JMS	ISSUE FOR PERMIT

NOTE: DRAWINGS RELATIVE (DO NOT SCALE)

APPENDIX D – ARIZONA ITEMS

Item No.	Item Name	Page
200	Principal Route location	82
201	Wearing Surface thickness	83
202	Foundation Type	84
203	District Maintenance Org	85
204	Original Project Number	86
205	Station-Principal Route (in BRM: Original Project Station	87
206	Bridge Rail Type (Type-Geometric- Structural)	88
207	Inspection Quarter	89
209	Structure Name	90
211	Posted Limit	91
212	Repair Priority	92
217	Culvert Barrel Height	93
218	Culvert Barrel Length	94
219	Culvert Fill Height	95
220	Foundation Embedment	96
221	Scour Countermeasure (Flow-Floor-Bank)	97
222	Date of Load Rating	98
223	TRACS Number	99
225	Total Deck Area	100
228	Next Inspection Due Date	101
229	Agency	102
230	Principal Route Number	105
231	Principal Route Letter	106
232	Principal Route Milepost	107
235	Structure Status	108

ITEM NAME: Principal Route LocationAZ ITEM NO. 200

DESCRIPTION:

A one-digit identifies the principal route on or under a structure (bridge or culvert).

BACKGROUND:

All structures under ADOT jurisdiction are recorded based on the concept of "principal" and "other" routes. All highway features are inventoried by principal route as well. In cases where two routes intersect at a bridge and routes pass over and under the bridge, a means is needed to identify which route is the principal route. The hierarchy for this determination is a combination of NBI Hems N5B and N5E. If routes have different service levels, the ranking is from highest to lowest service level as seen in Table 1. When both routes are of the same service level, the lowest route number and lowest suffix – low A to high Z will have the priority as seen in Table 2 (this only applies to numbered routes). When two highways of the same service level and number cross over each other, direction of traffic will determine the ranking as seen in Table 3.

Table 1

Route Service Level Ranking
Interstate highway
U.S. Numbered highway
State highway
County highway
City street

Table 2

State Route Ranking
24
89
89A
101L
989

Table 3

Directional Ranking
North
East
South
West

PROCEDURE:

If the bridge has two roadway records (On and Under structure), determine which record should contain the principal route.

Code "Y" (Yes) in the record for the Principal Route, and code "N" (No) in the record for the other route.

EXAMPLES:

1. 1-10 on the structure, with no route under the structure - i.e., bridge or culvert over waterway or railroad.
Code Item 200 for the On record Y
2. 1-10 On the structure, SR 51 Under the structure - i.e., 1-10 overpass.
For On record, Code Y.
For Under record, Code N
3. SR 86 On the structure, 1-10 under the structure - i.e., 1-10 underpass.
For On record, Code N
For Under record, Code Y
4. Pedestrian or railroad structure over 1-8, i.e. pedestrian/railroad underpass.
For Under record, Code Y

ITEM NAME: Wearing Surface Thickness..... AZ ITEM NO. 201**DESCRIPTION:**

A two-digit field, indicating the thickness of the overlay, usually asphaltic concrete that has been applied to the structural deck either at original construction or subsequently.

PROCEDURE:

Use the average thickness shown on contract plans. If available, check by field measuring at deck drains or by measuring down from known height of curb. Thickness is recorded to the nearest inch, and includes all material from driving surface to structural deck surface.

If no overlay is present, leave this item blank.

For the culvert structures not at grade, leave this item blank.

Refer to Item 108 - Wearing Surface/Protection System for additional information and cross-reference.

EXAMPLES:

Bridge deck has a measured AC overlay of 2.75", Code: 3 Bridge deck

has a measured AC overlay of 12.2 inches, Code: 12

ITEM NAME: Foundation Type.....AZ ITEM NO. 202**DESCRIPTION:**

A two-digit field, the first digit (a) of which identifies the type of abutment foundation and the second digit (b) identifies the type of pier foundation.

FIRST DIGIT ABUTMENT FOUNDATION	CODE	SECOND DIGIT PIER FOUNDATION	CODE
Spread on uncemented soil	1	Spread on uncemented soil	1
Spread on cemented soil	2	Spread on cemented soil	2
Spread on bedrock	3	Spread on bed rock	3
Steel H piles _	4	Steel H piles _	4
C-I-P pipe shell piles	5	C-I-P pipe shell piles	5
C-I-P fluted shell piles	6	C-I-P fluted shell piles	6
Precast concrete piles	7	Precast concrete piles	7
Timber piles	8	Timber piles	8
Drilled shaft or caisson	9	Drilled shaft or caisson	9
Other and unknown foundation	0	Other and unknown foundation	0

PROCEDURE:

The information should be taken from the contract plans or by field investigation of the foundation material.

If two or more types of abutment foundations are present, record the lower number in the first digit.

If two or more types of pier foundations are present, record the lower number in the second digit.

Leave the first digit blank for bridges without abutments. Leave the second digit blank for single-span bridges.

Leave this item blank for the reinforced concrete box culverts, bridge culverts and pipe arch culverts.

EXAMPLE:

Abutment 1 spread on uncemented soil, pier on drilled shafts and Abutment 2 on H-piles. Code **1 .2**.

Abutments on timber piling and piers spread on cemented soil. Code **1**

ITEM NAME: District Maintenance ORGAZ ITEM NO. 203

DESCRIPTION:

A four-digit field that identifies ADOT's District Maintenance Organization (ORG) who has maintenance responsibility for the structure
This item applies to State-maintained structures only.

PROCEDURE:

In order to get the information, first the structure location in a given route and milepost should be determined. District and ORG name should then be confirmed from the ADOT Districts web pages.

EXAMPLES:

A structure is located on U.S. 60, at milepost 72. The structure is located in Northwest District and the Wickenburg Maintenance ORG (5313).

Leave blank when unknown.

ITEM NAME: Original Project NumberAZ ITEM NO. 204

DESCRIPTION:

This eighteen-digit field identifies the project number under which the original construction of the structure was carried out.

PROCEDURE:

The original project number should be obtained from the original contract plans. When the plans are not available for State administered project, the Project Control Section should be contacted to obtain the necessary information. The local owner agency should supply the Project Number for project administered by them.

CODING:

Coding should be left justified with unused positions left blank.

Project Number IR - I - 10 - 5(40) -----

Leave blank when unknown.

ITEM NAME: Station-Principal Route (in BRM: Original Project Station)..... AZ ITEM NO. 205

DESCRIPTION:

A nine-digit field representing the construction route station of a structure for the principal route according to the system hierarchy.

PROCEDURE:

Determine the station for the structure from the contract plans. If plans are not available, leave this item blank.

For the structures carrying the principal route, record the Beginning Bridge station shown on the location sheet of the bridge plans. If the only bridge station shown is at the center of the structure, then the beginning bridge station should be computed and recorded .

For the structures with principal route passing under, record the station of the point of intersection between the principal route under and the construction centerline of the structure.

The beginning of the bridge is considered to be at the fill face of the back wall and should be used when plans are available or the position can easily be determined in the field. This item should be coordinated with Item 49.

The data in the nine-digit field should be right justified, with unused positions left blank. Do not include the plus sign and decimal point. The entry of the data may start out left justified, and the program will right justify upon execution of entry.

CODING:

Construction station: 825 + 32.67

Enter as follows: 825 3267 Data as stored: _ _ 8 2 5 3 2 6 7

ITEM NAME: Bridge Rail Type (Type-Geometric-Structural).....AZ ITEM NO. 206

DESCRIPTION:

A three-digit field representing the type of rail on the bridge or box culvert at grade.

PROCEDURE:

Record the rail type from the plans when available and verify from field inspection for changes.

For culverts at grade, where the height of fill is normally less than 2 feet and the curbs and/or rails delineate the roadway, record the rail type; otherwise leave blank.

Determine the geometric characteristics of the rail element and record all geometric features suitable for evaluating conformance to standards.

Determine the structural adequacy of the rail, using current AASHTO Standard Specification for Highway Bridges.

If the bridge has more than one type of rail, record the data for all types but code data for the least adequate system.

CODING:

A. First Digit - Rail Type: **X**

First Digit - Rail Type	Code
None	0
H-2-1	1
H-3-1	2
Single rail with parapet	3
Concrete {other than concrete barrier}	4
Baluster (Aluminum or Steel)	5
Special steel (including curb-mounted guardrail)	6
Timber	7
Thrie-beam retrofit	8
Concrete barrier	9

B. Second Digit - Geometric Conformance **X**

Second Digit - Geometric Conformance	Code
The existing bridge rail does not conform to current AASHTO geometric requirements.	0
The existing bridge rail conforms to current AASHTO geometric requirements.	1

C. Third Digit - Structural Conformance Code **X**

Second Digit - Geometric Conformance	Code
The existing bridge rail does not conform to current AASHTO structural requirements.	0
The existing bridge rail conforms to current AASHTO structural requirements.	1

AASHTO conformance for typical standards

A206B =I when:

N36a =I , or
bridge rails (H-2-1 Rail, H-1-1 Rail, H-3-1 Rail and Std. B-22.40) 2: 27"

A206C=I when N36(a) =1

ITEM NAME: Inspection Quarter..... AZ ITEM NO. 207

DESCRIPTION:

A one-digit field representing the quarter in which the structure is scheduled for a regular interval inspection.

FIELD TYPE: Number (1 to 8)

PROCEDURE:

The inspection quarter for a new structure is generally determined by assigning and keeping the quarter consistent with other nearby structures in the same geographic area.

CODING:

YEAR TYPE	MONTHS	INSPECTION QUARTER CODE
Even Year	Jan, Feb, Mar	1
	Apr, May, June	2
	Jul, Aug, Sep	3
	Oct, Nov, Dec	4
Odd Year	Jan, Feb, Mar	5
	Apr, May, June	6
	Jul, Aug, Sep	7
	Oct, Nov, Dec	8

ITEM NAME: Structure NameAZ ITEM NO. 209**DESCRIPTION:**

A twenty-digit field to record the name of the structure.

PROCEDURES:

The Bridge Group assigns the structure name to new State Bridges. The culverts with named waterway underneath should be given the structure name of the waterway with appropriate suffixes such as RCB, CMP, etc. For unnamed waterways underneath, simply code structure name as RCB, CMP, etc.

The names for local government structures can be derived as above or by using local official maps.

The name should have "OP" or "UP" as suffix depending upon whether the Principal Route is on or under the structure respectively. A traffic interchange will have "TI" as part of the name. The name of overpass with one-way traffic should have a directional suffix in it. Other commonly used names may be added in parentheses provided enough space is available.

Bridge - (BR)

This term is usually reserved for the structure over waterways or canyons.

Overpass - (OP)

A structure carrying the principal route over a roadway, railroad, or pedestrian crossing.

Underpass - (UP)

A structure where the principal route passes under a highway, railroad or pedestrian crossing.

Traffic Interchange – (TI)

An OP or UP is also called TI if on and off ramps are provided to the intersecting roadways.

Viaduct

A structure carrying a roadway over various features such as streets, waterways, railroads. The use of the name is optional.

Tunnel

A structure carrying a roadway through a topographical barrier.

CODING:

Structure name coding should be left justified, using any combination of alphabetic, numeric, special characters and blanks.

Abbreviations to be used for culvert type:

RCB Reinforced concrete box

RCBC - Reinforced concrete bridge culvert RCP

Reinforced concrete pipe

RCPA - Reinforced concrete pipe arch RCA -

Reinforced concrete arch CMP - Corrugated

metal pipe

CMPA - Corrugated metal pipe arch SPP

Structural plate pipe

SPPA - Structural plate pipe arch SPA -

Structural plate arch

EXAMPLES:

B L A C K C Y N _ T I _ O P N B

C A N Y O N _ D I A B L O R C B

CMP #2

ITEM NAME: Posted Limit..... AZ ITEM NO. 211**DESCRIPTION:**

A two-digit field indicating the actual posted weight restriction in gross tons.

PROCEDURE:

A Posted Weight Limit is required for all structures not capable of carrying Arizona legal loads as determined by the structural analysis.

A concrete structure need not be posted for the restricted loading when it has been carrying normal traffic for an appreciable length of time and shows no distress.

No structure will be limited to a weight restriction of less than three (3) tons. A bridge should be closed if not capable of carrying three (3) tons.

If this item is coded, then NBI Item 41 must be coded "P" (posted) or "K" (closed), and NBI Item 70 must be less than 5.

New or revised regulatory signing shall conform to the requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways.

Code the posted weight limit in gross tons. The value to be coded shall be the rating for the Type 3 vehicle. If no weight restriction is posted, leave this item blank.

ITEM NAME: Repair PriorityAZ ITEM NO. 212

DESCRIPTION:

A one-digit field to indicate repair scheduling requirements.

PROCEDURE:

If more than one repair recommendation is made on a report, the repair work requiring the highest Repair Priority should be noted on the Structure Inspection Report. Individual repair priorities are noted on the Structure Repair Report.

TYPE OF ACTION	CODE
Immediate action required	1
Repair work to take priority over routine work	2
Repair work that can be scheduled	3
No repairs - may require special attention	4
No action is required	5

ITEM NAME: Culvert Barrel HeightAZ ITEM NO. 217

DESCRIPTION:

A two-digit field indicating the height of culvert barrel to the nearest foot.

PROCEDURE:

The culvert barrel height can be taken from the plans and verified in the field. If plans are not available, the measurement must be determined in the field to the nearest foot.

For multiple-barrel culverts with varying heights, record the smallest height. For different barrel heights at inlet and outlet, record the smallest height.

Record the data on the Culvert Inspection Report.

This item is to be left blank for circular pipe culverts, and when not applicable.

Code a two-digit number indicating the culvert barrel height, to the nearest foot. It should be right justified.

EXAMPLES:

<u>Culvert Barrel Height</u>	<u>Code</u>
10 feet	10
6 feet	06

ITEM NAME: Culvert Barrel LengthAZ ITEM NO. 218**DESCRIPTION:**

A four-digit field indicating the length of culvert barrel to the nearest foot.

PROCEDURE:

The culvert barrel height can be taken from the plans and verified in the field. If plans are not available, the measurement must be determined. The length should be measured to the nearest foot, from face of headwall to face of headwall, along the centerline of the culvert.

For multiple-barrel culverts with varying lengths, record the minimum length. Record the data on the Culvert Inspection Report.

Code a four-digit number indicating the culvert barrel length, to the nearest foot. It should be right justified. Leave blank when not applicable.

EXAMPLES:

The barrel length of a box culvert is 46' - 7".

Code 47

An EB RCB, 65' long is extended 7' on the right and 54' through the median to a VB RCB, 66' long, which is extended 8' on the left.

New barrel length = 65'+7'+54'+66'+8'=200'

Code 200

ITEM NAME: Culvert Fill HeightAZ ITEM NO. 219**DESCRIPTION:**

A three-digit field indicating the maximum fill height in feet over the culvert, measured from the top surface of the fill or pavement to the top surface of the culvert.

PROCEDURE:

The maximum fill height over the culvert should be obtained from the plans and verified in the field. Measure the maximum fill height in the field when the plans are not available.

For culverts with no fill, code zeros. For all other cases, code actual maximum fill height to the nearest foot. Leave blank when not applicable.

Code ing should be right justified.

EXAMPLES:

<u>Culvert Fill Height</u>	<u>Code</u>
8 feet	<u> 8</u>
123 feet	<u>123</u>

ITEM NAME: Foundation EmbedmentAZ ITEM NO. 220

DESCRIPTION:

A two-digit field to indicate the depth, below the thalweg (lowest flow line elevation in the channel) of the bottom of the highest substructure footing or highest piling tip.

For single span structures, give the information for the most vulnerable abutment.

PROCEDURE:

The purpose of this item is to develop data for scour studies, and to provide a generalized indication of scour vulnerability. The substructure unit selected to represent the data, for the bridge as a whole, should be that unit or group of units that appears to represent the foundation most susceptible to scour.

Determine the elevation of the highest footings, either in the channel or directly adjacent, from plans. Establish flow line elevation by measurement, and then calculate the embedment depth.

Code no less than Q 1 for any substructure. For abutment foundations that are above the low stream bed elevation, and are selected to represent the bridge's most vulnerable foundation, Code 0 1.

Code 9 9 for embedment exceeding 100'.

Leave blank for any structure not crossing a waterway, and for all culverts.

EXAMPLES:

Distance from flow line elevation to the bottom of the highest vulnerable pier footing = 6.8 ft. Code 0 7

Distance from the highest pile tip elevation to the flow line = 109 ft. Code 99

ITEM NAME: Scour Countermeasures (Flow-Floor-Bank)AZ ITEM NO. 221

DESCRIPTION:

A three-digit field to identify the existing types of channel control and bank protection features at this site.

PROCEDURE:

Record the existing types of scour countermeasures from plans when available and verify from field inspection. Leave blank when not applicable.

CODING:

First Digit - Flow Control

X _ _

FLOW CONTROL TYPE	CODE
None	0
Concrete check dam	2
Wire tied riprap & rail check dam	3
Outlet drop structure	4
Groins or training dikes	5
Retard	6
A combination of the above	7
Other	9

Second Digit - Floor Protection

_ X _

FLOOR PROTECTION TYPE	CODE
No Protection	0
Concrete floor	1
Soil cement floor	2
Wire tied riprap floor	3
Dumped rock floor	4
Wire tied pier pads	5
Aprons	6
A combination of the above	7
Grouted rock	8
Other	9

Third Digit – Bank Protection

_ _ X

BANK PROTECTION TYPE	CODE
No Protection	0
Concrete Slope Paving	1
Soil cement	2
Rail bank	3
Grouted rock	4
Dumped rock riprap	5
Wire tied rock, (Gabions)	6
A combination of the above	7
Masonry	8
Other	9

ITEM NAME: Date of Load RatingAZ ITEM NO. 222

DESCRIPTION:

An eight-digit field to indicate the last date the structure was analyzed for load capacity.

PROCEDURE:

Code month, day and year of the date the structure was last analyzed. If unknown, leave blank.

EXAMPLE:

This structure was last analyzed for load capacity on September 24, 2008.

Code: 9/24/2008

ITEM NAME: TRACS Number..... AZ ITEM NO. 223

DESCRIPTION:

An eight-digit field to identify the TRACS Number.

PROCEDURE:

Enter the number used to reference data in TRACS, which included The Project Number, The Sub- Project and Phase. Leave blank if unknown or not applicable.

EXAMPLE:

TRACS Number: H325003C

Code: H 3 2 5 0 0 3 C

ITEM NAME: Total Deck AreaAZ ITEM NO. 225**DESCRIPTION:**

A six-digit field to indicate the total deck area of the bridge.

PROCEDURE:

The total deck area is usually the product of the width of the bridge out-to-out from NBI Item No 52 and the bridge length from NBI Item No. 49. If the bridge has a variable width due to ramp flares, or other reasons for a non-prismatic shape, the area needs to be calculated using the variable out-to-out surface width from bridge end to bridge end. For culverts not at grade (fill height 2' or more), use NBI Item N32 instead of barrel length.

CODING:

Code the area to the nearest square foot.

EXAMPLE:

NBI Item 52 is 30.3 ft. and NBI Item 49 is 46 ft.

Calculate: $30.3 \times 49 = 1487.7$ sq. ft.

Code: 1488

EXAMPLE:

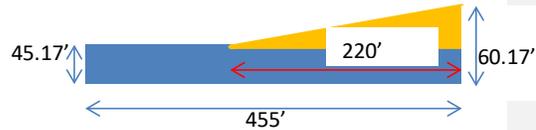
A bridge has a taper at one end to provide for an entrance ramp. The bridge is- nominally 45.17 feet out to out and the last 220 feet of the structure flares out from 45.17 feet to 60.17 feet.

The bridge is 455 feet long overall.

Calculate: Blue rectangle area = $45.17 \times 455 = 20552.35$ SF

Orange triangle area = $(60.17 - 45.17) \times 1/2 \times 220 = 1650$ SF

Total Area = 22202.35 sq. ft.



Code: 22202

EXAMPLE:

NBI Item 49 for a culvert at grade is 46 ft. and N52 is 60 ft.

Calculate: $46 \times 60 = 2760$ sq. ft. Code: 2760

EXAMPLE:

NBI Item 49 for a culvert not at grade is 40 ft. and NBI Item 32 is 60 ft.

Calculate: $40 \times 60 = 2400$ sq. ft.

Code: 2400

ITEM NAME: Next Inspection Due DateAZ ITEM NO. 228

DESCRIPTION:

A ten-digit field which indicates the day, month and year of the next inspection due date.

PROCEDURE:

This field is a calculated field using the current inspection date (N90) and frequency of inspection (N91) fields.

EXAMPLE:

The current inspection date for this structure (bridge) is 08/12/2015 with a frequency of 24 months. The next inspection for this structure will be during August 2017.

Code: 08/12/2017

The current inspection date for this structure (culvert) is 10/12/2014 with a frequency of 48 months. The next inspection for this structure will be during October 2018.

Code: 10/12/2018

ITEM NAME: AgencyAZ ITEM NO. 229

DESCRIPTION:

An eighteen-digit field to identify the actual name of the agency responsible for maintenance of the structure.

PROCEDURE:

Record the name of the agency that has responsibility for the maintenance of the bridge, and as a result would also have responsibility for inspecting the structure. In general this is the same agency that is being considered for coding in NBI Item No. 21, and may not be the owner of the bridge.

CODING:

The coding must match the names listed below under Agency so that the exact name can be used in queries.

AGENCY	SBIS CODE
ADOT	AZ
AZ STATE PARKS	AZ
APACHE CO	AP
COCHISE CO	CH
COCONINO CO	CN
GILA CO	GI
GRAHAM CO	GH
GREENLEE CO	GE
LA PAZ CO	LA
MARICOPA CO	MA
MOHAVE CO	MO
NAVAJO CO	NA
PIMA CO	PM
PINAL CO	PN
SANTA CRUZ CO	SC
YAVAPAI CO	YV
YUMA CO	YU
APACHE JCT	AJ
AVONDALE	AV
BISBEE	BB
BUCKEYE	BY
CAMP VERDE	CV
CHANDLER	CD
CLARKDALE	CK

CLIFTON	CF
COOLIDGE	CL
COITONWOOD	CW
EAGAR	EG
FLAGSTAFF	FS
FLORENCE	FC
FOUNTATN HILLS	FH
GILA BEND	GB
GILBERT	GT
GLENDALE	GN
GLOBE	GL
GOODYEAR	GY

KINGMAN	KM
LAKE HAVASU	LH
MARANA	MR
MESA	MS
MIAMI	MI
NOGALES	NG
ORO VALLEY	OV
PAGE	PG
PARADISE VALLEY	PV
PAYSON	PY
PEORIA	PE
PHOENIX	PX
PINETOP-LAKESIDE	PL
PRESCOIT	PT
SAFFORD	SF
SCOTTSDALE	SD
SEDONA	SE
SIERRA VISTA	SV
SPRINGERVILLE	SP
SUPERIOR	SR
SURPRISE	SS
TEMPE	TM
TOLLESON	TL
TUCSON	TN
WELLTON	WT
WILLIAMS	WL
WINKELMAN	WK
WINSLOW	WN
YUMA CITY	YM
BIA COCOPAH	
BIA COLORADO River	
BIA FT APACHE	
BIA FT YUMA	
BIA GILA RIVER	
BIA HOPI	
BIA HULAPAI	
BIA PAPAGO (Tohono O'Odham)	

BIA SAN CARLOS	
BLM	
NATL PARK SERVICE NAVAJO TRIBE	
US BUREC	
US BUREC CAWCD	

USAF DAVIS-MONTHAN	
USFS APACHE-SIT	
USFS COCONINO	
USFS CORONADO	
USFS KAIBAB	
USFS PRESCOTT	
USFS TONTO	
VETERANS ADMIN	

ITEM NAME: Principal Route NumberAZ ITEM NO. 230

DESCRIPTION:

A four digit field to indicate the route number of the principal route for each bridge.

BACKGROUND:

A simplified directly readable route number is needed for report identifications, sorting and record keeping. NBI Item 5 is too complex a number to handle this requirement effectively.

PROCEDURE:

Record the numeric portion of the Principal Route number for each bridge. The Principal Route is determined by the following order of route importance: Interstate highway, U.S. highway, State highway, County highway, City street, local. If two or more intersecting routes are of the same hierarchy, the lower route number will be considered the principal route.

EXAMPLES:

<u>Route</u>	<u>Code</u>
Interstate 8	8
State 40B	40
US 89A	89
US 191	191
Interstate 40 over Interstate 17	17

ITEM NAME: Principal Route Letter..... AZ ITEM NO. 231

DESCRIPTION:

A one digit field to identify the text modifier for Principal Routes.

PROCEDURE:

Record the alpha portion of the route number associated with each route. Do not include the general hierarchy designation such as "I" for Interstate or "U" for U.S. Highway. Record only the modifier as follows:

A - Alternate B
 - Business L -
 Loop
 S - Spur
 T - Temporary or Truck

Leave Blank for those routes without a modifier.

EXAMPLES:

<u>Route</u>	<u>Code</u>
US 89 A	A
State Route 40B	B
Interstate 10	Leave blank
Temp 191	T

ITEM NAME: Principal Route Milepost..... AZ ITEM NO. 232

DESCRIPTION:

A seven digit field to indicate the principal route milepost location of the bridge.

PROCEDURE:

Record the milepost associated with the principal route for the applicable bridge. For bridges carrying the principal route code the milepost at the beginning of the bridge. For bridges with the principal route under, code the milepost at the intersection of the centerlines of the routes.

CROSS REFERENCE: NBI Item No. 11

CODING:

Code the number to the nearest 1/100th of a mile and enter as a decimal number.

EXAMPLE: 123.45

ITEM NAME: Structure Status.....AZ ITEM NO. 235**DESCRIPTION:**

A one-digit field to indicate the status of the structure.

BACKGROUND:

An eligible structure is considered Active when generally in public service, regularly inspected, and its condition reported to FHWA on annual basis.

An eligible structure is considered Retired when no longer in use. An eligible ADOT structure is considered Retired when replaced or transferred to another local public agency with a new structure number assigned to it. Generally, this structure is no longer maintained by ADOT, not inspected by ADOT, and its condition not reported to FHWA by ADOT on annual basis. However, the same structure, if transferred to another local public agency, will be inspected, maintained, and its condition reported to FHWA on annual basis by the local public agency.

An eligible structure is considered new when its construction has not been completed; its construction has been completed but not inspected yet; its construction has been completed, inspected but not finalized and therefore, will not be reported to FHWA on annual basis at this time. An Active local public agency structure, when transferred to ADOT, will be issued a new structure number but considered Active.

Code	Description
1	New Structure
2	Retired Structure
3	Active Structure

PROCEDURE:**EXAMPLE:**

A bridge was recently transferred from ADOT (structure # 01234) to Cochise County (structure #12075):
Structure #01234 is coded as Retired

Structure #12075 is coded as Active

Code = 2

Code = 3

An ADOT Bridge was recently demolished (structure # 00002) and the new replacement bridge (structure # 1 0075) has been inspected and it has not been finalized yet:

Structure #00002 is coded as Retired

Structure #1 0075 is coded as New

Code = 2

Code = 1

APPENDIX E – CRITICAL FINDINGS PROCEDURE

Date:

Memorandum #:

There are four key components that comprise the critical findings procedure which are as follows:

- 1) **Description: Definition, Purpose and Classification**
- 2) **Starter, Trigger and Notification Process**
- 3) **Activities & Reporting**
- 4) **Close-out & Reporting**

Description: Definition, Purpose and Classification

Definition:

Federal Regulations (23 CFR 650, Subpart C) defines a critical finding as “A structural or safety-related deficiency that requires immediate follow-up inspection or action.”

ADOT further defines the deficiency as discovery of a bridge component, visually or by rating evaluation, of such severity that might critically threaten public safety and structural stability leading to partial or full closure of the structure.

Purpose:

The purpose of establishing the Critical Findings process is to bring those bridge deficiencies to the attention of responsible parties. Responsible parties then take action in a timely manner to restore service on the bridge and safeguard the traveling public using it. Federal regulations require critical findings to be reported to FHWA

Classification: Critical Findings are classified, based on levels of severity, as described below and then summarized in Table 1:

1 - Urgent (Color: Red) - Structural deficiency of primary structural bridge element which threatens the integrity of the structure as a whole.

- Bridge is closed and immediate action required.
- This may require bridge replacement or major rehabilitation.

2 - Restrictive (Color: Orange) - Structural deficiency that affects load postings and/or establishes restrictions.

- Bridge restricted ASAP.
- This may require lane or shoulder closures and/or load restrictions; analysis and recommendations done immediately.

3 - Serious (Color: Yellow) - Does not immediately jeopardize the bridge or the traveling public.

- No restrictions required.

Table 1- Summary of Severity Classification

Severity	Color Designation	Immediate Action (s)
Urgent	Red	Bridge Closure
Restrictive	Orange	Bridge Restriction
Serious	Yellow	None

Starter, Trigger and Notification Process

Starter: Any of the following persons may initiate the notification process:

- ADOT Bridge Inspectors,
- ADOT District Personnel,
- LPA Personnel
- Member of Public

Trigger: Any observation of the field conditions or examination of records by the Starter, as described below, shall justify a critical finding notification:

A. Field observations:

- A partial or complete bridge collapse
- Structural or other defects posing a definite and immediate public safety hazard
- Severe scour deficiencies
- Extreme deterioration of primary structural element(s)
- Other safety deficiencies caused by earth movement, natural disaster, traffic impact, etc.

B. Examination of various bridge or culvert inspection documents warrant granting any of the following NBI ratings:

- A. NBI item 113 - Scour Rating, an **Appraisal Rating** of 2 or less
- B. NBI item 66 (inventory load rating) of less than 3 tons.
- C. Following NBI items - A **Condition Rating** of 2 or less:
 - NBI item 58 (deck)
 - NBI item 59 (superstructure)
 - NBI item 60 (substructure)
 - NBI item 61 (channel and bank protection)
 - NBI item 62 (culvert)

Notification Process:

The Starter will immediately contact the appropriate ADOT District Engineer (DE) or the bridge owner, thus beginning the notification process. The ADOT DE or the bridge owner, in turn, shall contact the Bridge Group Bridge Preservation Program Manager (BPPM).

The ADOT Bridge Management Section Leader (BMSL) will assume the lead role in the notification process once he/she has been notified. The primary method of contact will be phone/e-mail notification and a required follow-up e-mail to properly document circumstances. See Exhibit A at the end of this document for the entire notification process.

The Critical Findings Report will document the entire notification process by including description of incident and action plan (any immediate, short-term and long-term plans going forward). Initial communication with Bridge Group shall be documented on the Critical Findings Report.

This Report can be found on the ADOT Bridge Group website (<http://www.azdot.gov/business/engineering-and-construction/bridge>) under "Critical Findings Report" topic.

Activities & Reporting

Initial Activities & Reporting:

Once ADOT DE or the bridge owner is made aware of the problem, a decision should be made by him or her on how to control the traffic over and under bridge in order to keep public safe and safely assess the damage. Technical staff (ADOT District Engineer or Local Public Agency Engineer) will perform the initial assessment in order to determine if the damages could be assessed locally or need further inspection.

Inspection of ADOT structures and those Local Public Agencies utilizing ADOT is done by Bridge Management Section (BMS) inspectors. Inspection of self-inspecting Local Public Agencies is conducted by their own resources.

Once the site inspection is complete and a related report is prepared by the inspector (s), indicating a case of Critical Finding, the inspection report will be defined as Initial Inspection-CF. Initial Inspection-CF will often start as a damage inspection following an initial assessment. But it is plausible to occur during any regularly scheduled inspection or random observation.

A check list of possible follow-up activities is reviewed at this point. The list should have activity check boxes associated with the inspection and confirmation of the Critical Finding. By checking these boxes, the inspector will be required to submit a Critical Findings report.

At this stage, Critical Finding report will be filled out only for the portions of the report titled "Part1-Critical Finding by inspector" and "Part 2-Action Plan by bridge owner".

Typical information required at this point includes the following:

- Basic bridge location Information
- Date and time of Incident or observation (if known)
- Written and thorough narrative documentation -supplemented with pictures
- Incident duration and any associated traffic restrictions imposed
- Classification of Critical Finding
- Inspector(s) name(s)
- Action Plans (short-term and initial long-term activities) and follow-ups

Short-Term Follow Up: Action means a plan is in place and sufficient countermeasures have been implemented to restore light service or to fortify closures in order to ensure public safety.

Initial Long-Term Action Plan: Countermeasures have been planned to be implemented to restore the structure to its full capacity and ensure public safety.

- A Long-Term Action Plan for the structure shall also be established at this time.

Intermediate - Final Activities & Reporting:

These activities occur after the initial Inspection-CF is submitted. It covers any action, such as Short-Term Follow-Up actions and finalized Long-Term Action Plan and relaying the information between all parties involved.

Critical Finding report at this stage will include, "Part1-Initial Inspection-CF" and "Part 2-Initial Actions", all completed or active parts of mitigation plans, including Short-Term Follow-Up actions and final Long-Term Action Plan steps. As a minimum, an interim report should be filled out for completion of Short-Term Follow-Up and Long-Term Actions in a timely manner.

Close-Out & Reporting

The close-out inspection is the inspection performed after Short-Term Follow-Up actions and Long-Term Action Plan have been completed and no structural or safety issues pending.

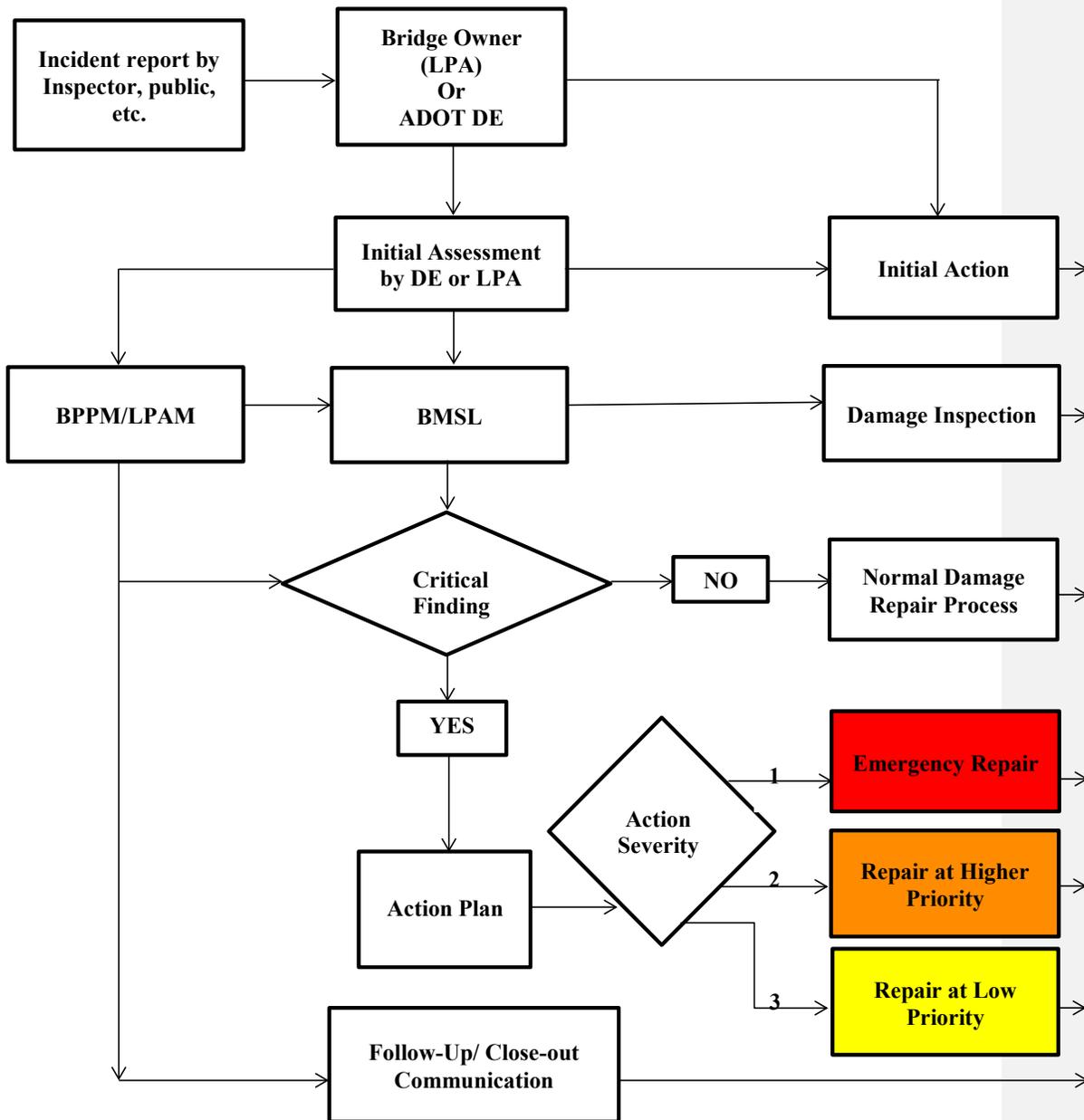
There may be several Interim steps and inspections ending with close-out inspections. Along with this closeout inspection, there should be an associated Critical Finding Activity. By checking this activity, the inspector will be required to submit a final Critical Findings Report. At this stage, the report should be filled out in its entirety. When this inspection document is e-mailed to all the interested parties, the case of Critical Finding will be considered closed.

Typical information required at this point includes the following:

- Description of Short-Term Follow-Up Actions & final Long-Term Action Plan
- Photo documentation to confirm Follow-up Actions have been addressed and/or implemented
- Date Follow-up Actions were completed

Exhibit A - Abbreviations and Critical Finding Process

- **ADOT DE** - ADOT District Engineer
- **LPA** - Local Public Agency representative
- **BPPM** - Bridge Preservation Program Manager
- **LPAM** - ADOT Local Public Agency Manager
- **BMSL** - ADOT Bridge Management Section Leader



DESCRIBE GENERAL BRIDGE INFORMATION, CRITICAL FINDING(S) AND ATTACH PHOTOS/SKETCHES



Responsible parties to be kept notified:

-
-
-
-
- FHWA - Arizona Division

Part 2. Describe action plan:**(To be filled by the owner)**

Describe specific steps of the action plan, include dates and responsible person for each action, responsible parties to be notified

Responsible parties to be notified:

- State Bridge Engineer
- Bridge Preservation Manager
- Bridge Design Manager
- District Engineer
- FHWA - Arizona Division

Part 3. Action plan steps

(To be filled by the owner)

Type of action/ repair, date of action/ repair, responsible party, company/organization
Updated information after Action Plan

--

Responsible parties to be notified:

-
-
-
-
- FHWA - Arizona Division

Part 4. Periodic Update of Action Plan

(To be filled by the owner)

Type of each step of action/ repair, date of action/ repair, responsible party, company/organization

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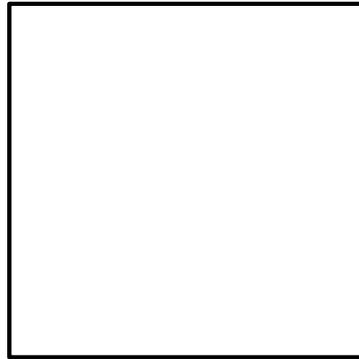
Responsible parties to be notified:

-
-
-
-
- FHWA - Arizona Division

Part 5. Post repair update and closure

(To be filled by the owner or its representative - to be signed and sealed by a Civil P.E. registered in Arizona)

Certification of completion of work, compliance with the intended design information and readiness of the bridge for receiving full capacity public and commercial transportation



Seal, Date and Expiration Date

Responsible parties to be notified:

-
-
-
-
- FHWA - Arizona Division

Appendix G

G.1 - Tunnel inventory items :

Table G.1.1 - Identification & Location

Table G.1.2 - Age and Service

Table G.1.3 - Owner, Operator, & highway classification

Table G.1.4 - Geometric Data

Table G.1.5 - Inspection

Table G.1.6 - Load Rating and Posting

Table G.1.7 - Navigation

Table G.1.8 - Structure Type & Material

Table G.1.1 - Identification & Location	
Item ID	Item Description
I.1	Tunnel Number
I.2	Tunnel Name
I.3	State Code
I.4	County Code
I.5	Place Code
I.6	Highway Agency District
I.7	Route Number
I.8	Route Direction
I.9	Route Type
I.10	Facility Carried
I.11	LRS Route ID
I.12	LRS Mile Point
I.13	Tunnel Portal's Latitude
I.14	Tunnel Portal's Longitude
I.15	Border Tunnel State or Country Code
I.16	Border Tunnel Financial Responsibility
I.17	Border Tunnel Number
I.18	Border Tunnel Inspection Responsibility

Table G.1.2 - Age and Service	
Item ID	Item Description
A.1	Year Built
A.2	Year Rehabilitated
A.3	Total Number of Lanes
A.4	Annual Average Daily Traffic
A.5	Annual Average Daily Truck Traffic
A.6	Year of Annual Average Daily Traffic
A.7	Detour Length
A.8	Service in Tunnel

Table G.1.3- Owner, Operator, & highway classification Items	
Item ID	Item Description
C.1	Owner
C.2	Operator
C.3	Direction of Traffic
C.4	Toll
C.5	NHS Designation
C.6	STRAHNET Designation
C.7	Functional Classification
C.8	Urban Code

Item ID	Item Description
G.1	Tunnel Length
G.2	Minimum Vertical Clearance over Tunnel Roadway
G.3	Roadway Width, Curb-to-Curb
G.4	Left Sidewalk Width
G.5	Right Sidewalk Width

Item ID	Item Description
D.1	Routine Inspection Target Date
D.2	Actual Routine Inspection Date
D.3	Routine Inspection Interval
D.4	In-Depth Inspection
D.5	Damage Inspection
D.6	Special Inspection

Item ID	Item Description
L.1	Load Rating Method
L.2	Inventory Load Rating Factor
L.3	Operating Load Rating Factor
L.4	Tunnel Load Posting Status
L.5	Posting Load – Gross
L.6	Posting Load – Axle
L.7	Posting Load – Type 3
L.8	Posting Load – Type 3S2
L.9	Posting Load – Type 3-3
L.10	Height Restriction
L.11	Hazardous Material Restriction
L.12	Other Restrictions

Item ID	Item Description
N.1	Under Navigable Waterway
N.2	Navigable Waterway Clearance
N.3	Tunnel or Portal Island Protection from Navigation

Item ID	Item Description
S.1	Number of Bores
S.2	Tunnel Shape
S.3	Portal Shapes
S.4	Ground Conditions
S.5	Complex

G.2 - Tunnel Elements :

Table G.2.1 – Structural

Table G.2.2 – Civil

Table G.2.3 – Mechanical Systems

Table G.2.4 – Electrical and Lighting Systems

Table G.2.5 – Fire/Life Safety/Security Systems

Table G.2.6 – Signs

Table G.2.7 – Protective Systems

Element Type	Element Name	Element #	Unit of Measure
Liners	Steel Tunnel Liner	10000	area, ft2
	Cast-in-Place Concrete Tunnel Liner	10001	area, ft2
	Precast Concrete Tunnel Liner	10002	area, ft2
	Shotcrete Tunnel Liner	10003	area, ft2
	Timber Tunnel Liner	10004	area, ft2
	Masonry Tunnel Liner	10005	area, ft2
	Unlined Rock Tunnel	10006	area, ft2
	Rock Bolt/Dowel	10007	Each
	Other Tunnel Liner	10009	area, ft2
Tunnel Roof Girders	Steel Tunnel Roof Girders	10010	length, ft
	Concrete Tunnel Roof Girders	10011	length, ft
	Prestressed Concrete Tunnel Roof Girders	10012	length, ft
	Other Tunnel Roof Girders	10019	length, ft
Columns/ Piles	Steel Columns/Piles	10020	Each
	Concrete Columns/Piles	10021	Each
	Other Columns/Piles	10029	Each
Cross Passageway	Steel Cross Passageway	10030	length, ft
	Concrete Cross Passageway	10031	length, ft
	Shotcrete Cross Passageway	10033	length, ft
	Timber Cross Passageway	10034	length, ft
	Masonry Cross Passageway	10035	length, ft
	Unlined Rock Cross Passageway	10036	length, ft
	Other Cross Passageway	10039	length, ft
Interior Walls	Concrete Interior Walls	10041	area,ft2
	Other Interior Walls	10049	area,ft2
Portal	Concrete Portal	10051	area,ft2
	Masonry Portal	10055	area,ft2
	Other Portal	10059	area,ft2
Ceiling Slab	Concrete Ceiling Slab	10061	area,ft2
	Other Ceiling Slab	10069	area,ft2
Ceiling Girder	Steel Ceiling Girder	10070	length, ft
	Concrete Ceiling Girder	10071	length, ft
	Prestressed Concrete Ceiling Girder	10072	length, ft
	Other Ceiling Girder	10079	length, ft
Hangers and Anchorages	Steel Hangers and Anchorages	10080	Each
	Other Hangers and Anchorages	10089	Each
Ceiling Panels	Steel Ceiling Panels	10090	area,ft2
	Concrete Ceiling Panels	10091	area,ft2
	Other Ceiling Panels	10099	area,ft2
Invert Slab	Concrete Invert Slab	10101	area,ft2
	Other Invert Slab	10109	area,ft2
Slab-on- Grade	Concrete Slab-on-Grade	10111	area,ft2
	Other Slab-on-Grade	10119	area,ft2
Invert Girder	Steel Invert Girder	10120	length, ft
	Concrete Invert Girder	10121	length, ft
	Prestressed Concrete Invert Girder	10122	length, ft
	Other Invert Girder	10129	length, ft
Joints	Strip Seal Expansion Joint	10130	length, ft
	Pourable Joint Seal	10131	length, ft
	Compression Joint Seal	10132	length, ft
	Assembly Joint With Seal	10133	length, ft
	Open Expansion Joint	10134	length, ft
	Assembly Joint Without Seal	10135	length, ft
	Other Joint	10139	length, ft
Gaskets	Gaskets	10140	length, ft

Table G.2.2 - Civil			
Element Type	Element Name	Element #	Unit of Measure
Wearing Surface	Concrete Wearing Surface	10151	area,ft2
	Asphalt Wearing Surface	10158	area,ft2
	Other Wearing Surface	10159	area,ft2
Traffic Barrier	Steel Traffic Barrier	10160	length, ft
	Concrete Traffic Barrier	10162	length, ft
	Other Traffic Barrier	10169	length, ft
Pedestrian Railing	Steel Pedestrian Railing	10170	length, ft
	Concrete Pedestrian Railing	10171	length, ft
	Other Pedestrian Railing	10179	length, ft
Table G.2.3 - Mechanical Systems			
Element Type	Element Name	Element #	Unit of Measure
Ventilation System	Ventilation System	10200	Each
	Fans	10201	Each
Drainage and Pumping System	Drainage and Pumping System	10300	Each
	Pumps	10301	Each
Emergency Generator System	Emergency Generator System	10400	Each
Flood Gate	Flood Gate	10475	Each
Table G.2.4 - Electrical and Lighting Systems			
Element Type	Element Name	Element #	Unit of Measure
Electrical Distribution	Electrical Distribution System	10500	Each
Emergency Distribution	Emergency Distribution System	10550	Each
Tunnel Lighting	Tunnel Lighting Systems	10600	Each
	Tunnel Lighting Fixtures	10601	Each
Emergency Lighting	Emergency Lighting Systems	10620	Each
	Emergency Lighting Fixtures	10621	Each
Table G.2.5 - Fire/Life Safety/Security Systems			
Element Type	Element Name	Element #	Unit of Measure
Fire Detection	Fire Detection System	10650	Each
Fire Protection	Fire Protection System	10700	Each
Emergency Communications	Emergency Communications System	10750	Each
Operations and Security	Operations and Security System	10800	Each
Table G.2.6—Signs			
Element Type	Element Name	Element #	Unit of Measure
Traffic Guidance	Traffic Sign	10850	Each
Egress Signs	Egress Sign	10870	Each
Variable Message Boards	Variable Message Board	10890	Each
Lane Signal	Lane Signal	10910	Each
	Lane Signal Fixture	10911	Each
Table G.2.7 - Protective Coating Elements			
Element Type	Element Name	Element #	Unit of Measure
Protective Coating	Steel Corrosion Protective Coating	10950	Each
	Concrete Corrosion Protective Coating	10951	Each
	Fire Protective Coating	10952	Each

G.3 Tunnel Reports Examples

G.3.1. SI & A Report for Tunnel

G.3.2. Inspection Report for Tunnel

G.3.3. Repair/Maintenance Report for Tunnel (only maintenance report exists)

G.3.4. Vertical Clearance Diagram (from previous Inspection)

G.3.5. Photo Report

G.3.1. Tunnel Inventory & Appraisal

Date Printed : 11/06/2019		ARIZONA DEPARTMENT OF TRANSPORTATION	
BRIDGE GROUP			
Tunnel Inventory and Appraisal			
Tunnel Number : 00407		Tunnel Name : Queen Creek Tunnel	Feature Under : US 60
Route : 60	MP : 228.47	Road Name : Queen Creek Tunnel	Agency : ADOT
			Location : 1.6 mi E Jct SR 177

LOCATION INFORMATION	DIMENSIONS	CONSTRUCTION PROJECT DATA
I3-State Code : 04	G1-Tunnel Length (feet): 1217	A1-Year Built: 1952
I6-State Hwy District : Southeast	G4-Lt Sidewalk Width (feet): 2.0	A2-Year Rehabilitated: 0
I4-County Code : 021	G5-Rt Sidewalk Width (feet): 2.0	A204-Orig Project Number: F-16(14)
I5-Place Code : 00000	G3-Roadway Width C-C (feet): 38.3	A205-Orig Project Station: 105+33.00
C8-Urban Code : 99999		A223-TRACS Number:
I13-Latitude: 33 Deg 18 Min 15.67 Sec		A225-Tunnel Area (sq. feet): 48342
I14-Longitude: 111 Deg 05 Min 0.66 Sec		
I15/I18-Border St Code - % Resp:		
I17/I16-Border Bridge Number:		

INVENTORY ROUTE DATA	VERTICAL & HORIZONTAL CLEARANCE	INSPECTION
A7-Detour Length (miles): 37	L10-Height Restriction: Yes	D2-Inspection Date: 08/19/2019
C4-Toll: No tolls	G2-Min Vert Cir (feet): 14.00	D3-Insp Freq (months): 24
I9-Route Type: 2		A207-Inspection Quarter: 7
I7/I8-No/Direction Rte: 00060 0		Inspection Types: Routine
A3-Total No. of Lanes: 3		D1-Next Insp Date: August 2021
I11-LRS Rt ID:		
I12-LRS MP:		
C7-Functional Class: 3		
A4-Avg Daily Traffic: 8250		
A6-Year of ADT: 2018		
C6-STRAHNET: 1		
C3-Direction of Traffic: 2		
C5-NHS: 1		
A5-Truck Traffic: 750		

RESPONSIBILITY	SERVICE, SHAPE, and BORE INFORMATION	CRITICAL FEATURES
C2-Operator: 01	A8-Service in Tunnel: Highway	D4-In-Depth Inspection: No
C1-Owner: 01	S2-Tunnel Shape: Horseshoe	D5-Damage Inspection: No
A203-ADOT Org Number: 5356	S3-Portal Shape: Horseshoe	D6-Special Inspection: No
A229-Agency: ADOT	S4-Ground Conditions: Rock	
	S5-Complex: Not Complex	
	S1-Number of Bores: 1	

LOAD, RATE, and POST	NAVIGATION
L4-Tunnel Load: A	N1-Under Nav Waterway: 0
L1-Load Rating Method: N	N3-Nav Island Prot: 0
L3-Operating Load Rtg/Factor:	N2-Nav Waterway Cir (feet): 0.0
L2-Inventory Load Rtg/Factor:	
L5-Posting Load - Gross (Tons):	
L6-Posting Load - Axle (Tons):	
L7-Posting Load - Type 3 (Tons):	
L8-Posting Load Type 3S2 (Tons):	
L9-Posting Load - Type 3-3 (Tons):	
A222-Date of Load Rtg:	
L11-Haz. Material Restriction: 0 - No	
L12-Other Restrictions: 0 - No	
A233-Posted Vert Cir NB/EB (ft-in): 13-6	
A233-Posted Vert Cir SB/WB (ft-in): 13-6	

A300T - GENERAL TUNNEL COMMENTS
This tunnel is in Active Status. Initial inspection was on 8/7/2017.

G.3.2. Tunnel Inspection Report - Page 1

Date Printed : 11/06/2019 ARIZONA DEPARTMENT OF TRANSPORTATION Page 1 of 2

BRIDGE GROUP

Tunnel Inspection Report

Tunnel No.: 00407	Tunnel Name: Queen Creek Tunnel	Inspected by: BRADY	
Route : 60	Road Name: Queen Creek Tunnel	Inspection Type: Routine	
MP : 228.47	Agency: ADOT	Inspection Date: Monday, August 19, 2019	
ADOT District: Southeast		Next Insp. Due By: August 2021	

Inspection Notes

Roadway/Safety: 1. Vertical clearance posting signs of 13'-6" are present at both approaches as a prewarning and are not posted on the tunnel itself. 2. The minimum vertical clearances are: 14.06' (EB) and 14.00' (WB). 3. Galvanized W-beam approach rail with timber blockouts and posts. East approach rail exhibits intermittent areas of rockfall damage (See Maintenance Report and Photo O). Embankment: 1. Northwest embankment exhibits rock fall wire mesh. Miscellaneous: 1. This was a routine inspection conducted by Stantec under Contract 2019-010.05 TO #1. 2. The tunnel was inventoried from west to east with stationing beginning at Station D+00 and ending at 12+17. 3. Lower portions of the tunnel were accessed from the ground with traffic control. 4. One previous repair item was not completed and is repeated. One new maintenance item has been recommended. Repair: 1. Repair spall and deteriorating concrete in east portal tunnel liner over the eastbound lanes. Maintenance: 1. Repair southeast approach rails where damaged by rockfall. Photos taken: A. West portal ID looking west B. East portal ID looking east C. Typical slab-on-grade condition D. Typical liner joint condition E. Typical liner condition F. Tunnel overview looking east G. Typical condition of lighting system along crown of tunnel H. Typical condition of security camera near mid length of tunnel I. Transverse crack open to 1/8" wide in concrete slab on grade J. Slab-on-grade joints have cracked and missing seats K. 8' x 4' patched spall in the west portal fascia over the westbound lane L. 4' x 2' spall with exposed and corroded rebar in east portal fascia over westbound lane M. Spall, delaminations, and deteriorating concrete with exposed rebar in east portal liner over eastbound lanes N. Vertical crack open to 1/16" in northwest wingwall O. Southeast approach rail exhibits impact damage and damaged or failed timber blockouts for majority of length P. East approach roadway exhibits moderate to wide transverse cracks Q. Vertical clearance sign at west approach R. Vertical clearance sign at east approach

Element No.	Element Description	Quantity	Units	Condition State			
				1	2	3	4
10001	Cast-In-Place Concrete Tunnel Liner	79105	sqft	72017	6138	950	0
CIP Reinforced Concrete Tunnel Liner							
02100	Delamination / Spall / Patch	4	sqft	0	4	0	0
1. The crown exhibits a 4 SF delamination near Station 1+50. 2. Construction joints have minor edge spalling (Photo D), with the heaviest concentration located at the first construction joint from the west portal. 3. North wall, at springline, exhibits intermittent areas of minor impact scrapes.							
02102	Efflorescence / Staining	2382	sqft	0	1582	800	0
1. Construction joints exhibit light to heavy efflorescence throughout, some isolated areas of stalactite buildup (Photo D). 2. Minor rust staining was evident in a few isolated locations. 3. Liner exhibits hairline diagonal cracks, some with efflorescence (Photo E).							
02103	Cracking (Concrete Liner)	4105	sqft	0	3955	150	0
1. Cracks open to 1/8" in the south wall, near the east end of the tunnel. 2. Hairline to moderate diagonal cracks throughout the tunnel liner. Heaviest concentration for the eastern-most 200 feet of the tunnel.							
10051	Concrete Portals	1500	sqft	1316	137	47	0
Reinforced Concrete Portal							
02100	Delamination / Spall / Patch	129	sqft	0	92	37	0
1. West portal liner exhibits a 6" diameter spall with exposed rebar and a 32 SF area of delamination over westbound lanes. 2. West portal fascia has a 8' x 4' patched spall at top over westbound lane. 3. East portal liner exhibits a 20 SF of large spalls over westbound lanes. 4. East portal liner exhibits a 60 SF area of delamination. 5. There is a 15 SF spall with exposed rebar, near drain over the eastbound lanes, in the east portal liner (See Repair Report and Photo M). Spall is greater than 1" deep. Adjacent concrete is delaminating and deteriorating. Reinforcing steel exhibits surface corrosion with no measurable section loss. 6. East portal fascia exhibits a 4' x 2' spall with exposed rebar at top over westbound lane.							
02103	Cracking (Concrete Liner)	195	sqft	140	45	10	0
1. East portal liner exhibits a few hairline to moderate transverse cracks in the crown at centerline.							
10111	Concrete Slab-on-Grade	46550	sqft	36354	10096	100	0
Concrete Slab-on-Grade . 1. Wheel lines exhibits minor wear/abrasion throughout.							
02100	Delamination / Spall / Patch	466	sqft	0	466	0	0
1. Slab-on-grade exhibits isolated shallow spalls and aggregate popouts.							
02109	Cracking (RC)	2428	sqft	0	2328	100	0
1. Slab-on-grade has transverse cracks open between hairline and 1/8" wide (Photo I).							
10131	Pourable Joint Seal	3926	ft	3676	0	0	250
Pourable Joint Seal present in slab-on-grade longitudinal and transverse joints. Quantity reflects (2) full length longitudinal joints and transverse joints spaced approximately 30' to 40'.							
05000	Seal Damage	250	ft	0	0	0	250
1. Joints exhibit intermittent areas of missing sealant (Photo J).							

Inspection Report - Page 2

Date Printed : 11/05/2019

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 2 of 2

BRIDGE GROUP

Tunnel Inspection Report

Tunnel No. :	00407	Tunnel Name :	Queen Creek Tunnel	Inspected by :	BBBBBBBBBB
Route :	60	Road Name :	Queen Creek Tunnel	Inspection Type :	Routine
MP :	228.47	Agency :	ADOT	Inspection Date :	Monday, August 19, 2019
ADOT District :	Southeast			Next Insp. Due By :	August 2021

Element No.	Element Description	Quantity	Units	Condition State			
				1	2	3	4
10500	Electrical Distribution System	1	each	1	0	0	0
Electrical conduit connecting lights and cameras. 1. No significant defects.							
10600	Tunnel Lighting System	285	each	0	285	0	0
Lights run full length of tunnel at centerline. Every 8th light is dimmer than rest. 1. No significant defects.							
10601	Tunnel Lighting Fixture	285	each	285	0	0	0
Lighting fixtures run the full length of the tunnel at centerline. 1. No significant defects.							
10800	Tunnel Operations and Security System	1	each	1	0	0	0
1) Surveillance Camera mounted to electrical distribution system along centerline at mid length through tunnel (Station 6+00). 1. No significant defects.							

G.3.3. Maintenance Report (no Repair Report)

Date Printed : 11/06/2019

ARIZONA DEPARTMENT OF TRANSPORTATION

BRIDGE GROUP

Tunnel Maintenance Report

Tunnel Number :	00407	Tunnel Name :	Queen Creek Tunnel	Inspected by :	
Route :	60	Road Name :	Queen Creek Tunnel	Inspection Type:	Routine
MP :	228.47	Agency :	ADOT	Inspection Date :	Monday, August 19, 2019
ADOT District:	Southeast	District Org:	6366	Next Insp. Due By :	August 2021

Work Candidate ID:	8682C12-C056-091219-9FEEB05AEB	A216 - Actual Completion Cost	\$
Action:	1000 Approach Railing-Repair	A216 - Completion Date:	
Estimated Quantity:			
Estimated Cost:	\$0.00		
A212 - Repair Priority:	3-Can be scheduled		
Repair southeast approach rails where damaged by rockfall			

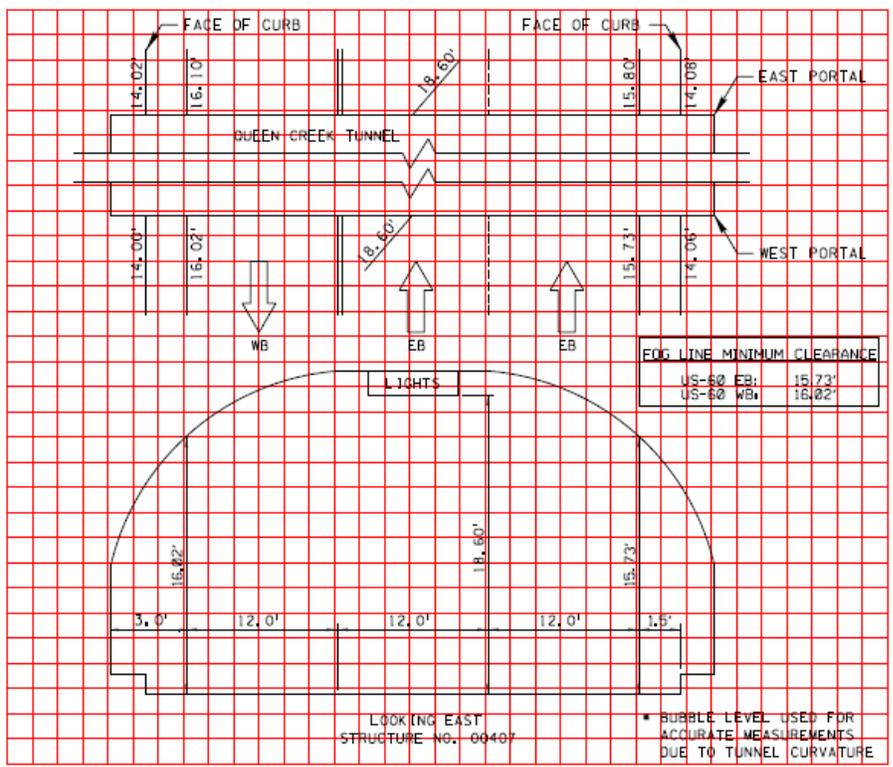
G.3.4. Clearance Diagram

STRUCTURE NAME	QUEEN CREEK TUNNEL	INSPECTION				
STRUCTURE NO.	407	DATE	8/7/17			
LOCATION	60 228.47	INITIAL				
	ROUTE MILEPOST	NEW/REVISED DIAGRAM	REV.			

MIN. VERTICAL CLEARANCE	
14.06'	NB / (EB)
14.00'	SB / (WB)



 NORTH



G.3.5. Photo Report (only 2 photos included)

a. West portal ID looking west

Date Printed : 11/06/2019

ARIZONA DEPARTMENT OF TRANSPORTATION

Page 1 of 18

BRIDGE GROUP

Bridge Inspection Photographs

Structure Number :	00407	Structure Name :	Queen Creek Tunnel	Inspected by :	[REDACTED]
Route :	60	Road Name :	Queen Creek Tunnel	Inspection Type:	Routine
MP :	228.47	Agency :	ADOT	Inspection Date :	Monday, August 19, 2019
ADOT District :	Southeast			Next Insp. Due By :	08/19/2021



File Name : 00407-2019-08-19-Photo-a.JPG
Description : West portal ID looking west

Photo m. Defects (delamination, spall, exposed rebar) in east portal liner over EB lanes

Bridge Inspection Photographs

Structure Number :	00407	Structure Name :	Queen Creek Tunnel	Inspected by :	
Route :	60	Road Name :	Queen Creek Tunnel	Inspection Type :	Routine
MP :	228.47	Agency :	ADOT	Inspection Date :	Monday, August 19, 2019
ADOT District :	Southeast			Next Insp. Due By :	08/19/2021



File Name : 00407-2019-08-19-Photo-m.JPG

Description : Spall, delaminations, and deteriorating concrete with exposed rebar in east portal liner over eastbound lanes