Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part III - Analysis of motor vehicle bridges failures due to Hurricane Maria

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Submitted by:

Gustavo Pacheco-Crosetti, PhD, PE
Professor

Héctor J. Cruzado, PhD, PE
Professor

Amado Vélez, MSCE, PE
Associate Professor

Gustavo Cruz-García
Undergraduate Student

Jonathan Hernández-Torres
Undergraduate Student

Adriana Murati-Núñez
Undergraduate Student

Valerie Rivera-Nieves
Undergraduate Student

David Rodríguez-Ortega
Undergraduate Student

Transportation Infrastructure Research Center – TIRC
Polytechnic University of Puerto Rico
377 Ponce de Leon Ave, San Juan, PR 00918

External Project Manager
Juan Carlos Rivera, Engineer
Puerto Rico Highway and Transportation Authority

In cooperation with

Rutgers, The State University of New Jersey
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Gustavo Pacheco-Crosetti (https://orcid.org/0000-0001-5346-6144) Héctor J. Cruzado (https://orcid.org/0000-0003-0268-5296)	CAIT-UTC-REG19

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16. Abstract
While the island was still recovering from the effects of Hurricane Irma, Hurricane Maria made landfall on September 20, 2017, as a strong category 4 hurricane. The hurricane affected many aspects of the transportation infrastructure, including roadway bridges. The objectives of this project were to collect, gather, and compile documented findings by diverse sources of the collapsed bridges due to Hurricane María, and to develop a common access repository of reports and multi-media multi-source information of collapsed bridges as tool for further studies. From the Puerto Rico Highway and Transportation Authority (PRHTA) bridge inventory, 19 bridges were identified to have collapse or that had a danger of imminent collapse due to severe structural damage or to severe deformations. These 19 bridges are comprehensively documented in this report inspection reports, photos and videos. Also documented in this report are examples of approach roadway collapse, which is sometimes confused with bridge collapse; examples of collapsed bridges that were not in the PRHTA inventory prior to the landfall of the hurricane on the island; and other common effects of the hurricane on roadway bridges. The compiled data and images of these structures suggest that the principal causes of the collapse were scouring of the piers and abutments, and hydrodynamic pressure combined with debris impact.

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1. Introduction

Hurricane Maria affected all types of infrastructural systems in Puerto Rico, including the transportation infrastructure. This project focused on gathering information on the collapse of roadway bridges in Puerto Rico due to Hurricane Maria.

1.1. Background

In the last 50 years, five hurricanes have made landfall in Puerto Rico: Hugo in 1999, which first made landfall in the municipal island of Vieques as a category 4 hurricane, and then made another landfall in Puerto Rico's northeastern corner as a category 3; Hortense in 1996, as a category 1; Georges in 1998, as a category 3; Irene in 2011, which landed as a tropical storm, but turn into a category 1 hurricane before leaving the island; and Maria in 2017, which landed as category 4, very close to being a category 5 (NOAA, n.d.). No hurricane made landfall in Puerto Rico from 1957 to 1988, but from 1900 to 1956, six hurricanes did make landfall (NOAA, n.d.). Therefore, every hurricane season, Puerto Rico is at constant risk of being hit by a hurricane. Sooner or later, another hurricane will make landfall in Puerto Rico.

A hurricane that did not make landfall in Puerto Rico was Irma in 2017. On September 6 and 7, this hurricane passed north of Puerto Rico as a category 5, as shown in Figure 1-1. Irma produced tropical storm winds and 10 to 15 inches of rainfall in Puerto Rico (Cangialosi, Latto, & Berg, 2021). Although it did not make landfall in Puerto Rico, Irma caused a near-total loss of electricity and water supply for several days, minor damages to home and businesses, with some weaker structures collapsing in the Puerto Rico mainland, and several homes destroyed in the municipal island of Culebra (Cangialosi, Latto, & Berg, 2021).

While the island was still recovering from the effects of Hurricane Irma, Hurricane Maria made landfall on September 20, 2017, as a strong category 4 hurricane with sustained winds of

155 mph (Pasch, Penny, & Berg, 2019). As shown in Figure 1-2, the hurricane crossed the main island of Puerto Rico from the southeast to the northwest, leaving as a category 3 hurricane with sustained winds of 110 mph. Besides the strong winds, the hurricane brought heavy rains, reaching 40 inches of rainfall in 48 hours (NWS, 2017). The rain caused severe flooding in several parts of the island that were furthered exacerbated in coastal regions due to the storm surge. The hurricane also caused a large quantity of landslides with a large concentration on the center of the island, where the topography presents higher elevations (NWS, 2017). The effects of Maria were probably intensified due to saturated soils and increased stream flows caused by Irma.

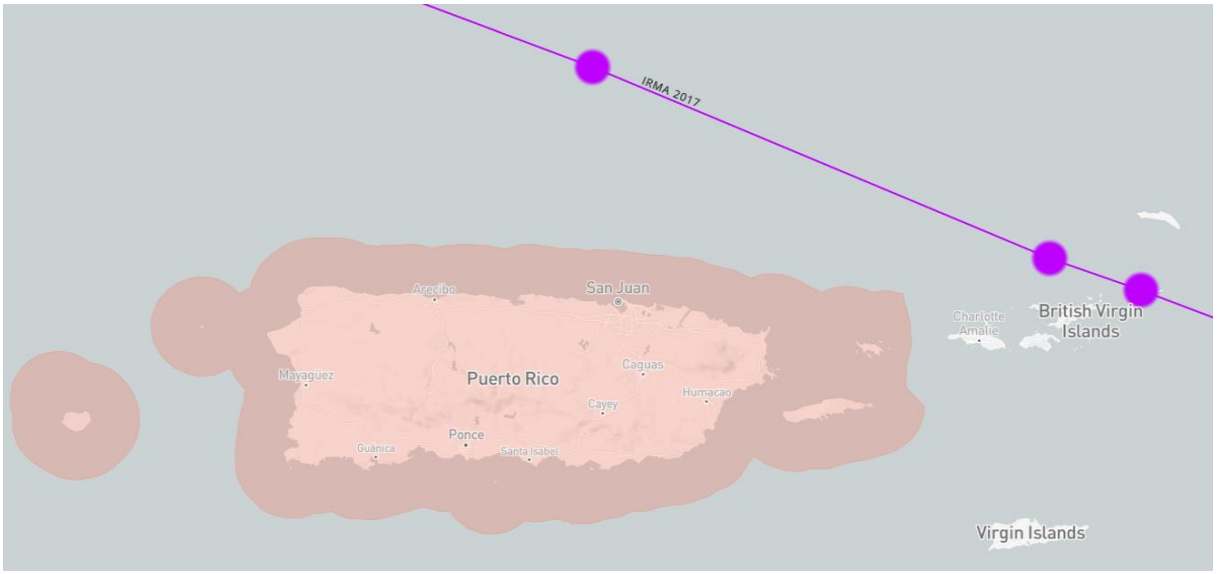


Figure 1-1: Trajectory of Hurricane Irma near Puerto Rico (NOAA, n.d.)



Figure 1-2: Trajectory of Hurricane Maria through Puerto Rico (NOAA, n.d.)

Hurricane Maria affected the different infrastructural systems of Puerto Rico, especially the energy and transportation infrastructures. Among the impacts to the transportation infrastructure were landslides affecting roadways, some bridges collapsing, and the failure of different types of traffic signals, signs, and luminaires. This study focused on the motor vehicle bridges (i.e., roadway bridges) that collapsed or suffered major structural damage in Puerto Rico due to Hurricane Maria.

1.2. Project Objectives

The objectives of this project were to:

- Collect, gather, and compile documented findings by diverse sources of the collapsed bridges due to Hurricane María.
- Develop a common access repository of reports and multi-media multi-source information of collapsed bridges as tool for further studies.

1.3. Methodology

In January 2019, personnel from the Puerto Rico Highway and Transportation Authority (PRHTA) provided an Excel spreadsheet which contained the inventory of bridges of the territory, indicating for each bridge a summary of the findings of the inspections. This inventory listed 1769 bridges, of which 24 bridges were unofficially identified to have collapsed due to Hurricane Maria. PRHTA also provided pdf copies of the reports of the bridge inspections conducted after Hurricane Maria.

Afterwards, PRHTA provided furthered information on the 24 bridges including pdf copies of inspection reports conducted before Hurricane Maria, digital photographs taken during inspections conducted before and after Maria, and pdf copies of reports of inspections conducted

by personnel of the Federal Highway Administration, when available. For each of the 24 bridges, a digital folder was prepared and filled with the information provided by PRHTA.

Later, research team members started searching the internet for photos and videos from social media posts and news reports about the collapse bridges in Puerto Rico during Hurricane Maria. The found photos and videos were added to the corresponding bridge's digital folder. During this process, other bridges that were not in the PRHTA inventory were identified and available media was collected and organized to later evaluate if these bridges should in fact be considered as having collapsed due to Hurricane Maria.

As the collected media was organized, the 24 bridges initially identified as collapsed were re-evaluated and re-organized as follows:

- Collapsed bridges – This category includes bridges that had a complete or partial collapse of its deck, as well as bridges for which there was a danger of imminent collapse due to either severe structural damage or to severe deformations. From the original list, 18 bridges were placed into this category. Afterwards, a bridge that was not in the list of 24 was added to this category, for a total of 19 collapsed bridges.
- Bridges with collapsed approach roadway – Two bridges were placed into this category. In these two cases it was found that one of the roadways approaching the bridge had collapsed, giving the impression of bridge collapse. In this research it was found that several other bridges in the PRHTA inventory had also experienced approach roadway collapse, but they were not confused with bridge collapse.
- Bridges not in inventory – Two bridges that were not in the PRHTA inventory prior to Hurricane Maria were placed into this category. This was done because it was not entirely clear what was the bridge's condition prior to the hurricane. It was later

found in this research that there were other bridges not in the inventory that collapsed.

- Misreported bridges – Two of the bridges were found to have been misreported as having collapsed: Bridges 1683 in the municipality of Utuado and Bridge 2869 in the municipality Patillas. In the case of Bridge 1683, it's a small structure that had water flowing on top of it at the time it was inspected after Hurricane Maria. It may be possible that the inspector was not familiar with this bridge and confused its condition with a collapse, but later inspections shown that the bridge suffered minor damages. In the case of Bridge 2869, it appears to have been listed as collapsed due to human error, as the bridge was reported to be in good condition after Hurricane Maria.

Finally, it was decided that this report itself would be the common access repository. Some general conclusions and recommendations were developed to complete this report.

1.4. Report organization

Chapters 2 presents the 19 bridges that collapsed or had severe structural damages due to Hurricane Maria and that were in the PRHTA inventory prior to the storm. Chapter 3 presents three bridges that had an approach roadway collapse. Chapter 4 presents four bridges that were not in the PRHTA inventory prior to Hurricane Maria and that might have collapsed due to the storm. Chapter 5 presents other cases of bridges that do not fall into the four categories listed in the previous section, but that had situations that may be of interest to the reader. Finally, Chapter 7 presents the conclusions and recommendations.

Chapters 2, 3 and 4 start with an introduction that included a table of the bridges that are include in said chapter. After this introduction, each bridge listed in the table is dedicated a section.

Very few words are written in the sections dedicated to the individual bridges for the following reasons:

- In accordance with the objectives of this project, the information was gathered and offered for furthered evaluation by the reader.
- The description of the documents, photos and videos presented would become repetitive.

Almost all the figures and videos in this report were either provided by PRHTA or obtained from the internet, except for some of the photographs of Bridge 3053, which were taken by one of the authors. For all the photos and videos, the authors have identified the source. When photos and videos were obtained from the internet, the URL where it was found is provided right below where the photo or video is presented. This was opted over doing a traditional references list, which would have become quite extensive. Still, a traditional list of references cited for other information that was not in the form of photos or videos is provided at the end of the report.

2. Collapsed bridges

In this chapter, the bridges were categorized as having collapsed due to the direct effects of Hurricane Maria are presented. In the collapsed bridge category were included bridges that had a complete or partial collapse of its deck due to the effects of Hurricane Maria. Also included were bridges for which there was a danger of imminent collapse due to either severe structural damage or to severe deformations.

For a bridge to be included in this category, it had to have been in the PRHTA inventory prior to the landfall of Hurricane Maria in Puerto Rico. The reasoning behind this is that bridges not in the inventory were not regularly inspected before Maria, so it is not clear what was their condition prior to the event. A bridge not in the PRHTA inventory might have been severely damaged before Hurricane Maria caused its collapse.

The list of collapsed bridges is presented in Table 2-1. It includes a total of 19 bridges; 18 were originally listed as having collapsed in the PRHTA inventory, with Bridge 1714 being added due to the damage description offered in the report of the inspection conducted by Hurricane Maria.

Each of the 19 collapsed bridges is dedicated a section in this chapter. Each section has the following subsections:

- General Information – Includes a table copied from BrideReports.com which includes the bridges basic information. This is followed by another table with other relevant data extracted from the PRHTA inventory. Finally, copies of drawings of the bridges are included. These drawings were included in bridge inspection reports from which they were extracted.
- Inspection before Hurricane Maria – Presents copies of the report of the last inspection conducted before the landfall of Maria. In some cases, the report was not

available, so the previous report was included. When this happened, it is noted in the section. Also, reports of bridges that were additionally inspected due to Hurricane Irma are included.

- Images before Hurricane Maria – Includes a satellite image of the bridge extracted from Google Earth Pro, plus a series of photographs from an inspection conducted prior to Hurricane Maria. This is offered so the reader can visualize the bridge before it was damaged by the Hurricane.
- Streamflow – This subsection is offered only for bridges that crossed over a stream that is monitored by the United States Geological Survey (USGS). For streams with more than one monitoring location, the closest to the bridge was selected. When available, this section includes a table with the yearly peak flow from 2010 to 2017, as obtained from the USGS National Water Dashboard (https://dashboard.waterdata.usgs.gov). The purpose is to offer the reader an idea of the effect that Maria had on streamflows that may have contributed to the collapse of bridges.
- Inspection after Hurricane Maria – Offers images of the report of the inspection conducted after Hurricane Maria. In some cases, more than one inspection report was available and therefore included. Some bridges appear to have been inspected twice by PRHTA personnel, while for some bridges, an inspection report by FHWA was made available.
- Images after Hurricane Maria – This subsection typically starts with a satellite image extracted from NOAA Hurricane Maria Imagery website (https://storms.ngs.noaa.gov/storms/maria/index.html#7/18.056/-64.824), if the

bridge location was properly photographed. This is followed by a satellite image of the bridge extracted from NOAA Google Earth Pro. The section may also contain photographs taken by PRHTA bridge inspector, and photos found on the internet. For photos obtained from the internet, the URL in which they were found is provided.

- Videos after Hurricane Maria – Includes online videos that present images of the collapsed bridge. When this subsection is not present, it means that no online videos were found. YouTube videos will play directly from the electronic document, but clicking on other videos will take the reader to the website where the video is located. For all videos, the URL in which they were found is provided.
- Temporary replacement / Repaired bridge / Reconstructed bridge – Shows one of more photos of the structure that was used to replace the collapse bridge, or the repaired bridge, or the reconstructed bridge, according to the case. In most cases, the collapsed bridges were replaced with temporary modular steel bridges.

Very few words are written in the sections dedicated to the individual bridges because, in accordance with the objectives of this project, the information was gathered and is offered for furthered evaluation by the reader. Additionally, the description of the documents, photos and videos presented would become repetitive.

The reader will notice that for some bridges there are few images, while for others there is an abundance of imagery. The main reason for this may be the bridge's location. Collapsed bridges closest to larger population and on state roadways were probably photographed more than bridges in more remote locations.

Table 2-1: Bridges that collapsed due to Hurricane Maria

ID	Municipality	Name	Coordinates
505	Utuado	PR-603 over Grande de Arecibo River	18°15'35.45"N, 66°43'20.31"W
653	Canóvanas	PR-957 over Canóvanas River	18°20'17.83"N, 65°53'18.09"W
679	Moca	PR-404 over Culebrinas River	18°21'35.20"N, 67°05'32.07"W
769	Mayagüez	PR-354 over Cañas River	18°13'29.63"N, 67°03'58.89"W
1125	Yauco	Off PR-372 over Duey River	18°03'10.78"N, 66°51'04.37"W
1130	Ciales	PR-145 over Grande de Manatí River	18°20'09.46"N, 66°27'48.44"W
1199	Arecibo	PR-623 over Tanamá River	18°23'03.93"N, 66°43'46.07"W
1355	Adjuntas	Off PR-123 @ 46.2 over Grande de Arecibo River	18°13'17.95"N, 66°43'16.82"W
1453	Caguas	Marginal Street over Bairoa River	18°15'23.79"N, 66°02'35.48"W
1462	Morovis	PR-567 over Grande de Manatí River	18°18'21.43"N, 66°26'15.73"W
1499	Utuado	Rural Local Road over Grande de Arecibo River	18°18'03.91"N, 66°41'54.14"W
1698	Corozal	Felix Avenue over Corozal River	18°20'15.95"N, 66°19'11.52"W
1714	San Germán	Off PR 330 over Duey River	18°08'10.54"N, 67°04'19.45"W
1728	San Germán	PR-358 over Hoconuco River	18°06'58.76"N, 67°03'30.69"W
1733	San Sebastián	PR-111 over El Salto Creek	18°21'32.08"N, 67°02'30.63"W
1917	Arecibo	PR-627 over Grande de Arecibo River	18°23'31.58"N, 66°40'49.93"W
1962	Villalba	PR-151 over Jacaguas River	18°07'36.61"N, 66°29'29.59"W
2574	Maricao	Off PR-428 over Prieto River	18°09'21.56"N, 66°51'22.38"W
2842	Juana Díaz	Local Road over Guayo River	18°05'03.32"N, 66°32'21.57"W

2.1. Bridge 505



(Extracted from Figure 2-20)

2.1.1. General information

Table 2-2: Bridge 505 general information from BridgeReports.com

Name	PR 603 over GRANDE DE ARECIBO RIVER
Structure number	005051
Location	0.07 Km FROM INT PR 10
Purpose	Carries highway over waterway
Route classification	Local (Urban)
Length of largest span	33.1 ft
Total length	144.4 ft
Roadway width between curbs	19.7 ft
Deck width edge-to-edge	23.3 ft
Owner	City of Municipal Highway Agency
Year built	1947
Historic significance	Bridge is not eligible for the National Register of Historic Places.
Number of main spans	12
Main spans material	Concrete
Main spans design	Slab
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-3: Bridge 505 general information from the PRHTA

ID	505
Highway	PR 603
Municipality	Utuado
Year Built	1947
Functionality	Urban-local
Lanes	2
ADT	7200
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	Waterway
Width	7.1 m
Length	44 m
Spans	12
Under clearance	0
Material	Concrete
Design	Slab
Scour Critical	4
Inspection Frequency	6 months
Approach Roadway Width	6.7 m
Bypass length	199 km
NBI Rating	1
NHS	0
Area	312.4 m^2

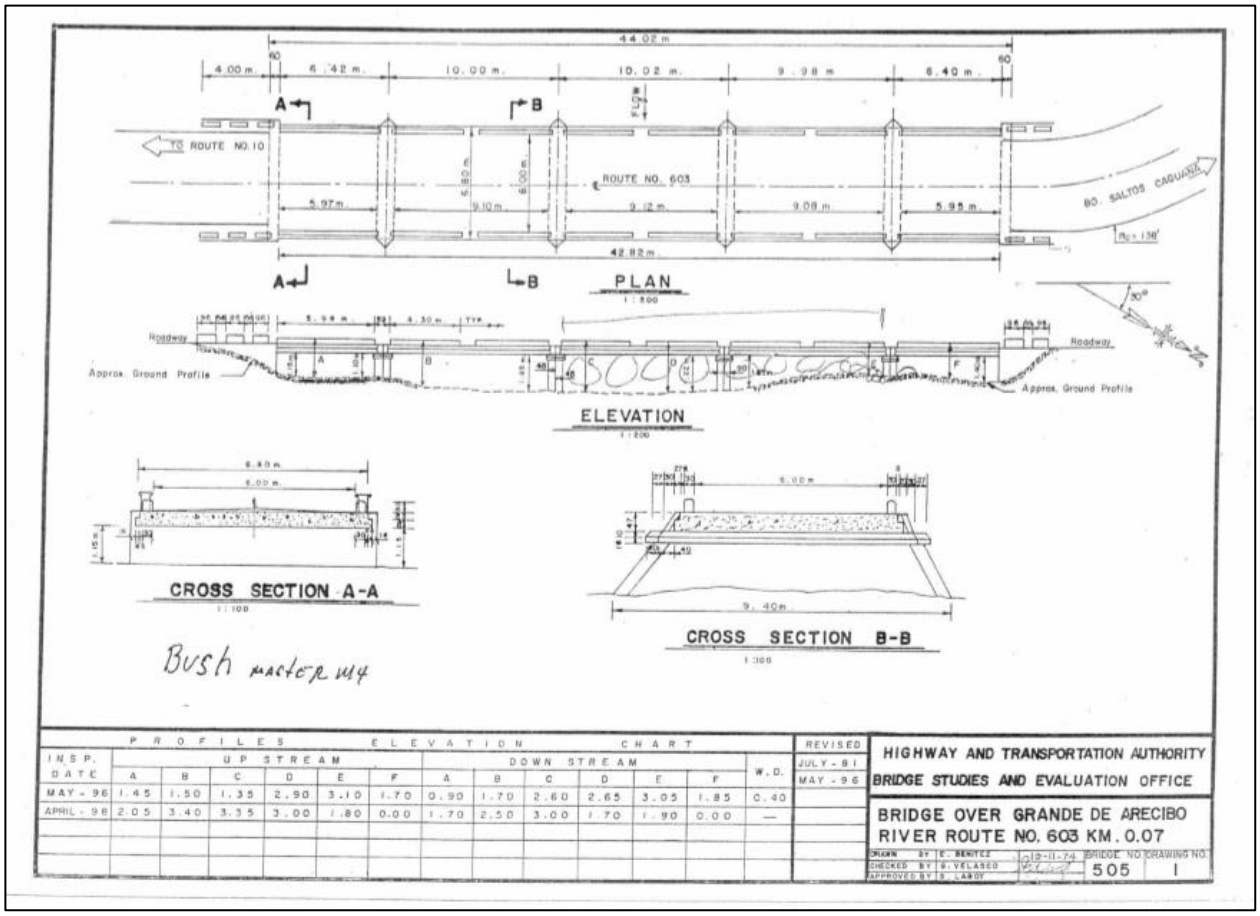


Figure 2-1: Bridge 505 drawings (source: PRHTA)

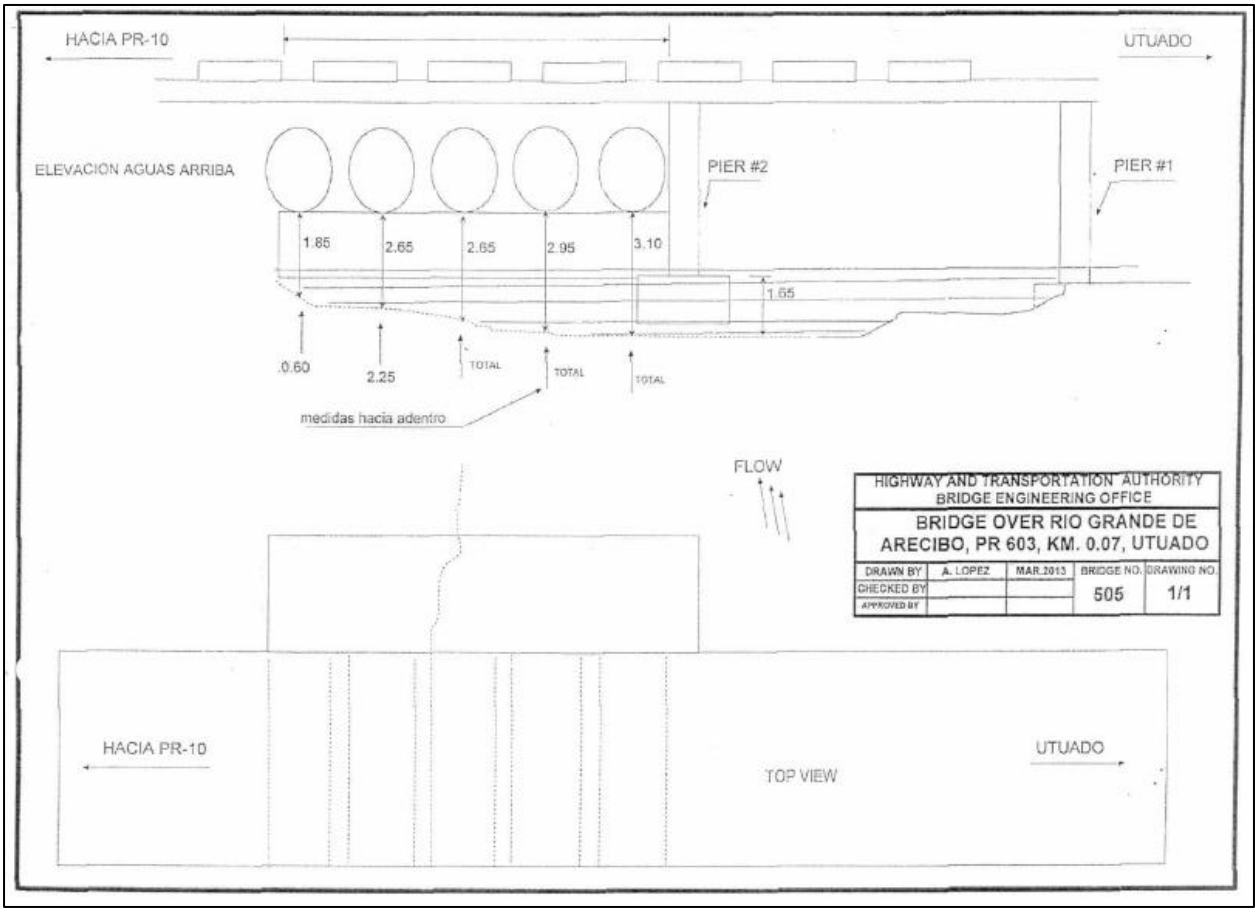


Figure 2-2: Bridge 505 drawings (source: PRHTA)

2.1.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 505

TEAM LEADER: Carlos M. García

BRIDGE EVALUATOR: Mayra I. Zayas

INSPECTION DATE: JULY 27,2017

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	6	1/2017	1/2018
ITEM 93 A	FC Inspection	N			
ITEM 93 B	Underwater Insp.	N			
ITEM 93 C	Other: SI	Yes	6	1/2017	1/2018

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	5	5	5	4	4	4	P
Current Inspection	5	5	5	3	3	2	P

Other Checks:(Y, N, NA)

- Y Scour Critical (items 113 & 60)
- Y AASHTO Core's& NBI CD consistent
- Y Smart Flags (scour, steel plate, fire damage, etc)
- Y Channel Profile/Clearance Table
- Y FC & Underwater Members Tables
- Y Asphalt Overlay Thickness
- Y Drawings
- Y Photos
- Y Critical Finding
- Y Inspector & Team Leader Signature

Review Comments:

*BASED ON LRST ITEM41=P ITEM64,66=27,16.70 (ETONS)

Reviewer: _____

Safety Eng.: _____

Figure 2-3: Bridge 505 inspection summary of July 27, 2017 (source: PRHTA)

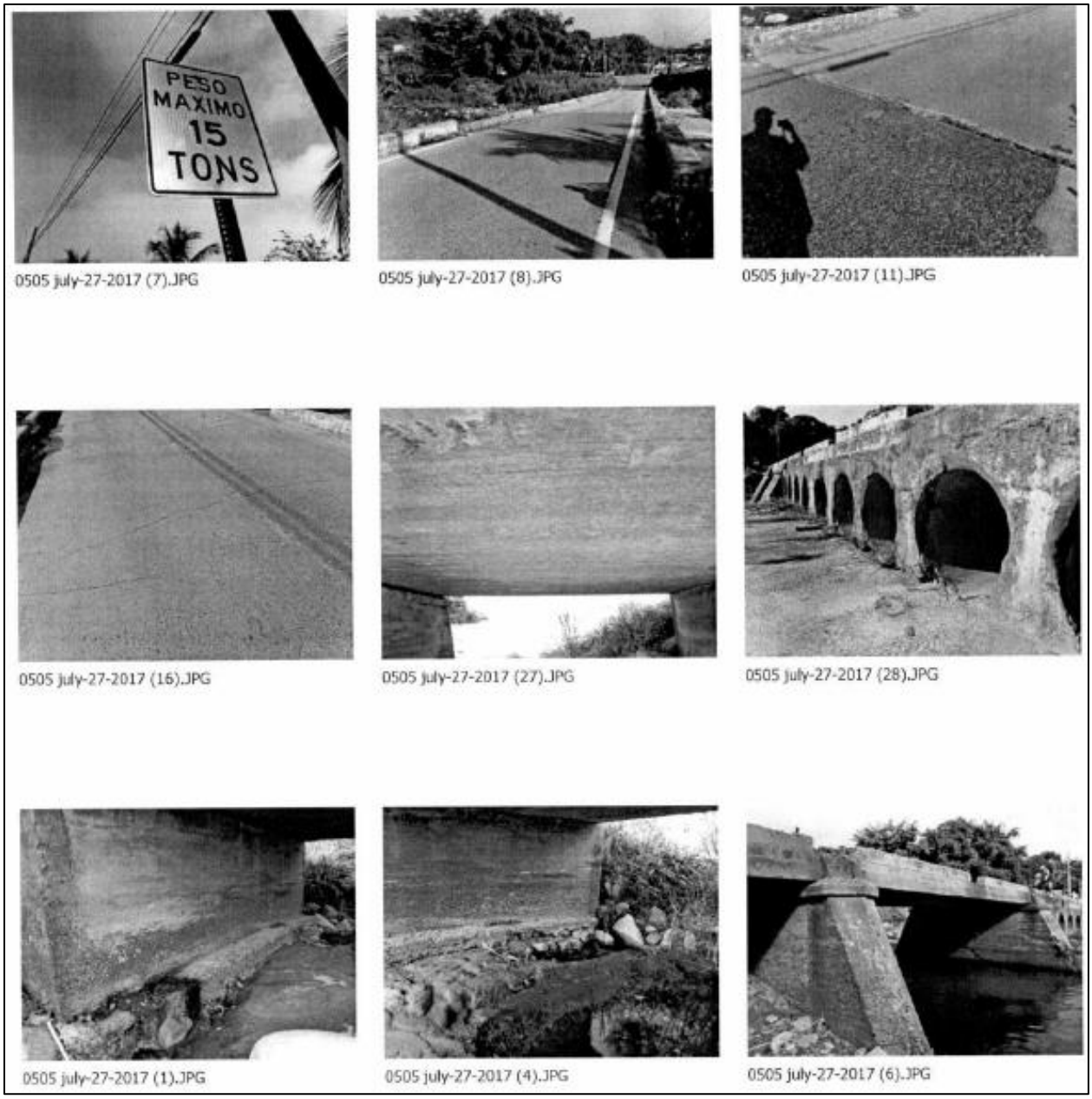


Figure 2-4: Bridge 505 inspection photos of July 27, 2017 (source: PRHTA)

2.1.3. Images before Hurricane Maria



Figure 2-5: Bridge 505 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-6: Bridge 505 photo from January 31, 2017 inspection (source: PRHTA)



Figure 2-7: Bridge 505 photo from January 31, 2017 inspection (source: PRHTA)



Figure 2-8: Bridge 505 photo from January 31, 2017 inspection (source: PRHTA)



Figure 2-9: Bridge 505 photo from January 31, 2017 inspection (source: PRHTA)



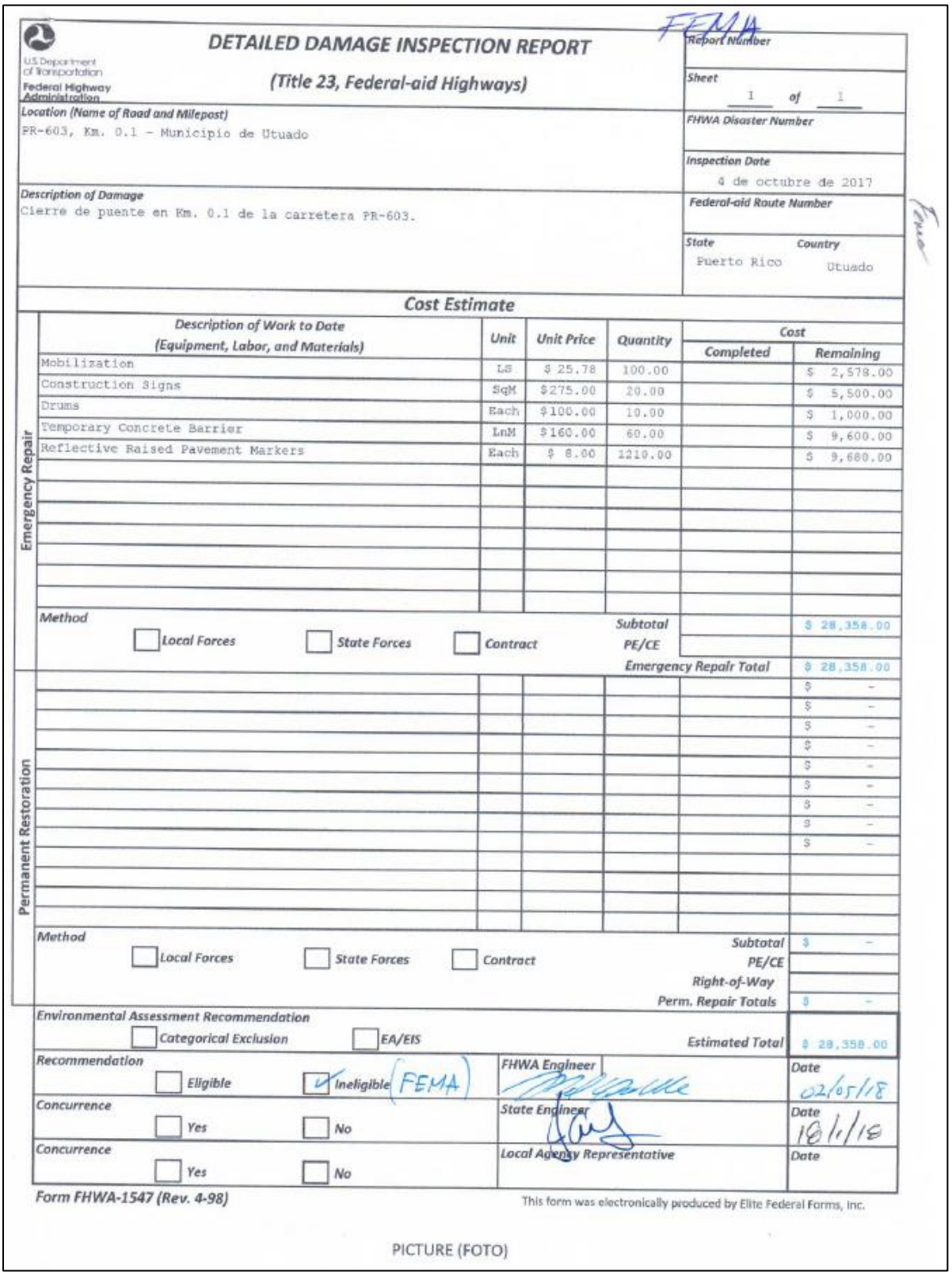
Figure 2-10: Bridge 505 photo from January 31, 2017 inspection (source: PRHTA)

2.1.4. Streamflow

Table 2-4: Peak streamflow at Grande de Arecibo River Above Utuado monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-04-23	12.79	15,200
2011	2011-09-13	13.78	18,500
2012	2012-07-08	10.14	8,130
2013	2013-06-25	12.00	12,900
2014	2014-08-24	13.38	17,100
2015	2015-05-27	9.50	6,710
2016	2016-09-21	10.51	8,970
2017	2017-09-20	20.33	44,700

2.1.5. Inspections after Hurricane Maria



U.S. Department of Transportation
Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

FEMA

Report Number

Sheet 1 of 1

Location (Name of Road and Milepost)
PR-603, Km. 0.1 – Municipio de Utuado

FHWA Disaster Number

Inspection Date
4 de octubre de 2017

Description of Damage
Cierre de puente en Km. 0.1 de la carretera PR-603.

Federal-aid Route Number

State: Puerto Rico Country: Utuado

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Mobilization	LS	$ 25.78	100.00		$ 2,578.00
Construction Signs	SqM	$275.00	20.00		$ 5,500.00
Drums	Each	$100.00	10.00		$ 1,000.00
Temporary Concrete Barrier	LnM	$160.00	60.00		$ 9,600.00
Reflective Raised Pavement Markers	Each	$ 8.00	1210.00		$ 9,680.00
				Subtotal	$ 28,358.00
				PE/CE	
				Emergency Repair Total	$ 28,358.00

Method: ☐ Local Forces ☐ State Forces ☐ Contract

Permanent Restoration

					$ –
				Subtotal	$ –
				PE/CE	
				Right-of-Way	
				Perm. Repair Totals	$ –

Method: ☐ Local Forces ☐ State Forces ☐ Contract

Environmental Assessment Recommendation
☐ Categorical Exclusion ☐ EA/EIS

Estimated Total: $ 28,358.00

Recommendation: ☐ Eligible ☑ Ineligible (FEMA)
FHWA Engineer: [signature] Date: 02/05/18

Concurrence: ☐ Yes ☐ No
State Engineer: [signature] Date: 10/1/18

Concurrence: ☐ Yes ☐ No
Local Agency Representative: Date:

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PICTURE (FOTO)

Figure 2-11: Bridge 505 inspection report from October 4, 2017 (source: FHWA)



Figure 2-12: Bridge 505 photo from October 4, 2017 inspection (source: FHWA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 505 MUNICIPALITY: Utuado

DATE: 10/12/17 TIME: 1:05 pm EVALUATOR NAME: Wilfredo Rodriguez
Carmen Jiménez

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane Maria

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT:

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: The bridge was failed.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-13: Bridge 505 inspection report from October 12, 2017 (source: PRHTA)

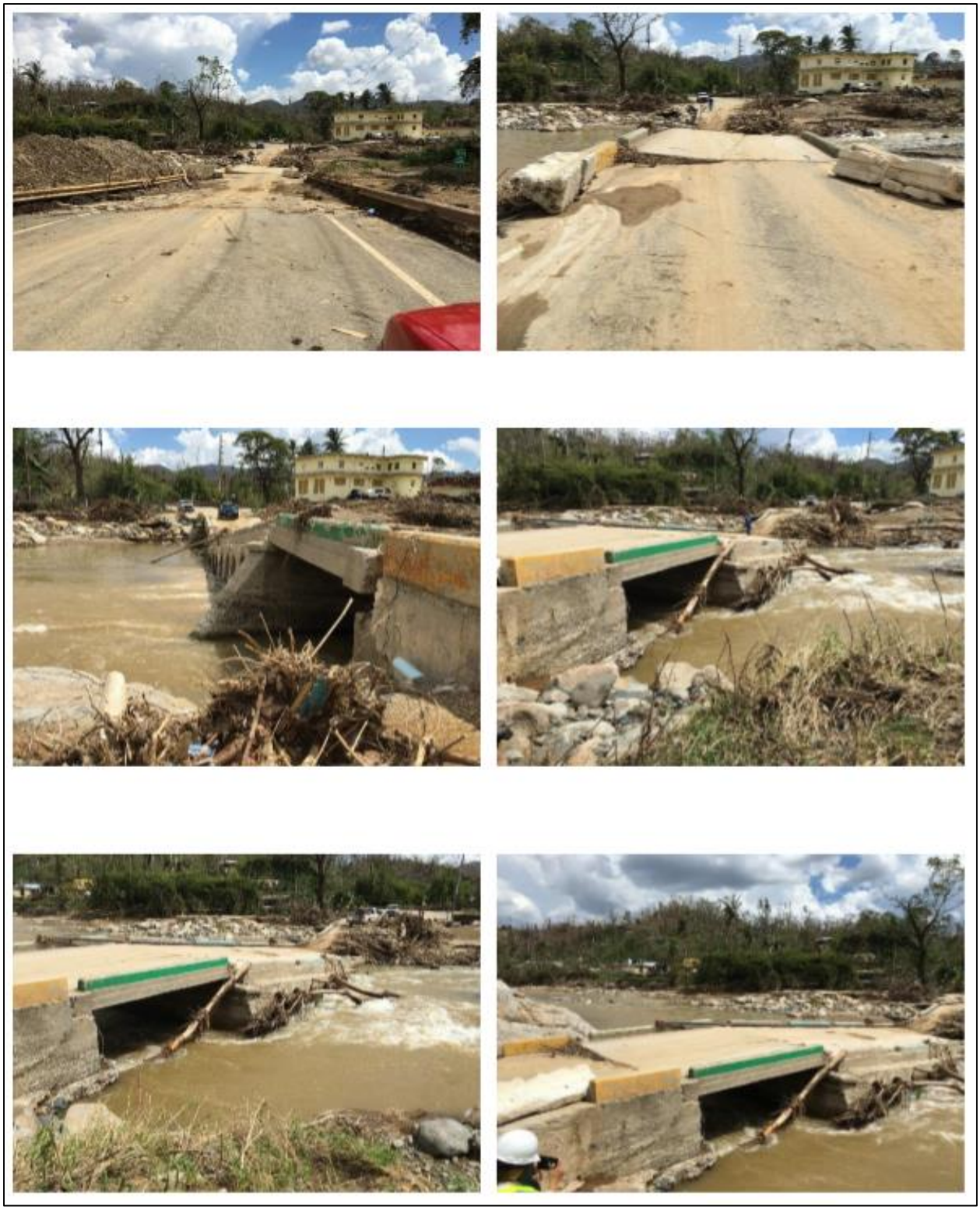


Figure 2-14: Bridge 505 photos from October 12, 2017 inspection (source: PRHTA)

U.S. Department of Transportation Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 2

Location (Name of Road and Milepost)
Bridge No. 505, PR-603 at Km. 0.07, Municipality of Utuado

FHWA Disaster Number

Inspection Date
October 30, 2017

Description of Damage
Bridge No. 505 is a low bridge with damages caused by Hurricane Maria on September 20, 2017. Damages were caused by the Rio Grande de Arecibo flooding.
• Install a single span Pre-fabricated Modular Steel Bridge 180' length with 18' of roadway supported on concrete footing pads.

Federal-aid Route Number

State Country

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Emergency Repair						
1	(Spec. 151-001) Mobilization 10%	LS	$750.00	100		$ 75,000.00
2	(Spec. 202-001) Removal of Structure and Obstruction	LS	$1,500.00	100		$ 150,000.00
3	(Spec. 206-001) Unclassified Excavation for Structure	CuM	$25.00	184		$ 4,600.00
4	(Spec. 210-001) Straw Bales	Each	$12.00	50		$ 600.00
5	(Spec. 210-007) Silt Fences	LnM	$8.00	30		$ 240.00
6	(Spec. 210-011) Floating Turbidity Barrier	LnM	$85.00	150		$ 12,750.00
7	(Spec. 301-002) Subbase Course (A-2-4)	CuM	$20.00	200		$ 4,000.00
8	(Spec. 304-002) Aggregate Base Course Class A	CuM	$50.00	80		$ 4,000.00
9	(Spec. 401-032) Hot Plant Bituminous Pavement S(75)(12)	Ton	$130.00	160		$ 20,800.00
10	(Spec. 401-036) Hot Plant Bituminous Pavement B(75)(34)	Ton	$130.00	200		$ 26,000.00
11	(Spec. 403-001) Cold Milling Bituminous Concrete Pavement	CuM	$120.00	24		$ 2,880.00
12	(Spec. 601-008) Class "D" Concrete	CuM	$900.00	100		$ 90,000.00
13	(Spec. 602-001) Reinforcing Steel	Pound	$2.00	31500		$ 63,000.00
14	(Spec. 606-001) Corrugated Steel Beam Guardrail, Single Face	LnM	$120.00	100		$ 12,000.00
15	(Spec. 606-051) Corrugated Steel Bridge Guardrail	LnM	$400.00	110		$ 44,000.00
16	(Spec. 611-011) Field and Laboratory Office Model 2	Month	$3,000.00	3		$ 9,000.00
17	(Spec. 613-001) Traffic Sign Assembly, Code OM-3R (Object Marker)	Each	$200.00	2		$ 400.00
18	(Spec. 613-001) Traffic Sign Assembly, Code OM-3L (Object Marker)	Each	$200.00	2		$ 400.00
19	(Spec. 618-007) Thermoplastic Pavement Marking Stripes (White)	LnM	$20.00	160		$ 3,200.00
20	(Spec. 638-001) Construction Signs	SqM	$210.00	15		$ 3,150.00
21	(Spec. 638-005) Drums	Each	$60.00	20		$ 1,200.00
22	(Spec. 638-010) Temporary Concrete Barrier	LnM	$50.00	110		$ 5,500.00
23	(Spec. 640-017) Reflective Raised Pavement Marker One Way, Any Co	Each	$10.00	16		$ 160.00
24	(Spec. 888-151) Allowance for PRASA	FA	$100.00	100		$ 10,000.00
25	(Spec. 961-016) Vehicular Modular Steel Bridge Installation (Hauling,	LS	$2,050.00	100		$ 205,000.00
26	(Spec. 961-017) Dismantling of Launching Nose and Installation Comp	LS	$150.00	100		$ 15,000.00
				Subtotal		$ 762,880.00
	Method: ☐ Local Forces ☐ State Forces ☐ Contract			PE/CE		
				Emergency Repair Total		$ 762,880.00
Permanent Restoration						
	Mobilization 10%	LS	$210,700.00	1		$ 210,700.00
	Replacement of Existing Bridge	SqM	$3,000.00	672		$ 2,016,000.00
	Removal of Existing Structures (Abutments)	LS	$91,000.00	1		$ 91,000.00
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
	Method: ☐ Local Forces ☐ State Forces ☒ Contract			Subtotal		$ 2,317,700.00
				PE/CE		
				Right-of-Way		
				Perm. Repair Totals		
				Estimated Total		$ 3,080,580.00

Environmental Assessment Recommendation
☐ Categorical Exclusion ☐ EA/EIS

Recommendation: ☒ Eligible ☐ Ineligible	FHWA Engineer: HECTOR RUBEN LAUREANO	Date	
Concurrence: ☐ Yes ☐ No	State Engineer	Date	
Concurrence: ☐ Yes ☐ No	Local Agency Representative	Date	

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Figure 2-15: Bridge 505 inspection report from October 30, 2017 (source: PRHTA)

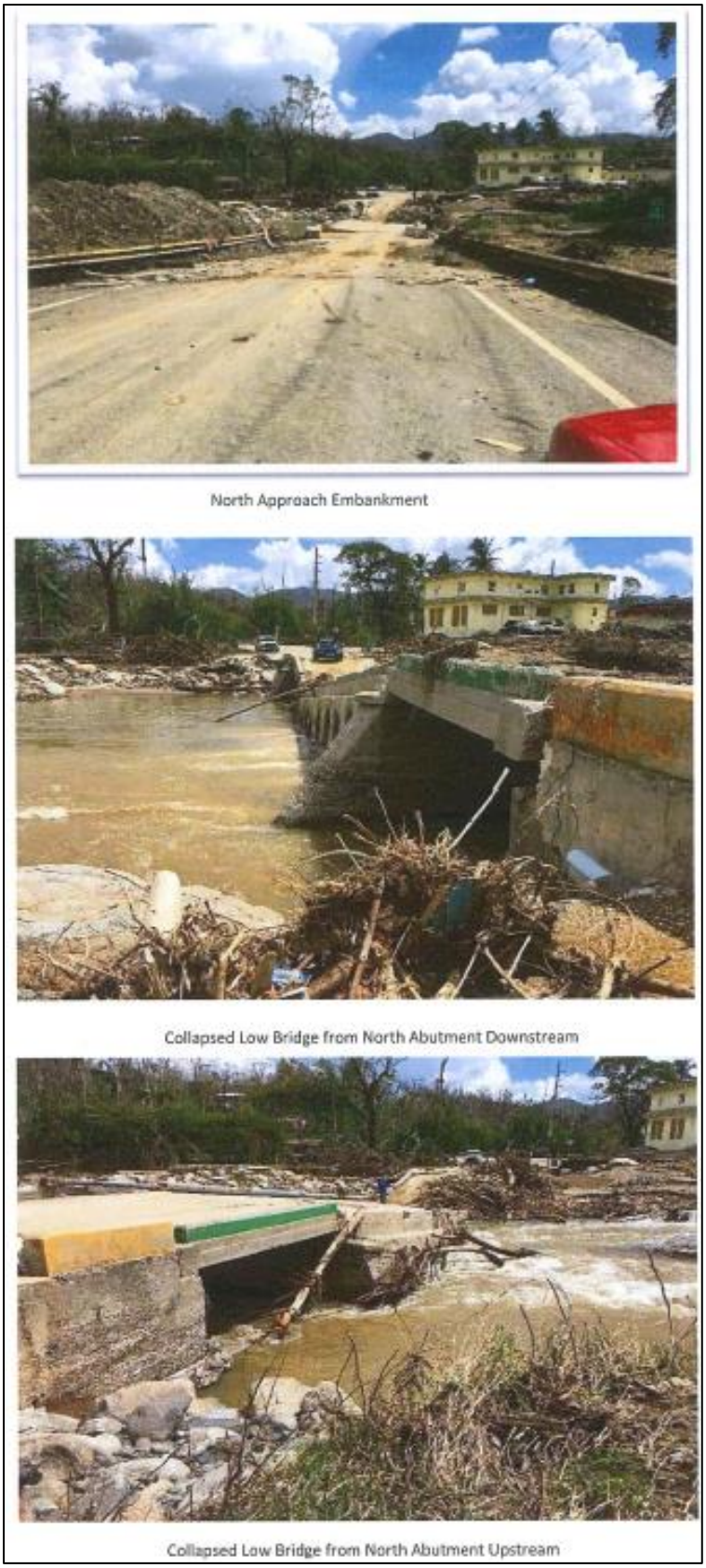


Figure 2-16: Bridge 505 photos from October 12, 2017 inspection (source: PRHTA)

2.1.6. Images after Hurricane Maria



Figure 2-17: Bridge 505 satellite image after Hurricane Maria (source: NOAA)



Figure 2-18: Bridge 505 satellite after Hurricane Maria (source: Google Earth Pro)



https://flic.kr/p/224nSiA

Figure 2-19: Social media image of collapsed Bridge 505 (source: Julia Maldonado)



https://flic.kr/p/2273iVP

Figure 2-20: Social media image of collapsed Bridge 505 (source: Julia Maldonado)



https://flic.kr/p/224nSRj

Figure 2-21: Social media image of collapsed Bridge 505 (source: Julia Maldonado)



https://robertleeread.medium.com/a-day-in-post-maria-utuado-puerto-rico-5877edd49504

Figure 2-22: Social media image of collapsed Bridge 505 (source: Robert L. Read)

2.1.7. Temporary replacement



Figure 2-23: Bridge 505 replacement (source: PRHTA)

2.2. Bridge 653



(Extracted from Figure 2-39)

2.2.1. General information

Table 2-5: Bridge 653 general information from BridgeReports.com

Name	PR 957 over CANÓVANAS RIVER
Structure number	006531
Location	5 KM SOUTH OF CANOVANAS
Purpose	Carries highway over waterway
Route classification	Minor Collector (Rural)
Length of largest span	41.7 ft
Total length	94.8 ft
Roadway width between curbs	19.7 ft
Deck width edge-to-edge	21.7 ft
Owner	State Highway Agency
Year built	1953
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	3
Main spans material	Concrete Continuous
Main spans design	Slab
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 2-6: Bridge 653 general information from the PRHTA

ID	653
Highway	PR-957 km 0.1
Municipality	Canóvanas
Year Built	1953
Functionality	Rural-minor collector
Lanes	2
ADT	1400
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	highway
Down Service	waterway
Width	6.6 m
Length	28.9 m
Spans	3
Under clearance	0
Material	Concrete Continuous
Design	Slab
Scour Critical	3
Inspection Frequency	24 months
Approach Roadway Width	6 m
Bypass length	12 km
NBI Rating	2
NHS	0
Area	190.74 m^2

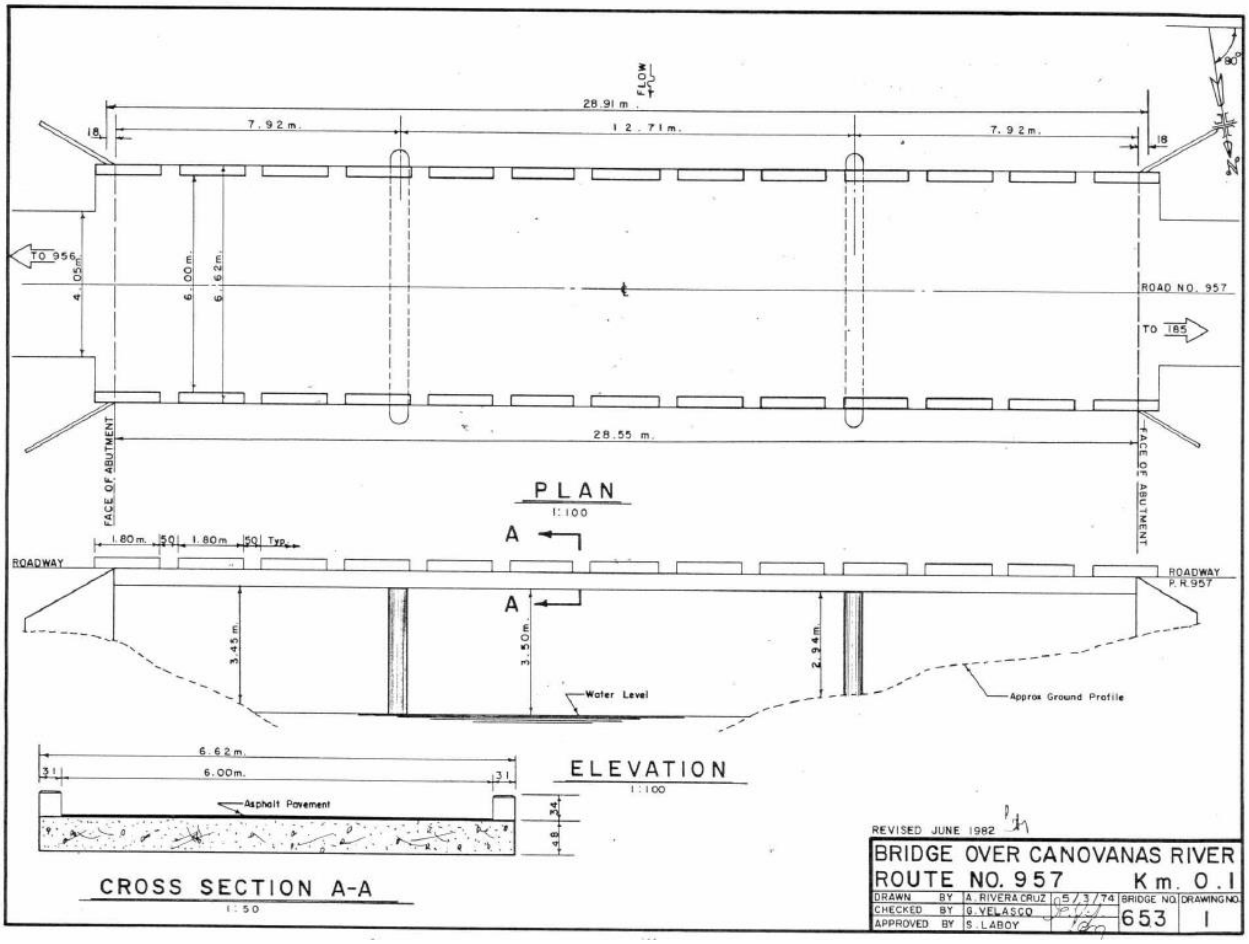


Figure 2-24: Bridge 653 drawings (source: PRHTA)

2.2.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 0653

TEAM LEADER: Mayra I. Zayas Rodríguez / AT López

INSP. DATE: Jul. 12 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	24	Jul. 2014	Jul. 12. 2018
ITEM 93 A	FC Inspection	N			
ITEM 93 B	Underwater Insp.	N			
ITEM 93 C	Other:	N			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	5	5	6	5	N	3
Current Inspection	5	5	6	5	N	3

Other Checks: (Y, N, NA)

Review Comments:

_ Scour Critical (items 113 & 60)
_ AASHTO Core's & NBI CD consistent
_ Smart Flags (scour, steel plate, fire damage, etc)
_ Channel Profile/Clearance Table
_ FC & Underwater Members Tables
_ Asphalt Overlay Thickness
_ Drawings
_ Photos
_ Critical Finding
_ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-25: Bridge 653 inspection summary of July 12, 2016 (source: PRHTA)



0653-jul-12-2016-001.jpg



0653-jul-12-2016-002.jpg



0653-jul-12-2016-005.jpg



0653-jul-12-2016-006.jpg



0653-jul-12-2016-007.jpg



0653-jul-12-2016-008.jpg



0653-jul-12-2016-010.jpg



0653-jul-12-2016-012.jpg



0653-jul-12-2016-017.jpg

Figure 2-26: Bridge 653 inspection photos of July 12, 2016 (source: PRHTA)

2.2.3. Images before Hurricane Maria



Figure 2-27: Bridge 653 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-28: Bridge 653 photo from July 12, 2016 inspection (source: PRHTA)



Figure 2-29: Bridge 653 photo from July 12, 2016 inspection (source: PRHTA)



Figure 2-30: Bridge 653 photo from July 12, 2016 inspection (source: PRHTA)



Figure 2-31: Bridge 653 photo from July 12, 2016 inspection (source: PRHTA)



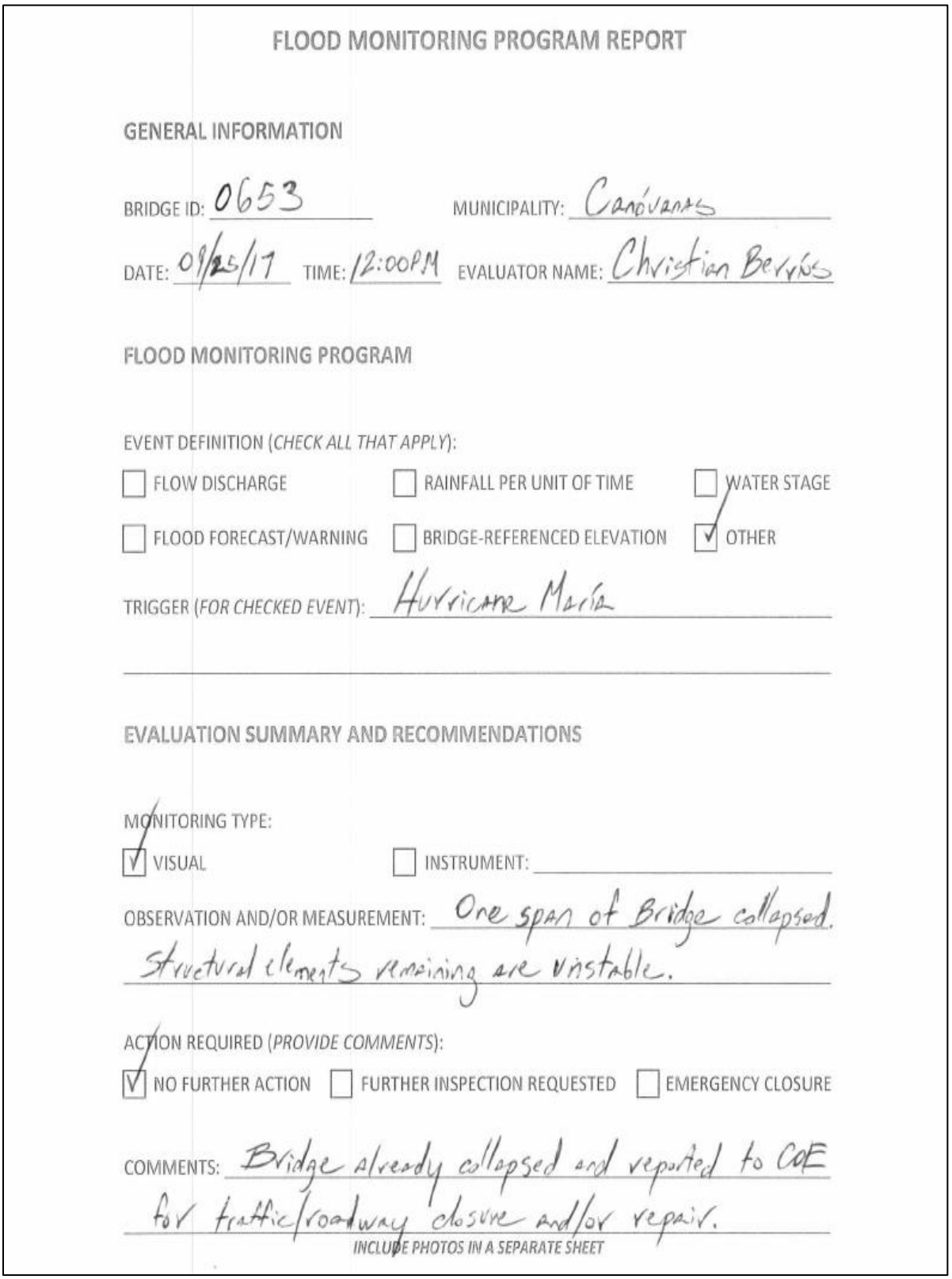
Figure 2-32: Bridge 653 photo from July 12, 2016 inspection (source: PRHTA)

2.2.4. Streamflow

Table 2-7: Peak streamflow at Canóvanas River Near Campo Rico monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-05-17	8.77	2,910
2011	2011-08-23	13.06	9,120
2012	2011-12-10	9.18	3,360
2013	2013-07-18	9.59	3,860
2014	2013-11-22	6.64	1,140
2015	2014-12-16	7.76	1,960
2016	2016-04-25	5.73	681
2017	2017-09-20	17.33	15,100

2.2.5. Inspections after Hurricane Maria



FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 0653 MUNICIPALITY: Canóvanas

DATE: 09/25/17 TIME: 12:00PM EVALUATOR NAME: Christian Berríos

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: One span of Bridge collapsed. Structural elements remaining are unstable.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

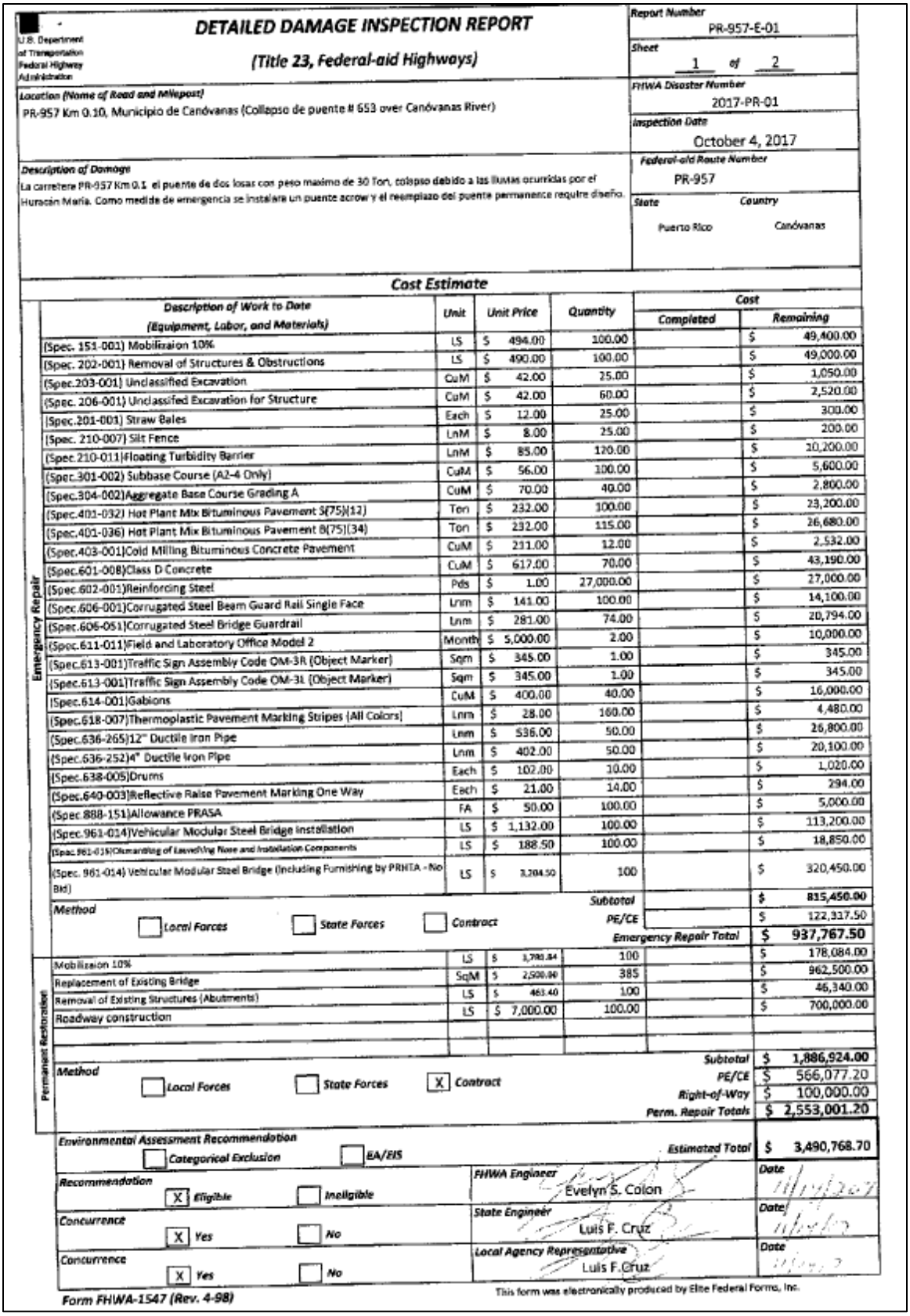
COMMENTS: Bridge already collapsed and reported to COE for traffic/roadway closure and/or repair.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-33: Bridge 653 inspection report from September 25, 2017 (source: PRHTA)



Figure 2-34: Bridge 653 photos from September 25, 2017 inspection (source: PRHTA)



U.S. Department of Transportation
Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number: PR-957-E-01
Sheet: 1 of 2
FHWA Disaster Number: 2017-PR-01
Inspection Date: October 4, 2017
Federal-aid Route Number: PR-957
State: Puerto Rico
Country: Canóvanas

Location (Name of Road and Milepost)
PR-957 Km 0.10, Municipio de Canóvanas (Colapso de puente # 653 over Canóvanas River)

Description of Damage
La carretera PR-957 Km 0.1 el puente de dos losas con peso maximo de 30 Ton, colapso debido a las lluvias ocurridas por el Huracán María. Como medida de emergencia se instalara un puente acrow y el reemplazo del puente permanence require diseño.

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Emergency Repair	(Spec. 151-001) Mobilizaion 10%	LS	$ 494.00	100.00		$ 49,400.00
	(Spec. 202-001) Removal of Structures & Obstructions	LS	$ 490.00	100.00		$ 49,000.00
	(Spec.203-001) Unclassified Excavation	CuM	$ 42.00	25.00		$ 1,050.00
	(Spec. 206-001) Unclassified Excavation for Structure	CuM	$ 42.00	60.00		$ 2,520.00
	(Spec.201-001) Straw Bales	Each	$ 12.00	25.00		$ 300.00
	(Spec. 210-007) Silt Fence	LnM	$ 8.00	25.00		$ 200.00
	(Spec.210-011)Floating Turbidity Barrier	LnM	$ 85.00	120.00		$ 10,200.00
	(Spec.301-002) Subbase Course (A2-4 Only)	CuM	$ 56.00	100.00		$ 5,600.00
	(Spec.304-002)Aggregate Base Course Grading A	CuM	$ 70.00	40.00		$ 2,800.00
	(Spec.401-032) Hot Plant Mix Bituminous Pavement S(75)(12)	Ton	$ 232.00	100.00		$ 23,200.00
	(Spec.401-036) Hot Plant Mix Bituminous Pavement B(75)(34)	Ton	$ 232.00	115.00		$ 26,680.00
	(Spec.403-001)Cold Milling Bituminous Concrete Pavement	CuM	$ 211.00	12.00		$ 2,532.00
	(Spec.601-008)Class D Concrete	CuM	$ 617.00	70.00		$ 43,190.00
	(Spec.602-001)Reinforcing Steel	Pds	$ 1.00	27,000.00		$ 27,000.00
	(Spec.606-001)Corrugated Steel Beam Guard Rail Single Face	Lnm	$ 141.00	100.00		$ 14,100.00
	(Spec.606-051)Corrugated Steel Bridge Guardrail	Lnm	$ 281.00	74.00		$ 20,794.00
	(Spec.611-011)Field and Laboratory Office Model 2	Month	$ 5,000.00	2.00		$ 10,000.00
	(Spec.613-001)Traffic Sign Assembly Code OM-3R (Object Marker)	Sqm	$ 345.00	1.00		$ 345.00
	(Spec.613-001)Traffic Sign Assembly Code OM-3L (Object Marker)	Sqm	$ 345.00	1.00		$ 345.00
	(Spec.614-001)Gabions	CuM	$ 400.00	40.00		$ 16,000.00
	(Spec.618-007)Thermoplastic Pavement Marking Stripes (All Colors)	Lnm	$ 28.00	160.00		$ 4,480.00
	(Spec.636-265)12" Ductile Iron Pipe	Lnm	$ 536.00	50.00		$ 26,800.00
	(Spec.636-252)4" Ductile Iron Pipe	Lnm	$ 402.00	50.00		$ 20,100.00
	(Spec.638-005)Drums	Each	$ 102.00	10.00		$ 1,020.00
	(Spec.640-003)Reflective Raise Pavement Marking One Way	Each	$ 21.00	14.00		$ 294.00
	(Spec 888-151)Allowance PRASA	FA	$ 50.00	100.00		$ 5,000.00
	(Spec.961-014)Vehicular Modular Steel Bridge Installation	LS	$ 1,132.00	100.00		$ 113,200.00
	(Spec.961-015)Dismantling of Launching Nose and Installation Components	LS	$ 188.50	100.00		$ 18,850.00
	(Spec. 961-014) Vehicular Modular Steel Bridge (Including Furnishing by PRHTA - No Bid)	LS	$ 3,204.50	100		$ 320,450.00
				Subtotal		$ 815,450.00
	Method: ☐ Local Forces ☐ State Forces ☐ Contract			PE/CE		$ 122,317.50
				Emergency Repair Total		$ 937,767.50
Permanent Restoration	Mobilizaion 10%	LS	$ 1,780.84	100		$ 178,084.00
	Replacement of Existing Bridge	SqM	$ 2,500.00	385		$ 962,500.00
	Removal of Existing Structures (Abutments)	LS	$ 463.40	100		$ 46,340.00
	Roadway construction	LS	$ 7,000.00	100.00		$ 700,000.00
				Subtotal		$ 1,886,924.00
	Method: ☐ Local Forces ☐ State Forces ☒ Contract			PE/CE		$ 566,077.20
				Right-of-Way		$ 100,000.00
				Perm. Repair Totals		$ 2,553,001.20
				Estimated Total		$ 3,490,768.70

Environmental Assessment Recommendation
☐ Categorical Exclusion ☐ EA/EIS

Recommendation
☒ Eligible ☐ Ineligible

Concurrence
☒ Yes ☐ No

Concurrence
☒ Yes ☐ No

FHWA Engineer: Evelyn S. Colon — Date: 10/19/2017
State Engineer: Luis F. Cruz — Date: 10/19/17
Local Agency Representative: Luis F. Cruz — Date: 10/19/17

Form FHWA-1547 (Rev. 4-98)

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Figure 2-35: Bridge 653 inspection report from October 4, 2017 (source: FHWA)

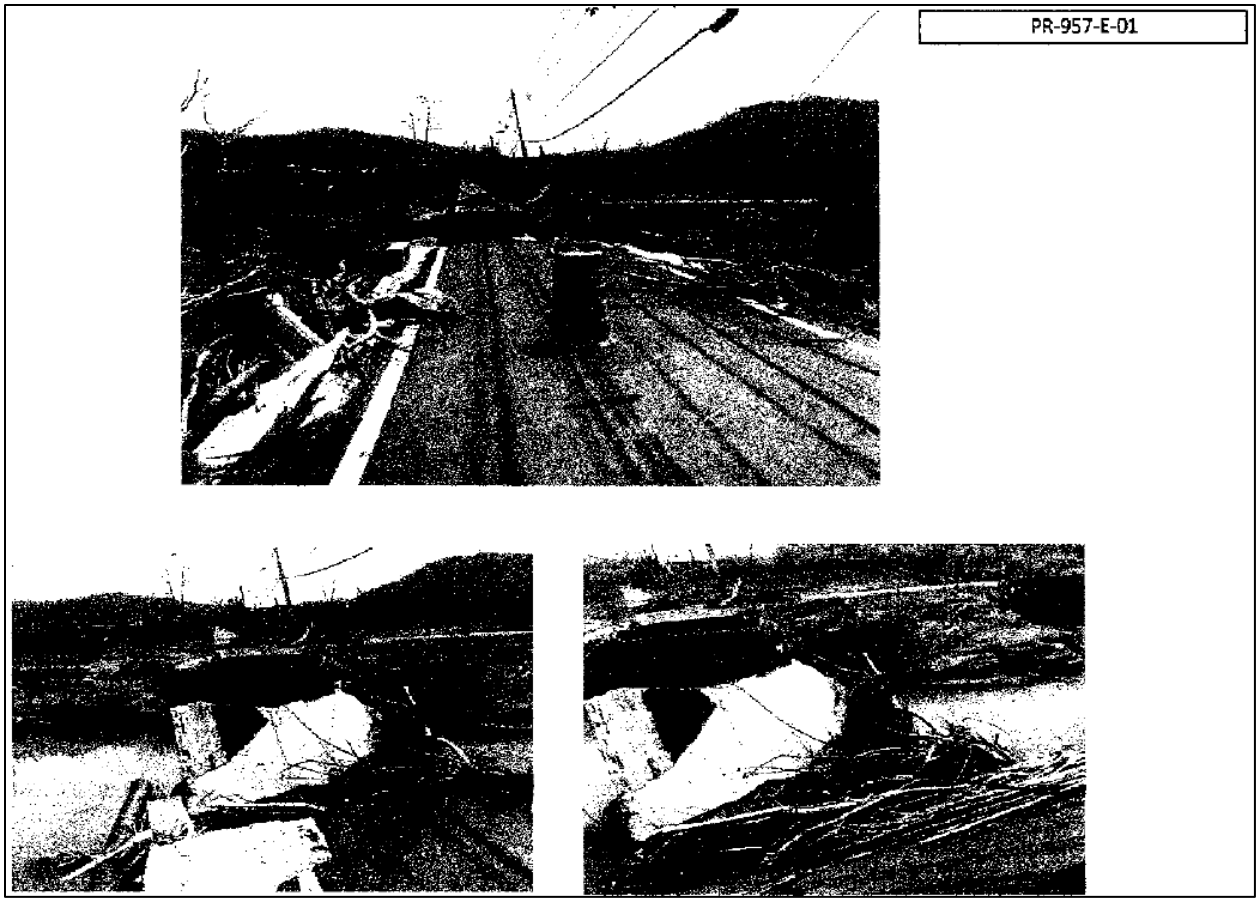


Figure 2-36: Bridge 653 photos from October 4, 2017 inspection (source: FHWA)

2.2.6. Images after Hurricane Maria



Figure 2-37: Bridge 653 satellite image after Hurricane Maria (source: NOAA)



Figure 2-38: Bridge 653 satellite after Hurricane Maria (source: Google Earth Pro)



https://twitter.com/leydaisabel3/status/910593673229946880

Figure 2-39: Social media image of collapsed Bridge 653 (source: L. Anqueira)

2.2.7. Videos after Hurricane Maria



https://youtu.be/ehDtoP3yLv0

Video 2-1: Social media video of collapsed Bridge 653 (source: Love Me)



https://youtu.be/3ESDnXjUZvw?t=140

Video 2-2: Drone video of damages in Canóvanas including Bridge 653 (source: Radazone)

2.2.8. Temporary replacement



http://www.presenciapr.com/wp-content/uploads/2018/02/palma-sola-010218.jpg

Figure 2-40: Bridge 653 replacement (source: Presencia)

2.3. Bridge 679



(Extracted from Figure 2-56)

2.3.1. General information

Table 2-8: Bridge 679 general information from BridgeReports.com

Name	PR 404 over CULEBRINAS RIVER
Structure number	006791
Location	3.5 KM SOUTHEAST OF MOCA
Purpose	Carries highway and pedestrian walkway over waterway
Route classification	Local (Rural)
Length of largest span	56.8 ft
Total length	212.0 ft
Roadway width between curbs	19.7 ft
Deck width edge-to-edge	28.9 ft
Owner	State Highway Agency
Year built	1953
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	4
Main spans material	Concrete continuous
Main spans design	Tee beam
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed structural deck)

Table 2-9: Bridge 679 general information from the PRHTA

ID	679
Highway	PR-404
Municipality	Moca
Year Built	1953
Functionality	Rural-local
Lanes	2
ADT	600
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway-pedestrian
Down Service	waterway
Width	8.8 m
Length	64.6 m
Spans	4
Under clearance	0
Material	Concrete continuous
Design	Tee beam
Scour Critical	4
Inspection Frequency	12 months
Approach Roadway Width	9.5 m
Bypass length	11 km
NBI Rating	2
NHS	0
Area	568.48 m^2

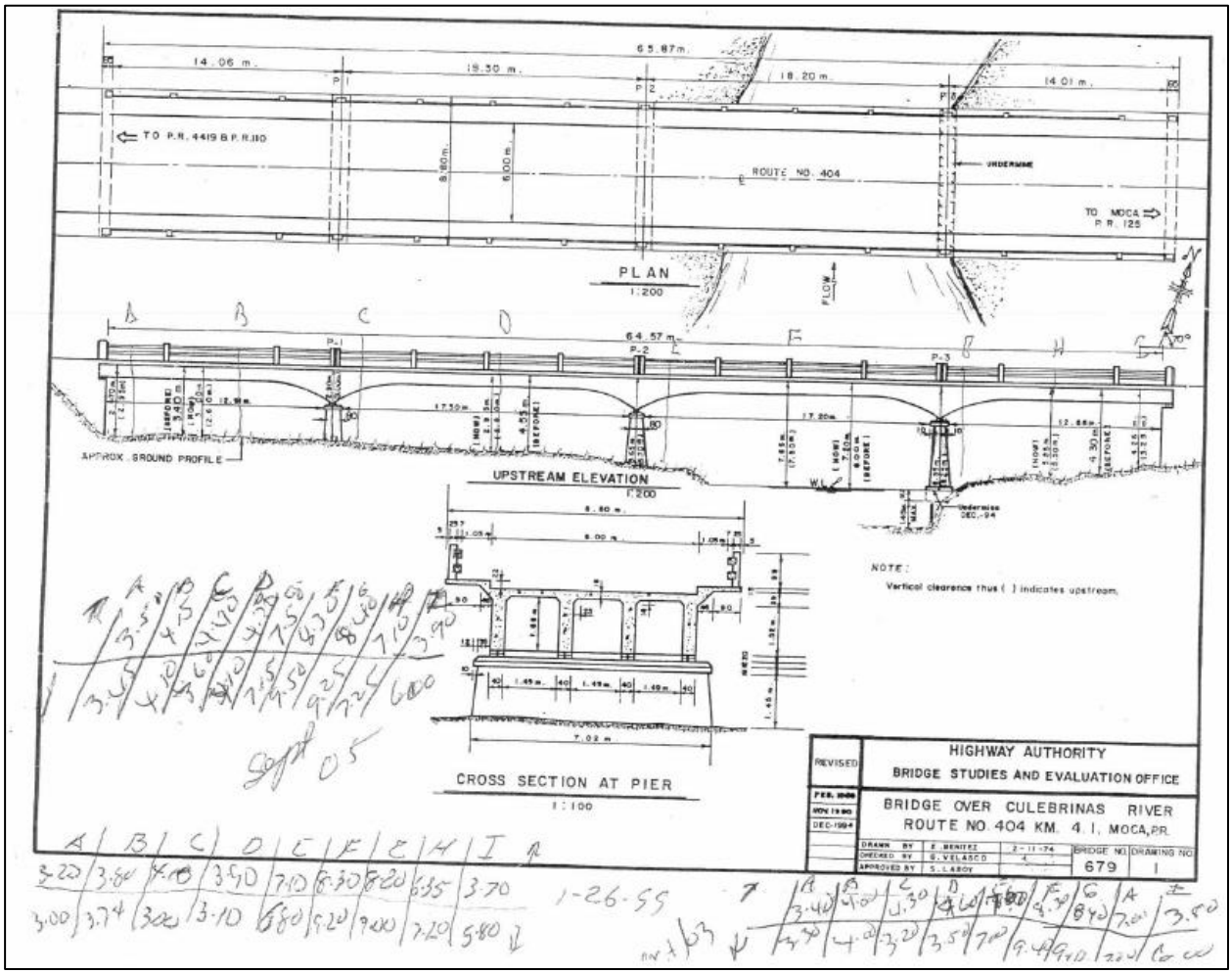


Figure 2-41: Bridge 679 drawings (source: PRHTA)

2.3.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 0679

TEAM LEADER: Mayra I. Zayas Rodríguez

INSP. DATE: April 15, 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	12	Mar. 3. 2015	Apr. 15. 2017
ITEM 93 A	FC Inspection				
ITEM 93 B	Underwater Insp.				
ITEM 93 C	Other:	Yes	12	Mar. 3 2015	Apr. 15. 2017

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	5	5	5	3	N	4
Current Inspection	5	5	4	3	N	4

Other Checks: (Y, N, NA)

Review Comments:

- Y Scour Critical (items 113 & 60)
- Y AASHTO Core's & NBI CD consistent
- Y Smart Flags (scour, steel plate, fire damage, etc)
- Y Channel Profile/Clearance Table
- Y FC & Underwater Members Tables
- Y Asphalt Overlay Thickness
- Y Drawings
- Y Photos
- Y Critical Finding
- Y Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-42: Bridge 679 inspection summary of April 15, 2016 (source: PRHTA)



Figure 2-43: Bridge 679 inspection photos of April 15, 2016 (source: PRHTA)

2.3.3. Images before Hurricane Maria



Figure 2-44: Bridge 679 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-45: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-46: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-47: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-48: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-49: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-50: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)



Figure 2-51: Bridge 679 photo from March 3, 2015 inspection (source: PRHTA)

2.3.4. Streamflow

Table 2-10: Peak streamflow at Culebrinas River at Highway 404 Near Moca monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-07-27	24.41	15,800
2011	2010-10-08	28.69	29,100
2012	2012-03-29	25.79	19,700
2013	2012-11-06	24.82	17,000
2014	2013-10-10	25.39	18,500
2015	2015-08-16	25.93	20,100
2016	2015-12-13	24.49	16,200
2017	2017-09-20	43.16	54,100

2.3.5. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 0679 MUNICIPALITY: Moca

DATE: 22/Sep/2017 TIME: 12:40 PM EVALUATOR NAME: Eric W. Rios Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María - 20/Sep/2017

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0 puente colapso

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Cerrado - Puente colapso (4 spans)

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-52: Bridge 679 inspection report from September 22, 2017 (source: PRHTA)



Figure 2-53: Bridge 679 photos from September 22, 2017 inspection (source: PRHTA)

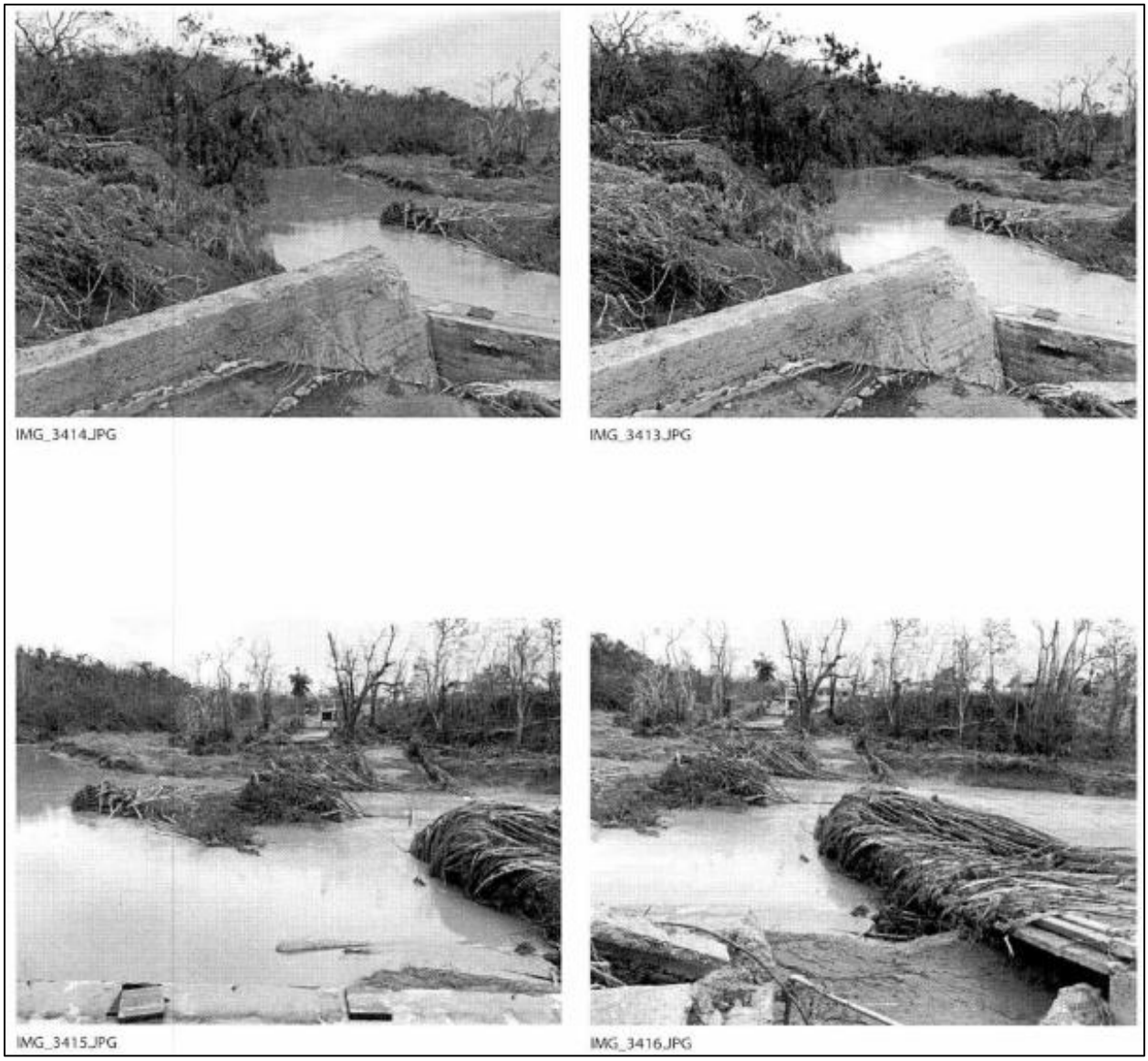


Figure 2-54: Bridge 679 photos from September 22, 2017 inspection (source: PRHTA)

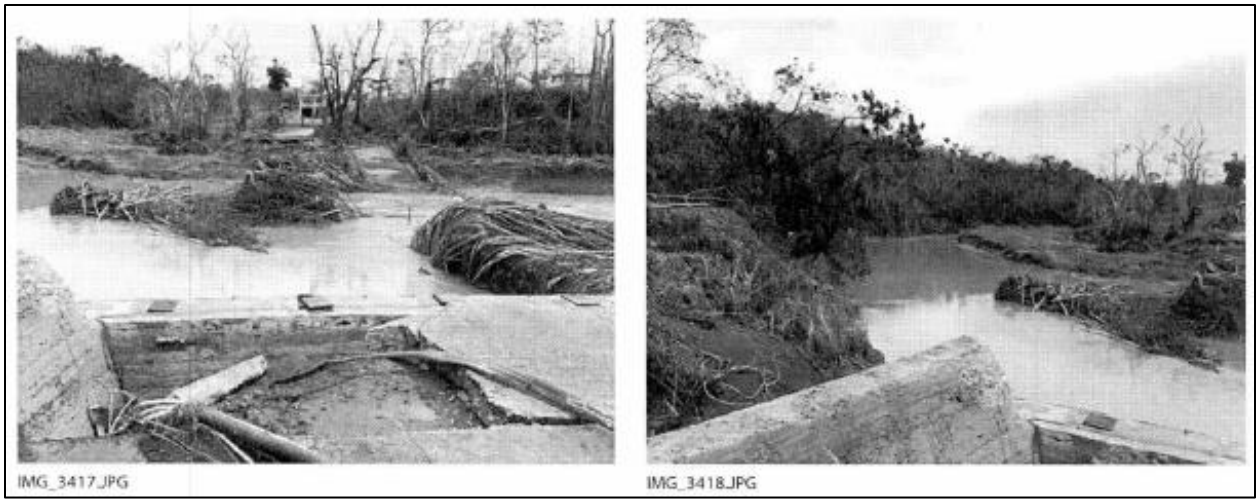


Figure 2-55: Bridge 679 photos from September 22, 2017 inspection (source: PRHTA)

2.3.6. Images after Hurricane Maria



Figure 2-56: Bridge 679 satellite image after Hurricane Maria (source: NOAA)



Figure 2-57: Bridge 679 satellite after Hurricane Maria (source: Google Earth Pro)

2.3.7. Videos after Hurricane Maria



https://youtu.be/RhRh1T3-Zic

Video 2-3: Amateur news report about the collapse of Bridge 679 (source: Nydia González aka Dyani07)

2.3.8. Temporary replacement



Figure 2-58: Bridge 679 replacement (source: PRHTA)

2.4. Bridge 769



(Extracted from Figure 2-78)

2.4.1. General information

Table 2-11: Bridge 769 general information from BridgeReports.com

Name	PR 354 over CAÑAS RIVER
Structure number	007691
Location	8.8 KM EAST OF MAYAGÜEZ
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	17.4 ft
Total length	59.7 ft
Roadway width between curbs	17.7 ft
Deck width edge-to-edge	19.7 ft
Owner	State Highway Agency
Year built	1957
Historic significance	Bridge is not eligible for the National Register of Historic Places.
Number of main spans	3
Main spans material	Concrete continuous
Main spans design	Slab
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-12: Bridge 769 general information from the PRHTA

ID	769
Highway	PR 354
Municipality	Mayagüez
Year Built	1957
Functionality	Rural-local
Lanes	2
ADT	1300
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	Waterway
Width	6 m
Length	18.2 m
Spans	3
Under clearance	0
Material	Concrete continuous
Design	Slab
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	6.8 m
Bypass length	6 km
NBI Rating	2
NHS	0
Area	109.2 m^2

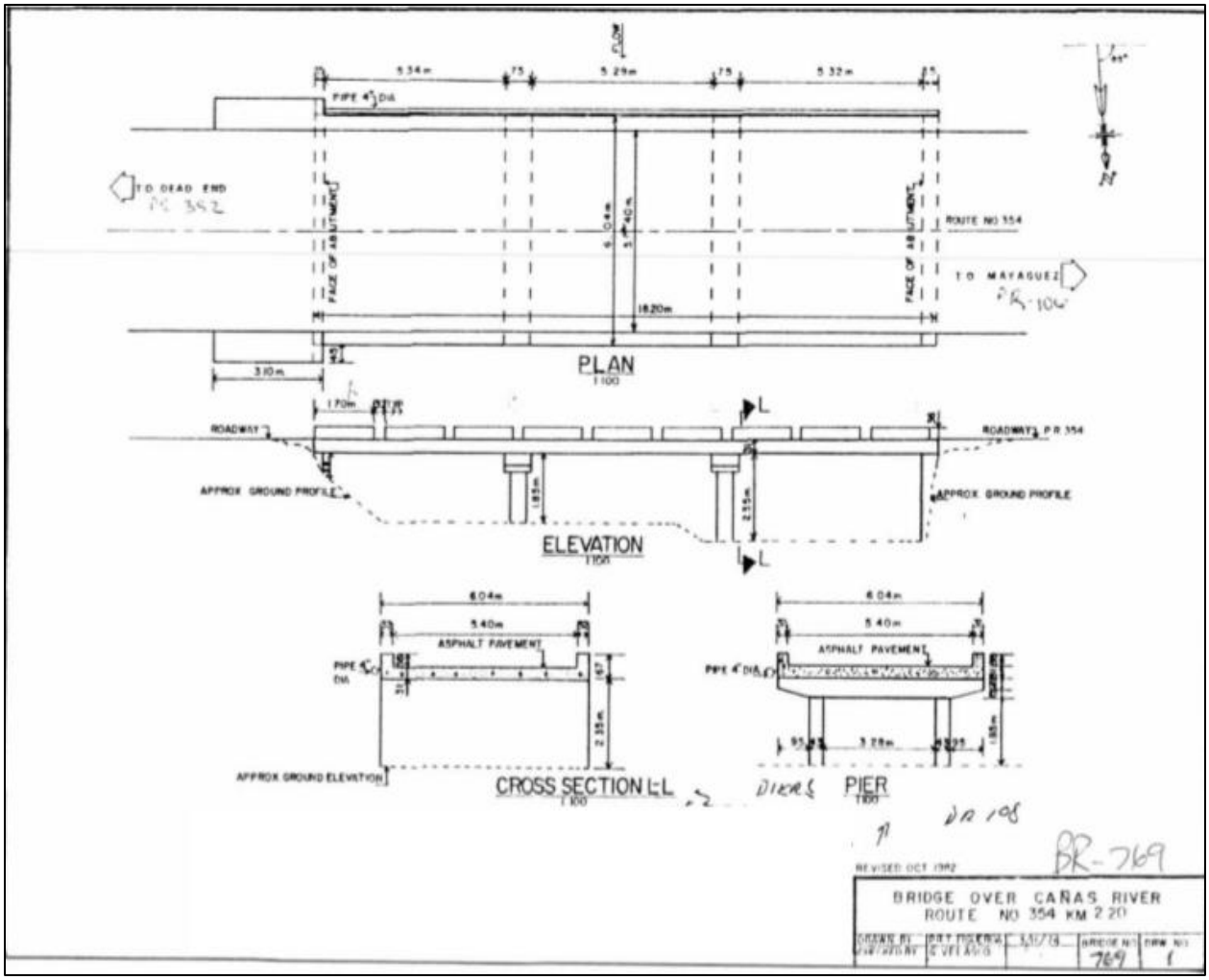


Figure 2-59: Bridge 769 drawings (source: PRHTA)

2.4.2. Inspections before Hurricane Maria

Note: The last inspection of Bridge 769 before Hurricane Maria was carried out in June 2017. The Report Summary and QC Sheet of this inspection was not available. Therefore, Figure 2-60 shows the summary of the June 2015 inspection. The photos of the June 2017 inspection were made available, as shown in Figure 2-61.

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 0769

TEAM LEADER: Heriberto González Medina

INSP. DATE: 16-Junio-2015

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	May 2013	Jun 2017
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other:	—			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	6	6	6	5	N	8
Current Inspection	6	6	6	5	N	8

Other Checks: (Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-60: Bridge 768 inspection summary of June 16, 2015 (source: PRHTA)



Figure 2-61: Bridge 769 inspection photos of June 30, 2017 (source: PRHTA)

2.4.3. Images before Hurricane Maria



Figure 2-62: Bridge 769 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-63: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-64: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-65: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-66: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-67: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-68: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)



Figure 2-69: Bridge 769 photo from June 30,2017 inspection (source: PRHTA)

2.4.4. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 0769 MUNICIPALITY: Mayaguez

DATE: 4/oct/2017 TIME: 10:27 AM EVALUATOR NAME: Eric W. Rios Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0 Puente colapsó

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Estructura colapsó, Abutment y tramo 1 colapsaron

INCLUDE PHOTOS IN A SEPARATE SHEET

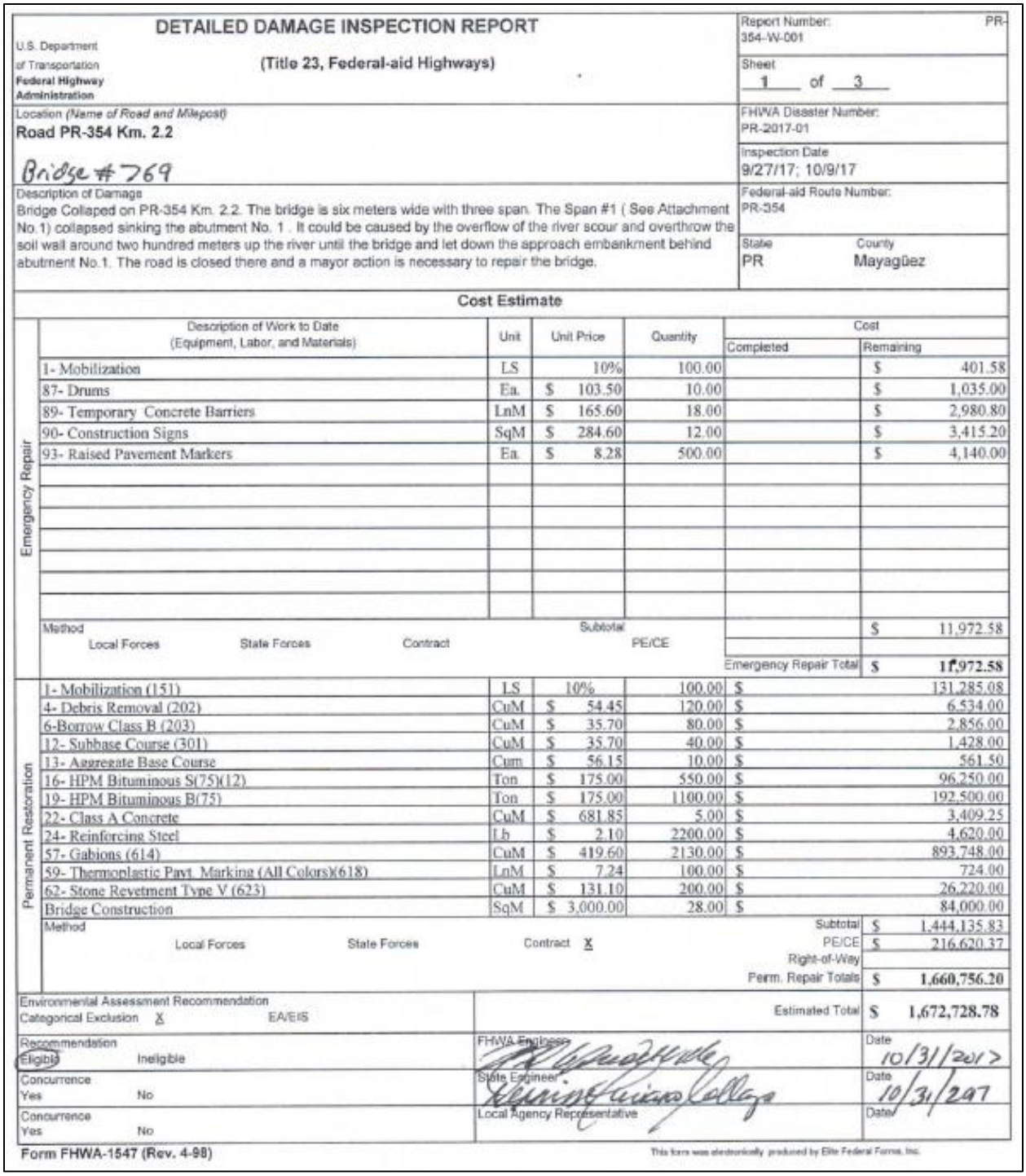
Figure 2-70: Bridge 769 inspection report from October 4, 2017 (source: PRHTA)



Figure 2-71: Bridge 769 photos from October 4, 2017 inspection (source: PRHTA)



Figure 2-72: Bridge 769 photos from October 4, 2017 inspection (source: PRHTA)



DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number: PR-354-W-001

Sheet 1 of 3

Location *(Name of Road and Milepost)*
Road PR-354 Km. 2.2

Bridge #769

FHWA Disaster Number: PR-2017-01

Inspection Date: 9/27/17; 10/9/17

Federal-aid Route Number: PR-354

State: PR County: Mayagüez

Description of Damage
Bridge Collaped on PR-354 Km. 2.2. The bridge is six meters wide with three span. The Span #1 (See Attachment No.1) collapsed sinking the abutment No. 1 . It could be caused by the overflow of the river scour and overthrow the soil wall around two hundred meters up the river until the bridge and let down the approach embankment behind abutment No.1. The road is closed there and a mayor action is necessary to repair the bridge.

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
1- Mobilization	LS	10%	100.00		$ 401.58
87- Drums	Ea.	$ 103.50	10.00		$ 1,035.00
89- Temporary Concrete Barriers	LnM	$ 165.60	18.00		$ 2,980.80
90- Construction Signs	SqM	$ 284.60	12.00		$ 3,415.20
93- Raised Pavement Markers	Ea.	$ 8.28	500.00		$ 4,140.00

Method: Local Forces / State Forces / Contract — Subtotal PE/CE: $ 11,972.58

Emergency Repair Total: $ 11,972.58

Permanent Restoration

1- Mobilization (151)	LS	10%	100.00	$ 131,285.08
4- Debris Removal (202)	CuM	$ 54.45	120.00	$ 6,534.00
6-Borrow Class B (203)	CuM	$ 35.70	80.00	$ 2,856.00
12- Subbase Course (301)	CuM	$ 35.70	40.00	$ 1,428.00
13- Aggregate Base Course	Cum	$ 56.15	10.00	$ 561.50
16- HPM Bituminous S(75)(12)	Ton	$ 175.00	550.00	$ 96,250.00
19- HPM Bituminous B(75)	Ton	$ 175.00	1100.00	$ 192,500.00
22- Class A Concrete	CuM	$ 681.85	5.00	$ 3,409.25
24- Reinforcing Steel	Lb	$ 2.10	2200.00	$ 4,620.00
57- Gabions (614)	CuM	$ 419.60	2130.00	$ 893,748.00
59- Thermoplastic Pavt. Marking (All Colors)(618)	LnM	$ 7.24	100.00	$ 724.00
62- Stone Revetment Type V (623)	CuM	$ 131.10	200.00	$ 26,220.00
Bridge Construction	SqM	$ 3,000.00	28.00	$ 84,000.00

Method: Local Forces / State Forces / Contract X

Subtotal: $ 1,444,135.83
PE/CE: $ 216,620.37
Right-of-Way:
Perm. Repair Totals: $ 1,660,756.20

Environmental Assessment Recommendation
Categorical Exclusion X EA/EIS

Estimated Total: $ 1,672,728.78

Recommendation: Eligible / Ineligible

FHWA Engineer — Date: 10/31/2017

Concurrence: Yes / No
State Engineer — Date: 10/31/2017

Concurrence: Yes / No
Local Agency Representative — Date:

Form FHWA-1547 (Rev. 4-98)

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Figure 2-73: Bridge 769 inspection report from September 27 and October 9, 2017 (source: FHWA)

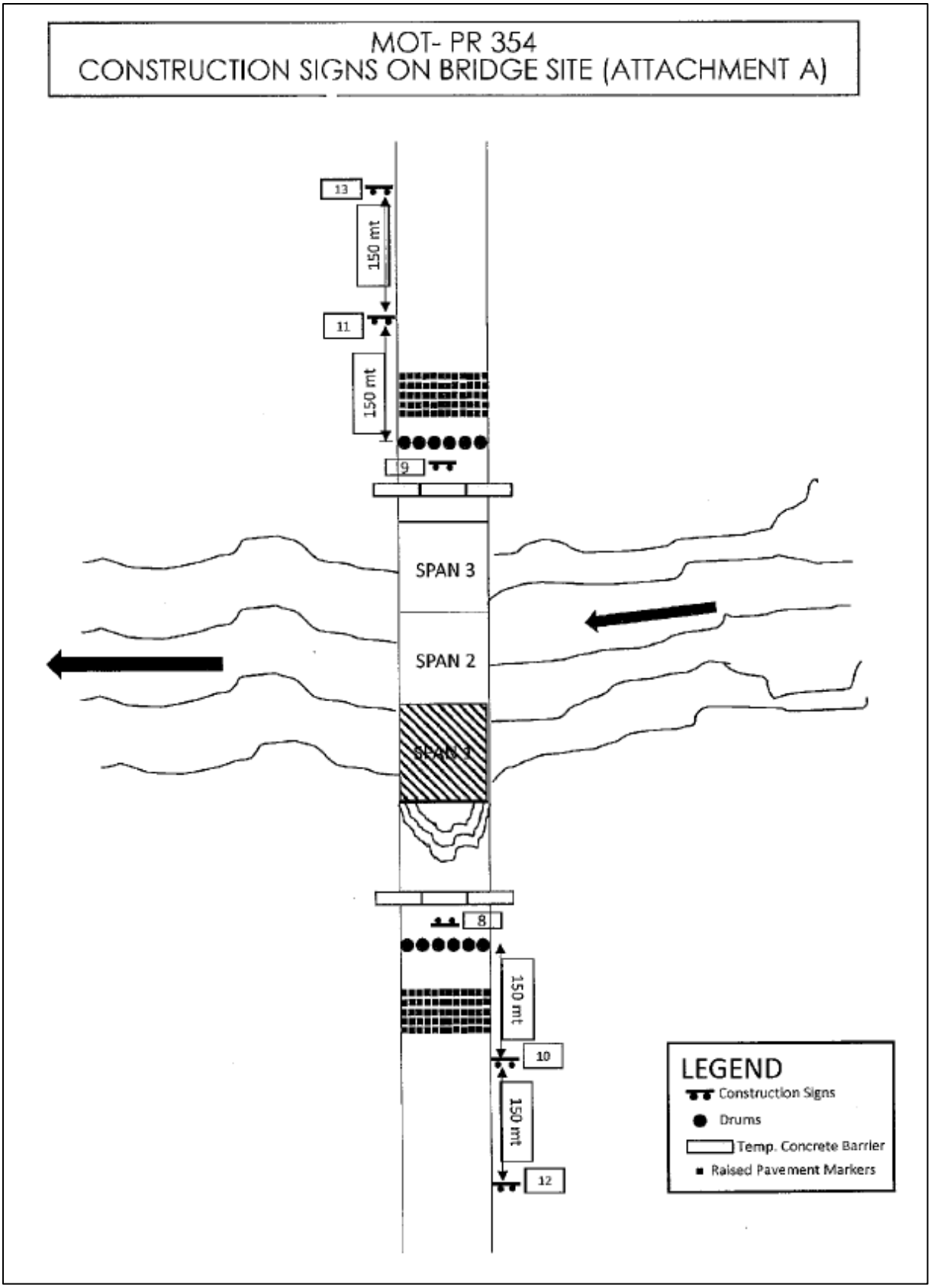
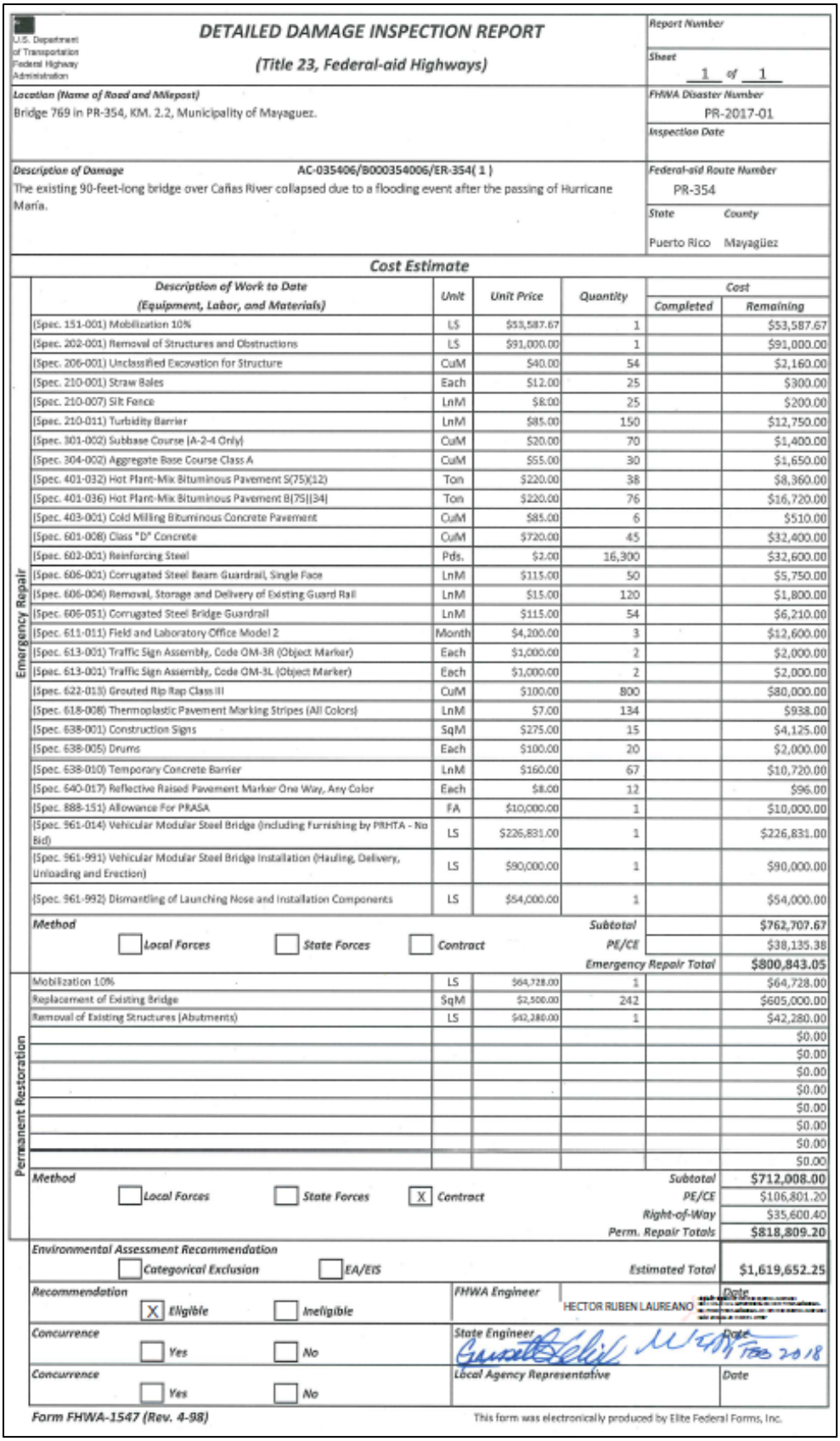


Figure 2-74: Diagram from October 9, 2017 report indicating collapsed span of Bridge 769 (source: FHWA)



U.S. Department of Transportation Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 1

Location (Name of Road and Milepost)
Bridge 769 in PR-354, KM. 2.2, Municipality of Mayaguez.

FHWA Disaster Number
PR-2017-01

Inspection Date

Description of Damage AC-035406/B000354006/ER-354(1)
The existing 90-feet-long bridge over Cañas River collapsed due to a flooding event after the passing of Hurricane María.

Federal-aid Route Number
PR-354

State: Puerto Rico County: Mayagüez

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Emergency Repair	(Spec. 151-001) Mobilization 10%	LS	$53,587.67	1		$53,587.67
	(Spec. 202-001) Removal of Structures and Obstructions	LS	$91,000.00	1		$91,000.00
	(Spec. 206-001) Unclassified Excavation for Structure	CuM	$40.00	54		$2,160.00
	(Spec. 210-001) Straw Bales	Each	$12.00	25		$300.00
	(Spec. 210-007) Silt Fence	LnM	$8.00	25		$200.00
	(Spec. 210-011) Turbidity Barrier	LnM	$85.00	150		$12,750.00
	(Spec. 301-002) Subbase Course (A-2-4 Only)	CuM	$20.00	70		$1,400.00
	(Spec. 304-002) Aggregate Base Course Class A	CuM	$55.00	30		$1,650.00
	(Spec. 401-032) Hot Plant-Mix Bituminous Pavement S(75)(12)	Ton	$220.00	38		$8,360.00
	(Spec. 401-036) Hot Plant-Mix Bituminous Pavement B(75)(34)	Ton	$220.00	76		$16,720.00
	(Spec. 403-001) Cold Milling Bituminous Concrete Pavement	CuM	$85.00	6		$510.00
	(Spec. 601-008) Class "D" Concrete	CuM	$720.00	45		$32,400.00
	(Spec. 602-001) Reinforcing Steel	Pds.	$2.00	16,300		$32,600.00
	(Spec. 606-001) Corrugated Steel Beam Guardrail, Single Face	LnM	$115.00	50		$5,750.00
	(Spec. 606-004) Removal, Storage and Delivery of Existing Guard Rail	LnM	$15.00	120		$1,800.00
	(Spec. 606-051) Corrugated Steel Bridge Guardrail	LnM	$115.00	54		$6,210.00
	(Spec. 611-011) Field and Laboratory Office Model 2	Month	$4,200.00	3		$12,600.00
	(Spec. 613-001) Traffic Sign Assembly, Code OM-3R (Object Marker)	Each	$1,000.00	2		$2,000.00
	(Spec. 613-001) Traffic Sign Assembly, Code OM-3L (Object Marker)	Each	$1,000.00	2		$2,000.00
	(Spec. 622-013) Grouted Rip Rap Class III	CuM	$100.00	800		$80,000.00
	(Spec. 618-008) Thermoplastic Pavement Marking Stripes (All Colors)	LnM	$7.00	134		$938.00
	(Spec. 638-001) Construction Signs	SqM	$275.00	15		$4,125.00
	(Spec. 638-005) Drums	Each	$100.00	20		$2,000.00
	(Spec. 638-010) Temporary Concrete Barrier	LnM	$160.00	67		$10,720.00
	(Spec. 640-017) Reflective Raised Pavement Marker One Way, Any Color	Each	$8.00	12		$96.00
	(Spec. 888-151) Allowance For PRASA	FA	$10,000.00	1		$10,000.00
	(Spec. 961-014) Vehicular Modular Steel Bridge (Including Furnishing by PRHTA - No Bid)	LS	$226,831.00	1		$226,831.00
	(Spec. 961-991) Vehicular Modular Steel Bridge Installation (Hauling, Delivery, Unloading and Erection)	LS	$90,000.00	1		$90,000.00
	(Spec. 961-992) Dismantling of Launching Nose and Installation Components	LS	$54,000.00	1		$54,000.00
	Method ☐ Local Forces ☐ State Forces ☐ Contract				Subtotal	$762,707.67
					PE/CE	$38,135.38
					Emergency Repair Total	$800,843.05
Permanent Restoration	Mobilization 10%	LS	$64,728.00	1		$64,728.00
	Replacement of Existing Bridge	SqM	$2,500.00	242		$605,000.00
	Removal of Existing Structures (Abutments)	LS	$42,280.00	1		$42,280.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
						$0.00
	Method ☐ Local Forces ☐ State Forces ☒ Contract				Subtotal	$712,008.00
					PE/CE	$106,801.20
					Right-of-Way	$35,600.40
					Perm. Repair Totals	$818,809.20
					Estimated Total	$1,619,652.25

Environmental Assessment Recommendation
☐ Categorical Exclusion ☐ EA/EIS

Recommendation ☒ Eligible ☐ Ineligible

FHWA Engineer HECTOR RUBEN LAUREANO [redacted] Date

Concurrence ☐ Yes ☐ No

State Engineer [redacted] Date FEB 2018

Concurrence ☐ Yes ☐ No

Local Agency Representative Date

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 2-75: Bridge 769 inspection report dated February 2018 (source: PRHTA)

2.4.5. Images after Hurricane Maria



Figure 2-76: Bridge 769 satellite image after Hurricane Maria (source: NOAA)

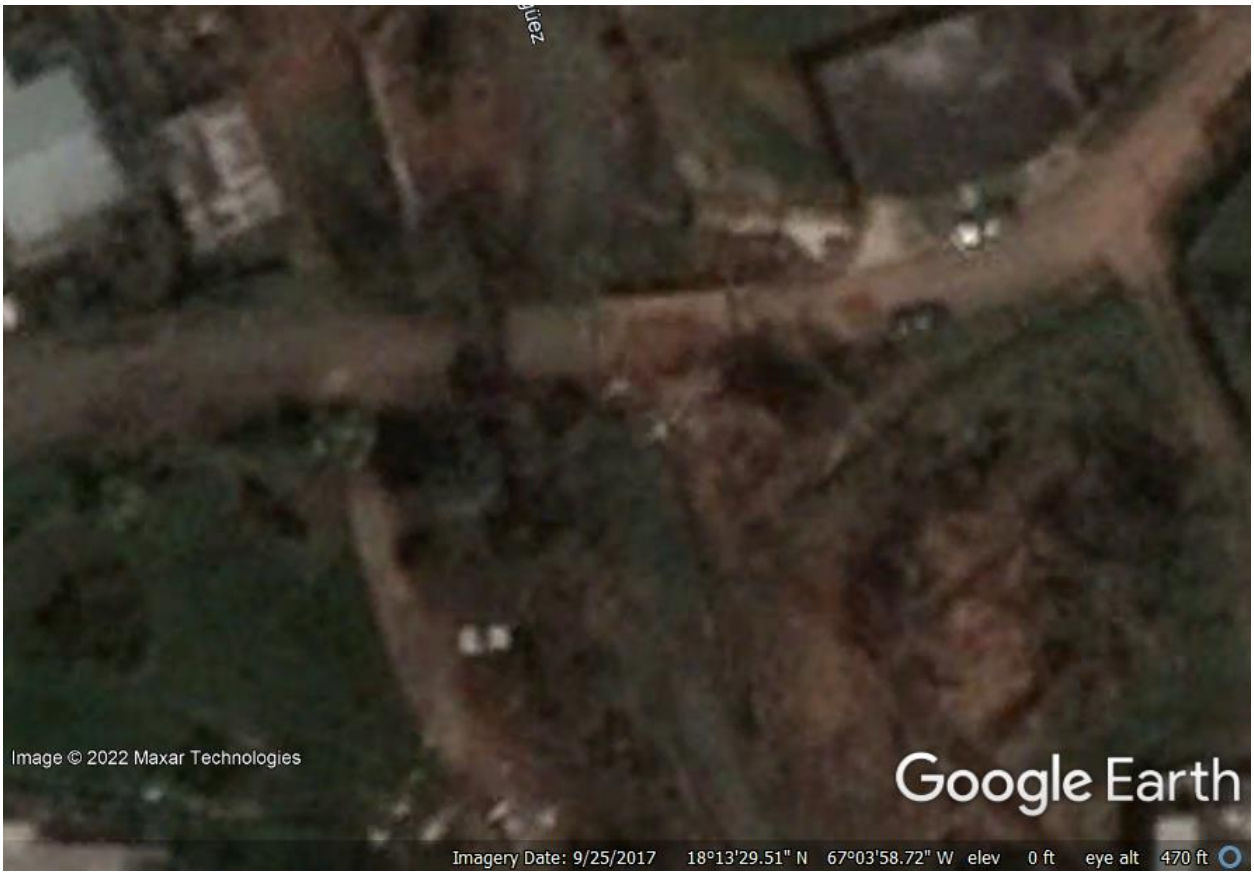


Figure 2-77: Bridge 769 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.facebook.com/richard.jibarito/posts/pfbid02KbDWHMNBnNKzGcGSEtZgRHoJ1zgxs3NjsfDd8voojJ4EaMfjn7YwrR45m8H5poeSl

Figure 2-78: Collapsed Bridge 769 image from Facebook post (source: Richard González Sonera)



https://laislaoeste.com/instalaran-puente-de-rio-canas-en-mayaguez/

Figure 2-79: Collapsed Bridge 769 image from news report (source: La Isla Oeste)

2.4.6. Temporary replacement



Figure 2-80: Bridge 769 replacement (source: PRHTA)

2.5. Bridge 1125



(Extracted from Figure 2-94)

2.5.1. General information

Table 2-13: Bridge 1125 general information from BridgeReports.com

Name	OFF PR 372 over DUEY RIVER
Structure number	011251
Location	0.2 KM EAST OF PR 372
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	33.8 ft
Total length	38.4 ft
Roadway width between curbs	18.7 ft
Deck width edge-to-edge	20.3 ft
Owner	City or Municipal Highway Agency
Year built	1978
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	-
Main spans material	Steel
Main spans design	Stringer/Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-14: Bridge 1125 general information from the PRHTA

ID	1125
Highway	OFF PR 372
Municipality	Yauco
Year Built	1978
Functionality	Rural-local
Lanes	2
ADT	100
Maintenance	Municipal Highway Agency
Owner	Municipal Highway Agency
Up Service	Highway
Down Service	Waterway
Width	6.2 m
Length	11.7 m
Spans	1
Under clearance	0
Material	Steel
Design	Stringer or Girder
Scour Critical	3
Inspection Frequency	6 months
Approach Roadway Width	8 m
Bypass length	2 km
NBI Rating	2
NHS	0
Area	72.54 m^2

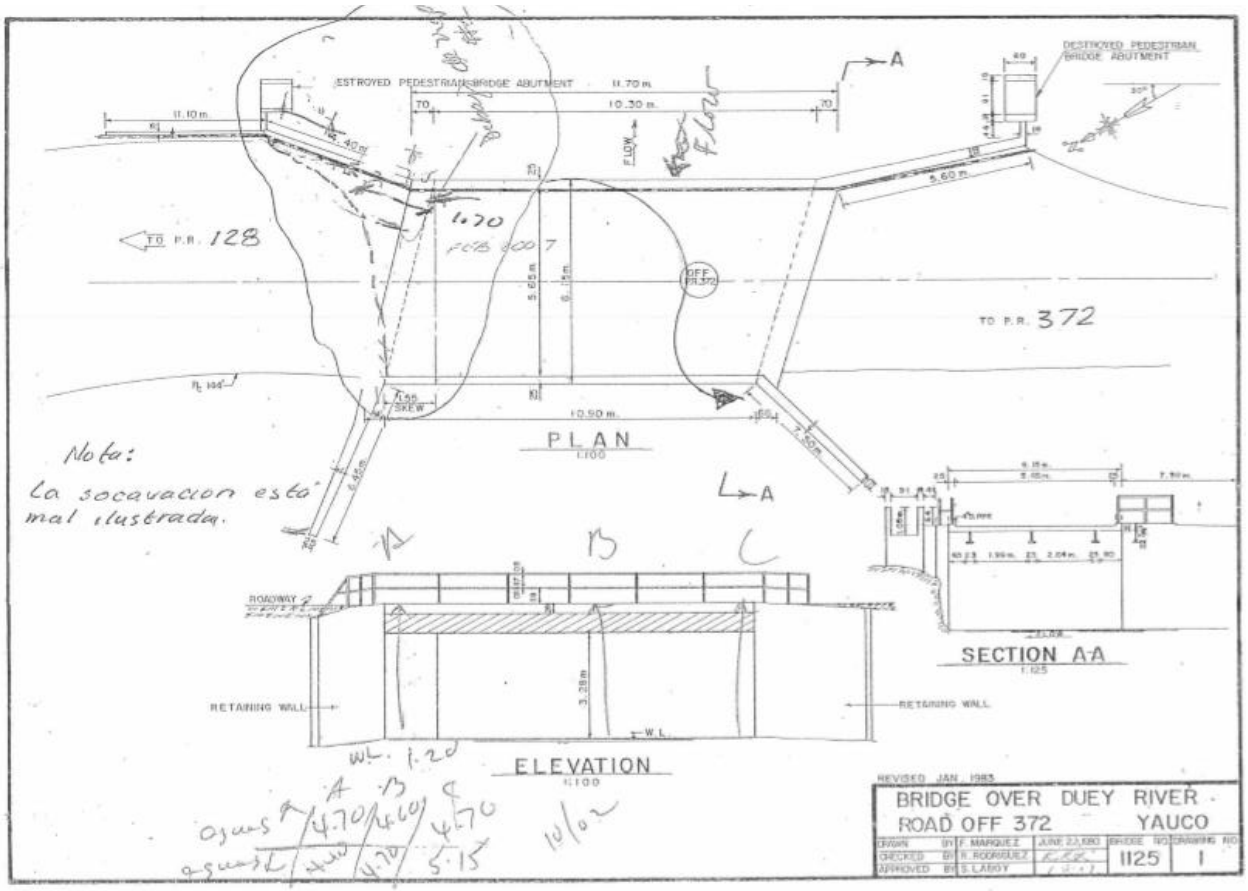


Figure 2-81: Bridge 1125 drawings (source: PRHTA)

2.5.2. Inspections before Hurricane Maria

Note: The last inspection of Bridge 1125 before Hurricane Maria was carried out on January 2, 2017. The Report Summary and QC Sheet of this inspection was not available. Therefore, Figure 2-82 shows the summary of the July 2016 inspection. The photos of the January 2017 inspection were made available, as shown in Figure 2-83.

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 1125

TEAM LEADER: Micky Santiago

INSP. DATE: July 20, 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	6	Dec-2015	Jan-2017
ITEM 93 A	FC Inspection	N	-	-	-
ITEM 93 B	Underwater Insp.	N	-	-	-
ITEM 93 C	Other: Scour	Yes	6	Dec-2015	Jan-2017

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	5	5	2	4	N	3
Current Inspection	5	5	2	4	N	3

Other Checks: (Y, N, NA)

Review Comments:

- Y Scour Critical (items 113 & 60)
- Y AASHTO Core's & NBI CD consistent
- Y Smart Flags (scour, steel plate, fire damage, etc)
- Y Channel Profile/Clearance Table
- Y FC & Underwater Members Tables
- Y Asphalt Overlay Thickness
- Y Drawings
- Y Photos
- Y Critical Finding
- Y Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-82: Bridge 1125 inspection summary of July 20, 2016 (source: PRHTA)



1125-jan-02-2017-001.jpg



1125-jan-02-2017-002.jpg



1125-jan-02-2017-003.jpg



1125-jan-02-2017-004.jpg



1125-jan-02-2017-008.jpg



1125-jan-02-2017-011.jpg



1125-jan-02-2017-018.jpg



1125-jan-02-2017-020.jpg



1125-jan-02-2017-027.jpg

Figure 2-83: Bridge 1125 inspection photos of January 2, 2017 (source: PRHTA)

2.5.3. Images before Hurricane Maria



Figure 2-84: Bridge 1125 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-85: Bridge 1125 photo from January 2, 2017 inspection (source: PRHTA)



Figure 2-86: Bridge 1125 photo from January 2, 2017 inspection (source: PRHTA)



Figure 2-87: Bridge 1125 photo from January 2, 2017 inspection (source: PRHTA)

2.5.4. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1125 MUNICIPALITY: Yauco

DATE: 10/10/17 TIME: 11:10 EVALUATOR NAME: D. Lm / E. Barbosa

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane Maria

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT:

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: Bridge collapsed due to flood event. Item #113 Score 0.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-88: Bridge 1125 inspection report from October 10, 2017 (source: PRHTA)

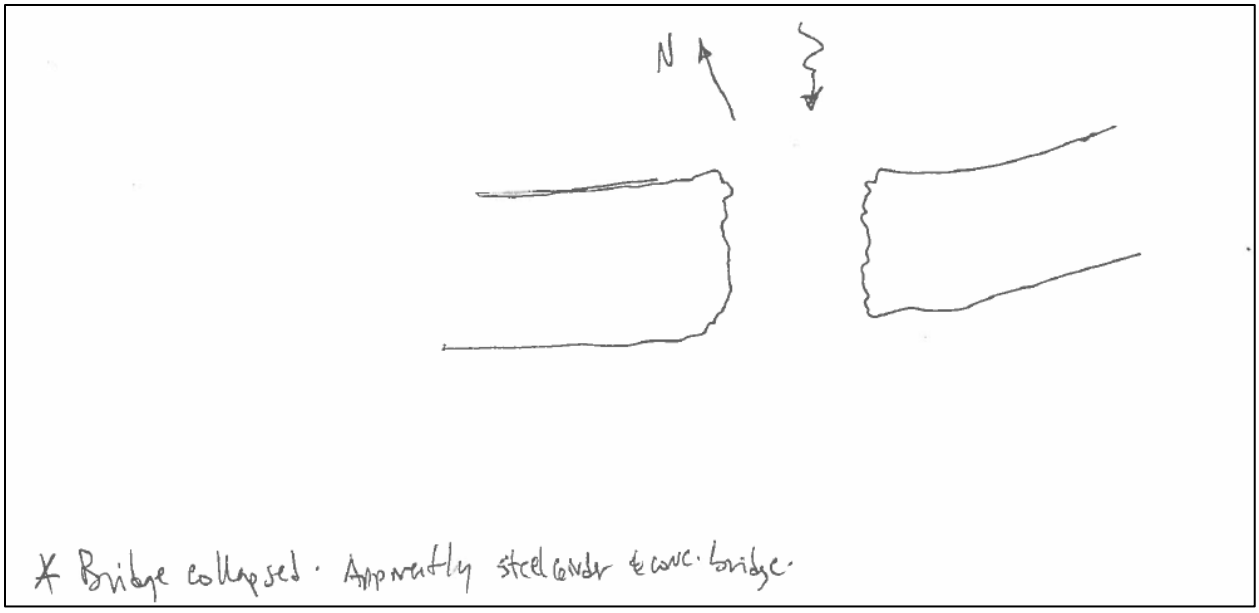


Figure 2-89: Sketch from October 10, 2017 inspection representing collapse of Bridge 1125 (source: PRHTA)



Figure 2-90: Bridge 1125 photos from October 10, 2017 inspection (source: PRHTA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1125 MUNICIPALITY: Yauco

DATE: Oct/12/2017 TIME: 8:10 AM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, Estructura colapso, falló el span y los estribos

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Estructura Colapsó

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-91: Bridge 1125 inspection report from October 12, 2017 (source: PRHTA)



Figure 2-92: Bridge 1125 photos from October 12, 2017 inspection (source: PRHTA)

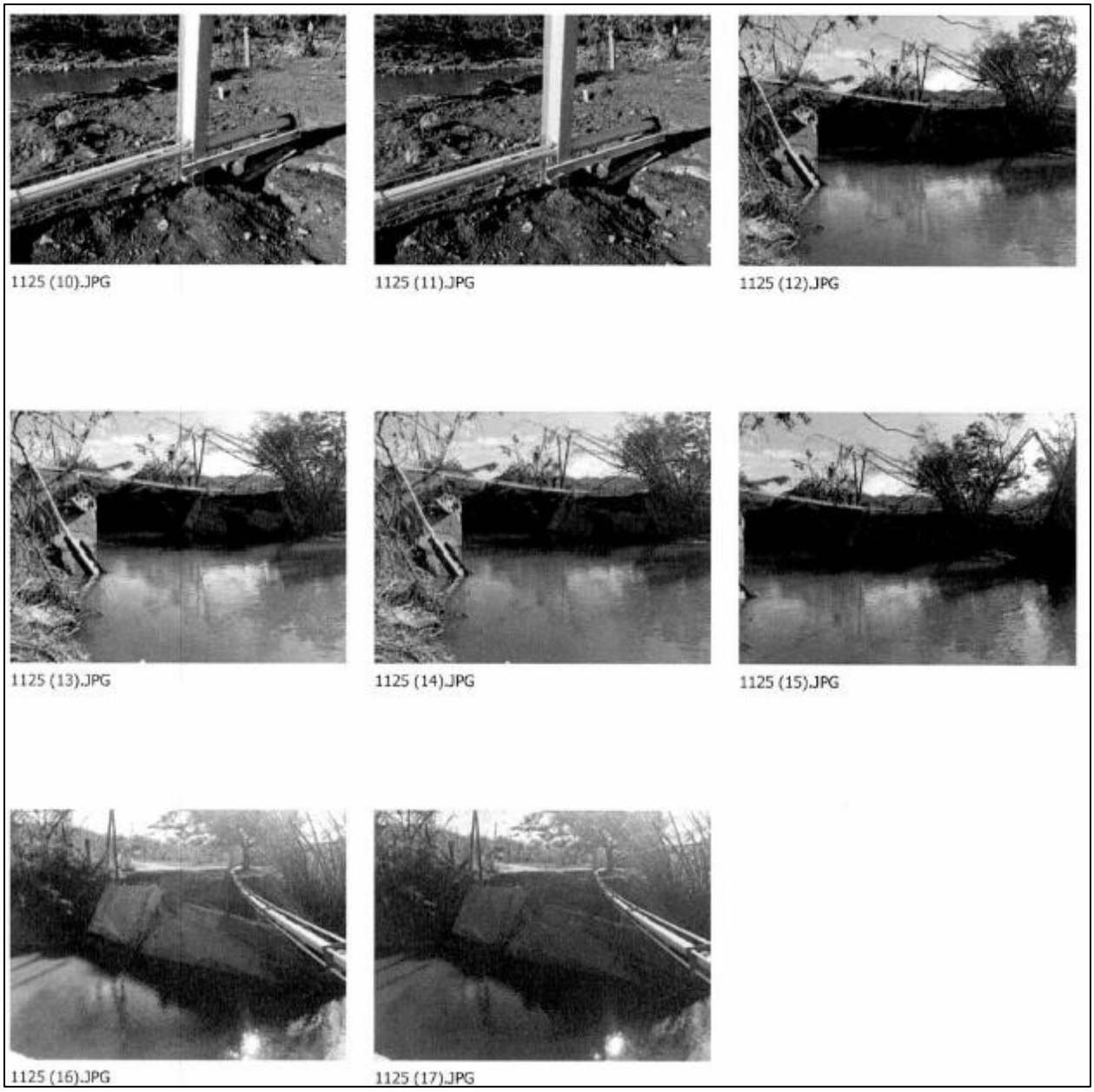


Figure 2-93: Bridge 1125 photos from October 12, 2017 inspection (source: PRHTA)

2.5.5. Images after Hurricane Maria



Figure 2-94: Bridge 1125 satellite image after Hurricane Maria (source: NOAA)



Figure 2-95: Bridge 1125 satellite after Hurricane Maria (source: Google Earth Pro)

2.5.6. Temporary replacement



Figure 2-96: Bridge 1125 replacement (source: PRHTA)

2.6. Bridge 1130



(Extracted from Figure 2-115)

2.6.1. General information

Table 2-15: Bridge 1130 general information from BridgeReports.com

Name	PR 145 over GRANDE DE MANATI RIVER
Structure number	011301
Location	1 KM NORTHEAST OF CIALES
Purpose	Carries highway and pedestrian walkway over waterway.
Route classification	Minor Arterial (Rural)
Length of largest span	72.2 ft
Total length	249.0 ft
Roadway width between curbs	23.3 ft
Deck width edge-to-edge	29.2 ft
Owner	State Highway Agency
Year built	1955
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	4
Main spans material	Concrete Continuous
Main spans design	Tee beam
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete

Table 2-16: Bridge 1130 general information from the PRHTA

ID	1130
Highway	PR 145 km 1
Municipality	Ciales
Year Built	1955
Functionality	Rural – Minor Arterial
Lanes	2
ADT	12400
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway – Pedestrian
Down Service	Waterway
Width	8.90 m
Length	75.9 m
Spans	4
Under clearance	0
Material	Concrete Continuous
Design	Tee Beam
Scour Critical	4
Inspection Frequency	12 Months
Approach Roadway Width	7.10 m
Bypass length	9 km
NBI Rating	1
NHS	1
Area	675.51 m^2

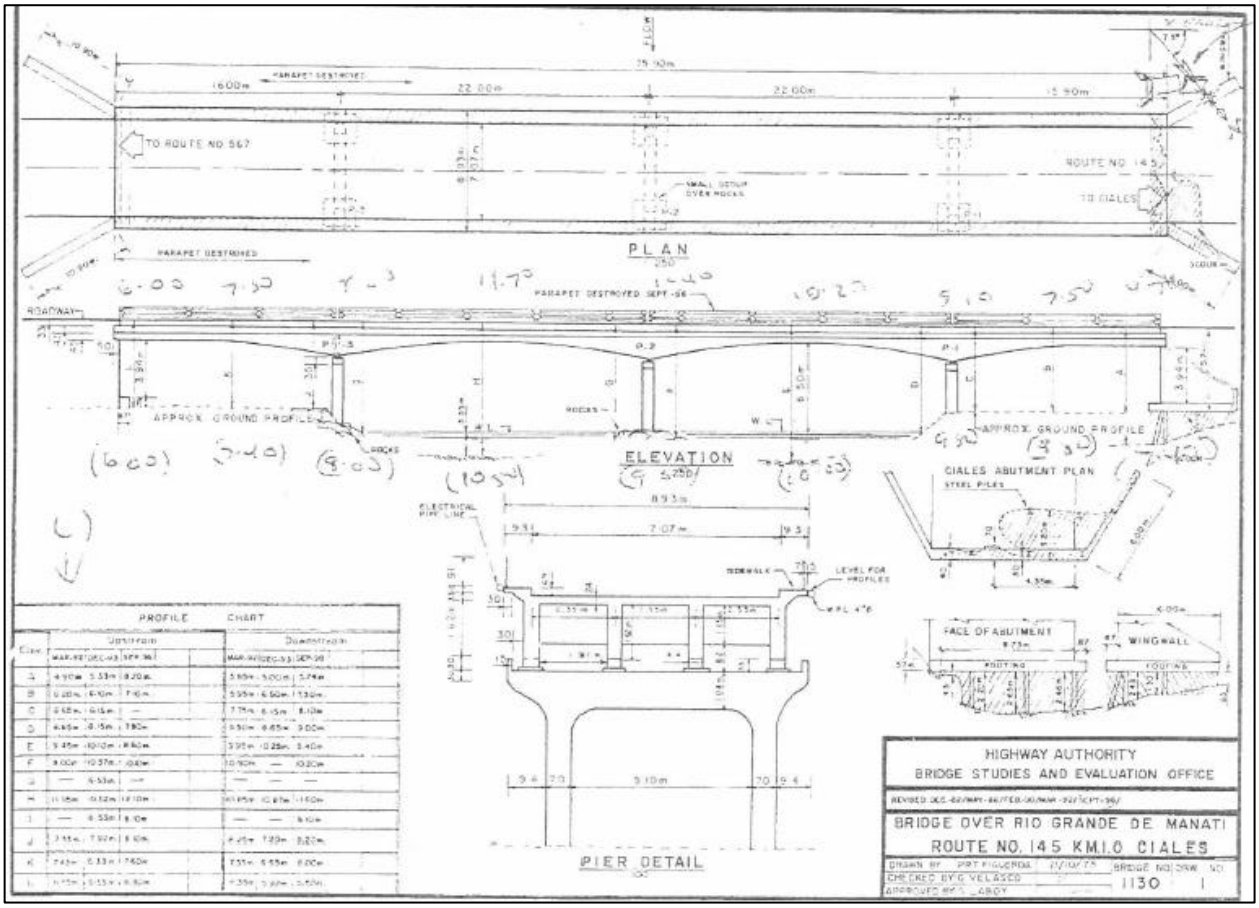


Figure 2-97: Bridge 1130 drawings (source: PRHTA)

2.6.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-** 1130

BRIDGE INSPECTOR : Marcos Rivera Hidalgo

BRIDGE EVALUATOR/TEAM LEADER: Arnaldo Mercado

INSP. DATE: August 24, 2017

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	12	August 24, 2016	August 24, 2018
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other : S.I. SUPERSTRUCTURE	YES	12	August 24, 2016	August 24, 2018

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	4	3	4	4	N	4	P
Current Inspection	3	3	4	4	N	4	P

Other Checks:(Y, N, NA)

Review Comments:

✓ Scour Critical (items 113 & 60)
✓ AASHTO Core's& NBI CD consistent
✓ Smart Flags (scour, steel plate, fire damage, etc)
✓ Channel Profile/Clearance Table
✓ FC & Underwater Members Tables
✓ Asphalt Overlay Thickness
✓ Drawings
✓ Photos
✓ Critical Finding
✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-98: Bridge 1130 inspection summary of April 22, 2017 (source: PRHTA)

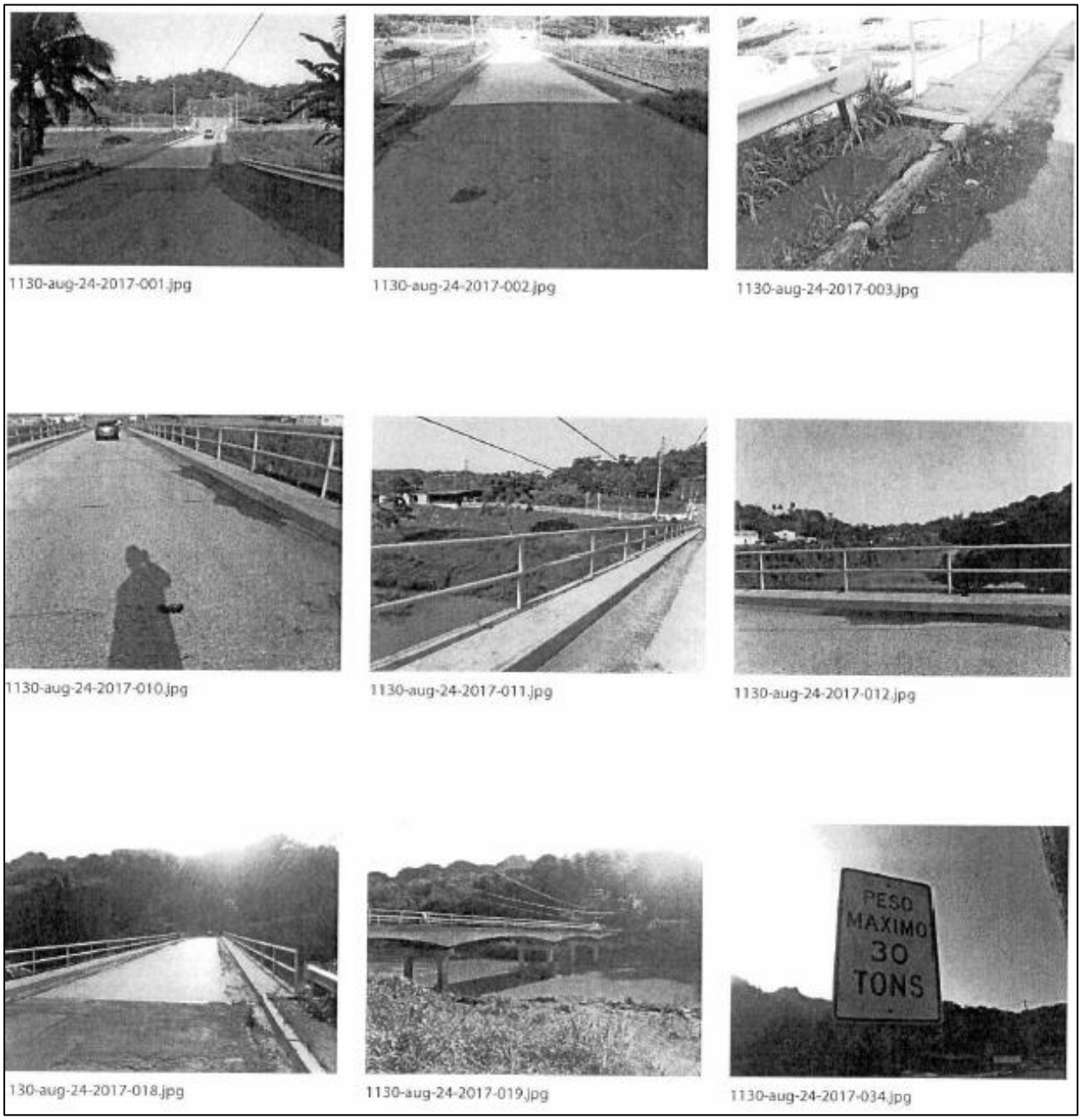


Figure 2-99: Bridge 1130 inspection photos of August 24, 2017 (source: PRHTA)

2.6.3. Images before Hurricane Maria

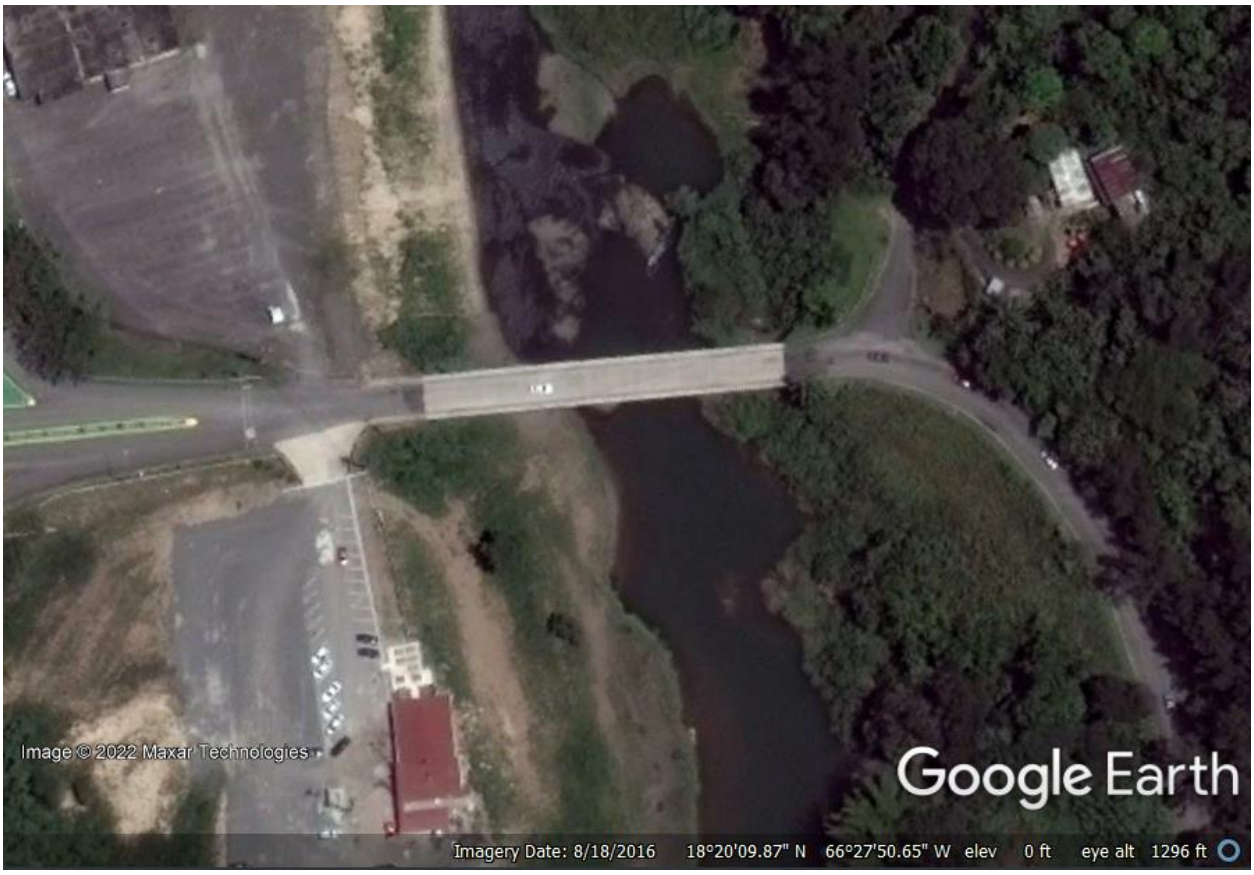


Figure 2-100: Bridge 1130 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-101: Bridge 1130 photo from April 22, 2017 inspection (source: PRHTA)



Figure 2-102: Bridge 1130 photo from April 22, 2017 inspection (source: PRHTA)



Figure 2-103: Bridge 1130 photo from April 22, 2017 inspection (source: PRHTA)



Figure 2-104: Bridge 1130 photo from April 22, 2017 inspection (source: PRHTA)



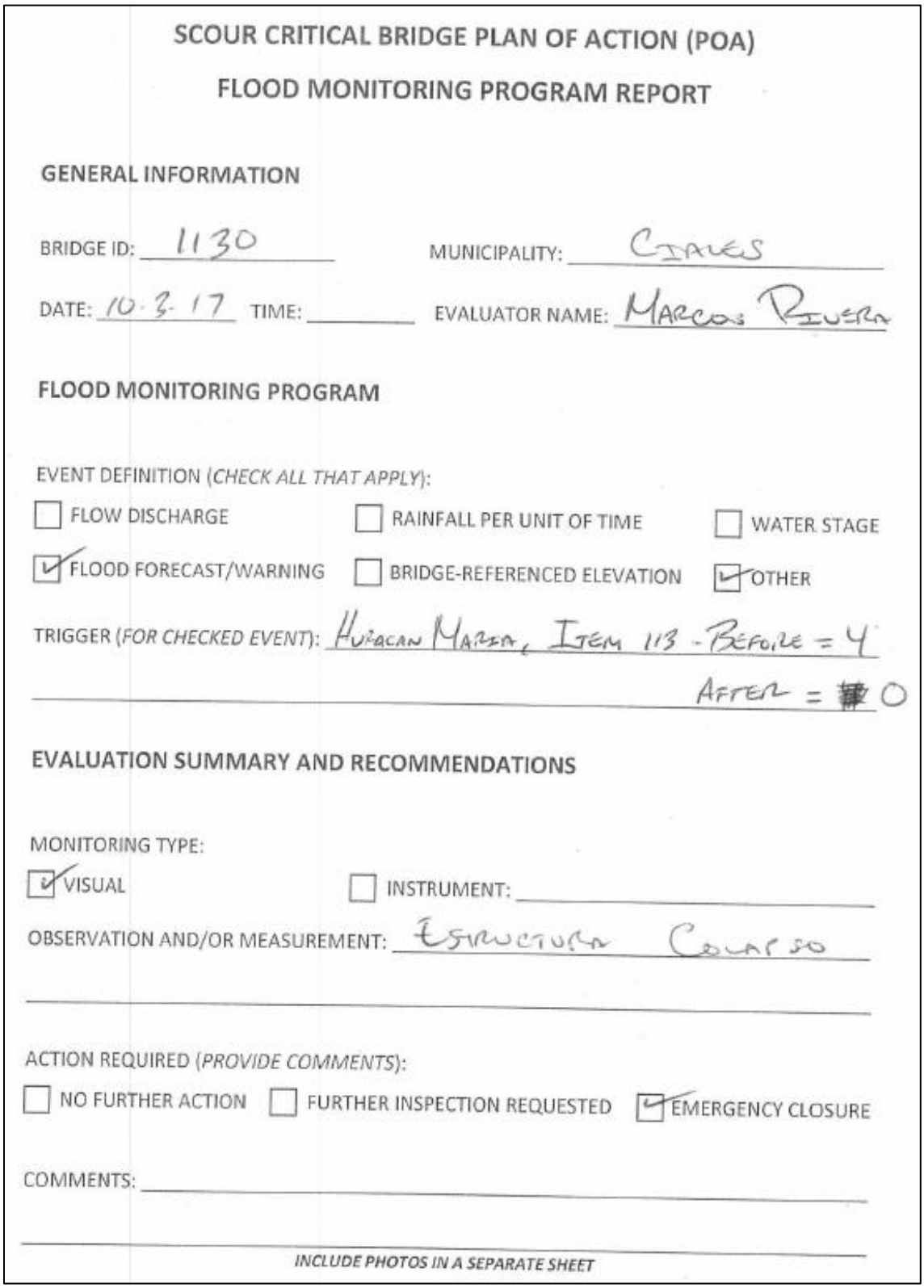
Figure 2-105: Bridge 1130 photo from April 22, 2017 inspection (source: PRHTA)

2.6.4. Streamflow

Table 2-17: Peak streamflow at Grande de Manatí River at Ciales monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-05-28	14.76	27,300
2011	2011-08-23	17.97	45,200
2012	2012-05-05	16.37	35,900
2013	2012-10-26	12.16	16,700
2014	2014-08-23	13.31	21,100
2015	2014-11-07	8.06	5,570
2016	2015-11-24	10.58	14,000
2017	2017-09-20	43.36	284,000

2.6.5. Inspections after Hurricane Maria



SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1130 MUNICIPALITY: CIALES

DATE: 10-3-17 TIME: _____ EVALUATOR NAME: MARCOS RIVERA

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): HURACAN MARIA, ITEM 113 - BEFORE = 4

AFTER = 0

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: ESTRUCTURA COLAPSO

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☑ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-106: Bridge 1130 inspection report from October 3, 2017 (source: PRHTA)

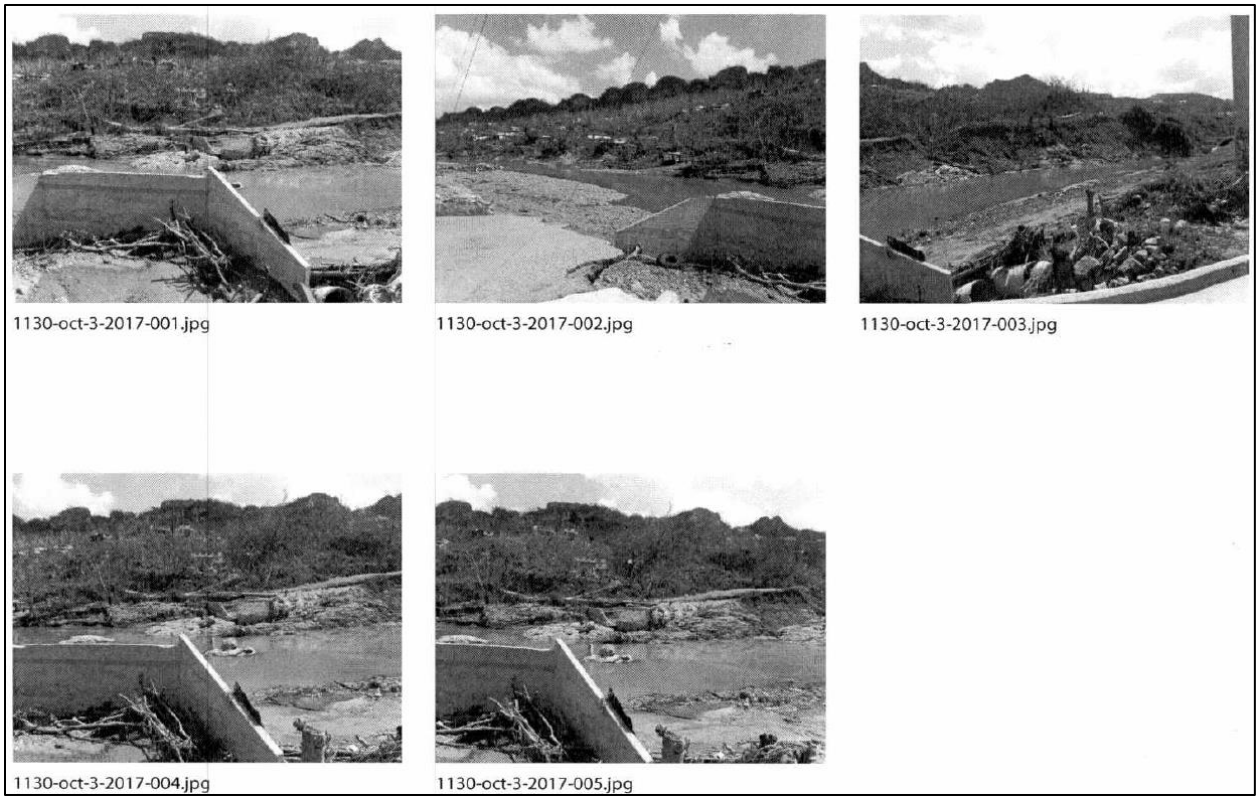


Figure 2-107: Bridge 1130 photos from October 3, 2017 inspection (source: PRHTA)

U.S. Department of Transportation Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 1

Location (Name of Road and Milepost)
Bridge 1130 in PR-145, KM. 1.0, Municipality of Ciales

FHWA Disaster Number

Inspection Date

Description of Damage
Bridge 1130 collapsed totaly due to flooding of the Rio Grande of Manati during Hurricane Maria. The bridge was a 4 span cast-in-place structure of 75.9 meters in length and 7.07 meters of rodway sections with sidewalks.

Federal-aid Route Number

State: Puerto Rico — County: San Germán

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Emergency Repair	[Spec. 152-001] Mobilization 10%	LS	$ 425,842.50	1		$ 425,842.50
	[Spec. 201-002] Clearing and Grubbing	Cda	$ 5,000.00	1		$ 5,000.00
	[Spec. 202-001] Removal of Structures and Obstructions	LS	$ 378,000.00	1		$ 378,000.00
	[Spec. 206-001] Unclassified Excavation for Structure	CuM	$ 40.00	7,425		$ 297,000.00
	[Spec. 210-001] Straw Bales	Each	$ 12.00	100		$ 1,200.00
	[Spec. 210-007] Silt Fence	LnM	$ 8.00	200		$ 1,600.00
	[Spec. 301-002] Subbase Course (A-2-4 Only)	CuM	$ 20.00	192		$ 3,840.00
	[Spec. 304-002] Aggregate Base Course Class A	CuM	$ 55.00	200		$ 11,000.00
	[Spec. 401-032] Hot Plant-Mix Bituminous Pavement S(75)(12)	Ton	$ 220.00	475		$ 104,500.00
	[Spec. 401-036] Hot Plant-Mix Bituminous Pavement B(75)(34)	Ton	$ 220.00	450		$ 99,000.00
	[Spec. 403-001] Cold Milling Bituminous Concrete Pavement	CuM	$ 85.00	30		$ 2,550.00
	[Spec. 601-008] Class "D" Concrete	CuM	$ 720.00	935		$ 673,200.00
	[Spec. 602-001] Reinforcing Steel	Kls.	$ 2.00	173,000		$ 346,000.00
	[Spec. 606-001] Corrugated Steel Beam Guardrail, Single Face	LnM	$ 115.00	300		$ 34,500.00
	[Spec. 606-051] Corrugated Steel Bridge Guardrail	LnM	$ 115.00	152		$ 17,480.00
	[Spec. 613-011] Field and Laboratory Office Model 2	Month	$ 4,200.00	5		$ 21,000.00
	[Spec. 613-001] Traffic Sign Assembly, Code OM-3R (Object Marker)	SgM	$ 1,000.00	1		$ 1,000.00
	[Spec. 613-001] Traffic Sign Assembly, Code OM-3L (Object Marker)	SgM	$ 1,000.00	1		$ 1,000.00
	[Spec. 618-008] Thermoplastic Pavement Marking Stripes (All Colors)	LnM	$ 7.00	500		$ 3,500.00
	[Spec. 622-013] Grouted Rip Rap, Class II	CuM	$ 100.00	2,760		$ 276,000.00
	[Spec. 638-001] Construction Signs	SgM	$ 275.00	15		$ 4,125.00
	[Spec. 638-005] Drums	Each	$ 100.00	100		$ 10,000.00
	[Spec. 638-010] Temporary Concrete Barrier	LnM	$ 160.00	116		$ 18,544.00
	[Spec. 638-013] Flashing Arrow Signs	Day	$ 80.00	30		$ 2,400.00
	[Spec. 638-047] Portable Changeable Message Sign (PCMS)	Month	$ 1,500.00	1		$ 1,500.00
	[Spec. 640-017] Reflective Raised Pavement Marker One Way, Any Color	Each	$ 8.00	16		$ 128.00
	[Spec. 961-014] Vehicular Modular Steel Bridge w/ Footwalk (Including Furnishing by	LS	$ 1,500,000.00	1		$ 1,500,000.00
	[Spec. 961-991] Vehicular Modular Steel Bridge Installation w/ Footwalk (Hauling, De	LS	$ 250,000.00	1		$ 250,000.00
	[Spec. 961-992] Dismantling of Launching Nose and Installation Components	LS	$ 112,500.00	1		$ 112,500.00
	[Spec. 981-001] Geosynthetic Reinforced Soil	SqM	$ 350.00	234		$ 81,858.00
						$ -
	Method: ☐ Local Forces ☐ State Forces ☐ Contract				Subtotal	$ 4,684,267.50
					PE/CE	$ 234,213.38
					Emergency Repair Total	$ 4,918,480.88
Permanent Restoration						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
	Method: ☐ Local Forces ☐ State Forces ☐ Contract				Subtotal	$ -
					PE/CE	
					Right-of-Way	$ 18,150.00
					Perm. Repair Totals	

Environmental Assessment Recommendation: ☐ Categorical Exclusion ☐ EA/EIS — Estimated Total: $ 4,936,630.88

Recommendation: ☒ Eligible ☐ Ineligible	FHWA Engineer: HECTOR RUBEN LAUREANO		Date: [redacted]
Concurrence: ☐ Yes ☐ No	State Engineer: [signature]		Date: 01/15/2019
Concurrence: ☐ Yes ☐ No	Local Agency Representative		Date

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 2-108: Bridge 1130 inspection report dated January 2019 (source: FHWA)



Figure 1. Bridge no. 1130 before Hurricane María



Figure 2. Bridge no. 1130 after Hurricane María

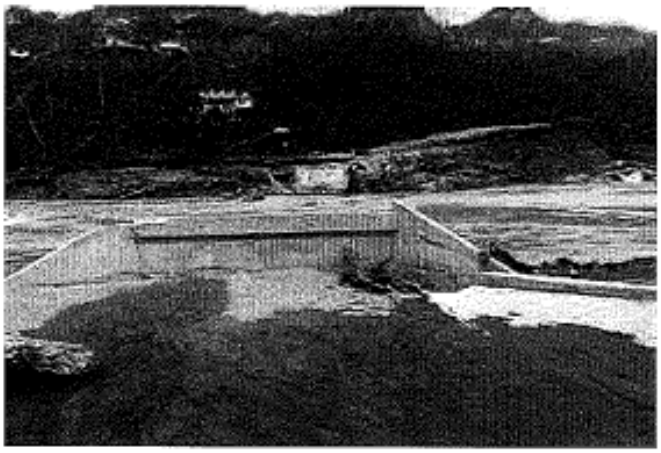


Figure 3. View from west abutment to PR-145

Figure 2-109: Bridge 1130 photos from report dated January 2019 (source: FHWA)

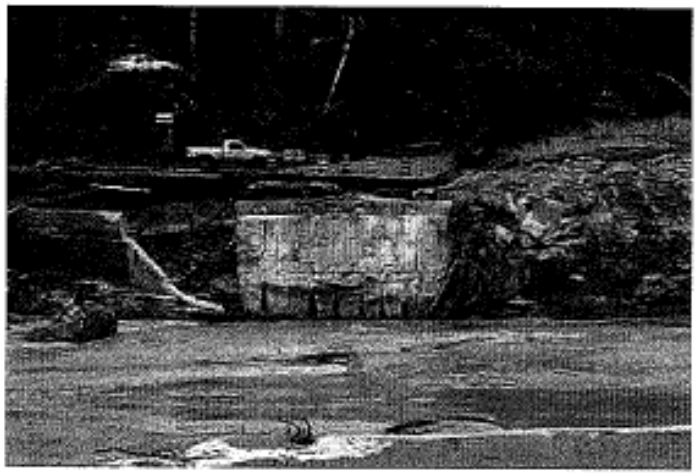


Figure 4. Remains of East Abutment



Figure 5. Upstream View

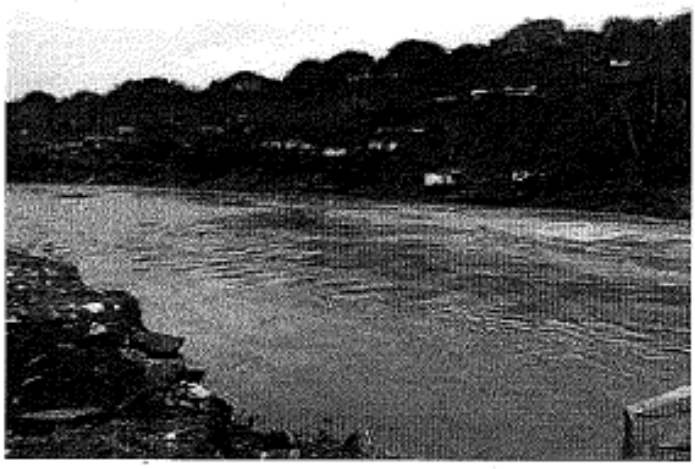


Figure 6. Downstream View

Figure 2-110: Bridge 1130 photos from report dated January 2019 (source: FHWA)

2.6.6. Images after Hurricane Maria



Figure 2-111: Bridge 1130 satellite image after Hurricane Maria (source: NOAA)



Figure 2-112: Bridge 1130 satellite after Hurricane Maria (source: Google Earth Pro)



https://nypost.com/2017/10/09/full-scope-of-puerto-ricos-devastation-seen-from-above/#14

Figure 2-113: Aerial image of collapsed Bridge 1130 (source: NY Post)



https://www.elnuevodia.com/noticias/locales/notas/el-cuerpo-de-ingenieros-estudia-manejo-de-inundaciones-en-ciales/

Figure 2-114: News outlet image of collapsed Bridge 1130 (source: El Nuevo Día)



https://www.facebook.com/JayFonsecaPR/photos/a.163264163691056/1918667841484004

Figure 2-115: Social media image of collapsed Bridge 1130 (source: Jay Fonseca)



https://huracanmaria.elnuevodia.com/2017/municipio/ciales/

Figure 2-116: News outlet image of collapsed Bridge 1130 (source: El Nuevo Día)



https://flic.kr/p/22brg3p

Figure 2-117: Social media image of collapsed Bridge 1130 (source: Julia Maldonado)



https://flic.kr/p/CwShTD

Figure 2-118: Social media image of collapsed Bridge 1130 (source: Julia Maldonado)



https://flic.kr/p/CwQRv6

Figure 2-119: Social media image of collapsed Bridge 1130 (source: Julia Maldonado)



https://flic.kr/p/228Fqcs

Figure 2-120: Social media image of collapsed Bridge 1130 (source: Julia Maldonado)

2.6.7. Videos after Hurricane Maria



https://fb.watch/eFkEboZqdH/

Video 2-4: Social media video of stream flow at location of Bridge 1130 (source: Huracán Maria-Videos y Fotos)



https://youtu.be/2-T3siP73po

Video 2-5: News report about the collapse of Bridge 1130 (source: Notiséis 360)



https://youtu.be/CQFofyglkFc

Video 2-6: Social media video depicting the remains of Bridge 1130 (source: Jose Garcia)



https://youtu.be/FdAYY96TuR8

Video 2-7: Social media video of collapsed Bridge 1130 (source: Johann Otero)



https://flic.kr/p/22bqsQe

Video 2-8: Social media video of collapsed Bridge 1130 (source: Julia Maldonado)



https://youtu.be/aMi506_3-vc

Video 2-9: Drone video of Bridge 1130 before and after Hurricane Maria (source: Puerto Rico Desde el Aire)



https://fb.watch/eF6WsNaQ3q/

Video 2-10: Social media video of Bridge 1130 before and after Hurricane Maria (source: Prohibido Olvidar - Boricua)



https://youtu.be/c7UEM472fiA?t=222

Video 2-11: Social media video about damages to Ciales municipality, including Bridge 1130 (source: Jibaro Aventurero - Antes Upper ViewPR)

2.6.8. Temporary replacement



https://www.facebook.com/puertadelacordilleracentral/posts/pfbid02kVjp5GtHAfu2n3S5vzsgThTWjmiNRaodQndUZEcNinHdZetAJhR43wsEzsrG4AAwl

Figure 2-121: Bridge 1130 replacement (source: Municipio de Ciales)

2.7. Bridge 1199



(Extracted from Figure 2-141)

2.7.1. General information

Table 2-18: Bridge 1199 general information from BridgeReports.com

Name	PR 623 over TANAMÁ RIVER
Structure number	011991
Location	9 KM SOUTH OF ARECIBO
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	36.1 ft
Total length	95.1 ft
Roadway width between curbs	19.7 ft
Deck width edge-to-edge	22.3 ft
Owner	State Highway Agency
Year built	1970
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	3
Main spans material	Steel
Main spans design	Stringer/Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 2-19: Bridge 1199 general information from the PRHTA

ID	1199
Highway	PR623
Municipality	Arecibo
Year Built	1970
Functionality	Rural-local
Lanes	2
ADT	1318
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	Waterway
Width	6.8 m
Length	29 m
Spans	3
Under clearance	0
Material	Steel
Design	Stringer or Girder
Scour Critical	2
Inspection Frequency	6 months
Approach Roadway Width	5.5 m
Bypass length	12 km
NBI Rating	1
NHS	0
Area	197.2 m^2

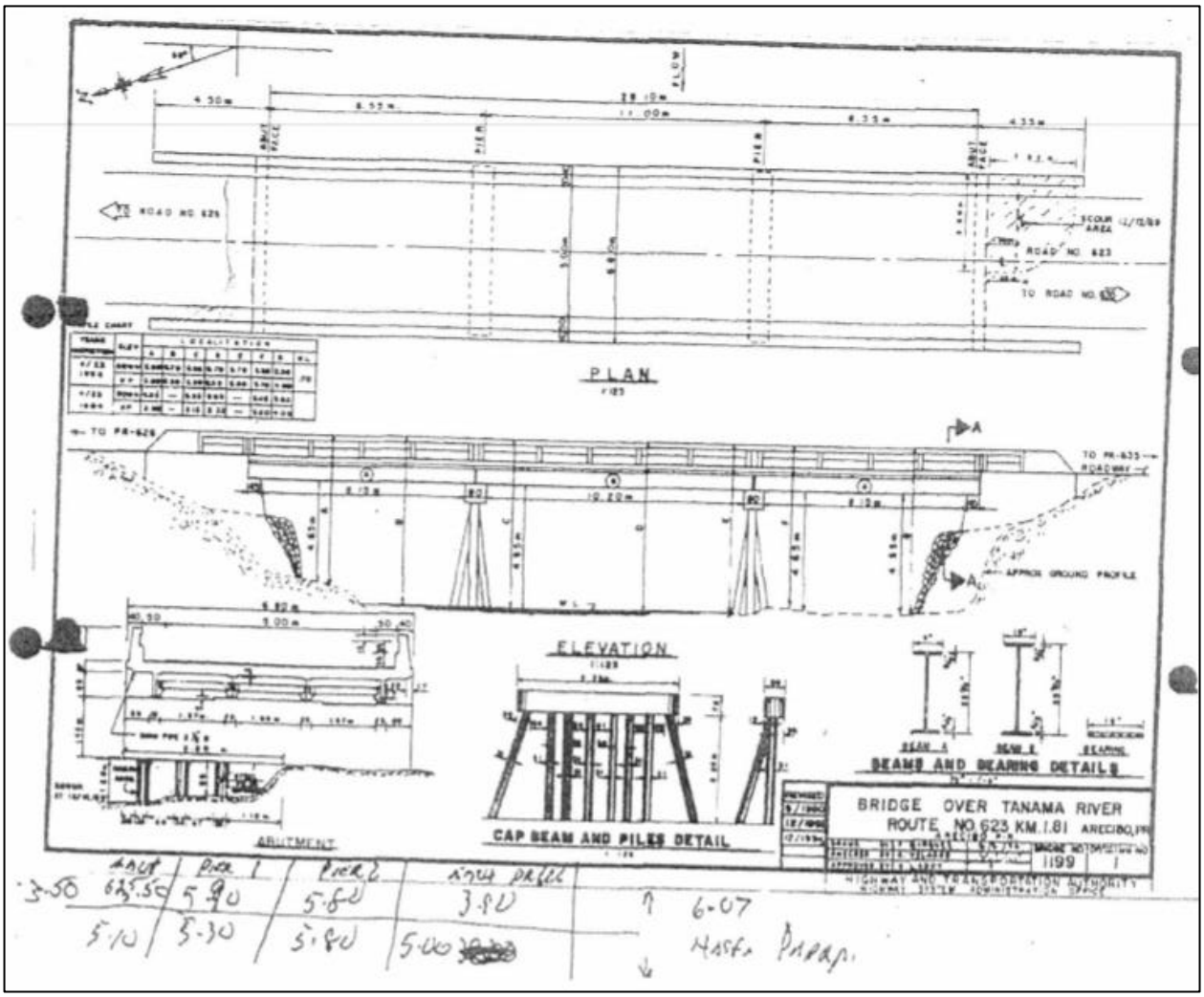


Figure 2-122: Bridge 1199 drawings (source: PRHTA)

2.7.2. Inspections before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-1199**

TEAM LEADER/BRIDGE INSPECTOR: Ángel T. López Torres

BRIDGE EVALUATOR: Arnaldo Mercado

INSP. DATE: January 17, 2017

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	6	July 27, 2016	July 17, 2017
ITEM 93 A	FC Inspection	NA			
ITEM 93 B	Underwater Insp.	NA			
ITEM 93 C	Other: S.I. Scour	Yes	6	July 27, 2016	July 17, 2017

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	6	6	3	4	N	2	P
Current Inspection	6	6	3	4	N	2	P

Other Checks:(Y, N, NA)

Review Comments:

_/_ Scour Critical (items 113 & 60)
_/_ AASHTO Core's& NBI CD consistent
_/_ Smart Flags (scour, steel plate, fire damage, etc)
_/_ Channel Profile/Clearance Table
_/_ FC & Underwater Members Tables
_/_ Asphalt Overlay Thickness
_/_ Drawings
_/_ Photos
_/_ Critical Finding
_/_ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-123: Bridge 1199 inspection summary of January 17, 2017 (source: PRHTA)

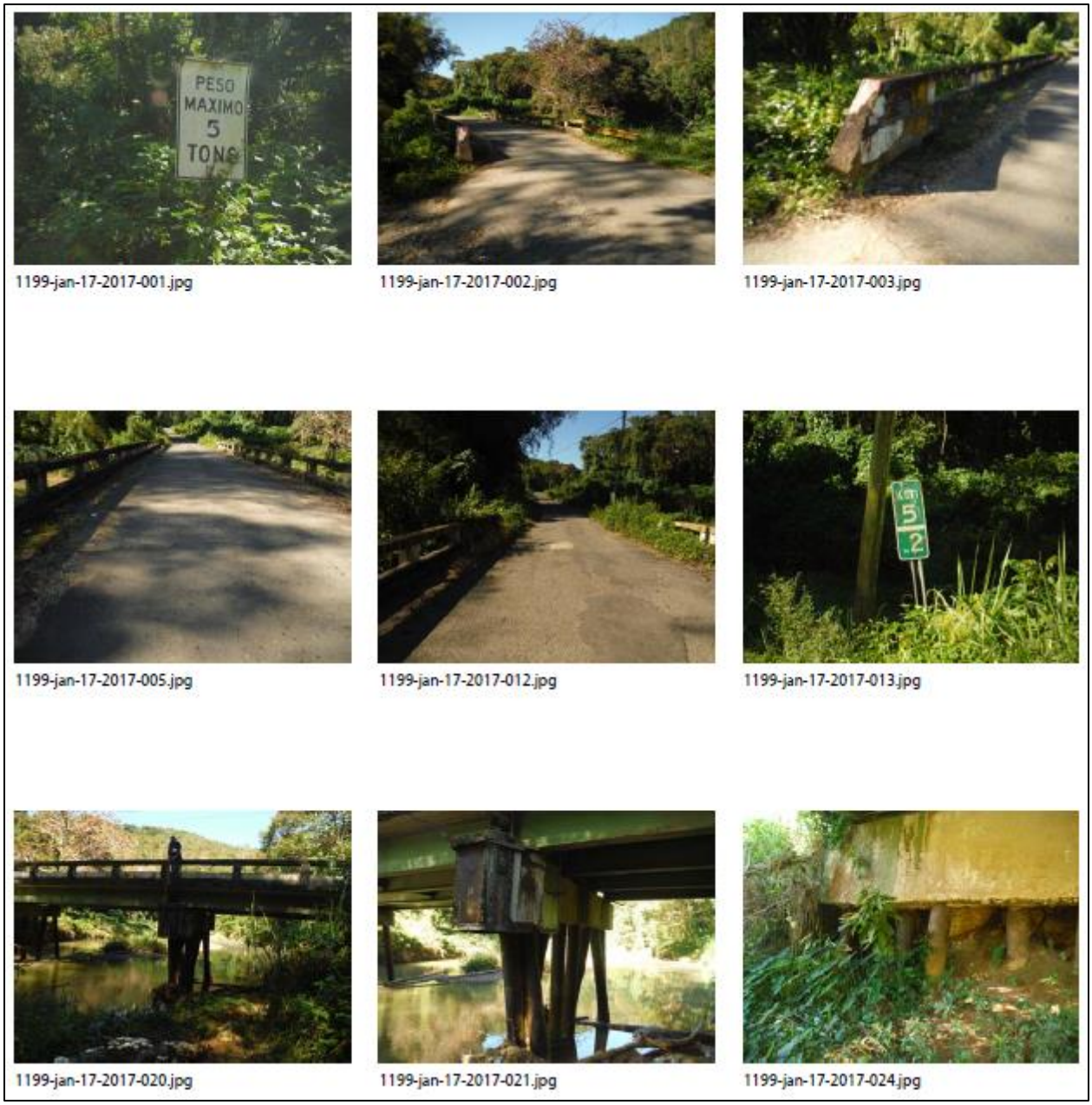


Figure 2-124: Bridge 1199 inspection photos of January 17, 2017 (source: PRHTA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1199 MUNICIPALITY: ARECIBO

DATE: SEP-8-2017 TIME: _____ EVALUATOR NAME: MARCOS RIVERA

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*): HURACAN IRMA

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): ITEM 113 FIELD: BEFORE = 2

AFTER = 2

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: _____

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-125: Bridge 1130 scour inspection of September 8, 2017 (source: PRHTA)



Figure 2-126: Bridge 1199 inspection photos of September 8, 2017 (source: PRHTA)

2.7.3. Images before Hurricane Maria



Figure 2-127: Bridge 1199 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-128: Bridge 1199 photo from January 17, 2017 inspection (source: PRHTA)



Figure 2-129: Bridge 1199 photo from January 17, 2017 inspection (source: PRHTA)



Figure 2-130: Bridge 1199 photo from January 17, 2017 inspection (source: PRHTA)



Figure 2-131: Bridge 1199 photo from January 17, 2017 inspection (source: PRHTA)



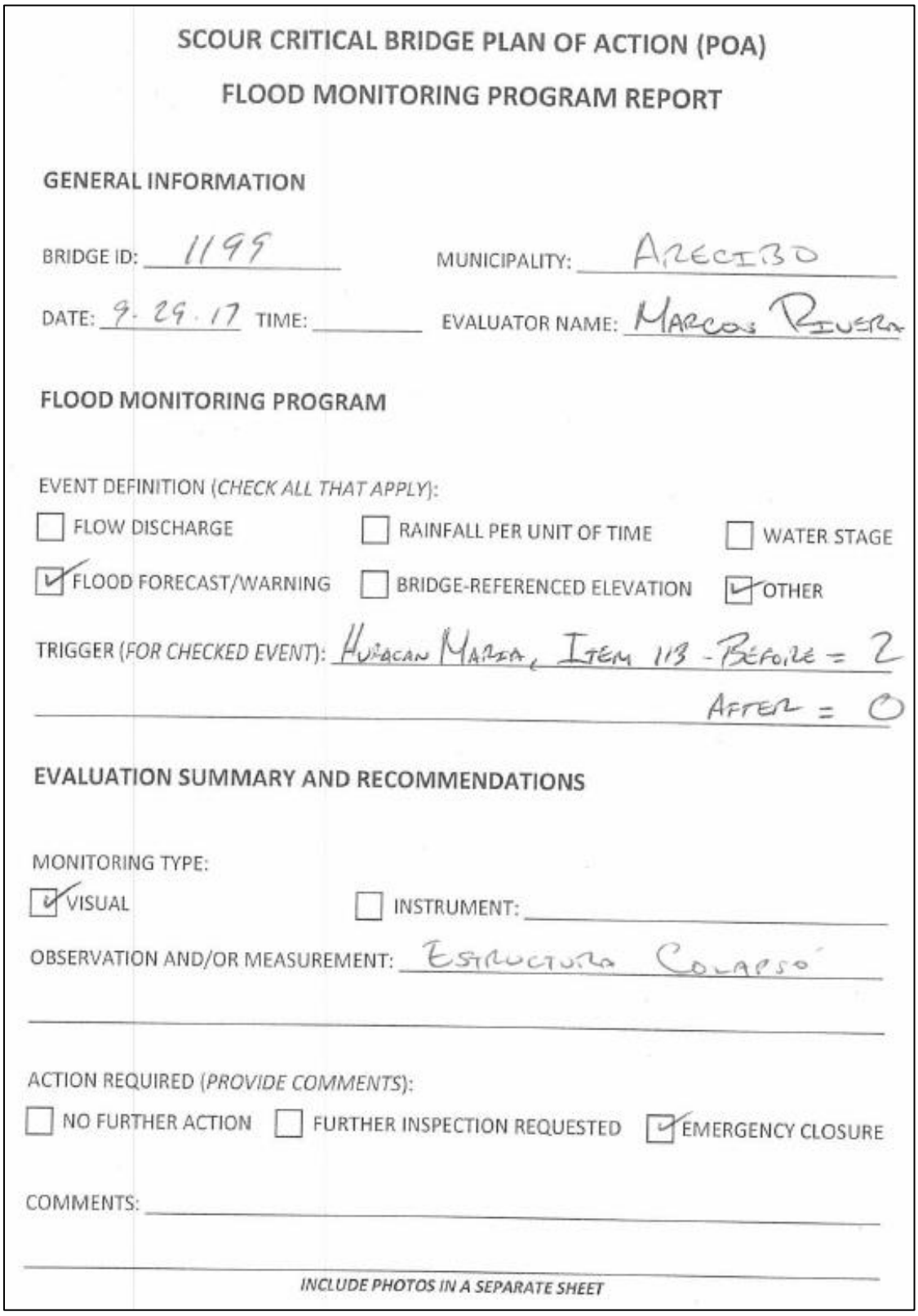
Figure 2-132: Bridge 1199 photo from January 17, 2017 inspection (source: PRHTA)

2.7.4. Streamflow

Table 2-20: Peak streamflow at Tanamá River at Charco Hondo monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2009-10-14	12.28	3,800
2011	2010-10-08	13.61	5,270
2012	2012-03-28	16.30	9,430
2013	2012-10-31	13.49	5,110
2014	2014-08-02	14.15	5,970
2015	2015-04-10	11.75	3,380
2016	2015-11-24	11.61	3,260
2017	2017-09-20	22.39	23,000

2.7.5. Inspection after Hurricane Maria



SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1199 MUNICIPALITY: ARECIBO

DATE: 9.29.17 TIME: _____ EVALUATOR NAME: MARCOS RIVERA

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): HURACAN MARIA, ITEM 113 - BEFORE = 2

AFTER = 0

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: ESTRUCTURA COLAPSO

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☑ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-133: Bridge 1199 inspection report from September 29, 2017 (source: PRHTA)



Figure 2-134: Bridge 1199 photos from September 29, 2017 inspection (source: PRHTA)

2.7.6. Images after Hurricane Maria



Figure 2-135: Bridge 1199 satellite image after Hurricane Maria (source: NOAA)



Figure 2-136: Bridge 1199 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 2-137: Bridge 1130 image from PRHTA inspection report



Figure 2-138: Bridge 1130 image from PRHTA inspection report



Figure 2-139: Bridge 1130 image from PRHTA inspection report



Figure 2-140: Bridge 1130 image from PRHTA inspection report



Figure 2-141: Bridge 1130 image from PRHTA inspection report



Figure 2-142: Image of deck of Bridge 505 washed down the river (source: PRHTA)

2.7.7. Temporary replacement



Figure 2-143: Bridge 1199 replacement (source: PRHTA)

2.8. Bridge 1355



(Extracted from Figure 2-161)

2.8.1. General information

Table 2-21: Bridge 1355 general information from BridgeReports.com

Name	OFF PR 123 AT 46.2 over GRANDE DE ARECIBO RIVER
Structure number	013551
Location	6 KM SOUTH OF UTUADO
Purpose	Carries highway over water
Route classification	Local (Rural)
Length of largest span	18.0 ft
Total length	174.9 ft
Roadway width between curbs	24.3 ft
Deck width edge-to-edge	26.2 ft
Owner	City or Municipal Highway Agency
Year built	1967
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	10
Main spans material	Concrete continuous
Main spans design	Slab
Deck type	Concrete-in-Place
Wearing surface	Bituminous

Table 2-22: Bridge 1355 general information from the PRHTA

ID	1355
Highway	OFF PR 123 AT 46.2
Municipality	Adjuntas
Year Built	1967
Functionality	Rural-local
Lanes	2
ADT	250
Maintenance	Municipal highway agency
Owner	Municipal highway agency
Up Service	Highway
Down Service	Waterway
Width	8 m
Length	53.3 m
Spans	10
Under clearance	0
Material	Concrete Continuous
Design	Slab
Scour Critical	2
Inspection Frequency	6 months
Approach Roadway Width	7.4 m
Bypass length	199 km
NBI Rating	1
NHS	0
Area	426.4 m^2

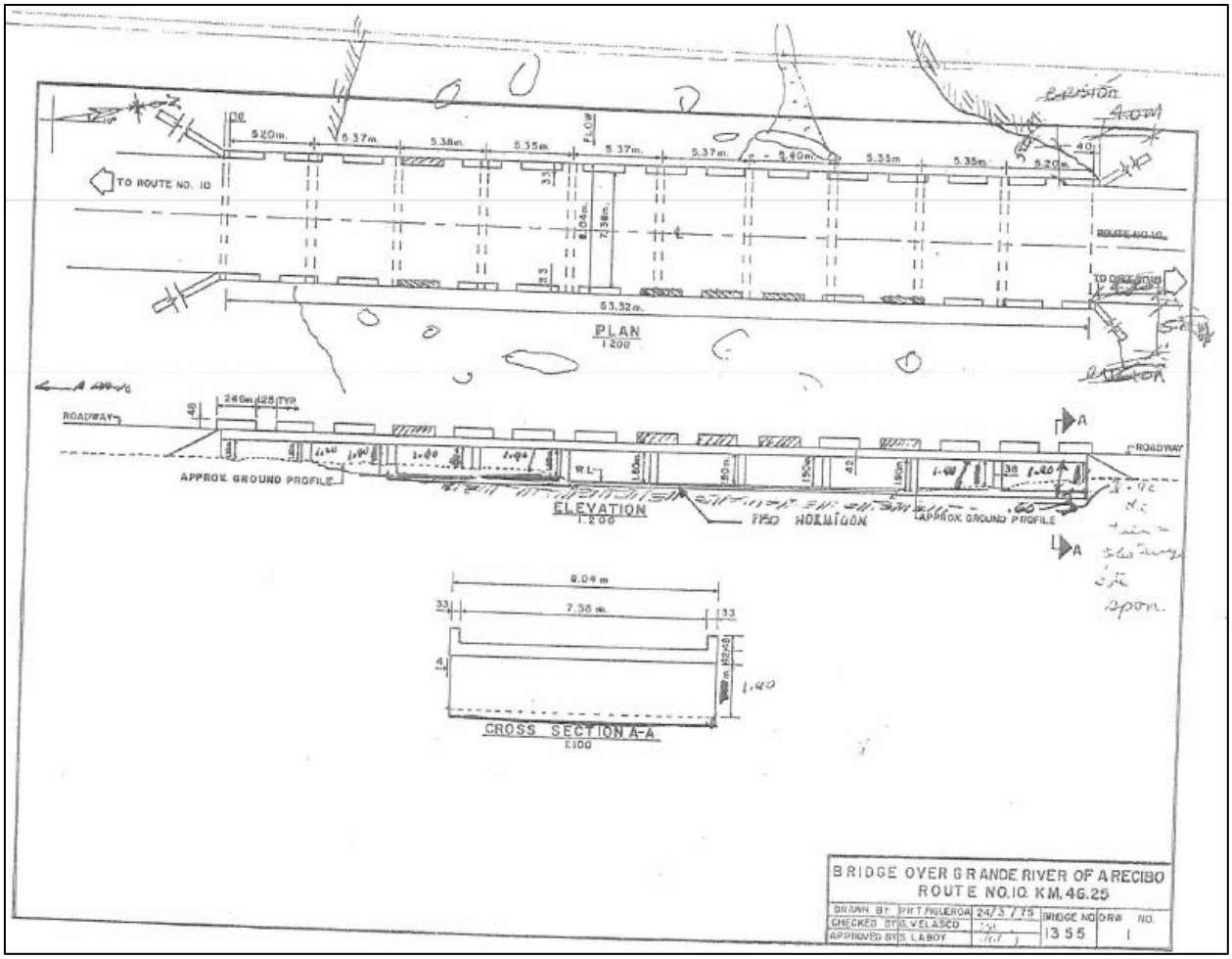


Figure 2-144: Bridge 1355 drawings (source: PRHTA)

2.8.2. Inspections before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-1355**

TEAM LEADER: **Micky** Santiago

BRIDGE EVALUATOR: Kiomarie Valle

INSP. DATE: **July 27, 2017**

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	6	~~jul-2016~~	Jan-2018
ITEM 93 A	FC Inspection	NA		Jan 2017 yi	
ITEM 93 B	Underwater Insp.	NA			
ITEM 93 C	Other: SI Super	NA	6	Jan 2017 ~~Jul-2016~~ yi	Jan-2018

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	5	5	3	5	N	2	P
Current Inspection	5	5	3	5	N	2	P

Other Checks:(Y, N, NA)

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's& NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Review Comments:

Reviewer: _____

Safety Eng.: _____

Figure 2-145: Bridge 1355 inspection summary of July 27, 2017 (source: PRHTA)



1355-Jul.-27-2017-001.jpg


1355-Jul.-27-2017-002.jpg


1355-Jul.-27-2017-004.jpg


1355-Jul.-27-2017-009.jpg


1355-Jul.-27-2017-010.jpg


1355-Jul.-27-2017-012.jpg


1355-Jul.-27-2017-015.jpg


1355-Jul.-27-2017-018.jpg


1355-Jul.-27-2017-022.jpg

Figure 2-146: Bridge 1355 inspection photos of July 27, 2017 (source: PRHTA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1355 MUNICIPALITY: UTUADO ~~ARECIBO~~

DATE: SEP. 8 · 2017 TIME: _____ EVALUATOR NAME: MARCOS RIVERA

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*): HURACAN IRMA

- ☐ FLOW DISCHARGE
- ☐ RAINFALL PER UNIT OF TIME
- ☐ WATER STAGE
- ☑ FLOOD FORECAST/WARNING
- ☐ BRIDGE-REFERENCED ELEVATION
- ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): ITEM 113 FIELD: BEFORE = 2

AFTER = 2

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

- ☑ VISUAL
- ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: _____

ACTION REQUIRED (*PROVIDE COMMENTS*):

- ☑ NO FURTHER ACTION
- ☐ FURTHER INSPECTION REQUESTED
- ☐ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-147: Bridge 1355 scour inspection of September 8, 2017 (source: PRHTA)



Figure 2-148: Bridge 1355 inspection photos of September 8, 2017 (source: PRHTA)

2.8.3. Images before Hurricane Maria



Figure 2-149: Bridge 1355 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-150: Bridge 1355 photo from July 27, 2017 inspection (source: PRHTA)



Figure 2-151: Bridge 1355 photo from July 27, 2017 inspection (source: PRHTA)



Figure 2-152: Bridge 1355 photo from July 27, 2017 inspection (source: PRHTA)



Figure 2-153: Bridge 1355 photo from July 27, 2017 inspection (source: PRHTA)



Figure 2-154: Bridge 1355 photo from July 27, 2017 inspection (source: PRHTA)

2.8.4. Streamflow

Table 2-23: Peak streamflow at Grande de Arecibo River Above Utuado monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-04-23	12.79	15,200
2011	2011-09-13	13.78	18,500
2012	2012-07-08	10.14	8,130
2013	2013-06-25	12.00	12,900
2014	2014-08-24	13.38	17,100
2015	2015-05-27	9.50	6,710
2016	2016-09-21	10.51	8,970
2017	2017-09-20	20.33	44,700

2.8.5. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1355 MUNICIPALITY: UTUADO

DATE: 11.8.17 TIME: _____ EVALUATOR NAME: MARCOS RIVERA

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): HURACAN MARIA, ITEM 113, BEFORE = 2

AFTER = 0

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Bridge Collapsed. N/A

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☑ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-155: Bridge 1355 inspection report from November 8, 2017 (source: PRHTA)

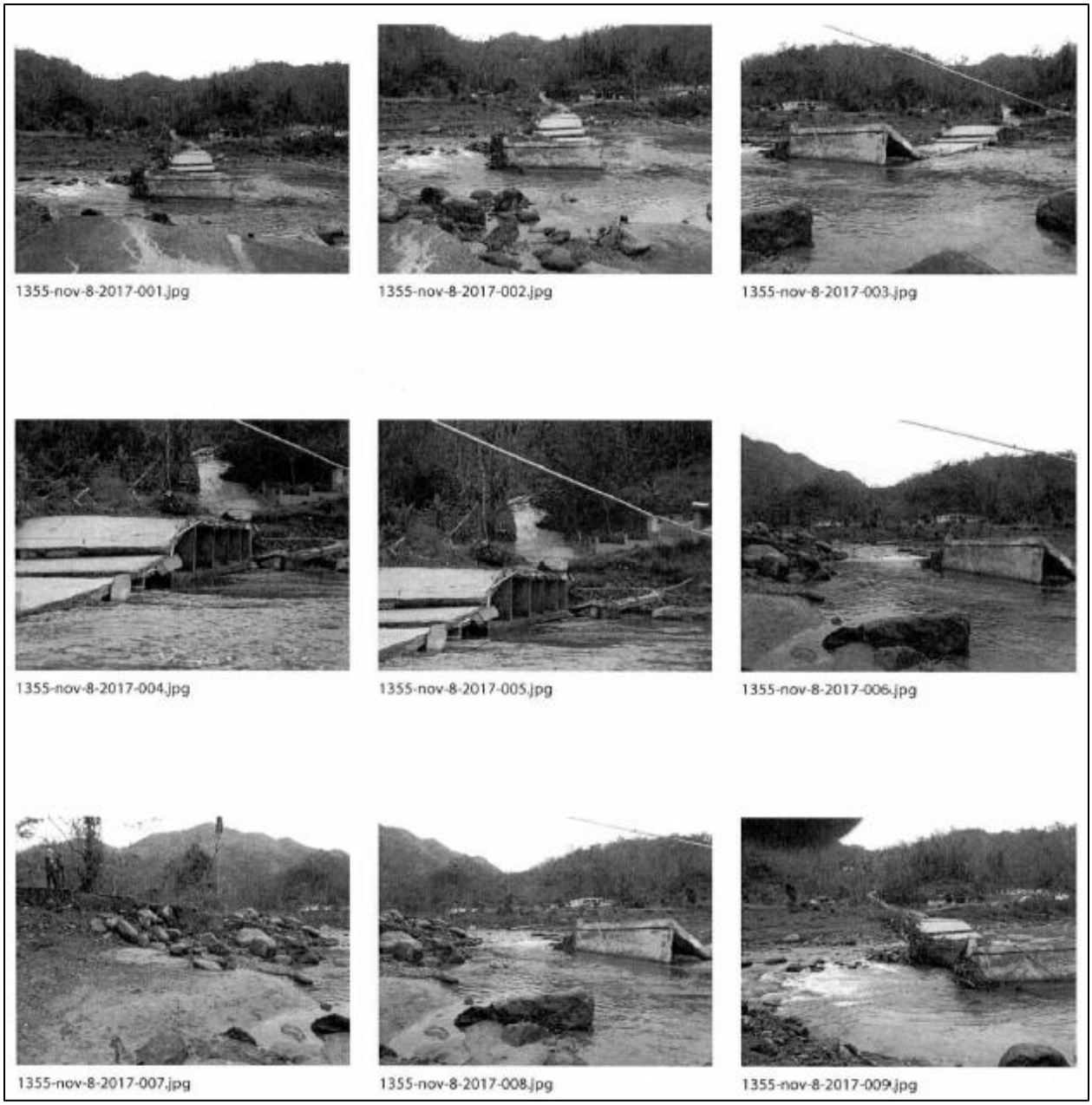


Figure 2-156: Bridge 1355 photos from November 8, 2017 inspection (source: PRHTA)

2.8.6. Images after Hurricane Maria



Figure 2-157: Bridge 1355 satellite image after Hurricane Maria (source: NOAA)



Figure 2-158: Bridge 1355 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 2-159: Image of collapsed Bridge 1355 (source: FHWA)



Figure 2-160: Image of collapsed Bridge 1355 (source: FHWA)



Figure 2-161: Image of collapsed Bridge 1355 (source: FHWA)



Figure 2-162: Image of collapsed Bridge 1355 (source: FHWA)



Figure 2-163: Bridge 1355 image from PRHTA inspection report



Figure 2-164: Bridge 1355 image from PRHTA inspection report



Figure 2-165: Bridge 1355 image from PRHTA inspection report



Figure 2-166: Bridge 1355 image from PRHTA inspection report



Figure 2-167: Bridge 1355 image from PRHTA inspection report

2.8.7. Temporary replacement



Figure 2-168: Bridge 1355 replacement under construction (source: PRHTA)

2.9. Bridge 1453



(Extracted from Figure 2-189)

2.9.1. General information

Table 2-24: Bridge 1453 general information from BridgeReports.com

Name	MARGINAL STREET over BAIROA RIVER
Structure number	014531
Location	WEST SIDE OF CAGUAS
Purpose	Carries highway and pedestrian walkway over waterway
Route classification	Local (Urban)
Length of largest span	39.0 ft
Total length	82.4 ft
Roadway width between curbs	40.0 ft
Deck width edge-to-edge	52.8 ft
Owner	City or Municipal Highway Agency
Year built	1973
Historic significance	Bridge is not eligible for the National Register of Historic Places.
Number of main spans	2
Main spans material	Prestressed concrete
Main spans design	Box beam or girders - Multiple
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 2-25: Bridge 1453 general information from the PRHTA

ID	1453
Highway	Marginal Street
Municipality	Caguas
Year Built	1973
Functionality	Urban-local
Lanes	2
ADT	4000
Maintenance	Municipal Highway Agency
Owner	Municipal Highway Agency
Up Service	Highway-pedestrian
Down Service	Waterway
Width	16.1 m
Length	25.1 m
Spans	2
Under clearance	0
Material	Prestressed concrete
Design	Box beam or girder - simple
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	3 m
Bypass length	17 km
NBI Rating	1
NHS	0
Area	404.11 m^2

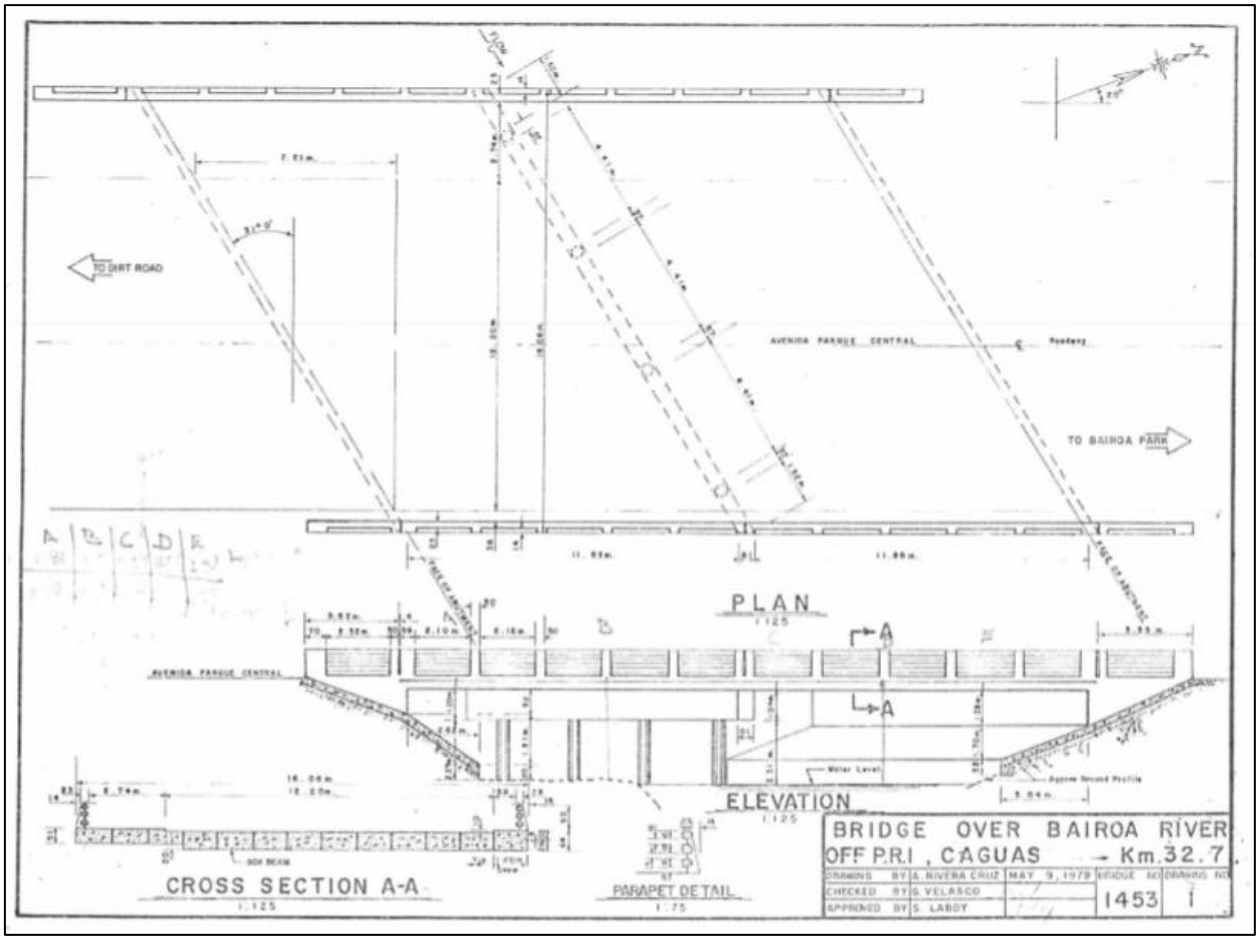


Figure 2-169: Bridge 1453 drawings (source: PRHTA)

2.9.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 1453

TEAM LEADER: Heriberto González Medina

INSP. DATE: 10 - FEBRERO - 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	FEB. 2014	FEB 2018
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other:	—			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	6	6	6	6	N	8
Current Inspection	6	6	6	6	N	8

Other Checks: (Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-170: Bridge 1453 inspection summary of February 10, 2016 (source: PRHTA)



Figure 2-171: Bridge 1453 inspection photos of February 10, 2016 (source: PRHTA)

2.9.3. Images before Hurricane Maria

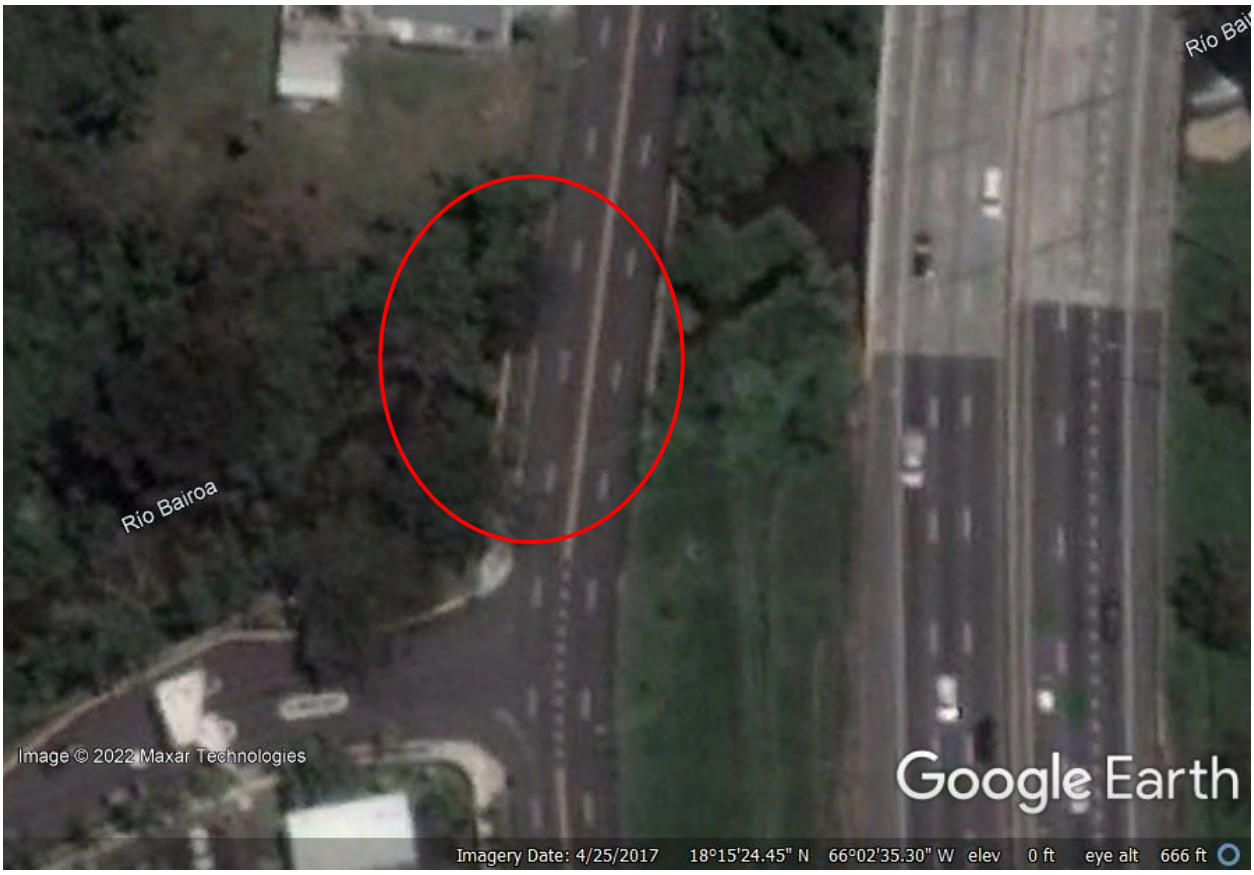


Figure 2-172: Bridge 1453 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-173: Bridge 1453 photo from February 10, 2016 inspection (source: PRHTA)



Figure 2-174: Bridge 1453 photo from February 10, 2016 inspection (source: PRHTA)



Figure 2-175: Bridge 1453 photo from February 10, 2016 inspection (source: PRHTA)



Figure 2-176: Bridge 1453 photo from February 10, 2016 inspection (source: PRHTA)



Figure 2-177: Bridge 1453 photo from February 10, 2016 inspection (source: PRHTA)

2.9.4. Streamflow

Table 2-26: Peak streamflow at Bairoa River Above Bairoa, Caguas monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-08-30	9.72	2,040
2011	2011-08-03	10.54	2,550
2012	2012-08-24	8.51	2,250
2013	2013-07-18	9.43	1,870
2014	2014-08-23	8.84	2,690
2015	2014-11-07	8.96	2,860
2016	2015-10-24	7.83	1,440
2017	2017-09-20	14.50	5,600

2.9.5. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1453 MUNICIPALITY: Caguas

DATE: 10/17/17 TIME: 1:30 PM EVALUATOR NAME: Christian Berríos

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Bridge partially collapsed due to pier failure. Scour at abutments with washed backfill and damaged slopewalls. Box beams unstable and many debris obstructing openings.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: Bridge already closed by municipality. Reported to CoE for further action.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-178: Bridge 1453 inspection report from October 17, 2017 (source: PRHTA)



Figure 2-179: Bridge 1453 photos from October 17, 2017 inspection (source: PRHTA)



Figure 2-180: Bridge 1453 photos from October 17, 2017 inspection (source: PRHTA)



Figure 2-181: Bridge 1453 photos from October 17, 2017 inspection (source: PRHTA)

2.9.6. Images after Hurricane Maria



Figure 2-182: Bridge 1453 satellite image after Hurricane Maria (source: NOAA)



Figure 2-183: Bridge 1453 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 2-184: Bridge 1453 image from PRHTA inspection report



Figure 2-185: Bridge 1453 image from PRHTA inspection report



Figure 2-186: Bridge 1453 image from PRHTA inspection report



Figure 2-187: Bridge 1453 image from PRHTA inspection report



Figure 2-188: Bridge 1453 image from PRHTA inspection report



Figure 2-189: Bridge 1453 image from PRHTA inspection report



Figure 2-190: Bridge 1453 image from PRHTA inspection report



Figure 2-191: Bridge 1453 image from PRHTA inspection report



Figure 2-192: Bridge 1453 image from PRHTA inspection report



Figure 2-193: Bridge 1453 image from PRHTA inspection report



Figure 2-194: Image of damaged Bridge 1453 (source: PRHTA)



Figure 2-195: Image of damaged Bridge 1453 (source: PRHTA)



Figure 2-196: Image of damaged Bridge 1453 (source: PRHTA)



Figure 2-197: Image of damaged Bridge 1453 (source: PRHTA)



Figure 2-198: Image of damaged Bridge 1453 (source: PRHTA)



Figure 2-199: Image of damaged Bridge 1453 (source: PRHTA)



https://twitter.com/ivettesosaT2/status/920353013121904640

Figure 2-200: Tweet showing damaged Bridge 1453 (source: Ivette Sosa)

2.9.7. Videos after Hurricane Maria



https://youtu.be/5S-NPacw_Kg

Video 2-12: Social media video of damaged Bridge 1453 (source: Abner Correa)



https://youtu.be/-2aeQeWt-PY

Video 2-13: Social media video of damaged Bridge 1453 (source: Abner Correa)



https://youtu.be/s8-TvynONDs

Video 2-14: Social media video of damaged Bridge 1453 (source: Valexanddraa)

2.9.8. Repaired bridge



Figure 2-201: Repaired Bridge 1453



Figure 2-202: Repaired Bridge 1453

2.10. Bridge 1462



(Extracted from Figure 2-219)

2.10.1. General information

Table 2-27: Bridge 1462 general information from BridgeReports.com

Name	PR 567 over GRANDE DE MANATI RIVER
Structure number	014621
Location	4.7 KM S W OF CIALES
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	65.6 ft
Total length	274.0 ft
Roadway width between curbs	26.6 ft
Deck width edge-to-edge	30.5 ft
Owner	State Highway Agency
Year built	1978
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	4
Main spans material	Prestressed concrete
Main spans design	Stringer/ Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 2-28: Bridge 1462 general information from the PRHTA

ID	1462
Highway	PR-567 km 11.7
Municipality	Morovis
Year Built	1978
Functionality	Rural-local
Lanes	2
ADT	2200
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	waterway
Width	9.3 m
Length	83.5 m
Spans	4
Under clearance	0
Material	Prestressed Concrete
Design	Stringer or girder
Scour Critical	3
Inspection Frequency	24 months
Approach Roadway Width	8.1 m
Bypass length	14 km
NBI Rating	2
NHS	0
Area	776.55 m2

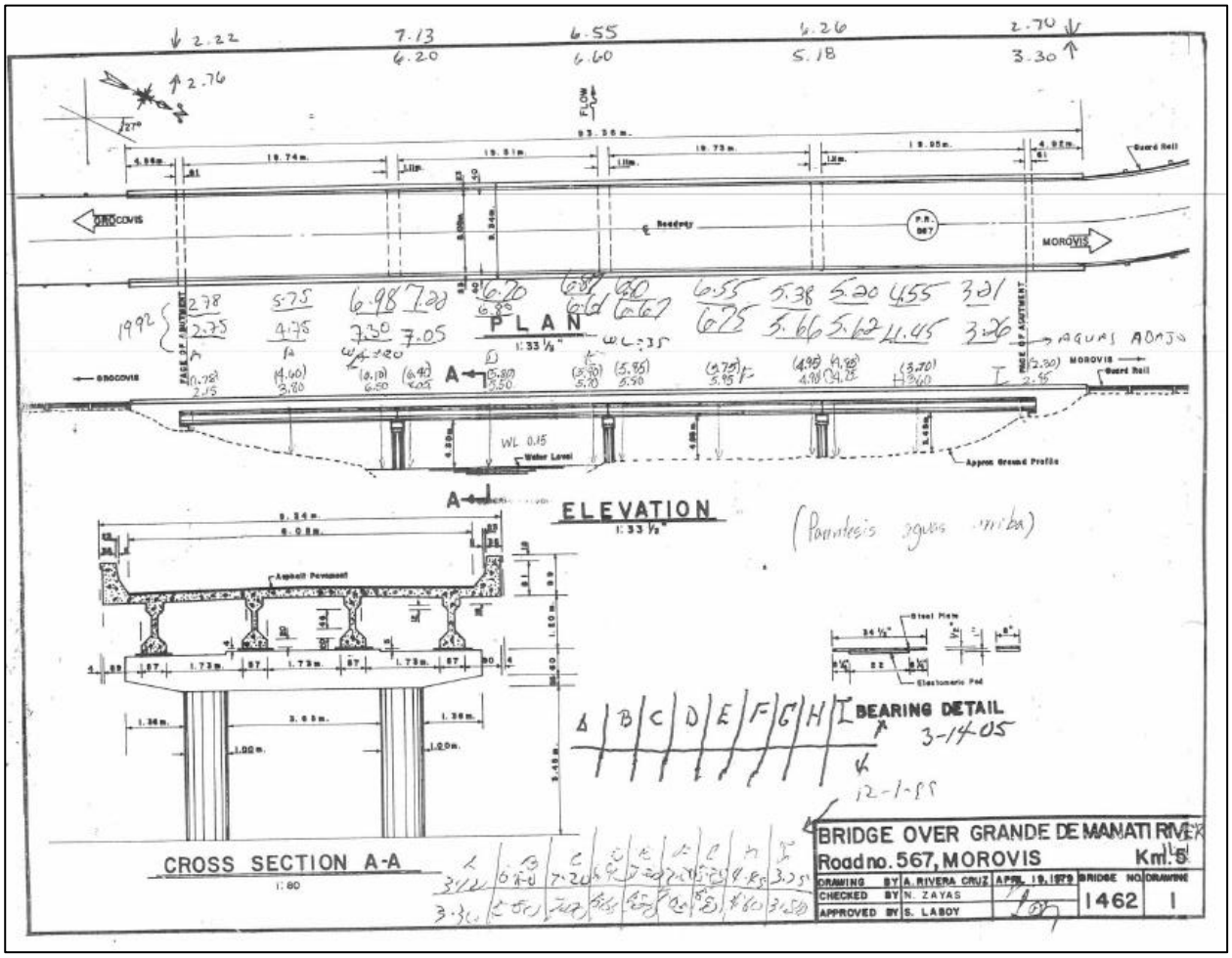


Figure 2-203: Bridge 1462 drawings (source: PRHTA)

2.10.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **1462**

TEAM LEADER: **AT LÓPEZ**

BRIDGE EVALUATOR: **MI ZAYAS**

Inspection Type and Dates: **JAN. 31,2017**

1. **Bridge Inspection Schedule Summary:**

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	2/2015	1/2019
ITEM 93 A	FC Inspection	N			
ITEM 93 B	Underwater Insp.	N			
ITEM 93 C	Other:	N			

2. **NBI Condition Rating Summary:**

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	6	7	6	7	N	3	P
Current Inspection	6	7	6	7	N	3	P

Other Checks: (Y, N, NA) Review Comments:

✓ AASHTO Core's & NBI CD consistent Smart Flags (scour, steel plate, fire damage, etc)
✓ Channel Profile/Clearance Table
✓ FC & Underwater Members Tables
✓ Asphalt Overlay Thickness ✓ Drawings
✓ Photos
✓ Critical Finding
✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-204: Bridge 1462 inspection summary of January 31, 2017 (source: PRHTA)



Figure 2-205: Bridge 1462 inspection photos of January 31, 2017 (source: PRHTA)

2.10.3. Images before Hurricane Maria



Figure 2-206: Bridge 1462 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-207: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-208: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-209: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-210: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-211: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-212: Bridge 1462 photo from February 11, 2015 inspection (source: PRHTA)



Figure 2-213: Photo of structure upstream from Bridge 1462 from February 11 inspection (source: PRHTA)

2.10.4. Streamflow

Table 2-29: Peak streamflow at Grande de Manatí River at Ciales monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-05-28	14.76	27,300
2011	2011-08-23	17.97	45,200
2012	2012-05-05	16.37	35,900
2013	2012-10-26	12.16	16,700
2014	2014-08-23	13.31	21,100
2015	2014-11-07	8.06	5,570
2016	2015-11-24	10.58	14,000
2017	2017-09-20	43.36	284,000

2.10.5. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1462 MUNICIPALITY: Morovis

DATE: 10/09/17 TIME: 10:37am EVALUATOR NAME: José Márquez / Joengill M.

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT:

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☑ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: El puente colapsó, 0. Se encontraron 2 "spans" del puente a orillas del río en el lado derecho. Se encontró 1 span del puente a 185m aprox. aguas abajo.

INCLUDE PHOTOS IN A SEPARATE SHEET

Otro span fue encontrado a 350m aprox. aguas abajo y una pilastra a 310m aprox. aguas abajo. Los otros 5 pilastras no fueron encontradas.

Figure 2-214: Bridge 1462 inspection report from October 9, 2017 (source: PRHTA)

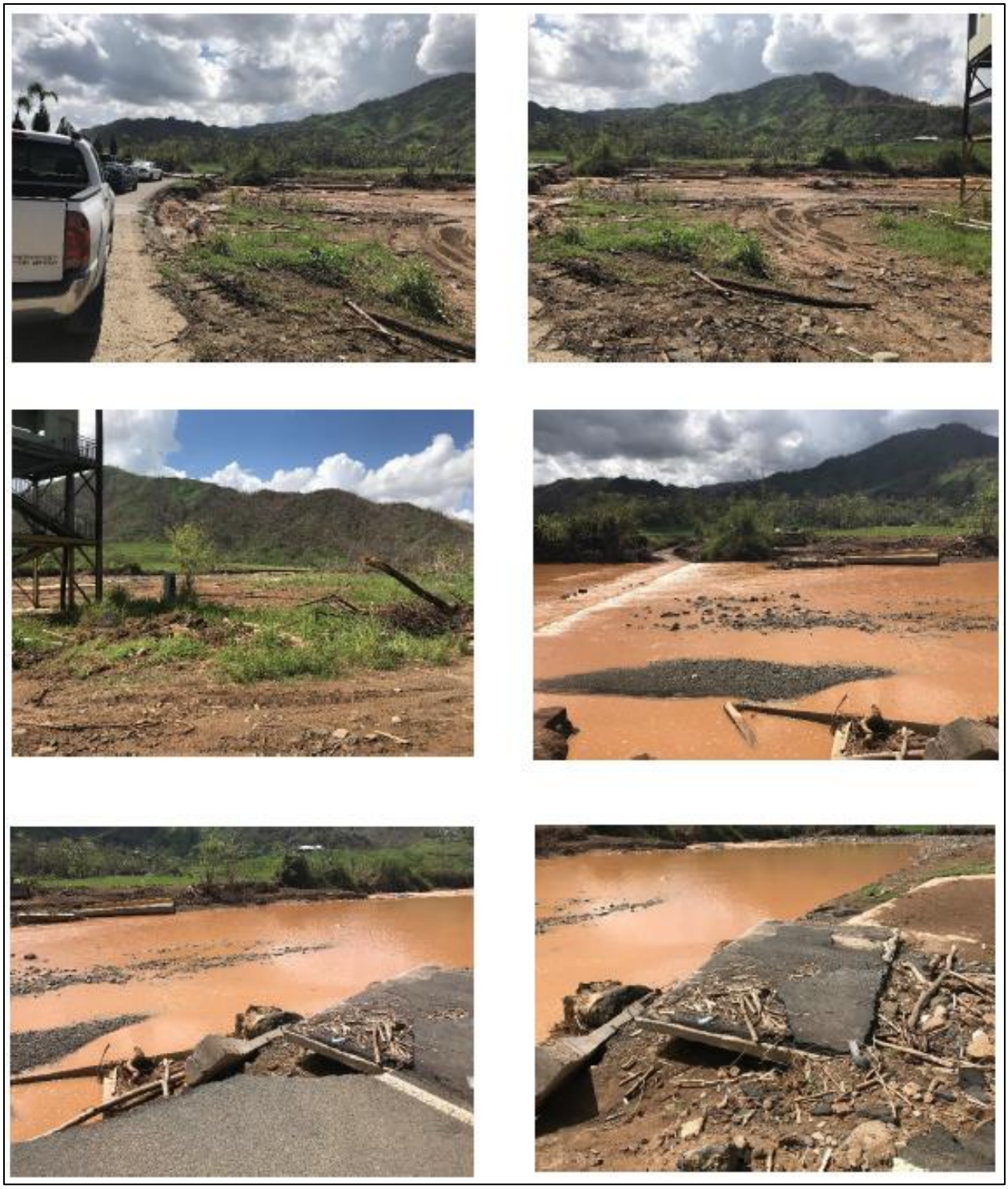


Figure 2-215: Bridge 1462 photos from October 9, 2017 inspection (source: PRHTA)



Figure 2-216: Bridge 1462 photos from October 9, 2017 inspection (source: PRHTA)

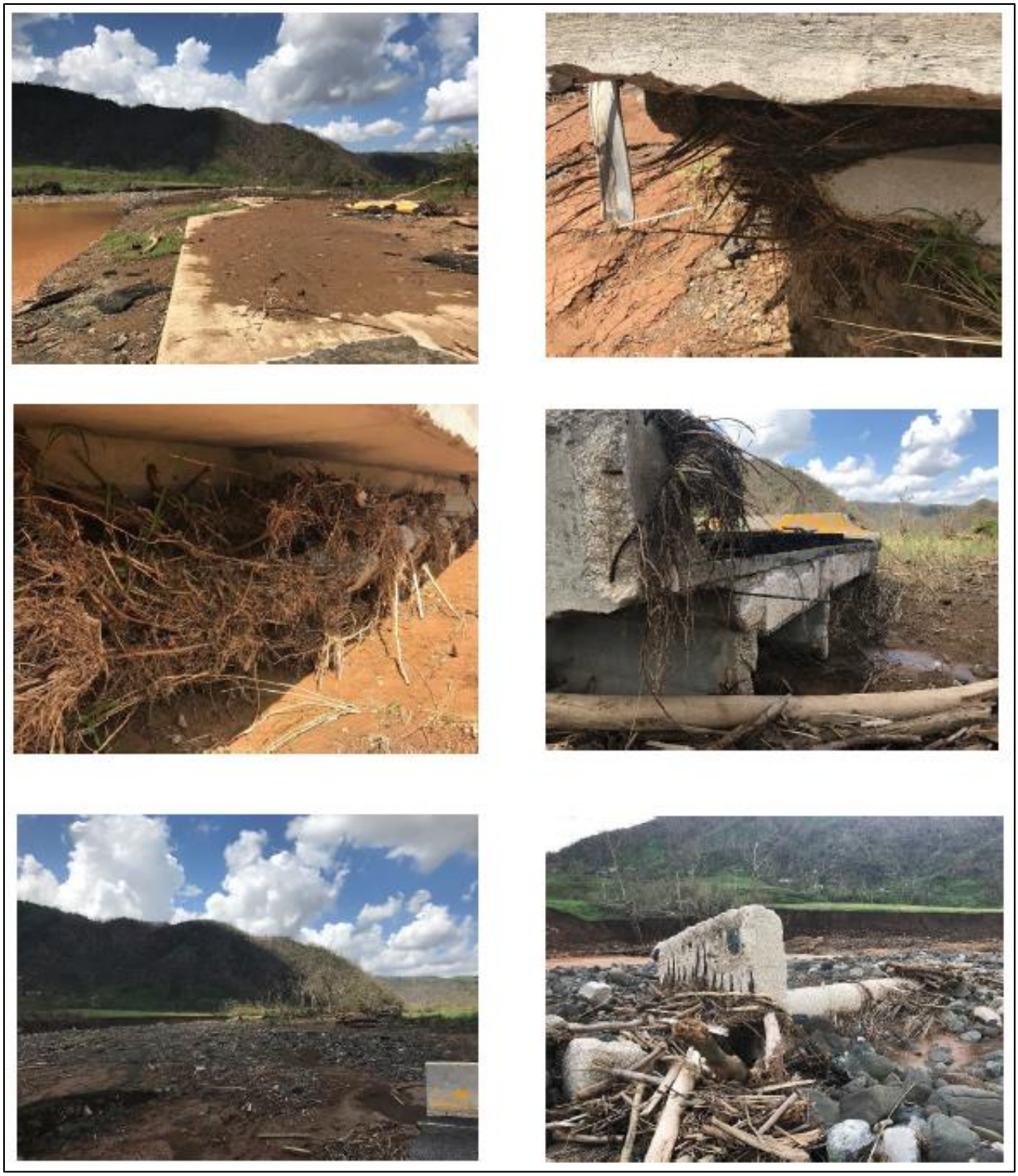
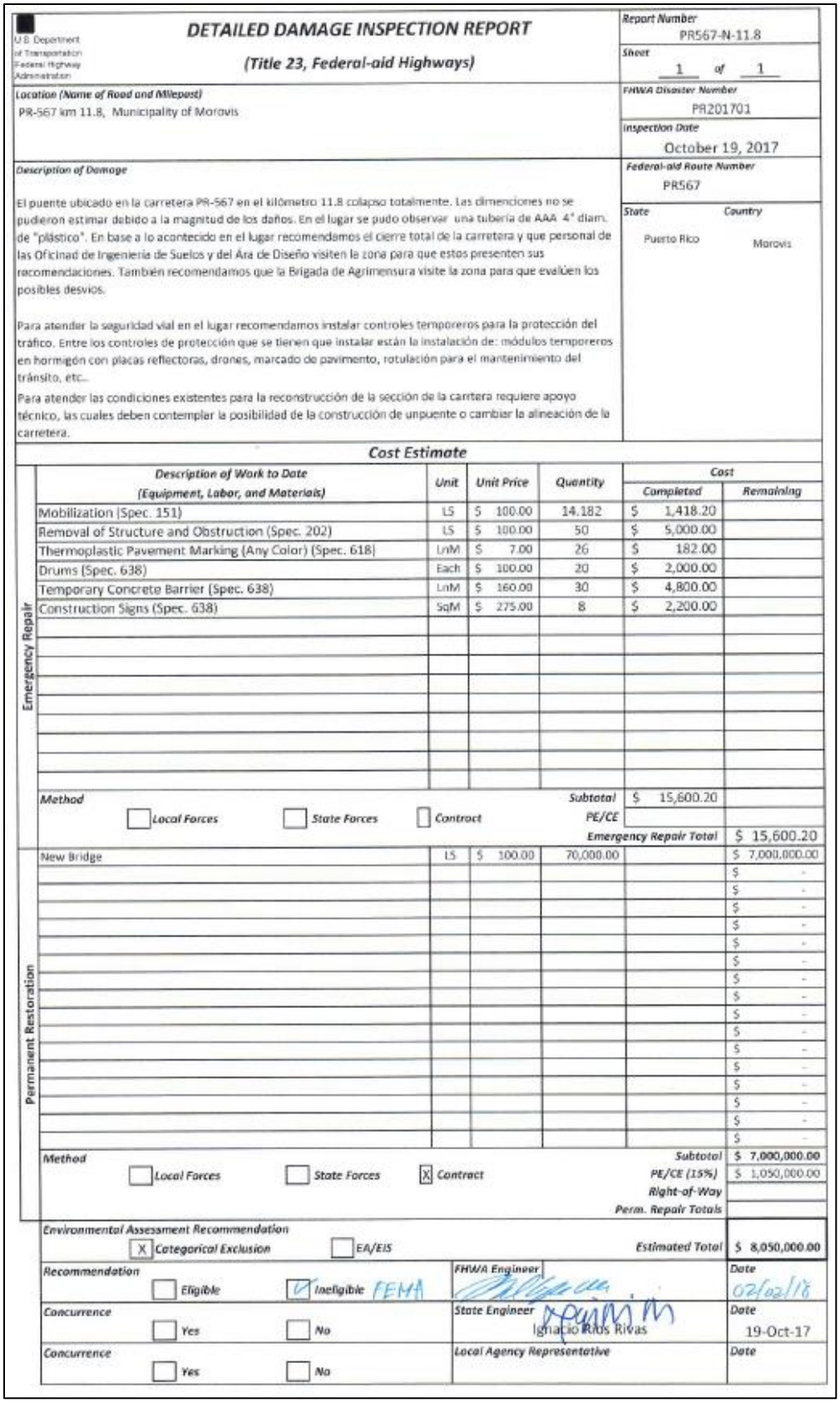


Figure 2-217: Bridge 1462 photos from October 9, 2017 inspection (source: PRHTA)



U.S. Department of Transportation Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number: PR567-N-11.8

Sheet: 1 of 1

Location (Name of Road and Milepost): PR-567 km 11.8, Municipality of Morovis

FHWA Disaster Number: PR201701

Inspection Date: October 19, 2017

Federal-aid Route Number: PR567

State: Puerto Rico **Country:** Morovis

Description of Damage

El puente ubicado en la carretera PR-567 en el kilómetro 11.8 colapso totalmente. Las dimenciones no se pudieron estimar debido a la magnitud de los daños. En el lugar se pudo observar una tubería de AAA 4" diam. de "plástico". En base a lo acontecido en el lugar recomendamos el cierre total de la carretera y que personal de las Oficinad de Ingeniería de Suelos y del Ara de Diseño visiten la zona para que estos presenten sus recomendaciones. También recomendamos que la Brigada de Agrimensura visite la zona para que evalúen los posibles desvíos.

Para atender la seguridad vial en el lugar recomendamos instalar controles temporeros para la protección del tráfico. Entre los controles de protección que se tienen que instalar están la instalación de: módulos temporeros en hormigón con placas reflectoras, drones, marcado de pavimento, rotulación para el mantenimiento del tránsito, etc..

Para atender las condiciones existentes para la reconstrucción de la sección de la carrtera requiere apoyo técnico, las cuales deben contemplar la posibilidad de la construcción de unpuente o cambiar la alineación de la carretera.

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Mobilization (Spec. 151)	LS	$ 100.00	14.182	$ 1,418.20	
Removal of Structure and Obstruction (Spec. 202)	LS	$ 100.00	50	$ 5,000.00	
Thermoplastic Pavement Marking (Any Color) (Spec. 618)	LnM	$ 7.00	26	$ 182.00	
Drums (Spec. 638)	Each	$ 100.00	20	$ 2,000.00	
Temporary Concrete Barrier (Spec. 638)	LnM	$ 160.00	30	$ 4,800.00	
Construction Signs (Spec. 638)	SqM	$ 275.00	8	$ 2,200.00	

Method: ☐ Local Forces ☐ State Forces ☐ Contract

Subtotal $ 15,600.20

PE/CE

Emergency Repair Total $ 15,600.20

Permanent Restoration

New Bridge	LS	$ 100.00	70,000.00		$ 7,000,000.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -

Method: ☐ Local Forces ☐ State Forces ☒ Contract

Subtotal $ 7,000,000.00

PE/CE (15%) $ 1,050,000.00

Right-of-Way

Perm. Repair Totals

Environmental Assessment Recommendation: ☒ Categorical Exclusion ☐ EA/EIS

Estimated Total $ 8,050,000.00

Recommendation: ☐ Eligible ☑ Ineligible FEMA

FHWA Engineer: [signature] Date: 02/02/18

Concurrence: ☐ Yes ☐ No

State Engineer: [signature] Ignacio Ríos Rivas Date: 19-Oct-17

Concurrence: ☐ Yes ☐ No

Local Agency Representative Date

Figure 2-218: Bridge 1462 inspection report from October 19, 2017 (source: FHWA)



Figure 2-219: Bridge 1467 from October 19, 2017 inspection (source: FHWA)

2.10.6. Images after Hurricane Maria



Figure 2-220: Bridge 1462 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 2-221: Inspection of collapsed Bridge 1462 (source: PRHTA)



Figure 2-222: Inspection of collapsed Bridge 1462 (source: PRHTA)



Figure 2-223 Inspection of collapsed Bridge 1462 (source: PRHTA)



Figure 2-224: Inspection of collapsed Bridge 1462 (source: PRHTA)



Figure 2-225: Inspection of collapsed Bridge 1462 (source: PRHTA)



https://flic.kr/p/DY9SWE

Figure 2-226: Social media image of collapsed Bridge 1462 (source: Julia Maldonado)



https://flic.kr/p/224nBkj

Figure 2-227: Social media image of collapsed Bridge 1462 (source: Julia Maldonado)



https://flic.kr/p/211KJ29

Figure 2-228: Social media image of collapsed Bridge 1462 (source: Julia Maldonado)



https://flic.kr/p/224nxK3

Figure 2-229: Social media image of collapsed Bridge 1462 (source: Julia Maldonado)



https://flic.kr/p/224nzyy

Figure 2-230: Social media image of collapsed Bridge 1462 (source: Julia Maldonado)



https://www.facebook.com/giovannibrignoniblog/photos/a.517078145294915/523880147948048

Figure 2-231: Social media image of collapsed Bridge 1462 (source: Giovanni Brignoni)



https://www.facebook.com/giovannibrignoniblog/photos/a.517078145294915/523880077948055

Figure 2-232: Social media image of collapsed Bridge 1462 (source: Giovanni Brignoni)



https://apnews.com/article/puerto-rico-donald-trump-us-news-ap-top-news-hurricane-maria-475dbbe238ac4820a5c2c32091aab499

Figure 2-233: Collapsed Bridge 1462 image from news report (source: AP News)



https://wtop.com/media-galleries/2017/09/photos-scenes-devastation-puerto-rico-maria/

Figure 2-234: Collapsed Bridge 1462 image from news report (source: AP News)



https://www.elnuevodia.com/noticias/locales/notas/tres-barrios-en-morovis-continuan-incomunicados/?TB_iframe=true&width=370.8&height=658.8

Figure 2-235: Collapsed Bridge 1462 image from news report (source: El Nuevo Día)



https://www.elnuevodia.com/noticias/locales/notas/aislado-el-barrio-san-lorenzo/

Figure 2-236: Collapsed Bridge 1462 image from news report (source: El Nuevo Día)



https://twitter.com/jestevesT2/status/915997147371151360

Figure 2-237: Social media image of collapse of Bridge 1462 (source: Jose Esteves)



https://nypost.com/2017/10/09/full-scope-of-puerto-ricos-devastation-seen-from-above/#6

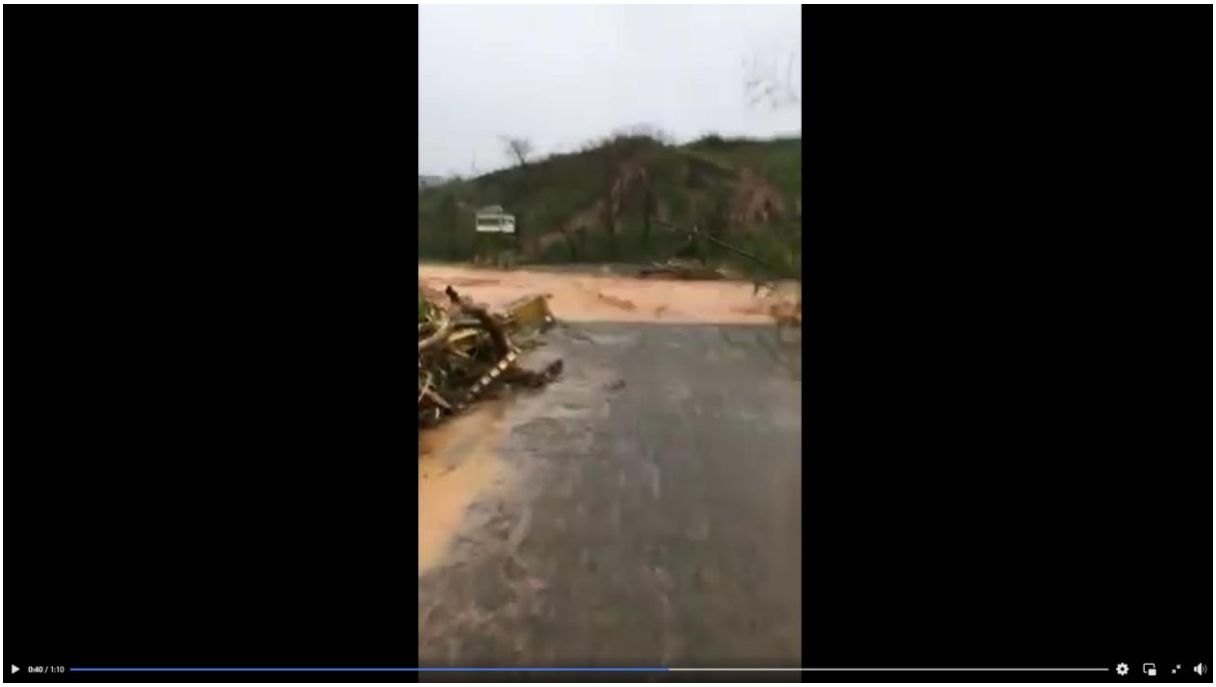
Figure 2-238: Collapsed Bridge 1462 image from news report (source: New York Post)



https://bridgehunter.com/pr/morovis/bh81844/

Figure 2-239: Screenshot of collapsed Bridge 1462 from FEMA video (source: Bridgehunter.com)

2.10.7. Videos after Hurricane Maria



https://www.facebook.com/1614771861/videos/10212592662124234/

Video 2-15: Social media video of collapsed Bridge 1462 (source: Johnny Rodríguez)



https://www.facebook.com/832251257/videos/10156693467061258/

Video 2-16: Social media video of collapsed Bridge 1462 (source: Sirio Arnaldo Alvarez-Cruz)



https://www.facebook.com/100000565791309/videos/2241274072568097/

Video 2-17: Social media video of collapsed Bridge 1462 (source: Ivette Pabón)



https://www.cnn.com/videos/world/2017/09/28/bridge-collapse-morovis-puerto-rico-watson-lok-cnni.cnn

Video 2-18: News report about the effects of collapsed Bridge 1462 (source: CNN)



https://fb.watch/etxJs1Fuq1/

Video 2-19: Social media video of collapsed Bridge 1462 (source: Giovanni Brignoni)



https://youtu.be/lYy78BmWgB4?t=130

Video 2-20: Drone video of Morovis, including collapsed Bridge 1462 (source: Jibaro Aventurero - Antes Upper ViewPR)

2.10.8. Temporary replacement



Figure 2-240: Bridge 1462 replacement (source: PRHTA)

2.11. Bridge 1499



(Extracted from Figure 2-264)

2.11.1. General information

Table 2-30: Bridge 1499 general information from BridgeReports.com

Name	RURAL LOCAL ROAD over GRANDE DE ARECIBO RIVER
Structure number	014991
Location	5 KM NORTHEAST OF UTUADO
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	73.8 ft
Total length	231.0 ft
Roadway width between curbs	22.6 ft
Deck width edge-to-edge	26.6 ft
Owner	City or Municipal Highway Agency
Year built	1973
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	3
Main spans material	Prestressed Concrete
Main spans design	Stringer / Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-31: Bridge 1499 general information from the PRHTA

ID	1499
Highway	PR 123 km 0.03
Municipality	Utuado
Year Built	1973
Functionality	Rural-Local
Lanes	2
ADT	250
Maintenance	Municipal Highway Agency
Owner	Municipal Highway Agency
Up Service	Highway
Down Service	Waterway
Width	8.1 m
Length	70.4 m
Spans	3
Under clearance	0
Material	Prestressed Concrete
Design	Stringer or Girder
Scour Critical	4
Inspection Frequency	6 months
Approach Roadway Width	7 m
Bypass length	199 km
NBI Rating	0
NHS	0
Area	570.24 m^2

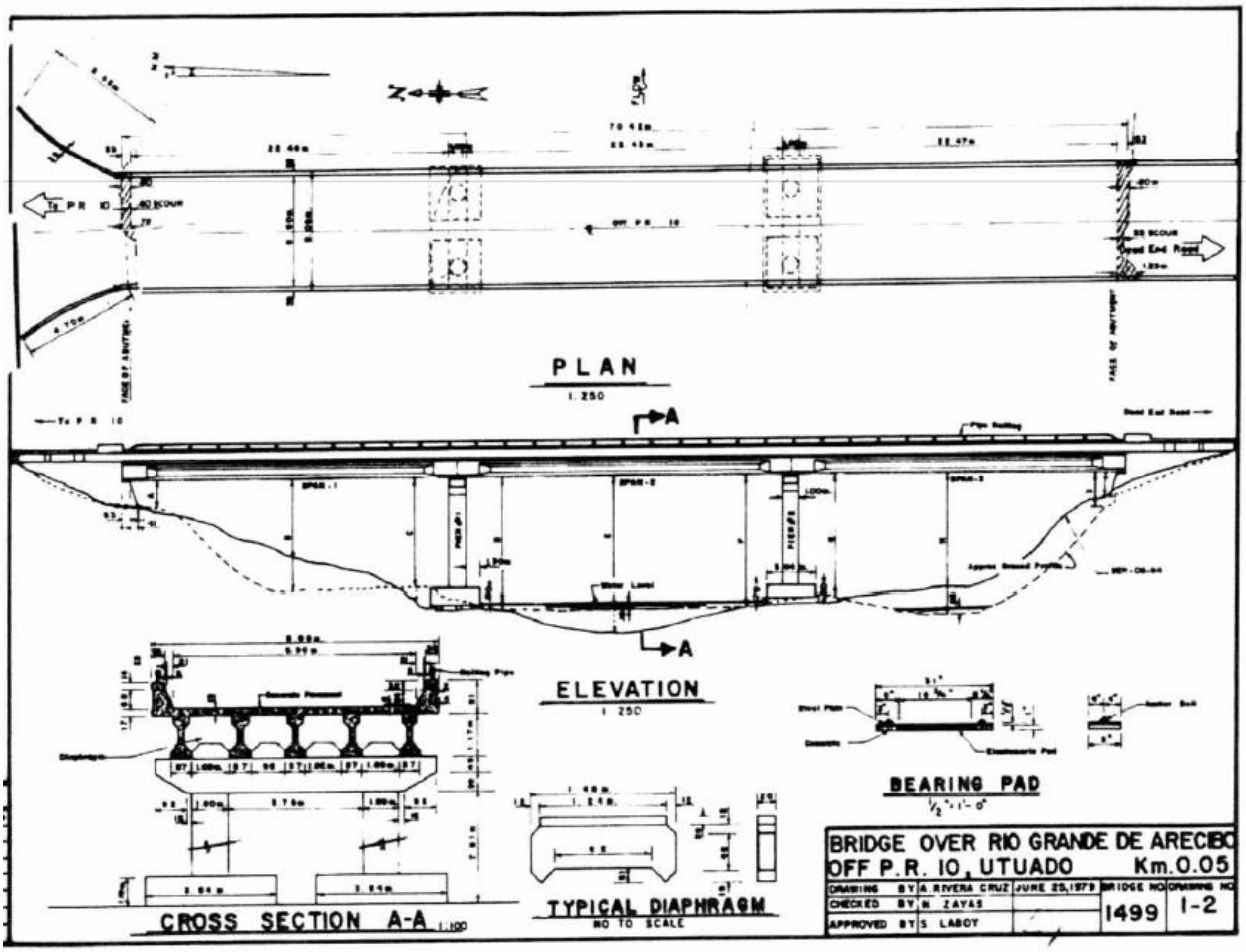


Figure 2-241: Bridge 1499 drawings (source: PRHTA)

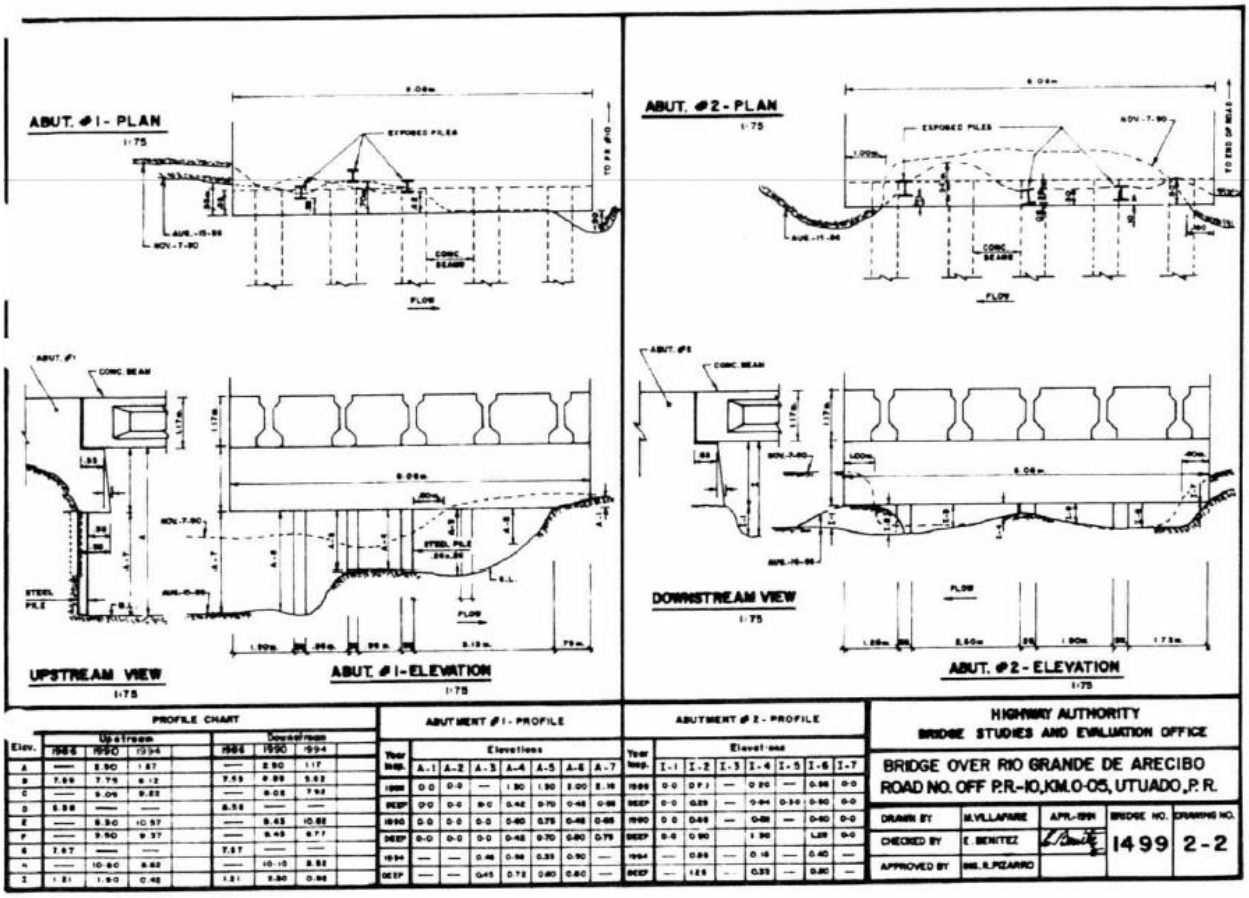


Figure 2-242: Bridge 1499 drawings (source: PRHTA)

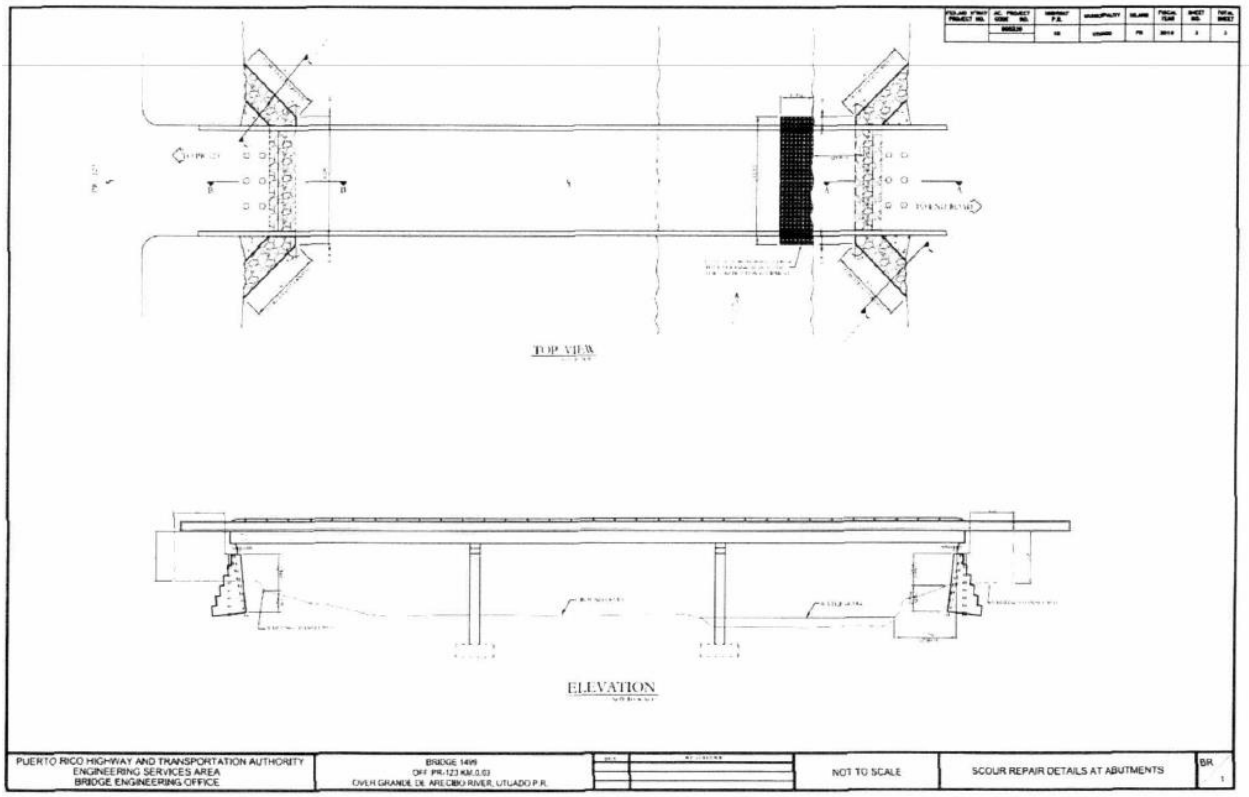


Figure 2-243: Bridge 1499 drawings (source: PRHTA)

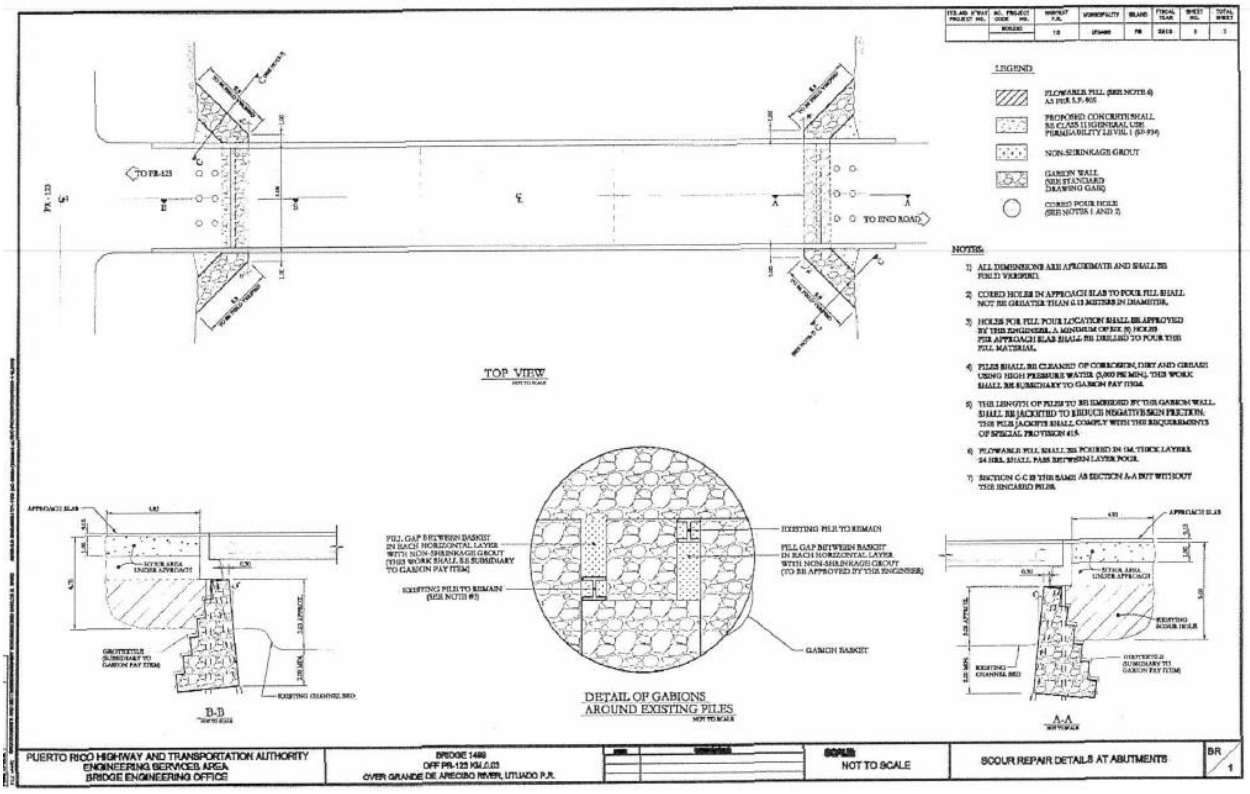


Figure 2-244: Bridge 1499 drawings (source: PRHTA)

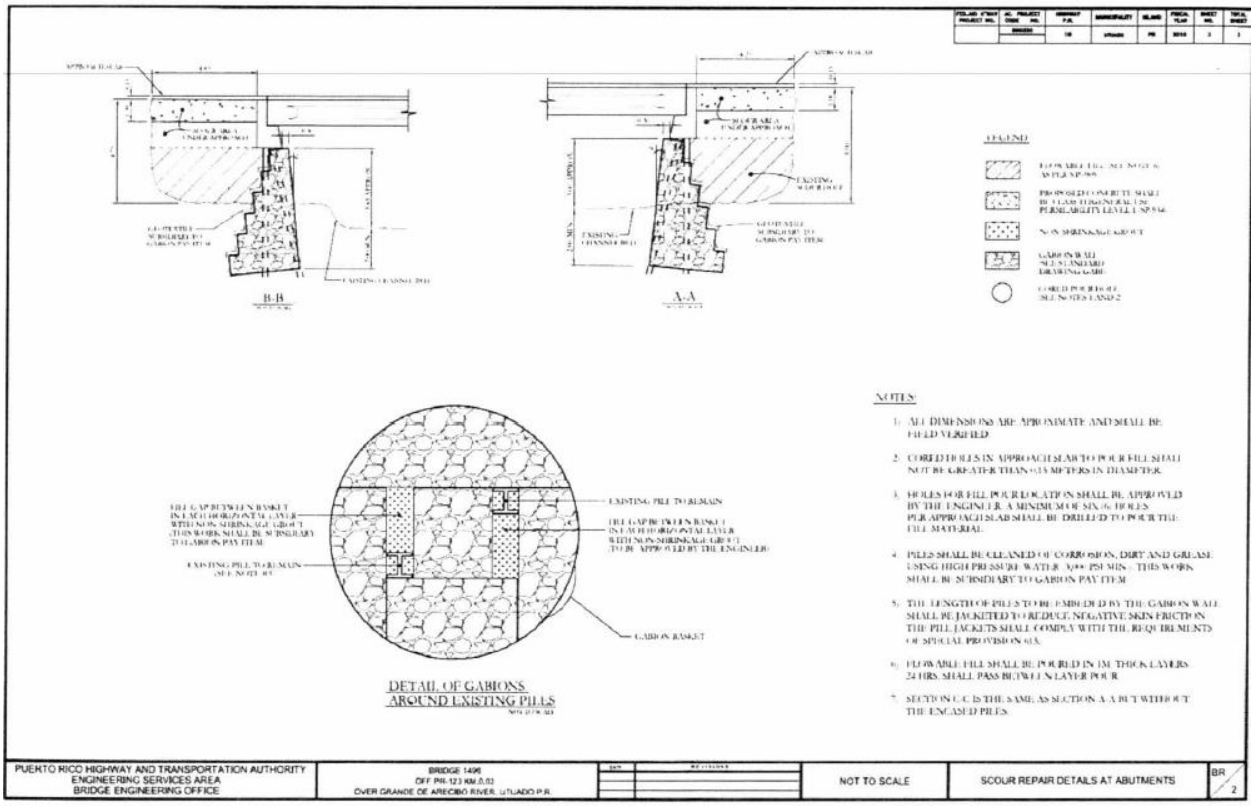


Figure 2-245: Bridge 1499 drawings (source: PRHTA)

2.11.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 1499

TEAM LEADER: CM García

BRIDGE EVALUATOR: MI Zayas

INSPECTION DATE: January 10, 2017

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	~~6~~ 12	Jul.6.2016	~~Jul.10.2017~~ Jan 2018
ITEM 93 A	FC Inspection	–		YC	
ITEM 93 B	Underwater Insp.	–			
ITEM 93 C	Other: SI	Yes	12 YC	Jul.6.2016	~~Jul.10.2017~~ Jan 2018 YC

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	6	7	~~6~~ 6	2	N	~~4~~ 4	~~P~~ P
Current Inspection	6	7	~~6~~ 6 YC	2	N	~~4~~ 4 YC	P

Other Checks:(Y, N, NA)

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's& NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: [signature]

Safety Eng.: [signature]

Review Comments:

✓ SI no hay socav en footing
Subir item 113 = 4
y Item 60 = 6

✓ SI @ 12 meses para
monitorear footing scour

✓ Clearance Table

* Se reinspeccionó en abril 2017 por Hidrologo ChrisTeam Services.
Next insp. en abril 2018. YC 26 Jul 2017

Figure 2-246: Bridge 1499 inspection summary of January 10, 2017 (source: PRHTA)

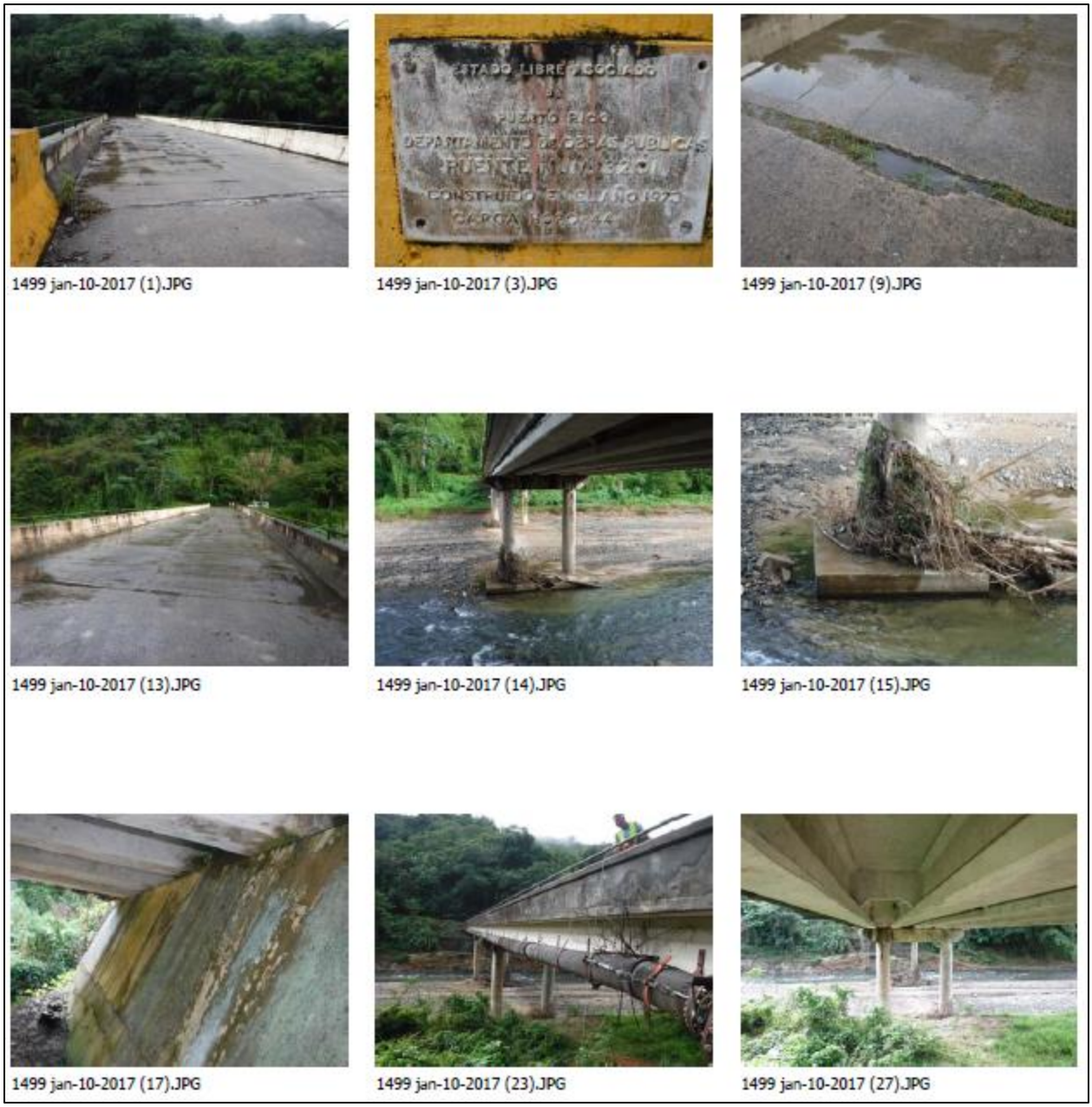


Figure 2-247: Bridge 1499 inspection photos of January 10, 2017 (source: PRHTA)

Note: According to the National Bridge Inventory, another inspection was conducted in April 2017. The Report Summary and QC Sheet and the photos of this inspection were not available.

2.11.3. Images before Hurricane Maria



Figure 2-248: Bridge 1499 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-249: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-250: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-251: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-252: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-253: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-254: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)



Figure 2-255: Bridge 1499 photo from January 10, 2017 inspection (source: PRHTA)

2.11.4. Streamflow

Table 2-32: Peak streamflow at Grande de Arecibo River Below Utuado monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-04-23	16.81	18,900
2011	2010-10-08	19.78	30,500
2012	2012-03-28	15.17	14,200
2013	2012-11-19	13.97	11,000
2014	2014-08-24	17.28	17,100
2015	2014-11-03	13.20	7,120
2016	2016-09-21	13.14	7,010
2017	2017-09-20	31.84	70,700

2.11.5. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1499 MUNICIPALITY: Utuado

DATE: 10/5/17 TIME: 11:00am EVALUATOR NAME: Christian Berrios

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane Maria

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Two (2) spans (west side) collapsed; beams, pier and deck in river. Remaining span unstable with remaining pier cracked.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: 30 families (150 persons) stranded at other side without. Emergency reported high priority. detour.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-256: Bridge 1499 inspection report from October 5, 2017 (source: PRHTA)

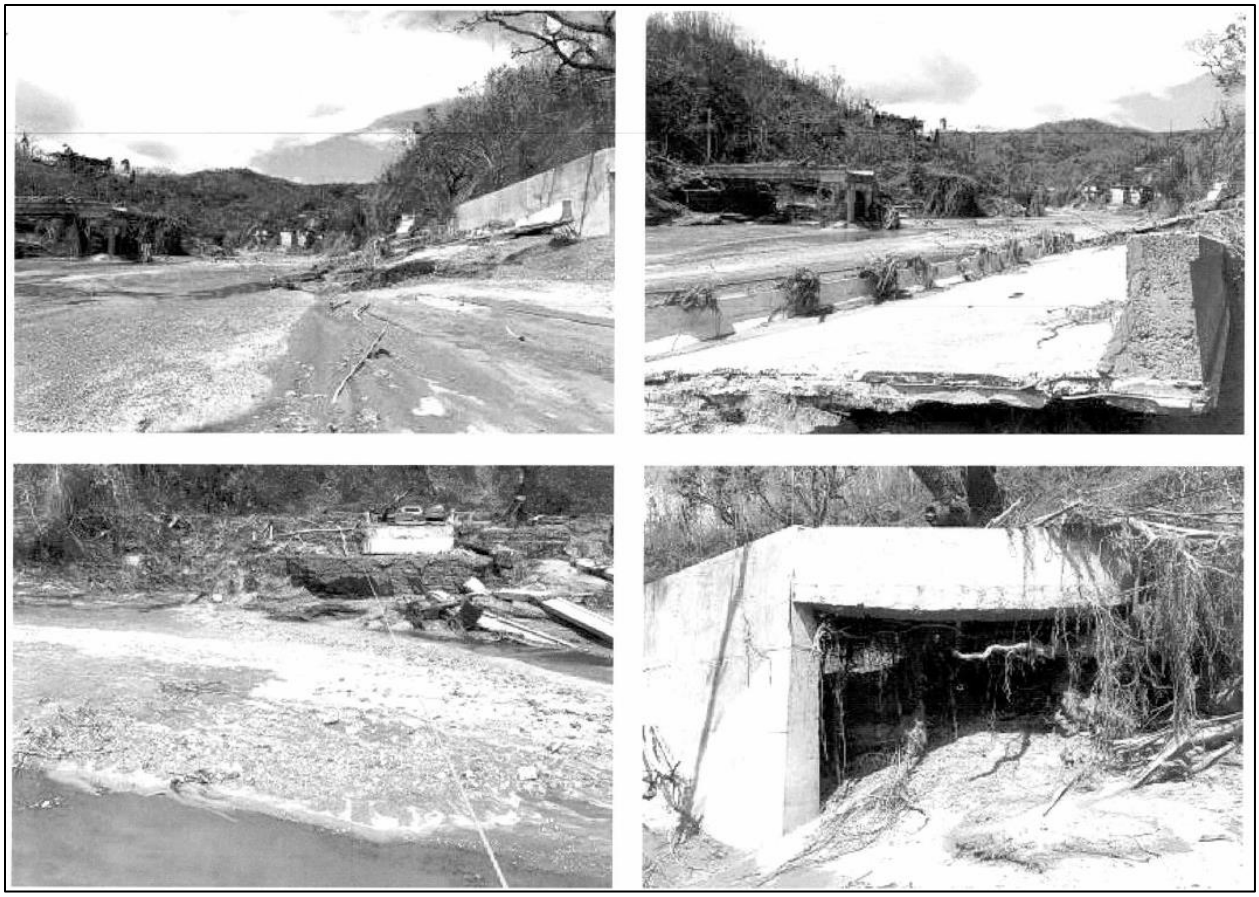


Figure 2-257: Bridge 1499 photos from October 5, 2017 inspection (source: PRHTA)



Figure 2-258: Bridge 1499 photos from October 5, 2017 inspection (source: PRHTA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1499 MUNICIPALITY: Utuado

DATE: 10/11/17 TIME: _____ EVALUATOR NAME: Wilfredo Rodriguez
Carmen Jiménez

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: _____

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Item 113 – 0 The bridge was failed

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-259: Bridge 1499 inspection report from October 11, 2017 (source: PRHTA)



Figure 2-260: Bridge 1467 from October 11, 2017 inspection (source: PRHTA)

2.11.6. Images after Hurricane Maria



Figure 2-261: Bridge 1499 satellite after Hurricane Maria (source: NOAA)



Figure 2-262: Bridge 1499 satellite after Hurricane Maria (source: Google Earth Pro)



https://abc7ny.com/news/puerto-rico-town-gets-new-bridge-6-months-after-hurricane-washed-away-old-one/3214063/

Figure 2-263: News report image of collapsed Bridge 1499 (source: ABC)



https://www.thestar.com/news/world/2018/07/13/report-shows-fema-unprepared-for-puerto-rico-hurricane.html

Figure 2-264: News report image of collapsed Bridge 1499 (source: Toronto Star)



https://www.dvidshub.net/image/3872963/hurricane-maria-aid-delivery-utuado

Figure 2-265: Social media image of collapsed Bridge 1499 (source: US Air Force)



https://www.nytimes.com/es/2017/10/18/espanol/despues-del-huracan-maria-los-puertorriquenos-recurren-a-la-creatividad-para-sobrevivir.html

Figure 2-266: News report image of collapsed Bridge 1499 (source: NY Times)



https://www.noticel.com/huracanes/el-tiempo/ahora/top-stories/20200814/puentes-impactados-por-maria-ya-sufrian-por-falta-de-mantenimiento/

Figure 2-267: News report image of collapsed Bridge 1499 (source: Noticel)



https://www.nbcnews.com/storyline/puerto-rico-crisis/two-months-after-hurricane-maria-puerto-rico-still-crisis-mode-n822536

Figure 2-268: News report image of collapsed Bridge 1499 (source: NBC News)

2.11.7. Videos after Hurricane Maria



https://fb.watch/etGiWajuGf/

Video 2-21: Social media video of Bridge 1499 before collapsing (source: Huracán Maria-Videos y Fotos)



https://youtu.be/LI85rQoxhPQ

Video 2-22: News report of collapsed Bridge 1499 (source: CNN en Español)



https://youtu.be/sNRcS1XiGpE

Video 2-23: Social media video of collapsed Bridge 1499 (source: Jibaro Aventurero - Antes Upper ViewPR)

2.11.8. Temporary replacement



Figure 2-269: Bridge 1499 replacement (source: PRHTA)

2.12. Bridge 1698



(Extracted from Figure 2-284)

2.12.1. General information

Table 2-33: Bridge 1698 general information from BridgeReports.com

Name	FELIX AVENUE over COROZAL RIVER
Structure number	016981
Location	ENTRANCE TO FELIX DEV
Purpose	Carries highway and pedestrian walkway over water way
Route classification	Local (Urban)
Length of largest span	65.6 ft
Total length	71.5 ft
Roadway width between curbs	26.2 ft
Deck width edge-to-edge	36.4 ft
Owner	City or Municipal Highway Agency
Year built	1975
Historic significance	Bridge is no eligible for the National Register of Historic Places.
Number of main spans	-
Main spans material	Prestressed concrete
Main spans design	Stringer/Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 2-34: Bridge 1698 general information from the PRHTA

ID	1698
Highway	Felix Avenue
Municipality	Corozal
Year Built	1975
Functionality	Urban-local
Lanes	2
ADT	3000
Maintenance	Municipal highway agency
Owner	Municipal highway agency
Up Service	Highway-pedestrian
Down Service	Waterway
Width	11.1 m
Length	21.8 m
Spans	1
Under clearance	0
Material	Prestressed concrete
Design	Stringer or girder
Scour Critical	-
Inspection Frequency	24 months
Approach Roadway Width	8 m
Bypass length	2 km
NBI Rating	2
NHS	0
Area	241.98 m^2

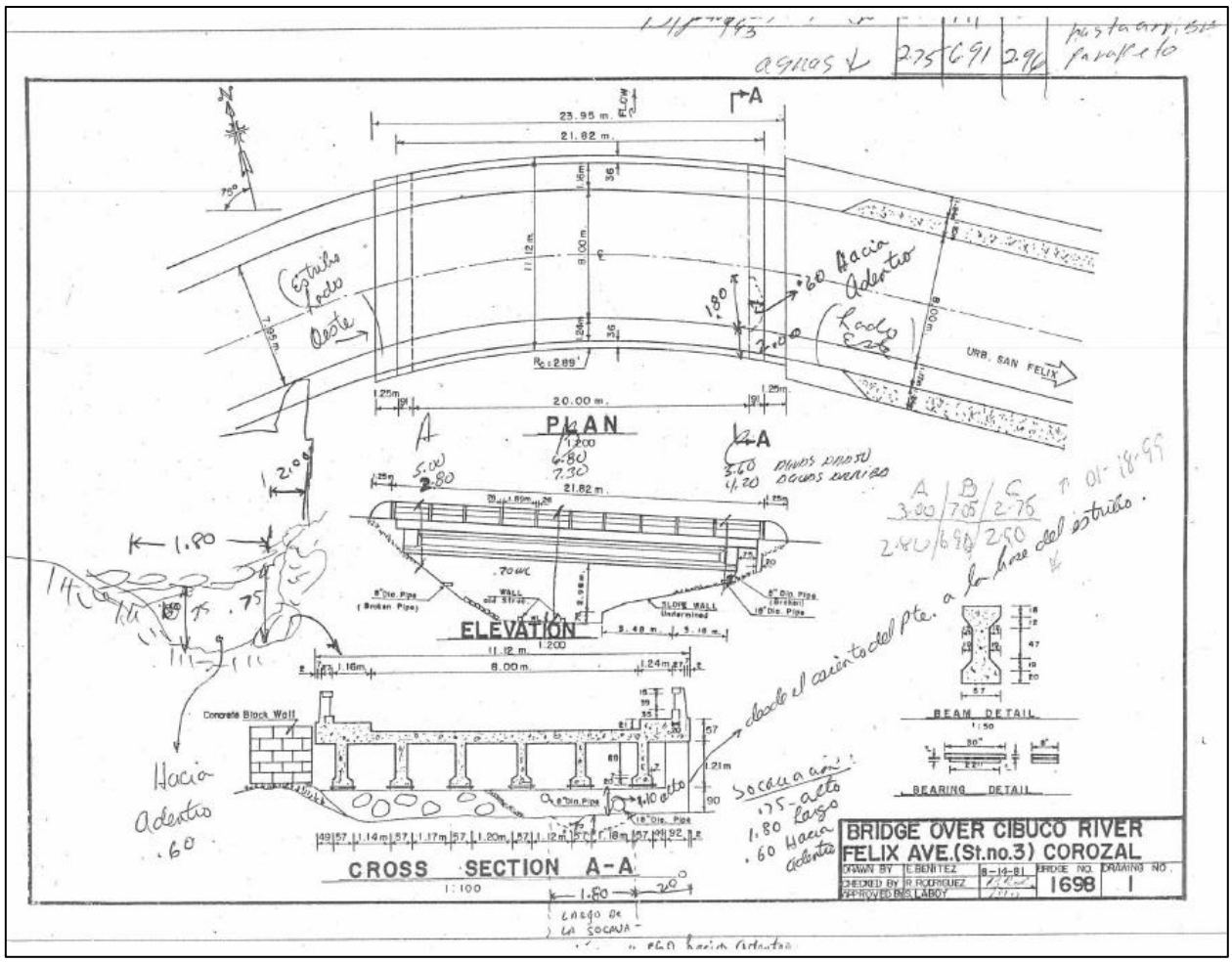


Figure 2-270: Bridge 1698 drawings (source: PRHTA)

2.12.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-1698**

TEAM LEADER: Micky Santiago

BRIDGE EVALUATOR: Kiomarie Valle

INSP. DATE: **January 12, 2017**

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	24	Jan-2015	Jan-2019
ITEM 93 A	FC Inspection	NA			
ITEM 93 B	Underwater Insp.	NA			
ITEM 93 C	Other: SI Super	NA			

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	6	6	6	6	N	8	A
Current Inspection	6	6	6	6	N	8	A

Other Checks:(Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's& NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.:_____

Figure 2-271: Bridge 1698 inspection summary of January 12, 2017 (source: PRHTA)



1698-Ene.-12-2017-001.jpg



1698-Ene.-12-2017-003.jpg



1698-Ene.-12-2017-004.jpg



1698-Ene.-12-2017-009.jpg



1698-Ene.-12-2017-010.jpg



1698-Ene.-12-2017-012.jpg



1698-Ene.-12-2017-015.jpg



1698-Ene.-12-2017-016.jpg



1698-Ene.-12-2017-017.jpg

Figure 2-272: Bridge 1698 inspection photos of January 12, 2017 (source: PRHTA)

2.12.3. Images before Hurricane Maria



Figure 2-273: Bridge 1698 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-274: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)



Figure 2-275: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)



Figure 2-276: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)



Figure 2-277: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)



Figure 2-278: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)

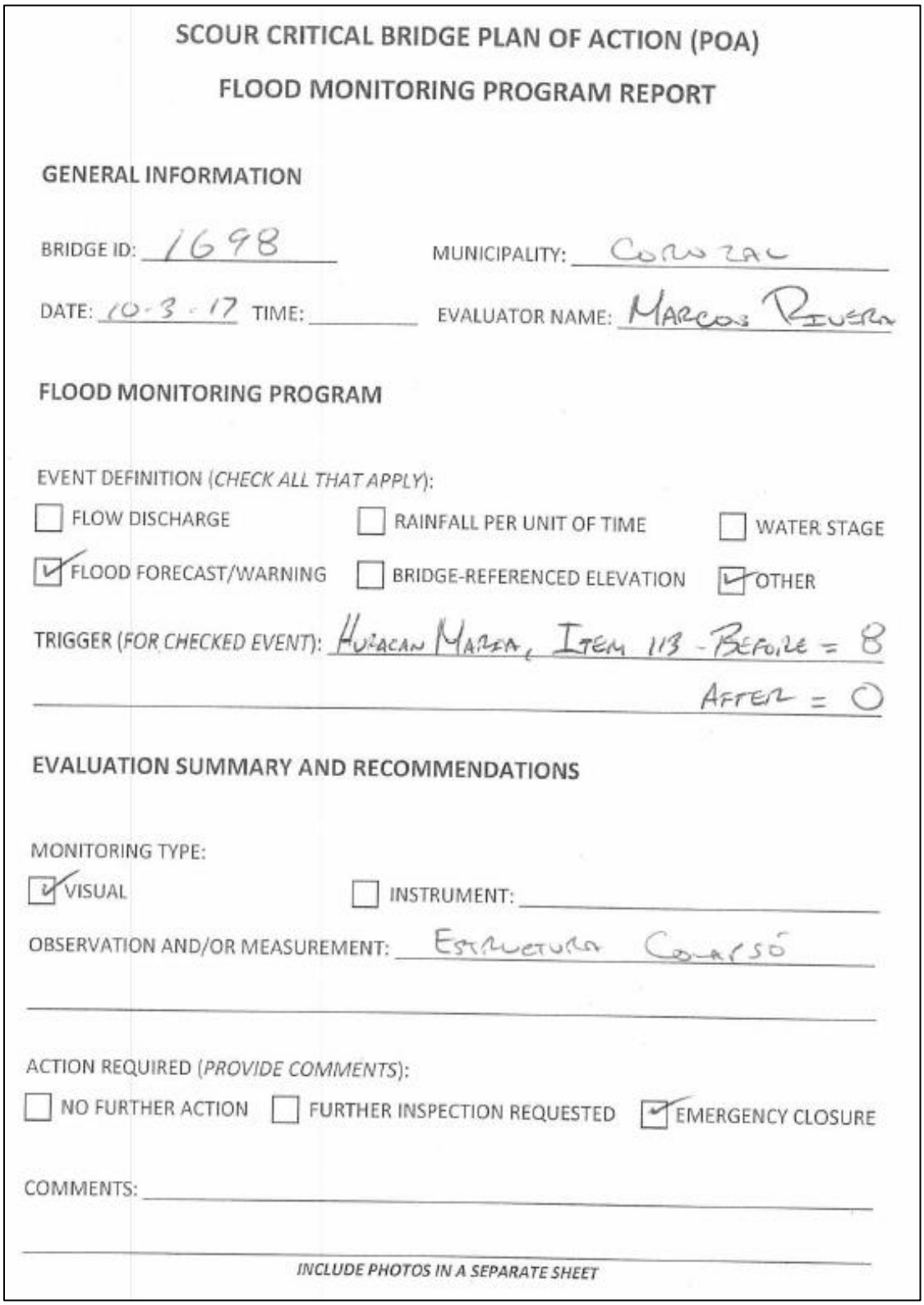


Figure 2-279: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)



Figure 2-280: Bridge 1698 photo from January 12, 2017 inspection (source: PRHTA)

2.12.4. Inspection after Hurricane Maria



SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1698 MUNICIPALITY: Corozal

DATE: 10-3-17 TIME: _____ EVALUATOR NAME: Marcos Rivera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracan Maria, Item 113 - Before = 8

After = 0

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Estructura Colapso

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☑ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-281: Bridge 1698 inspection report from October 3, 2017 (source: PRHTA)

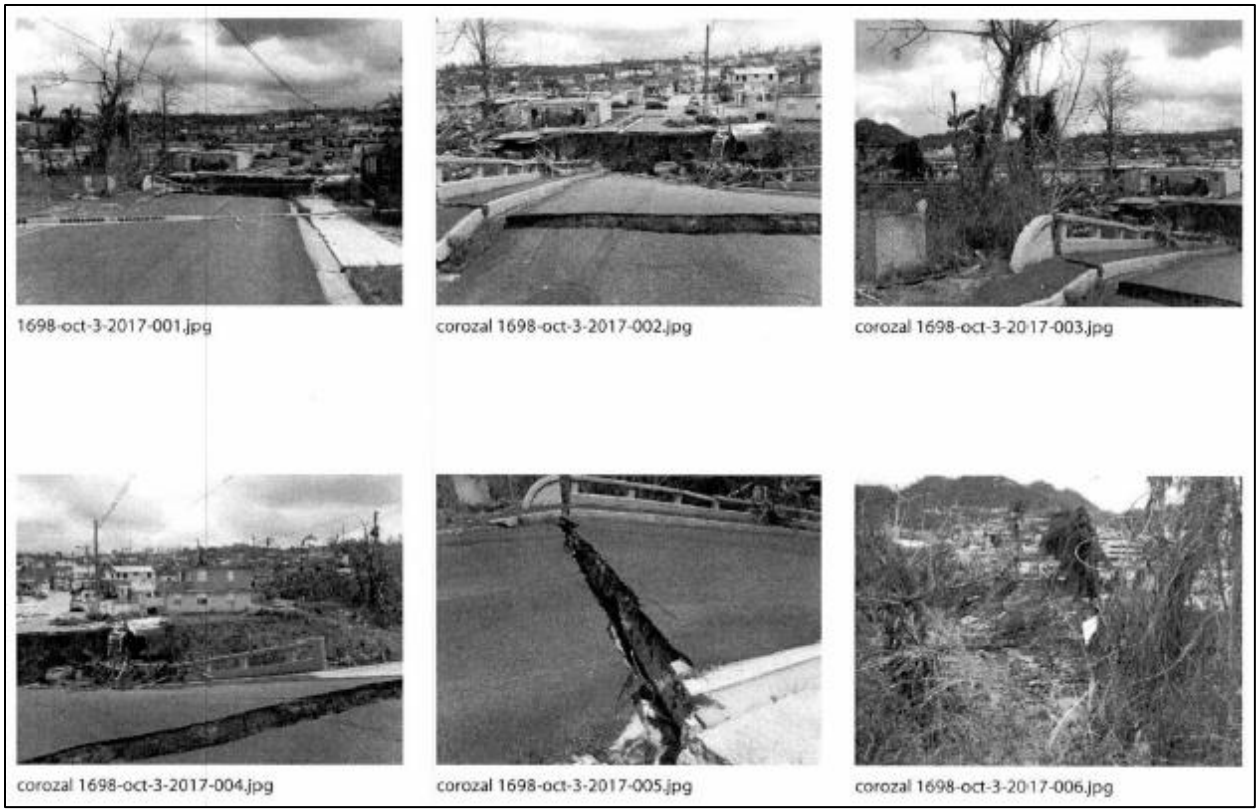


Figure 2-282: Bridge 1698 photos from October 3, 2017 inspection (source: PRHTA)

2.12.5. Images after Hurricane Maria



Figure 2-283: Bridge 1698 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.elnuevodia.com/noticias/locales/fotogalerias/corozal-luego-del-paso-de-maria/

Figure 2-284: Collapsed Bridge 1698 image from news report (source: El Nuevo Día)



https://www.pressreader.com/puerto-rico/el-nuevo-dia1/20171008/281663960222791

Figure 2-285: Collapsed Bridge 1698 image from news report (source: El Nuevo Día)

2.12.6. Videos after Hurricane Maria



https://youtu.be/8D2zXBhQd_s

Video 2-24: Social media video of collapsed Bridge 1698 (source: Nicole Joan Morales Ortiz)

2.12.7. Reconstructed bridge



Figure 2-286: Bridge 1698 replacement (source: PRHTA)



Figure 2-287: Bridge 1698 replacement (source: PRHTA)



Figure 2-288: Bridge 1698 replacement (source: PRHTA)

2.13. Bridge 1714



(Extracted from Figure 2-20)

Note: Bridge was not among the bridges identified as collapsed in the PRHTA inventory. Therefore, no additional information was obtained from PRHTA, including inspection reports prior to Hurricane Maria. In the final stages of this project, as a final check was given to the inventory, a closer look was given to the report of the inspection conducted after Maria. In this report, the inspector stated in Spanish that the bridge collapsed and that the piers had settled, causing the bridge to deform. He also indicated that, at one end, the approach roadway had lost fill material, producing a huge pothole.

2.13.1. General information

Table 2-35: Bridge 1714 general information from BridgeReports.com

Name	OFF PR 330 over DUEY RIVER
Structure number	017141
Location	BO. DUEY FRENTE ESCUELA
Purpose	Carries highway and pedestrian walkway over waterway
Route classification	Local (Rural)
Length of largest span	128.0 ft
Total length	128.0 ft
Roadway width between curbs	18.0 ft
Deck width edge-to-edge	23.6 ft
Skew angle	28°
Owner	City or Municipal Highway Agency
Year built	1976
Historic significance	Bridge is not eligible for the National Register of Historic Places
Design load	MS 18 / HS 20 [5]
Main span material	Steel
Main span design	Stringer/Multi-beam or girder
Deck type	Not applicable

Table 2-36: Bridge 1714 general information from the PRHTA

ID	1714
Highway	OFF PR 330
Municipality	San Germán
Year Built	1976
Functionality	Rural-local
Lanes	2
ADT	250
Maintenance	Municipal Highway Agency
Owner	Municipal Highway Agency
Up Service	Highway-pedestrian
Down Service	Waterway
Width	7.2 m
Length	26.4 m
Spans	3
Under clearance	0
Material	Steel
Design	Stringer or girder
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	5.6 m
Bypass length	199 km
NBI Rating	1
NHS	0
Area	190.08 m^2

2.13.2. Images before Hurricane Maria



Figure 2-289: Bridge 1714 satellite image before Hurricane Maria (source: Google Earth Pro)

2.13.3. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1714 MUNICIPALITY: San Germán

DATE: 22/Sep/2017 TIME: 10:50AM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0 Puente Colapso
Approach PR-330 perdió todo el material de relleno (hueco grande)
Pilero se asentaron y puente esta deformado

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Puente colapso

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-290: Bridge 1714 inspection report from September 22, 2017 (source: PRHTA)



Figure 2-291: Bridge 1714 photos from September 22, 2017 inspection (source: PRHTA)



Figure 2-292: Bridge 1714 photos from September 22, 2017 inspection (source: PRHTA)

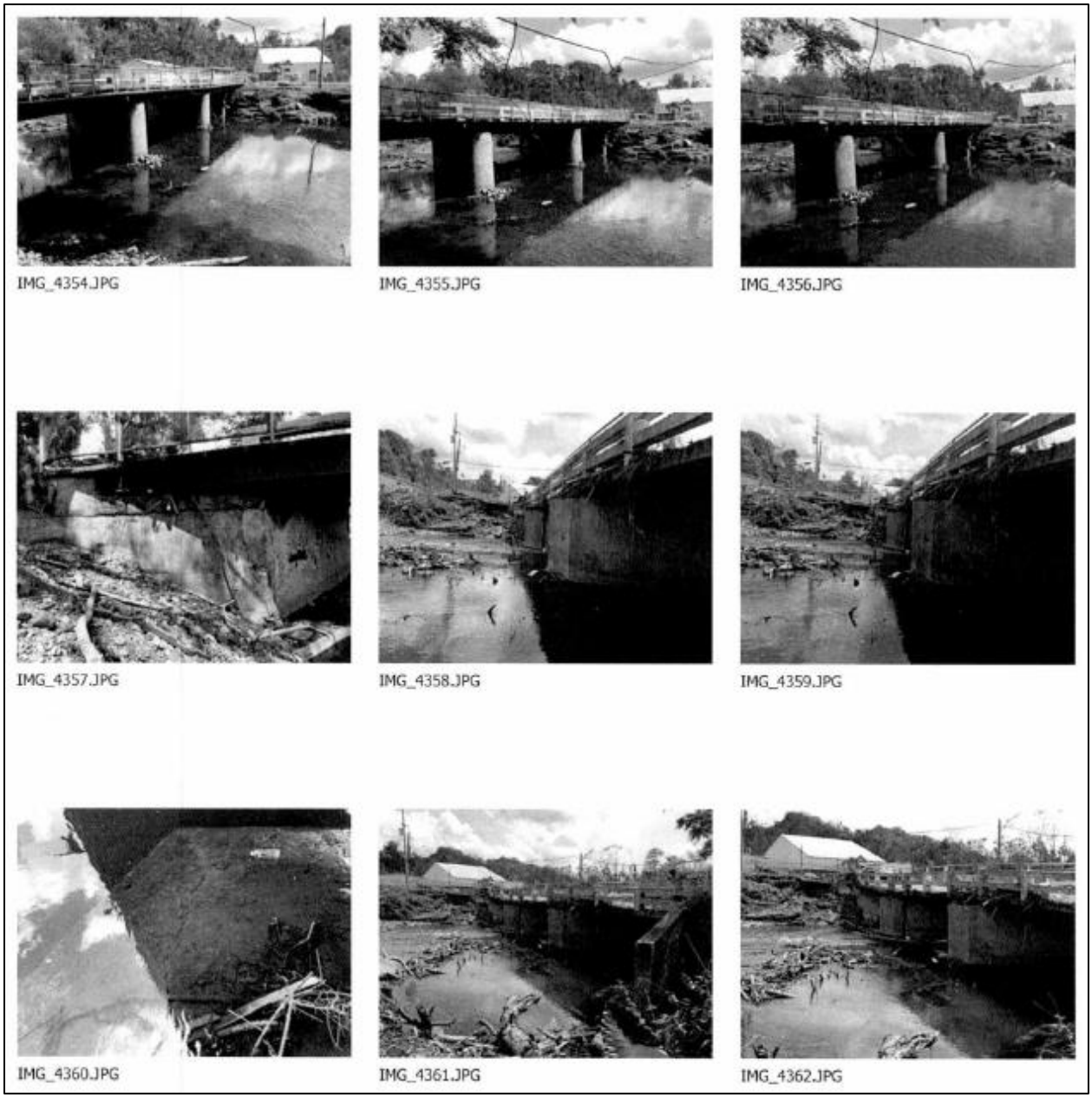


Figure 2-293: Bridge 1714 photos from September 22, 2017 inspection (source: PRHTA)

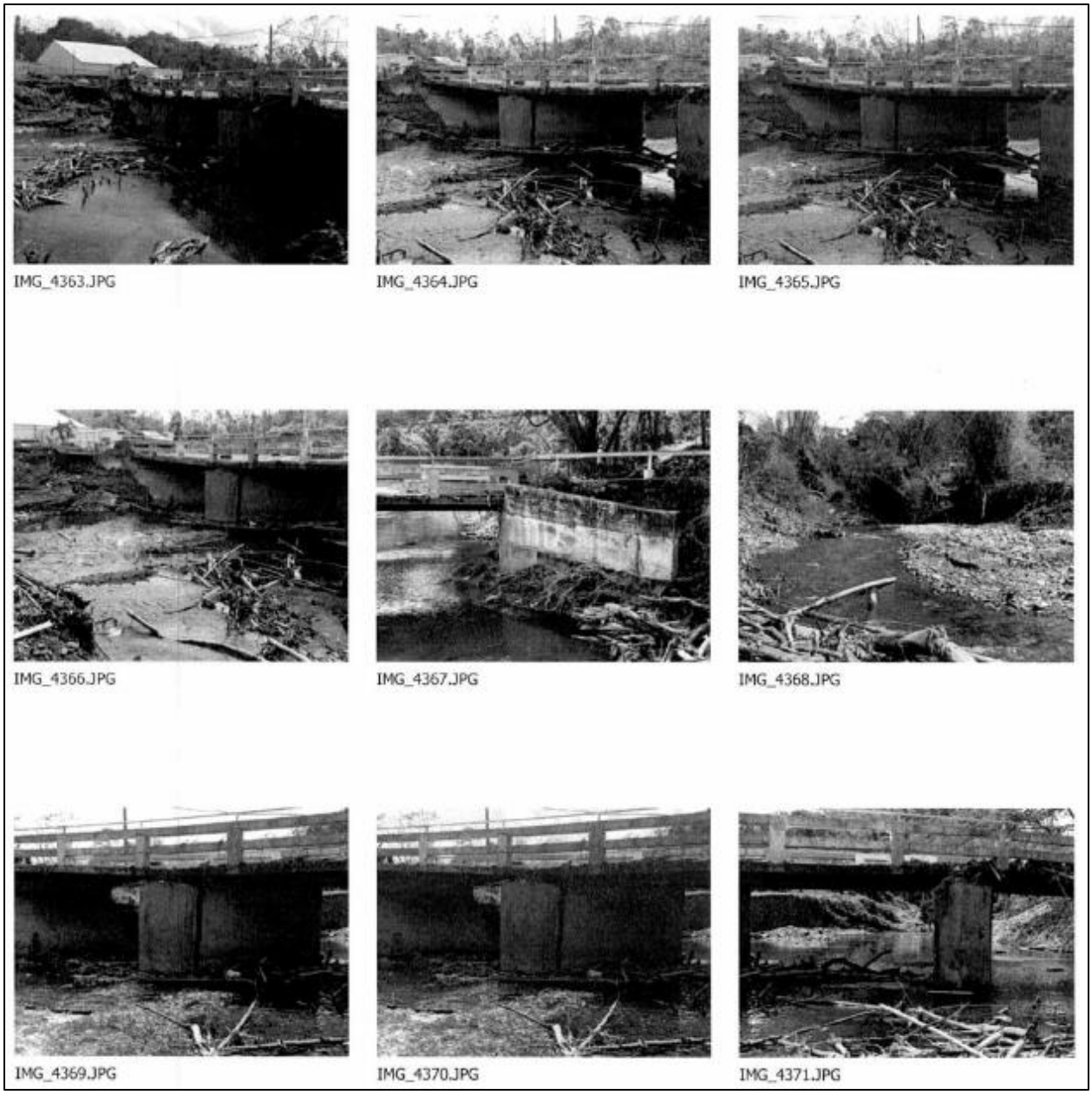


Figure 2-294: Bridge 1714 photos from September 22, 2017 inspection (source: PRHTA)



IMG_4372.JPG



IMG_4373.JPG



IMG_4374.JPG



IMG_4375.JPG



IMG_4376.JPG



IMG_4377.JPG



IMG_4378.JPG



IMG_4379.JPG

Figure 2-295: Bridge 1714 photos from September 22, 2017 inspection (source: PRHTA)

2.13.4. Images after Hurricane Maria



Figure 2-296: Bridge 1714 satellite image after Hurricane Maria (source: NOAA)



Figure 2-297: Bridge 1714 satellite after Hurricane Maria (source: Google Earth Pro)

2.13.5. Temporary replacement



https://www.facebook.com/CiudadDeSanGerman/posts/pfbid02AHWEFMW61kn3H925pzA8U6Yn89LRJP7SyXsxVdFn4hAePVTeAPtBwwFQVA8atFnil

Figure 2-298: Bridge 1714 replacement (source: Ciudad de San Germán)

2.14. Bridge 1728



(Extracted from Figure 2-314)

2.14.1. General information

Table 2-37: Bridge 1728 general information from BridgeReports.com

Name	PR 358 over HOCONUCO RIVER
Structure number	017281
Location	2 KM OF INT PR2 & PR358
Purpose	Carries highway over waterway
Route classification	Minor Collector (Rural)
Length of largest span	4.9 ft
Total length	61.7 ft
Roadway width between curbs	16.1 ft
Deck width edge-to-edge	18.0 ft
Owner	State Highway Agency
Year built	1978
Historic significance	Bridge is no eligible for the National Register of Historic Places
Number of main spans	11
Main spans material	Concrete
Main spans design	Culvert
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-38: Bridge 1728 general information from the PRHTA

ID	1728
Highway	PR-358
Municipality	San German
Year Built	1978
Functionality	Rural-minor collector
Lanes	2
ADT	1,000
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	Waterway
Width	5.5 m
Length	18.8 m
Spans	11
Under clearance	0
Material	Concrete
Design	Culvert
Scour Critical	4
Inspection Frequency	24 months
Approach Roadway Width	4.6 m
Bypass length	6 km
NBI Rating	1
NHS	0
Area	103.4 m^2

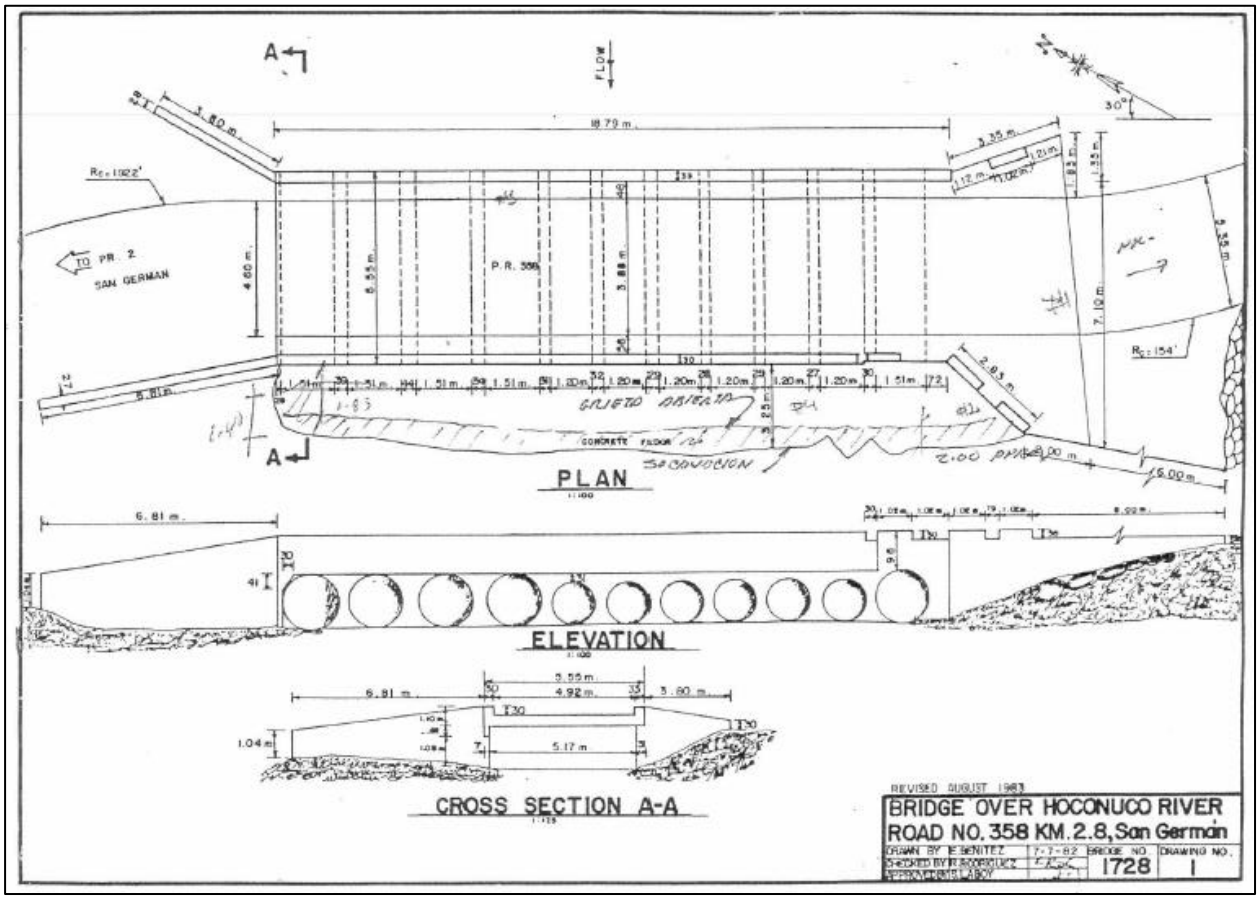


Figure 2-299: Bridge 1728 drawings (source: PRHTA)

2.14.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-1728**

TEAM LEADER: Micky Santiago

BRIDGE EVALUATOR: Kiomarie Valle

INSP. DATE: **May 12, 2017**

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	12 ~~24~~	April-2015	May-~~2019~~ 2018
ITEM 93 A	FC Inspection	NA			
ITEM 93 B	Underwater Insp.	NA			
ITEM 93 C	Other: SI ~~Super~~ Scour	NA	12	—	May 2018

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	N	N	N	3	4	4	A
Current Inspection	N	N	N	3	4	4	A

Other Checks:(Y, N, NA)

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's& NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Review Comments:

✓ – 55 @ 12 x SCOUR
arrcglar pons – OK ICV C.

Reviewer: _____

Safety Eng.: _____

Figure 2-300: Bridge 1728 inspection summary of May 12, 2017 (source: PRHTA)



1728-May.-12-2017-001.jpg



1728-May.-12-2017-007.jpg



1728-May.-12-2017-008.jpg



1728-May.-12-2017-011.jpg



1728-May.-12-2017-013.jpg



1728-May.-12-2017-015.jpg



1728-May.-12-2017-019.jpg



1728-May.-12-2017-026.jpg



1728-May.-12-2017-027.jpg

Figure 2-301: Bridge 1728 inspection photos of May 12, 2017 (source: PRHTA)

2.14.3. Images before Hurricane Maria

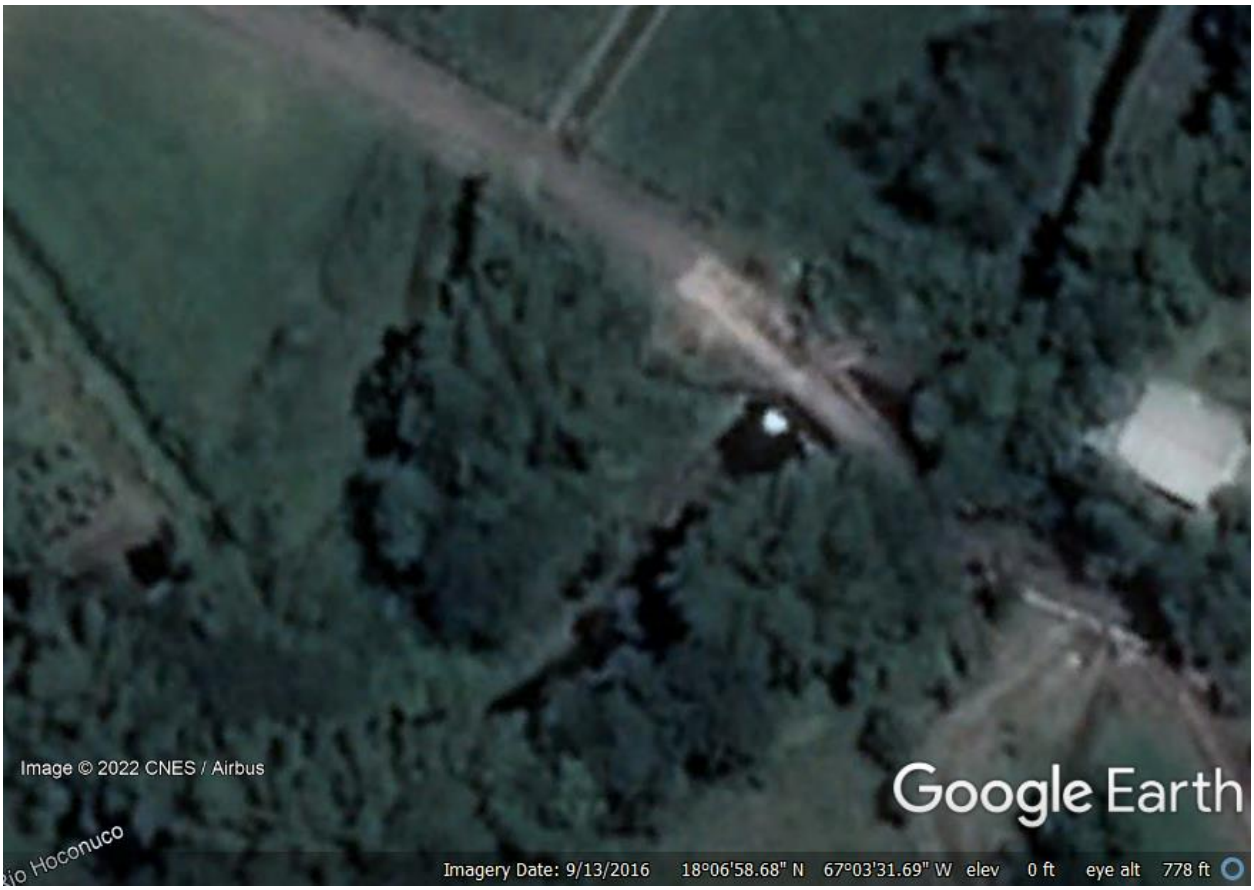


Figure 2-302: Bridge 1728 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-303: Bridge 1728 photo from May 12, 2017 inspection (source: PRHTA)



Figure 2-304: Bridge 1728 photo from May 12, 2017 inspection (source: PRHTA)



Figure 2-305: Bridge 1728 photo from May 12, 2017 inspection (source: PRHTA)



Figure 2-306: Bridge 1728 photo from May 12, 2017 inspection (source: PRHTA)



Figure 2-307: Bridge 1728 photo from May 12, 2017 inspection (source: PRHTA)

2.14.4. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1728 MUNICIPALITY: San Lorenzo

DATE: 23/Sep/2017 TIME: 3:48 PM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, 10 barrels socavados y desgarrados

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Puente colapsó, barrels fallecon

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-308: Bridge 1728 inspection report from September 23, 2017 (source: PRHTA)



Figure 2-309: Bridge 1728 photos from September 23, 2017 inspection (source: PRHTA)



Figure 2-310: Bridge 1728 photos from September 23, 2017 inspection (source: PRHTA)

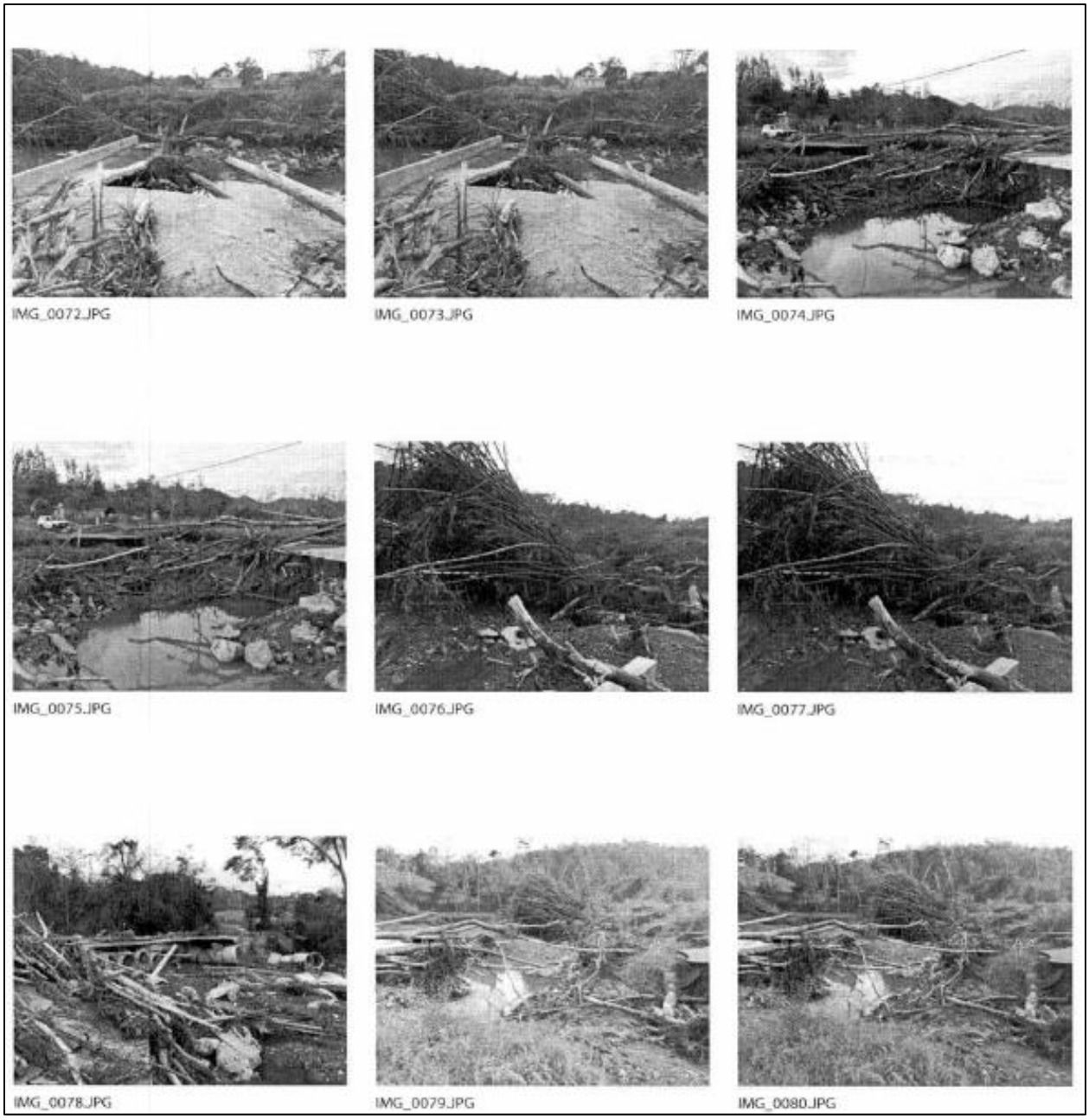


Figure 2-311: Bridge 1728 photos from September 23, 2017 inspection (source: PRHTA)

2.14.5. Images after Hurricane Maria



Figure 2-312: Bridge 1728 satellite image after Hurricane Maria (source: NOAA)



Figure 2-313: Bridge 1728 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.facebook.com/coleccionistas.coampi/posts/pfbid02dmkS5Yj5xfGKM9HtopEMJMnpTaMgPoUZMu6Hi3bUBXnLk6Zpoo7b8KxtJptGzTW2l

Figure 2-314: Social media image of collapsed Bridge 1728 (source: Coleccionistas Coampi)



https://www.facebook.com/leyda.ortiz.50/posts/pfbid0x6h8PLThDAdQGsCY2tuDMe1HEZ6HavjUc9GmS9enXR3AUMCY4xJAxkfXatstEAVDl

Figure 2-315: Social media image of collapsed Bridge 1728 (source: Leyda Ortiz)



https://www.facebook.com/miriam.cruzmiranda.92/posts/pfbid03pURP2c5Bwcv49qtz9KHAwyuqLxJwg6fZXzrcPtCJwL5vdepFMfNzawSjkjTzUgwl

Figure 2-316: Social media image of collapsed Bridge 1728 (source: Miriam Cruz Miranda)



https://www.facebook.com/miriam.cruzmiranda.92/posts/pfbid03pURP2c5Bwcv49qtz9KHAwyuqLxJwg6fZXzrcPtCJwL5vdepFMfNzawSjkjTzUgwl

Figure 2-317: Social media image of collapsed Bridge 1728 (source: Miriam Cruz Miranda)



https://www.facebook.com/miriam.cruzmiranda.92/posts/pfbid03pURP2c5Bwcv49qtz9KHAwyuqLxJwg6fZXzrcPtCJwL5vdepFMfNzawSjkjTzUgwl

Figure 2-318: Social media image of collapsed Bridge 1728 (source: Miriam Cruz Miranda)

2.14.6. Temporary replacement



https://www.facebook.com/noticiasareaoeste/photos/a.1645033062390018/2313724465520871/

Figure 2-319: Bridge 1728 replacement (source: Noticias Área Oeste)

2.15. Bridge 1733



(Extracted from Figure 2-332)

2.15.1. General information

Table 2-39: Bridge 1733 general information from BridgeReports.com

Name	PR 111 over EL SALTO CREEK
Structure number	017331
Location	5 KM N W OF SAN SEBASTIAN
Purpose	Carries highway over waterway
Route classification	Minor Arterial (Rural)
Length of largest span	11.5 ft
Total length	25.9 ft
Roadway width between curbs	-
Deck width edge-to-edge	-
Owner	State Highway Agency
Year built	1980
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	2
Main spans material	Steel
Main spans design	Culvert
Deck type	Not applicable
Wearing surface	-

Table 2-40: Bridge 1733 general information from the PRHTA

ID	1733
Highway	PR-111
Municipality	San Sebastian
Year Built	1980
Functionality	Rural-minor arterial
Lanes	2
ADT	26000
Maintenance	State highway agency
Owner	State highway agency
Up Service	Highway
Down Service	Waterway
Width	15.1 m
Length	7.9 m
Spans	2
Under clearance	0
Material	Steel
Design	Culvert
Scour Critical	8
Inspection Frequency	6 months
Approach Roadway Width	15.1 m
Bypass length	6 km
NBI Rating	1
NHS	0
Area	119.29 m^2

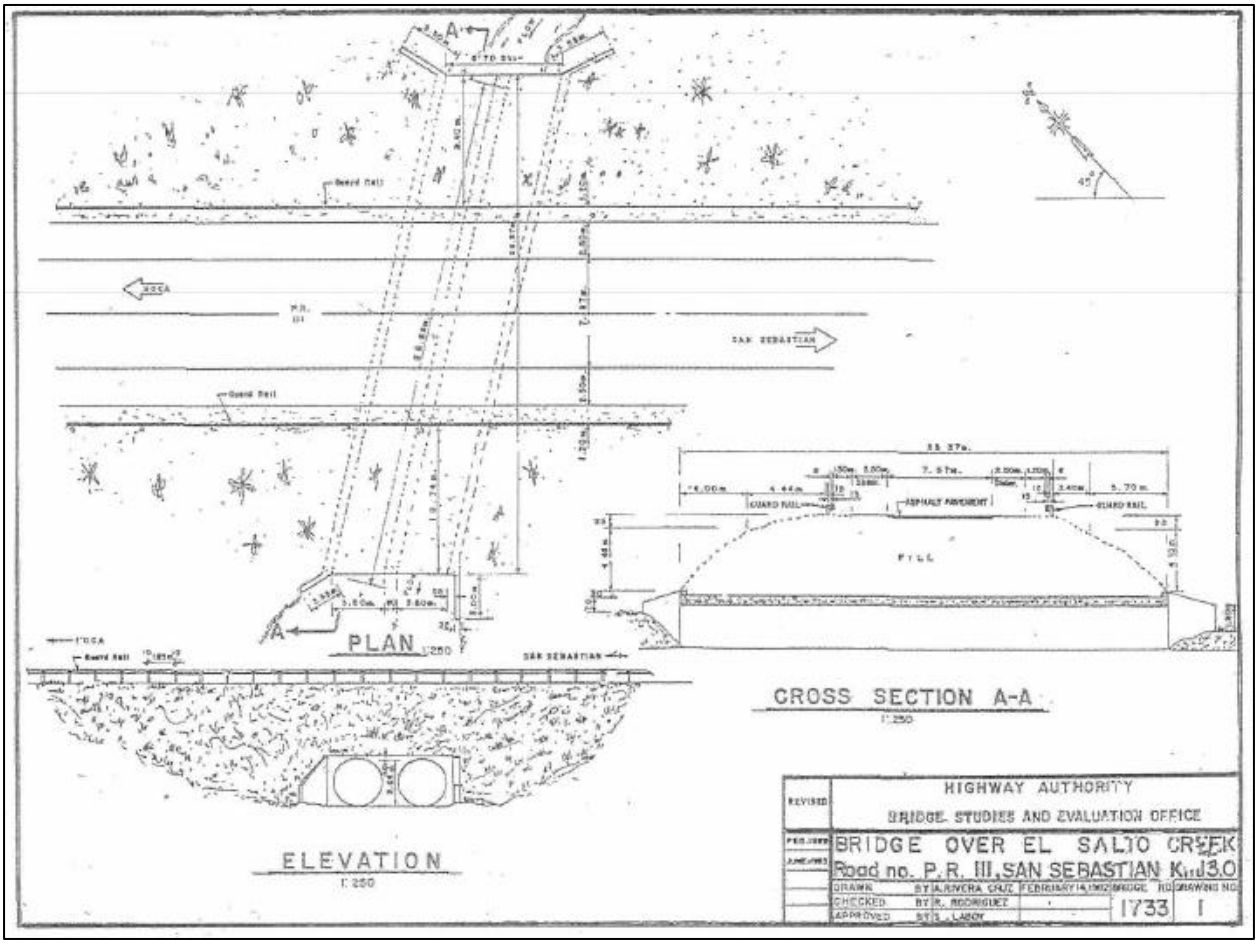


Figure 2-320: Bridge 1733 drawings (source: PRHTA)

2.15.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: **BR-1733**

TEAM LEADER: Eric W. Ríos Mera

BRIDGE EVALUATOR: Saúl J. Sandoval

INSPECTION DATE: **July 14, 2016**

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	6	1/2016	1/2017
ITEM 93 A	FC Inspection	NA			
ITEM 93 B	Underwater Insp.	NA			
ITEM 93 C	Other: SI Culvert	Yes	6	1/2016	1/2017

2. NBI Condition Rating Summary & Field Review of Bridge Posting:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113	Item 41
Previous Inspection	N	N	N	5	2	8	A
Current Inspection	N	N	N	5	2	8	A

Other Checks:(Y, N, NA)

Review Comments:

_✓_ Scour Critical (items 113 & 60)
_✓_ AASHTO Core's& NBI CD consistent
_✓_ Smart Flags (scour, steel plate, fire damage, etc)
_✓_ Channel Profile/Clearance Table
_✓_ FC & Underwater Members Tables
_✓_ Asphalt Overlay Thickness
_✓_ Drawings
_✓_ Photos
_✓_ Critical Finding
_✓_ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-321: Bridge 1733 inspection summary of July 14, 2016 (source: PRHTA)



Figure 2-322: Bridge 1733 inspection photos of July 14, 2016 (source: PRHTA)

Note: According to the National Bridge Inventory, another inspection was conducted in July 2017. The Report Summary and QC Sheet and the photos of this inspection were not available.

2.15.3. Images before Hurricane Maria



Figure 2-323: Bridge 1733 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-324: Bridge 1733 photo from January 12, 2016 inspection (source: PRHTA)



Figure 2-325: Bridge 1733 photo from January 12, 2016 inspection (source: PRHTA)



Figure 2-326: Bridge 1733 photo from January 12, 2016 inspection (source: PRHTA)

2.15.4. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1733 MUNICIPALITY: Moca

DATE: 22/Sep/2017 TIME: 12:10 PM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María – 20/Sep/2017

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, tubos corrugados colapsados

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Cerrado, Puente Colapsó (2 tubos corrugados fallaron)

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-327: Bridge 1733 inspection report from September 22, 2017 (source: PRHTA)

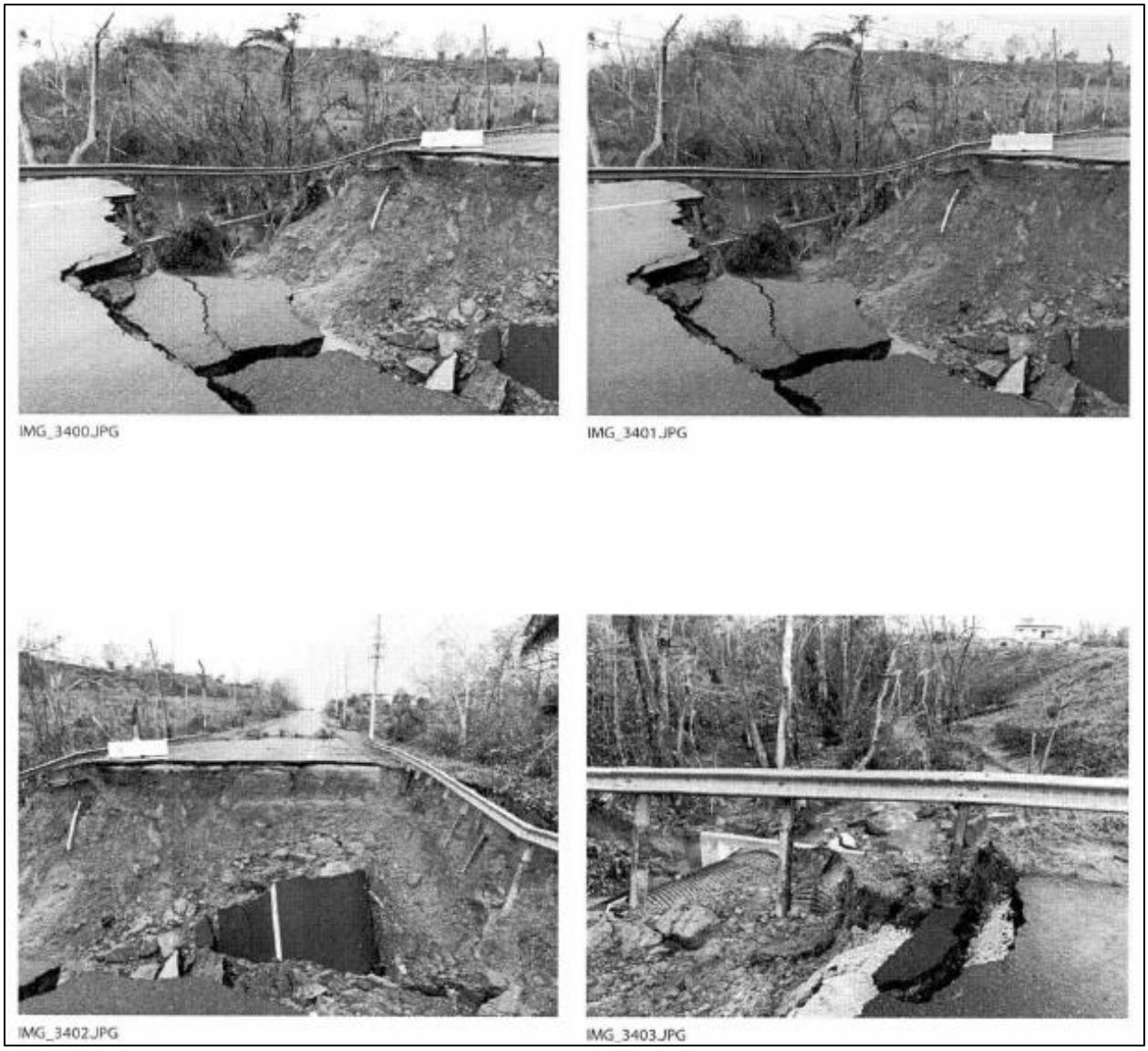


Figure 2-328: Bridge 1733 photos from September 22, 2017 inspection (source: PRHTA)



Figure 2-329: Bridge 1733 photos from September 22, 2017 inspection (source: PRHTA)

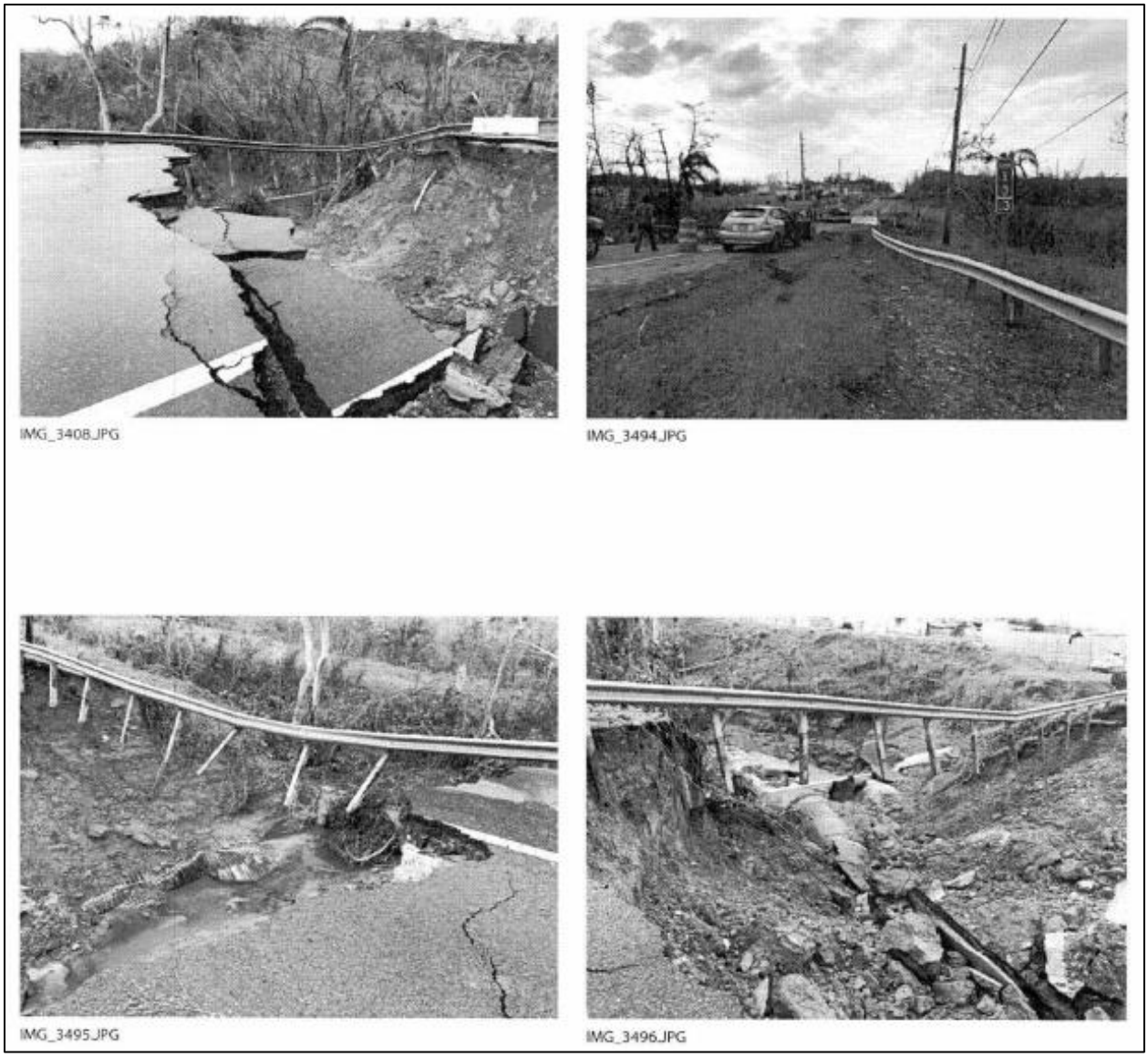


Figure 2-330: Bridge 1733 photos from September 22, 2017 inspection (source: PRHTA)

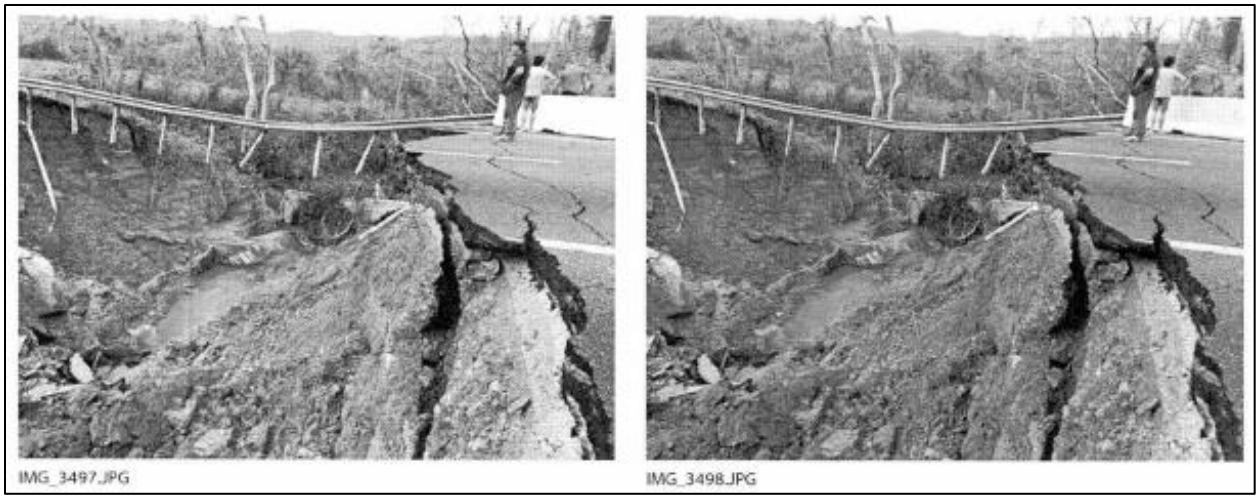


Figure 2-331: Bridge 1733 photos from September 22, 2017 inspection (source: PRHTA)

2.15.5. Images after Hurricane Maria



Figure 2-332: Bridge 1733 satellite image after Hurricane Maria (source: NOAA)



Figure 2-333: Bridge 1733 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.facebook.com/Mariahuracan20deseptiembre/posts/722078228251589

Figure 2-334: Social media image of collapsed Bridge 1733 (source: Joaquín Lebrón Rosado)



https://huracanmaria.elnuevodia.com/2017/municipio/moca

Figure 2-335: Collapsed Bridge 1733 image from news report (source: El Nuevo Día)



https://www.cbsnews.com/pictures/hurricane-maria-puerto-ricos-long-road-to-recovery/26/

Figure 2-336: Collapsed Bridge 1733 image from news report (source: CBS News)

2.15.6. Videos after Hurricane Maria



https://twitter.com/NotiUno/status/911381359637221376

Video 2-25: News report about collapsed Bridge 1733 (source: NotiUno 630)

2.15.7. Temporary Replacement



Figure 2-337: Bridge 1733 replacement (source: PRHTA)

2.16. Bridge 1917



(Extracted from Figure 2-353)

2.16.1. General information

Table 2-41: Bridge 1917 general information from BridgeReports.com

Name	PR 627 over GRANDE DE ARECIBO RIVER
Structure number	019171
Location	11 KM S E OF ARECIBO
Purpose	Carries highway over waterway
Route classification	Minor Collector
Length of largest span	43.3 ft
Total length	337.9 ft
Roadway width between curbs	16.4 ft
Deck width edge-to-edge	18.7 ft
Owner	State Highway Agency
Year built	1988
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	8
Main spans material	Concrete Continuous
Main spans design	Slab
Deck type	Concrete Cast=in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-42: Bridge 1917 general information from the PRHTA

ID	1917
Highway	PR-627
Municipality	Arecibo
Year Built	1988
Functionality	Rural-minor collector
Lanes	2
ADT	259
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	highway
Down Service	Waterway
Width	5.7 m
Length	103 m
Spans	8
Under clearance	0
Material	Concrete Continuous
Design	Slab
Scour Critical	-
Inspection Frequency	24 months
Approach Roadway Width	6.1 m
Bypass length	199 km
NBI Rating	2
NHS	0
Area	587.1 m^2

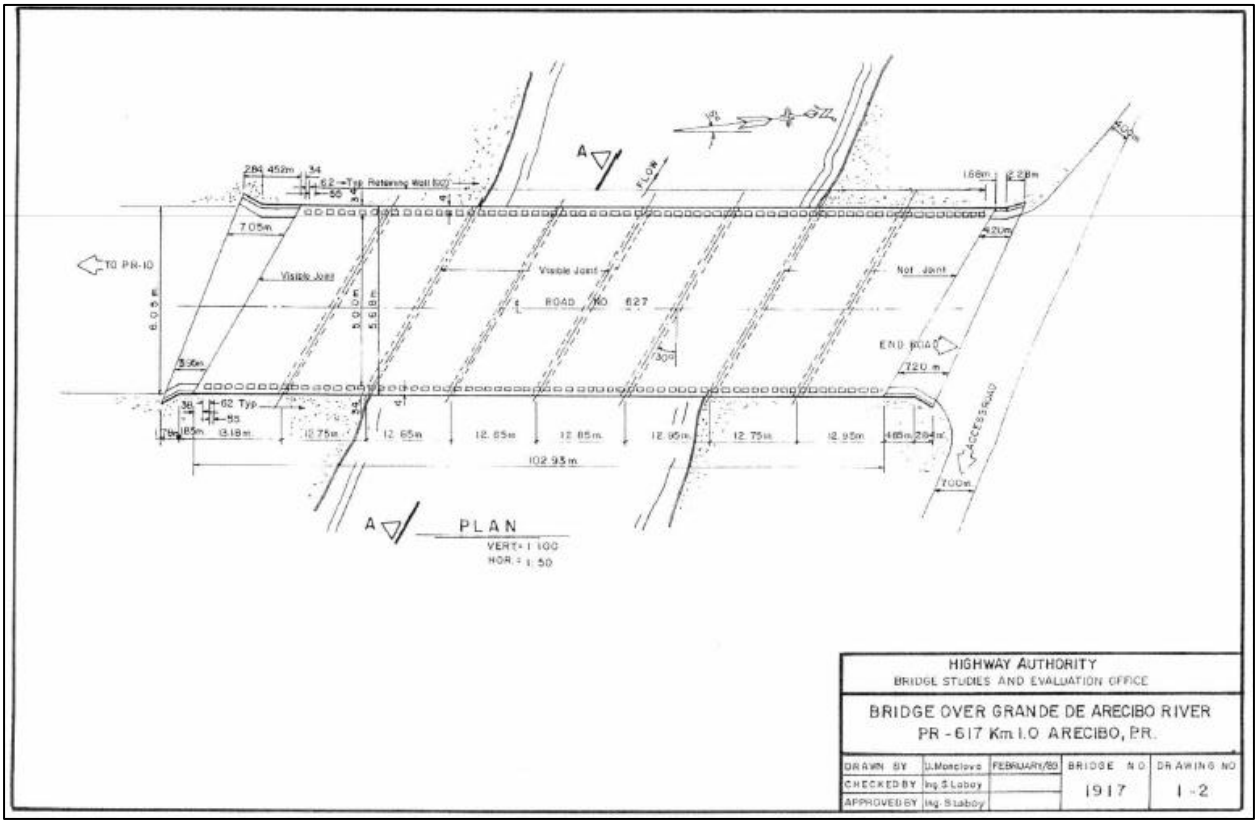


Figure 2-338: Bridge 1917 drawings (source: PRHTA)

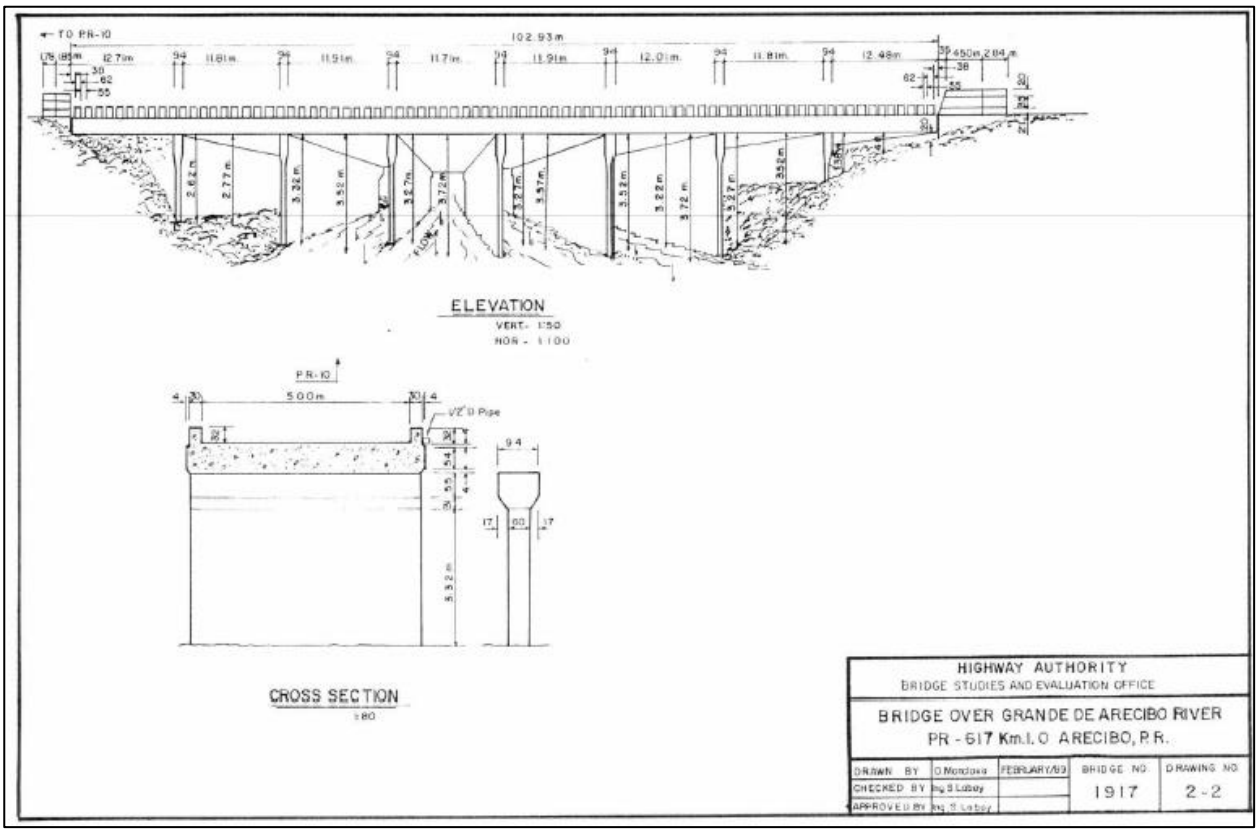


Figure 2-339: Bridge 1917 drawings (source: PRHTA)

2.16.2. Inspection before Hurricane Maria

Note: The last inspection of Bridge 1917 before Hurricane Maria was carried out on July 28, 2017. The Report Summary and QC Sheet of this inspection was not available. Therefore, Figure 2-340 shows the summary of the July 2015 inspection. The photos of the July 2017 inspection were made available, as shown in Figure 2-341.

INSPECTION REPORT SUMMARY & QCSHEET

BRIDGE: **BR-1917**

TEAM LEADER: **Eric W. Ríos Mera**

INSP. DATE: **July 30, 2015**

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp.DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	24	7/2013	7/2017
ITEM 93 A	FC Inspection	No			
ITEM 93 B	Underwater Insp.	No			
ITEM 93 C	Other:	No			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	6	6	5	7	N	4
Current Inspection	6	6	5	7	N	4

Other Checks:(Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's& NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-340: Bridge 1917 inspection summary of July 15, 2015 (source: PRHTA)



Figure 2-341: Bridge 1917 inspection photos of July 28, 2017 (source: PRHTA)

2.16.3. Images before Hurricane Maria



Figure 2-342: Bridge 1917 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-343: Bridge 1917 photo from July 28, 2017 inspection (source: PRHTA)



Figure 2-344: Bridge 1917 photo from July 28, 2017 inspection (source: PRHTA)



Figure 2-345: Bridge 1917 photo from July 28, 2017 inspection (source: PRHTA)



Figure 2-346: Bridge 1917 photo from July 28, 2017 inspection (source: PRHTA)



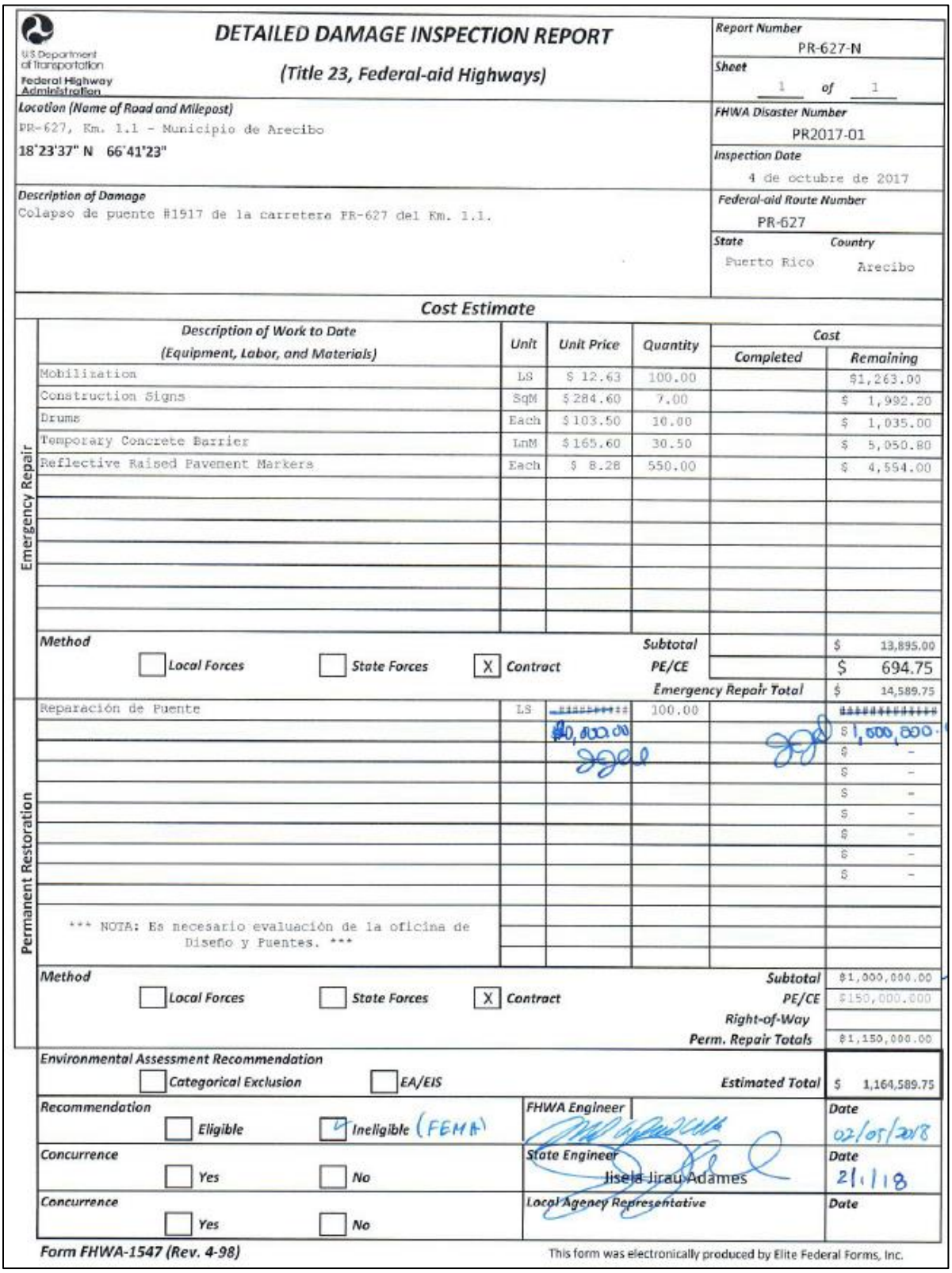
Figure 2-347: Bridge 1917 photo from July 28, 2017 inspection (source: PRHTA)

2.16.4. Streamflow

Table 2-43: Peak streamflow at Grande de Arecibo River Near San Pedro monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-04-23	16.08	19,900
2011	2010-10-08	18.53	30,500
2012	2012-03-28	19.70	36,400
2013	2012-11-20	11.75	6,350
2014	2014-08-24	15.36	17,100
2015	2014-11-04	10.98	5,360
2016	2015-10-26	9.932	3,600
2017	2017-09-20	33.32	164,000

2.16.5. Inspections after Hurricane Maria



U.S Department of Transportation
Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number: PR-627-N
Sheet: 1 of 1

Location (Name of Road and Milepost): PR-627, Km. 1.1 - Municipio de Arecibo
18°23'37" N 66°41'23"

FHWA Disaster Number: PR2017-01
Inspection Date: 4 de octubre de 2017

Description of Damage: Colapso de puente #1917 de la carretera PR-627 del Km. 1.1.

Federal-aid Route Number: PR-627
State: Puerto Rico
Country: Arecibo

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Mobilization	LS	$ 12.63	100.00		$1,263.00
Construction Signs	SqM	$ 284.60	7.00		$ 1,992.20
Drums	Each	$ 103.50	10.00		$ 1,035.00
Temporary Concrete Barrier	LnM	$ 165.60	30.50		$ 5,050.80
Reflective Raised Pavement Markers	Each	$ 8.28	550.00		$ 4,554.00
				Subtotal	$ 13,895.00
				PE/CE	$ 694.75
				Emergency Repair Total	$ 14,589.75

Method: [ ] Local Forces [ ] State Forces [X] Contract

Permanent Restoration

Reparación de Puente	LS	$1,000,000	100.00		$ 1,000,000
*** NOTA: Es necesario evaluación de la oficina de Diseño y Puentes. ***					
				Subtotal	$1,000,000.00
				PE/CE	$150,000.000
				Right-of-Way	
				Perm. Repair Totals	$1,150,000.00

Method: [ ] Local Forces [ ] State Forces [X] Contract

Environmental Assessment Recommendation: [ ] Categorical Exclusion [ ] EA/EIS

Estimated Total: $ 1,164,589.75

Recommendation: [ ] Eligible [✓] Ineligible (FEMA)
FHWA Engineer: Date 02/05/2018

Concurrence: [ ] Yes [ ] No
State Engineer: Jisela Jirau Adames Date 2/1/18

Concurrence: [ ] Yes [ ] No
Local Agency Representative: Date

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 2-348: Bridge 1917 inspection report from October 4, 2017 (source: FHWA)

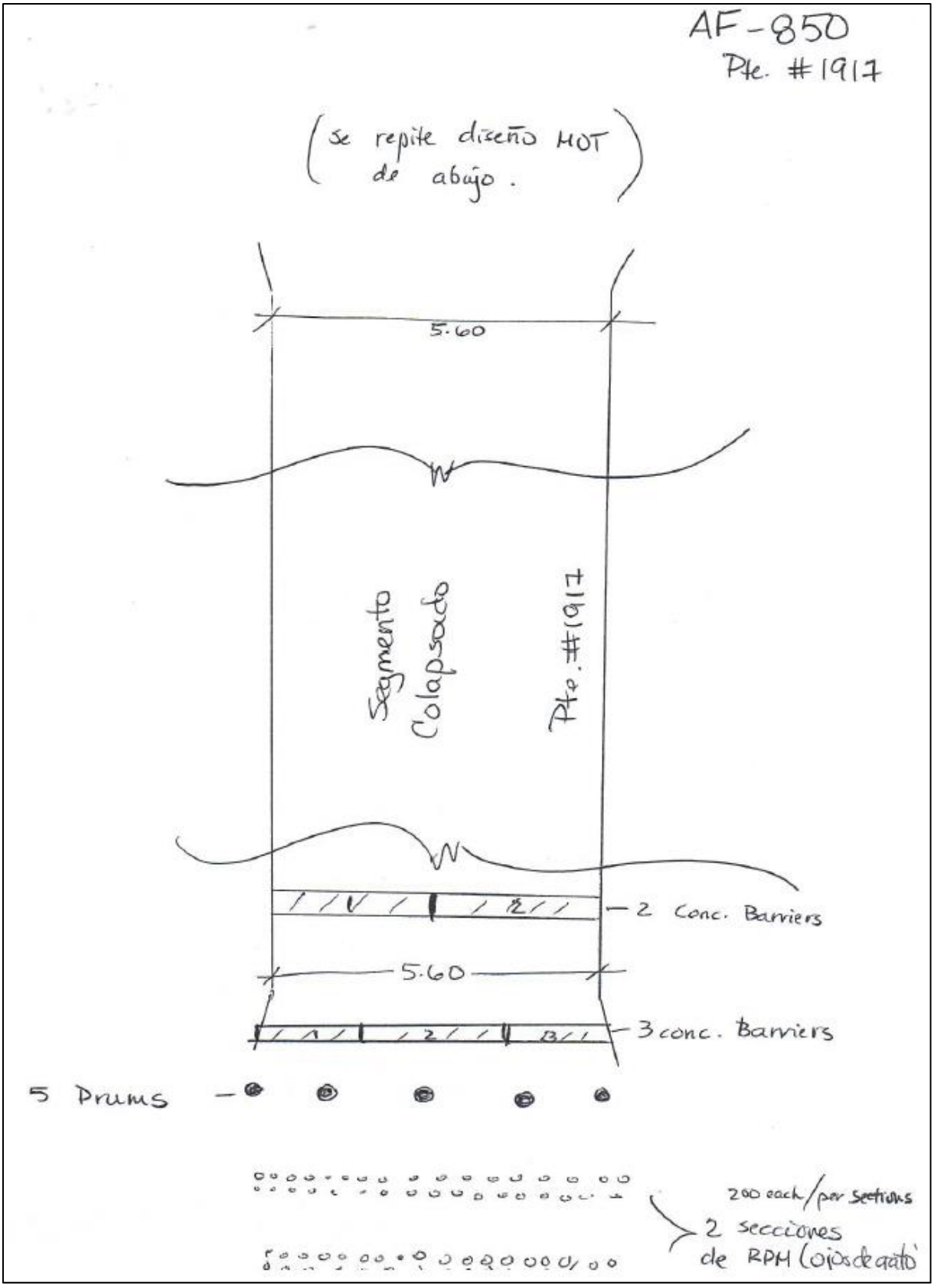


Figure 2-349: Bridge 1917 diagram from October 4, 2017 inspection report (source: FHWA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1917 MUNICIPALITY: ~~Utuado~~ Arecibo

DATE: 10/5/17 TIME: 9:50am EVALUATOR NAME: Christian Bermos

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ ~~OTHER~~

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Bridge has four (4) spans collapsed due to contraction in corner spans.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: Bridge already collapsed and reported to office.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-350: Bridge 1917 inspection report from October 5, 2017 (source: PRHTA)

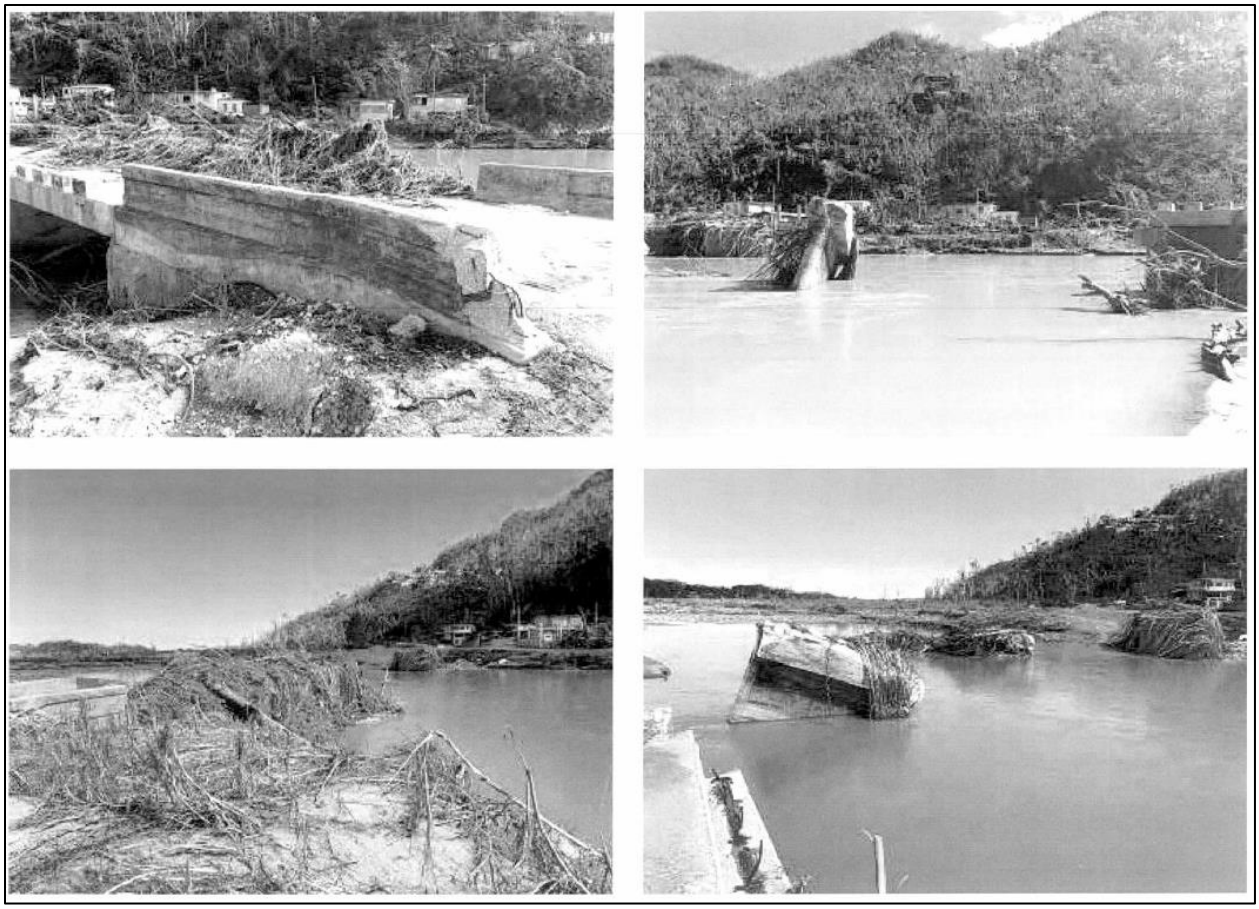


Figure 2-351: Bridge 1917 photos from October 5, 2017 inspection (source: PRHTA)

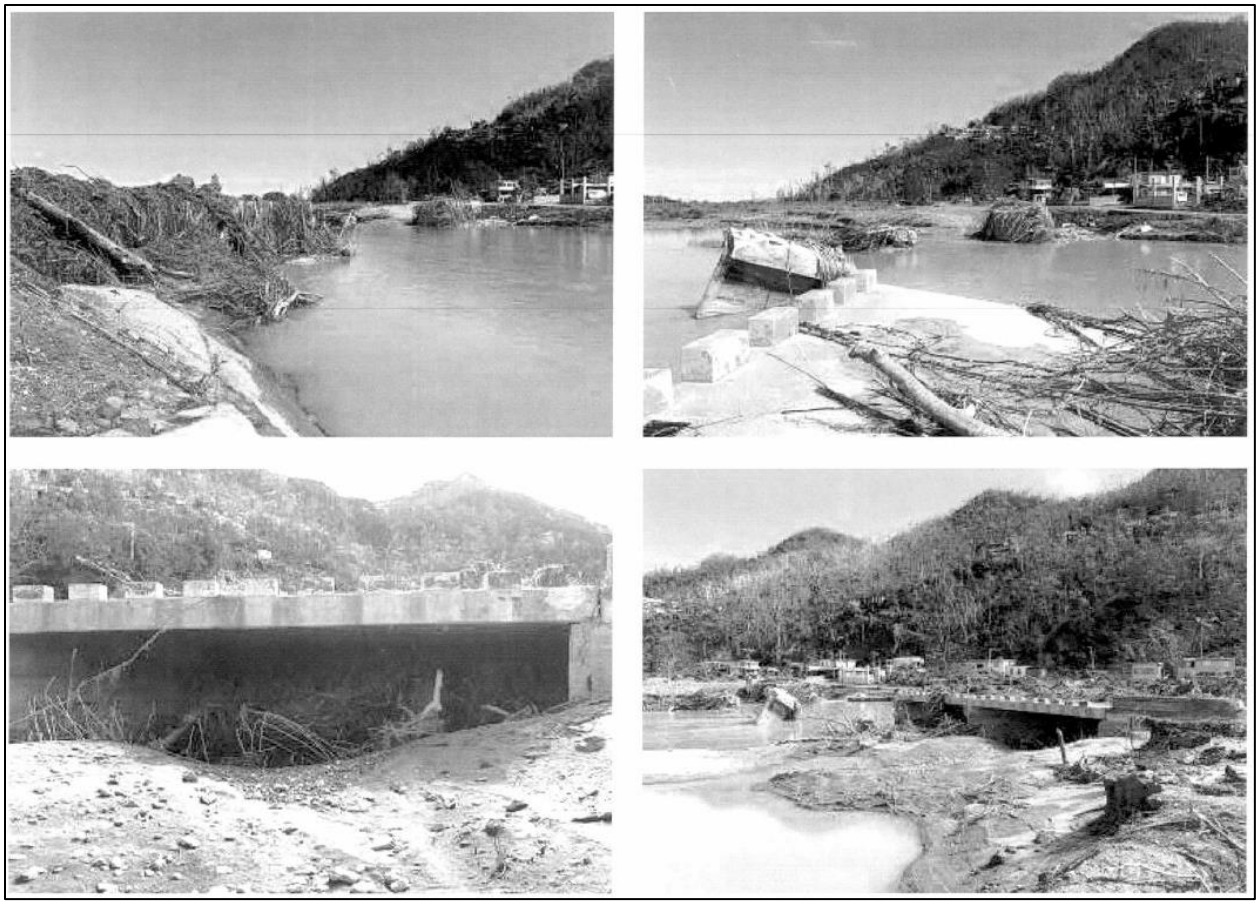


Figure 2-352: Bridge 1917 photos from October 5, 2017 inspection (source: PRHTA)

2.16.6. Images after Hurricane Maria



Figure 2-353: Bridge 1917 satellite image after Hurricane Maria (source: NOAA)



Figure 2-354: Bridge 1917 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 2-355: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-356: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-357: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-358: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-359: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-360: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-361: Collapsed Bridge 1917 (source: PRHTA)



Figure 2-362: Collapsed Bridge 1917 (source: PRHTA)



https://www.atlantafed.org/economy-matters/inside-the-fed/2018/01/04/atlanta-fed-cash-staff-steps-up-to-support-puerto-rico

Figure 2-363: Social media image of collapsed Bridge 1917 (source: FEMA)



https://www.mabeybridge.com/es/noticias-y-medios/news/el-nuevo-puente-de-mabey-consigue-reconectar-las-comunidades-puertorriquenas-tras-el-huracan-maria

Figure 2-364: Social media image of collapsed Bridge 1917 (source: Mabey Bridge)



http://www.carroconstruction.com/pr_FEMA_Bridge1917_Arecibo.html

Figure 2-365: Social media image of collapsed Bridge 1917 (source: Construcciones José Carro)



http://www.carroconstruction.com/pr_FEMA_Bridge1917_Arecibo.html

Figure 2-366: Social media image of collapsed Bridge 1917 (source: Construcciones José Carro)

2.16.7. Temporary replacement



https://www.mabeybridge.com/es/noticias-y-medios/news/el-nuevo-puente-de-mabey-consigue-reconectar-las-comunidades-puertorriquenas-tras-el-huracan-maria

Figure 2-367: Bridge 1917 replacement (source: Mabey Bridge)

2.17. Bridge 1962



(Extracted from Figure 2-388)

2.17.1. General information

Table 2-44: Bridge 1962 general information from BridgeReports.com

Name	PR 151 over JACAGUAS RIVER
Structure number	019621
Location	EAST SIDE OF VILLALBA
Purpose	Carries highway and pedestrian walkway over waterway
Route classification	Minor Collector (Rural)
Length of largest span	47.9 ft
Total length	153.6 ft
Roadway width between curbs	24.0 ft
Deck width edge-to-edge	40.0 ft
Owner	State Highway Agency
Year built	1990
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	3
Main spans material	Concrete
Main spans design	Box beam or girders - Multiple
Deck type	Concrete Precast Panels
Wearing surface	Bituminous

Table 2-45: Bridge 1962 general information from the PRHTA

ID	1962
Highway	PR 151 km 0.17
Municipality	Villalba
Year Built	1990
Functionality	Rural-minor collector
Lanes	2
ADT	7200
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway-Pedestrian
Down Service	Waterway
Width	12.2 m
Length	46.8 m
Spans	3
Under clearance	0
Material	Concrete
Design	Box Beam or Girder-Simple
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	7.5 m
Bypass length	9 km
NBI Rating	2
NHS	0
Area	570.96 m^2

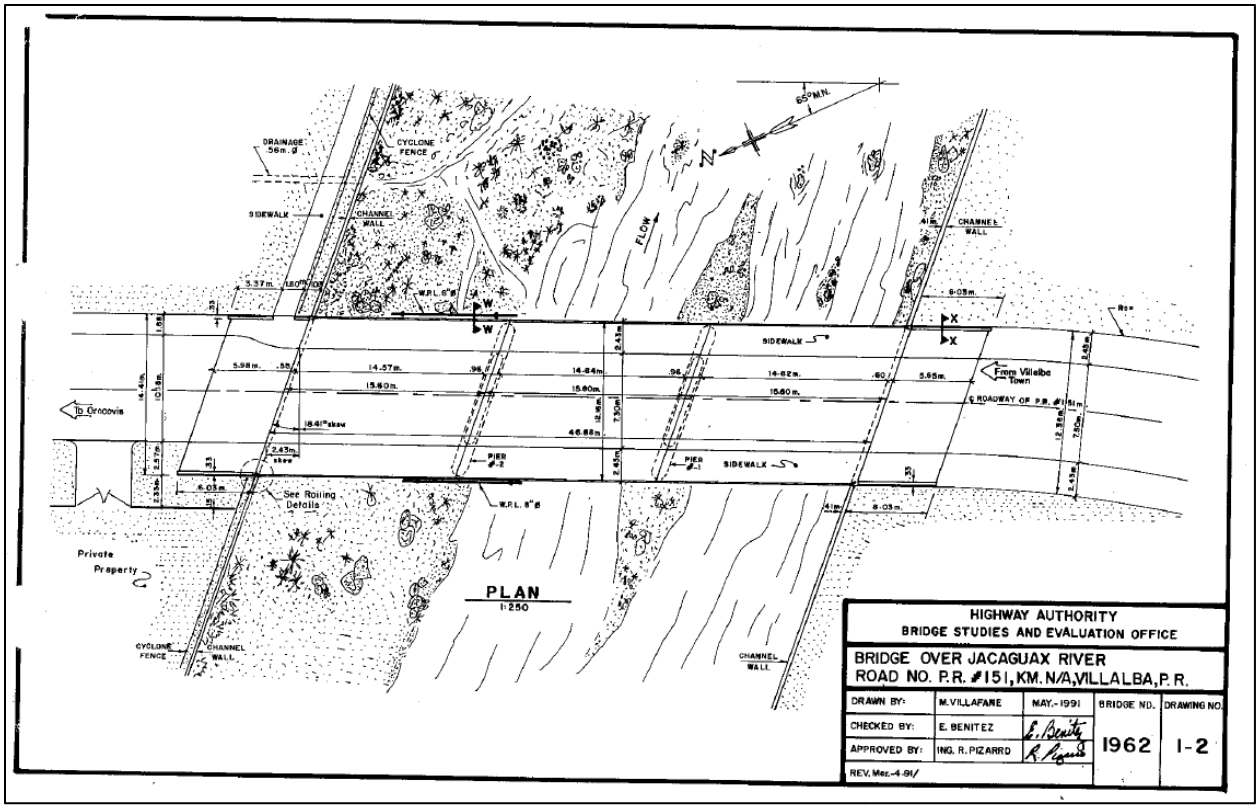


Figure 2-368: Bridge 1962 drawings (source: PRHTA)

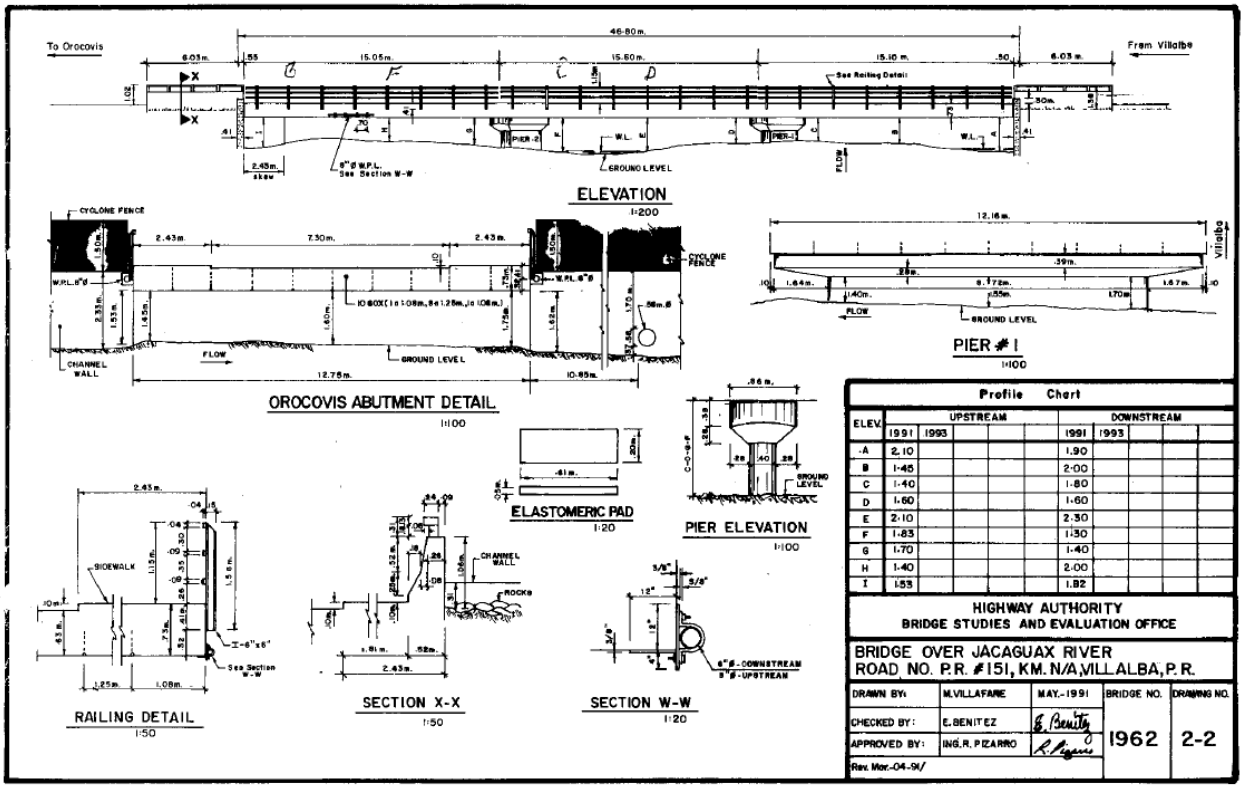


Figure 2-369: Bridge 1962 drawings (source: PRHTA)

2.17.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 1962

TEAM LEADER: Heriberto González Medina/Inspector: Carlos Garcia

INSP. DATE: 14 - Octubre - 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	Oct. 2014	Oct. 2018
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other:	—			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	8	8	7	7	N	8
Current Inspection	6	7	7	7	N	8

Other Checks: (Y, N, NA)

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Review Comments:

OK CHG Clearance Table

Reviewer: [signature]

Safety Eng.: [signature]

Figure 2-370: Bridge 1962 inspection summary of October 14, 2016 (source: PRHTA)

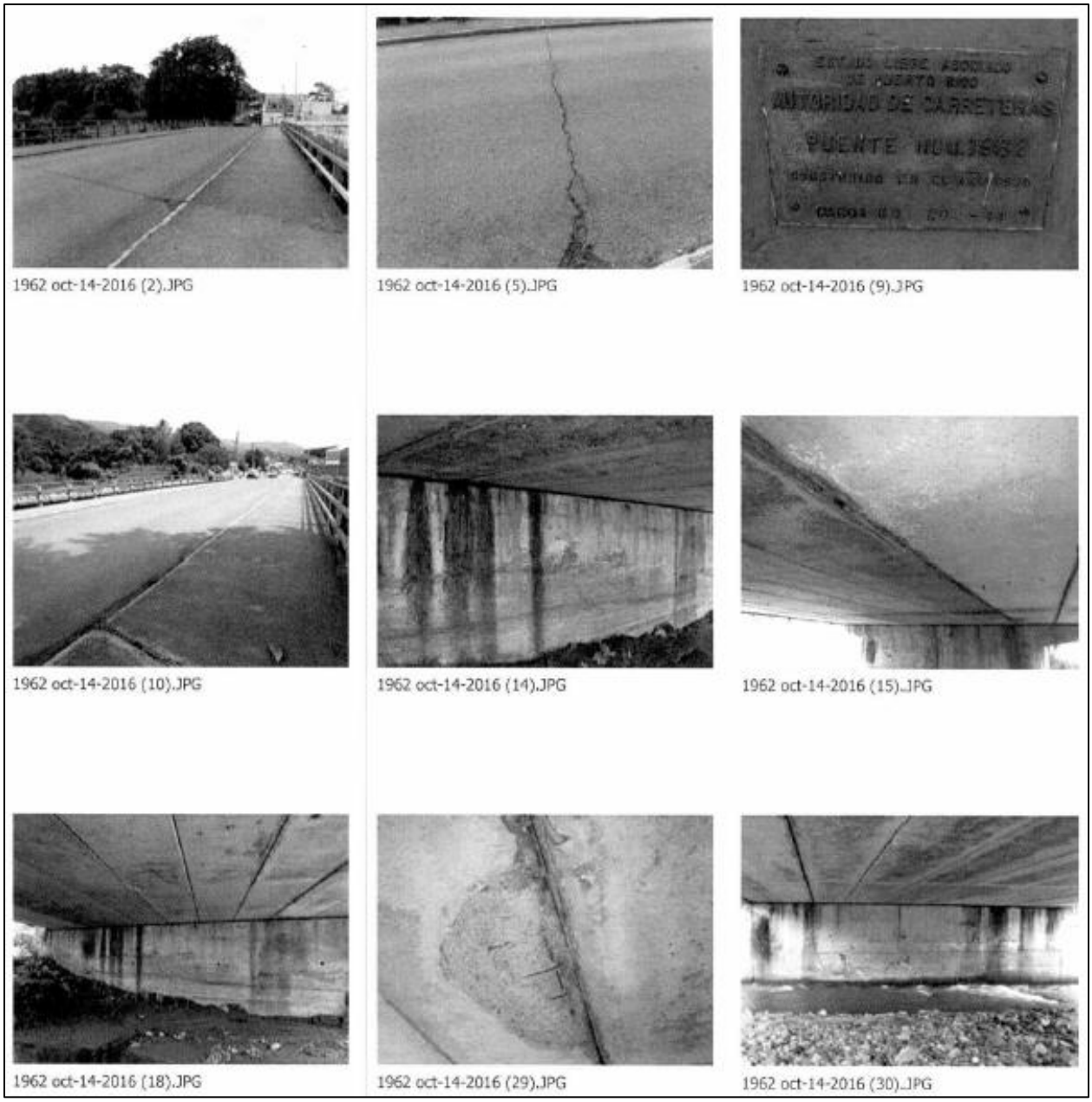


Figure 2-371: Bridge 1962 inspection photos of October 14, 2016 (source: PRHTA)

2.17.3. Images before Hurricane Maria



Figure 2-372: Bridge 1962 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-373: Bridge 1962 photo from October 29, 2014 inspection (source: PRHTA)



Figure 2-374: Bridge 1962 photo from October 29, 2014 inspection (source: PRHTA)



Figure 2-375: Bridge 1962 photo from October 29, 2014 inspection (source: PRHTA)



Figure 2-376: Bridge 1962 photo from October 29, 2014 inspection (source: PRHTA)



Figure 2-377: Bridge 1962 photo from October 29, 2014 inspection (source: PRHTA)

2.17.4. Streamflow

Table 2-46: Peak streamflow at Jacaguas River Above Lago Guayabal monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	N/A	N/A	N/A
2011	N/A	N/A	N/A
2012	N/A	N/A	N/A
2013	2012-10-26	10.61	4,520
2014	2014-08-23	12.87	9,600
2015	2015-04-20	10.90	5,030
2016	2016-08-28	12.29	7,990
2017	2017-09-20	17.19	21,000

2.17.5. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1962 MUNICIPALITY: Villalba

DATE: 23/Sep/2017 TIME: 2:20PM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, tramo estribo puente falló, canal falló

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Cerrado, tramo estribo puente colapsó

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-378: Bridge 1962 inspection report from September 23, 2017 (source: PRHTA)

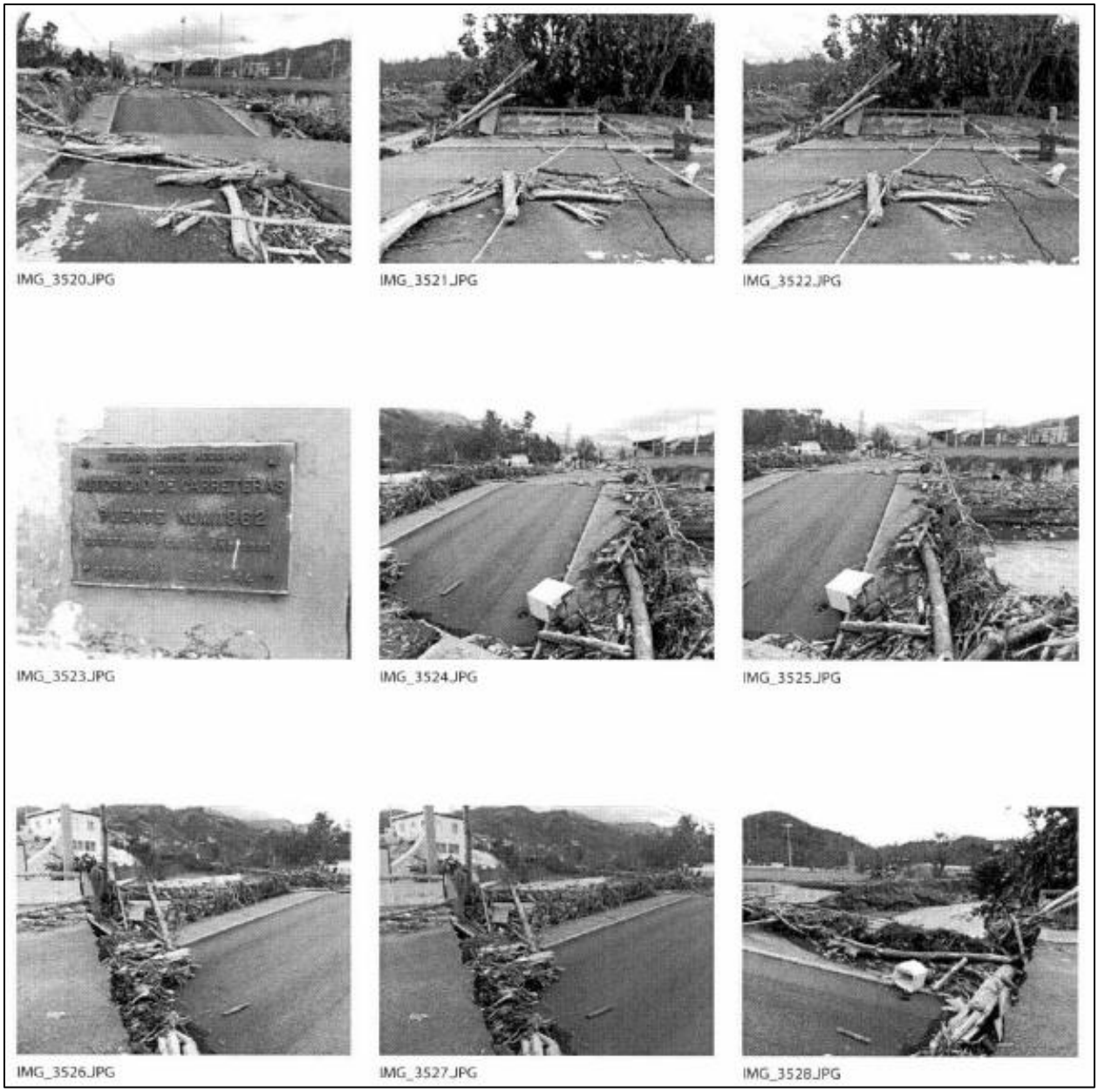


Figure 2-379: Bridge 1962 photos from September 23, 2017 inspection (source: PRHTA)



Figure 2-380: Bridge 1962 photos from September 23, 2017 inspection (source: PRHTA)



Figure 2-381: Bridge 1962 photos from September 23, 2017 inspection (source: PRHTA)



Figure 2-382: Bridge 1962 photos from September 23, 2017 inspection (source: PRHTA)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1962 MUNICIPALITY: Villalba

DATE: 24/oct./17 TIME: 11:45 EVALUATOR NAME: H. Santiago

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*): Huracan María

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☒ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☐ OTHER

TRIGGER (*FOR CHECKED EVENT*): Field Item 113: Ats = 8

Actual = 0

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Las aguas sobre pasaron la estructura mucha acumulación de sedimento, escombros y basura en spn #2 y #3. Estribo falló, colapsando el spn #1, estructura cerrada

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: _____

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-383: Bridge 1962 inspection report from October 24, 2017 (source: PRHTA)

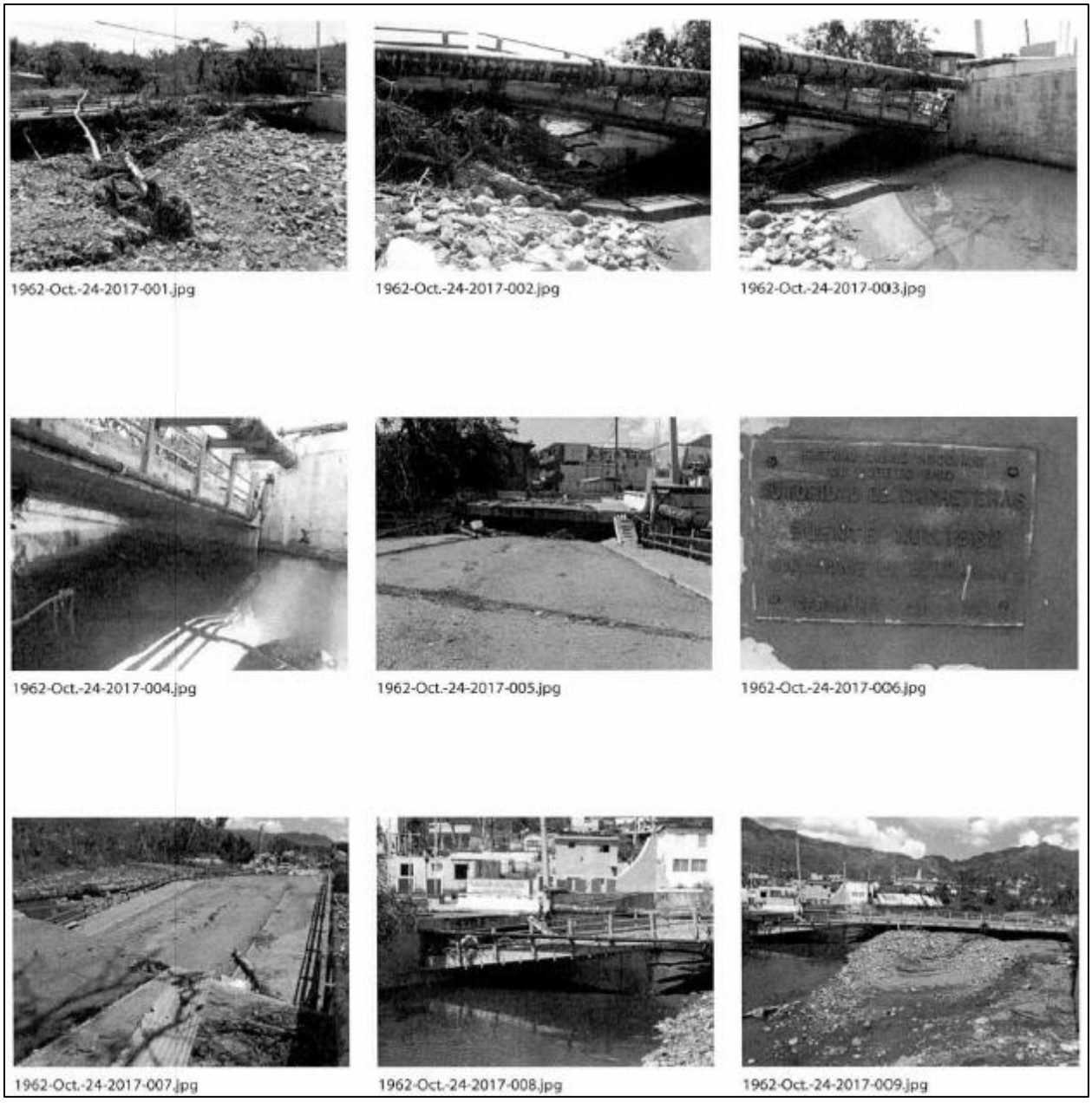
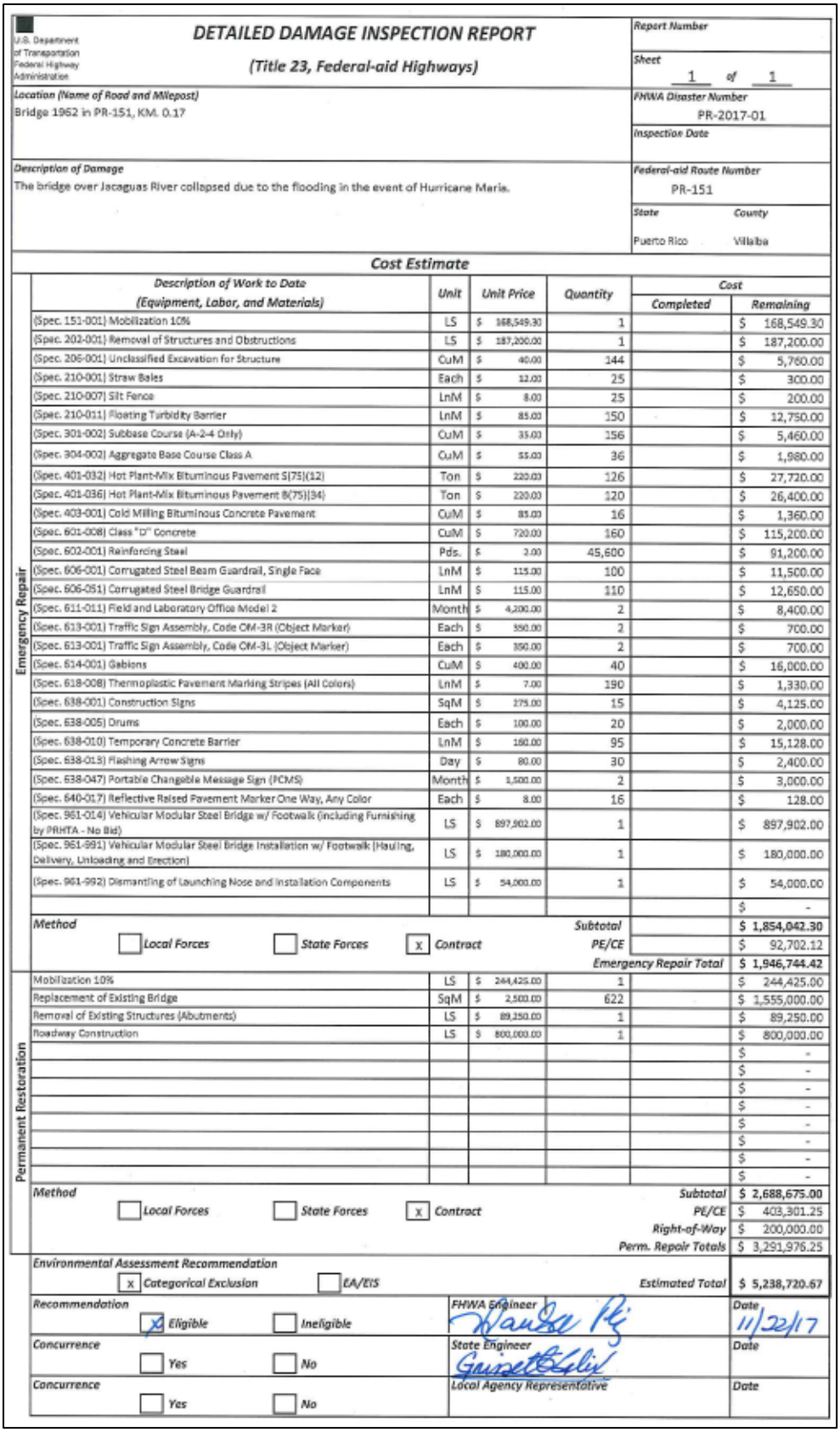


Figure 2-384: Bridge 1962 photos from October 24, 2017 inspection (source: PRHTA)



U.S. Department of Transportation Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 1

Location (Name of Road and Milepost)
Bridge 1962 in PR-151, KM. 0.17

FHWA Disaster Number
PR-2017-01

Inspection Date

Description of Damage
The bridge over Jacaguas River collapsed due to the flooding in the event of Hurricane Maria.

Federal-aid Route Number
PR-151

State: Puerto Rico
County: Villalba

Cost Estimate

	Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Emergency Repair	(Spec. 151-001) Mobilization 10%	LS	$ 168,549.30	1		$ 168,549.30
	(Spec. 202-001) Removal of Structures and Obstructions	LS	$ 187,200.00	1		$ 187,200.00
	(Spec. 206-001) Unclassified Excavation for Structure	CuM	$ 40.00	144		$ 5,760.00
	(Spec. 210-001) Straw Bales	Each	$ 12.00	25		$ 300.00
	(Spec. 210-007) Silt Fence	LnM	$ 8.00	25		$ 200.00
	(Spec. 210-011) Floating Turbidity Barrier	LnM	$ 85.00	150		$ 12,750.00
	(Spec. 301-002) Subbase Course (A-2-4 Only)	CuM	$ 35.00	156		$ 5,460.00
	(Spec. 304-002) Aggregate Base Course Class A	CuM	$ 55.00	36		$ 1,980.00
	(Spec. 401-032) Hot Plant-Mix Bituminous Pavement S(75)(12)	Ton	$ 220.00	126		$ 27,720.00
	(Spec. 401-036) Hot Plant-Mix Bituminous Pavement B(75)(34)	Ton	$ 220.00	120		$ 26,400.00
	(Spec. 403-001) Cold Milling Bituminous Concrete Pavement	CuM	$ 85.00	16		$ 1,360.00
	(Spec. 601-008) Class "D" Concrete	CuM	$ 720.00	160		$ 115,200.00
	(Spec. 602-001) Reinforcing Steel	Pds.	$ 2.00	45,600		$ 91,200.00
	(Spec. 606-001) Corrugated Steel Beam Guardrail, Single Face	LnM	$ 115.00	100		$ 11,500.00
	(Spec. 606-051) Corrugated Steel Bridge Guardrail	LnM	$ 115.00	110		$ 12,650.00
	(Spec. 611-011) Field and Laboratory Office Model 2	Month	$ 4,200.00	2		$ 8,400.00
	(Spec. 613-001) Traffic Sign Assembly, Code OM-3R (Object Marker)	Each	$ 350.00	2		$ 700.00
	(Spec. 613-001) Traffic Sign Assembly, Code OM-3L (Object Marker)	Each	$ 350.00	2		$ 700.00
	(Spec. 614-001) Gabions	CuM	$ 400.00	40		$ 16,000.00
	(Spec. 618-008) Thermoplastic Pavement Marking Stripes (All Colors)	LnM	$ 7.00	190		$ 1,330.00
	(Spec. 638-001) Construction Signs	SqM	$ 275.00	15		$ 4,125.00
	(Spec. 638-005) Drums	Each	$ 100.00	20		$ 2,000.00
	(Spec. 638-010) Temporary Concrete Barrier	LnM	$ 160.00	95		$ 15,128.00
	(Spec. 638-013) Flashing Arrow Signs	Day	$ 80.00	30		$ 2,400.00
	(Spec. 638-047) Portable Changeble Message Sign (PCMS)	Month	$ 1,500.00	2		$ 3,000.00
	(Spec. 640-017) Reflective Raised Pavement Marker One Way, Any Color	Each	$ 8.00	16		$ 128.00
	(Spec. 961-014) Vehicular Modular Steel Bridge w/ Footwalk (including Furnishing by PRHTA - No Bid)	LS	$ 897,902.00	1		$ 897,902.00
	(Spec. 961-991) Vehicular Modular Steel Bridge Installation w/ Footwalk (Hauling, Delivery, Unloading and Erection)	LS	$ 180,000.00	1		$ 180,000.00
	(Spec. 961-992) Dismantling of Launching Nose and Installation Components	LS	$ 54,000.00	1		$ 54,000.00
						$ -
	Method: [ ] Local Forces [ ] State Forces [x] Contract				Subtotal	$ 1,854,042.30
					PE/CE	$ 92,702.12
					Emergency Repair Total	$ 1,946,744.42
Permanent Restoration	Mobilization 10%	LS	$ 244,425.00	1		$ 244,425.00
	Replacement of Existing Bridge	SqM	$ 2,500.00	622		$ 1,555,000.00
	Removal of Existing Structures (Abutments)	LS	$ 89,250.00	1		$ 89,250.00
	Roadway Construction	LS	$ 800,000.00	1		$ 800,000.00
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
						$ -
	Method: [ ] Local Forces [ ] State Forces [x] Contract				Subtotal	$ 2,688,675.00
					PE/CE	$ 403,301.25
					Right-of-Way	$ 200,000.00
					Perm. Repair Totals	$ 3,291,976.25

Environmental Assessment Recommendation
[x] Categorical Exclusion [ ] EA/EIS

Estimated Total: $ 5,238,720.67

Recommendation: [x] Eligible [ ] Ineligible	FHWA Engineer		Date 11/22/17
Concurrence: [ ] Yes [ ] No	State Engineer		Date
Concurrence: [ ] Yes [ ] No	Local Agency Representative		Date

Figure 2-385: Bridge 1962 inspection report dated November 22, 2017 (source: FHWA)

2.17.6. Images after Hurricane Maria



Figure 2-386: Bridge 1962 satellite image after Hurricane Maria (source: NOAA)



Figure 2-387: Bridge 1962 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.facebook.com/cheboricua/posts/pfbid02Qq3G7eKQBdNVScfbkhjAJDL8NPcbpZPfHyREYkHgNnaheSwNNnp5711duUQPHr8Al

Figure 2-388: Social media image of collapsed Bridge 1962 (source: CHE)



https://huracanmaria.elnuevodia.com/2017/municipio/villalba/

Figure 2-389: News report image of collapsed Bridge 1962 (source: El Nuevo Día)



https://www.vocesdelsurpr.com/2018/06/siguen-los-problemas-con-instalacion-de-puente-de-la-vega-en-villalba/

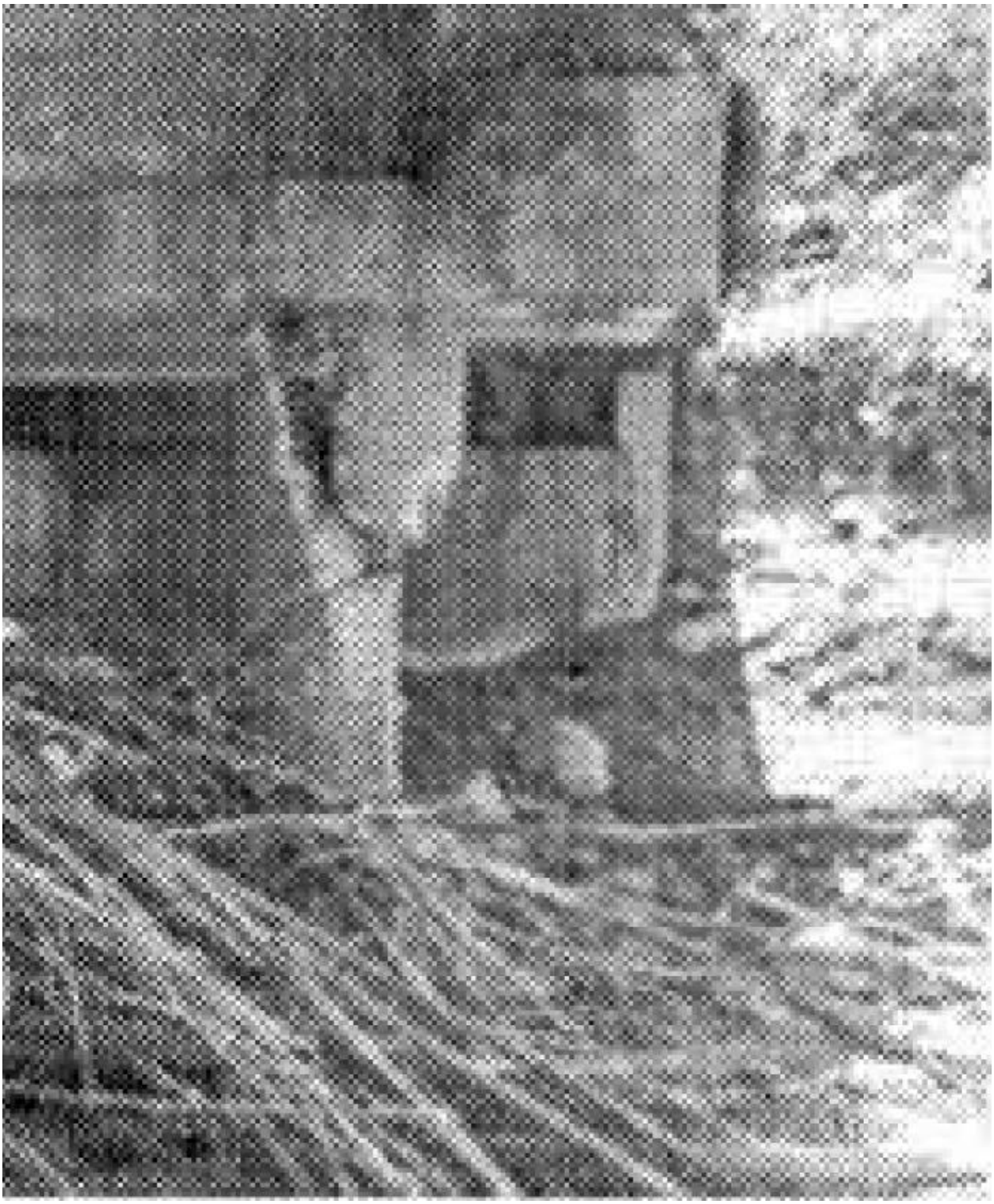
Figure 2-390: News report image of collapsed Bridge 1962 (source: Voces del Sur)

2.17.7. Temporary replacement



Figure 2-391: Bridge 1962 replacement (source: PRHTA)

2.18. Bridge 2574



(Extracted from Figure 2-407)

2.18.1. General information

Table 2-47: Bridge 2574 general information from BridgeReports.com

Name	OFF PR 428 over PRIETO RIVER
Structure number	025741
Location	17 KMS. SE. OF MARICAO
Purpose	Carries highway and pedestrian walkway over water way.
Route classification	Local (Rural)
Length of largest span	30.2 ft
Total length	90.2 ft
Roadway width between curbs	10.2 ft
Deck width edge-to-edge	16.7 ft
Owner	City or Municipal Highway Agency
Year built	1968
Historic significance	Bridge is not eligible for the National Register of Historic Places.
Number of main spans	3
Main spans material	Steel
Main spans design	Stinger/Multi beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Monolithic Concrete (concurrently placed with structural deck)

Table 2-48: Bridge 2574 general information from the PRHTA

ID	2574
Highway	OFF PR-428
Municipality	Maricao
Year Built	1968
Functionality	Rural-local
Lanes	1
ADT	100
Maintenance	Municipal highway agency
Owner	Municipal highway agency
Up Service	Highway-pedestrian
Down Service	waterway
Width	5.1 m
Length	27.5 m
Spans	3
Under clearance	0
Material	Steel
Design	Stringer or girder
Scour Critical	-
Inspection Frequency	12 months
Approach Roadway Width	5.1 m
Bypass length	199 km
NBI Rating	1
NHS	0
Area	140.25 m^2

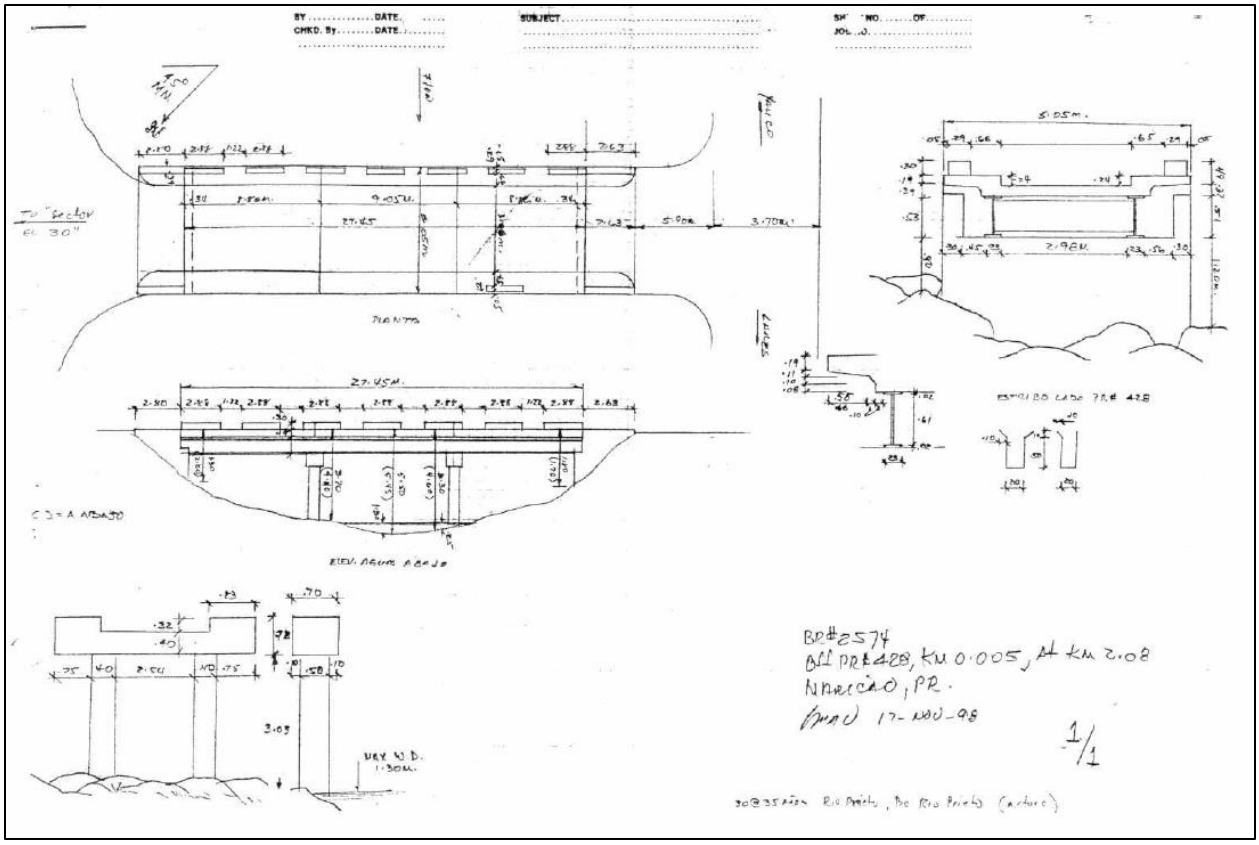


Figure 2-392: Bridge 2574 drawings (source: PRHTA)

2.18.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 2574

TEAM LEADER: Heriberto González Medina/Inspector: Angel Lopez

INSP. DATE: 7-Marzo-2017

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	12	MAR 2016	MAR 2018
ITEM 93 A	FC Inspection	YES	12	MAR 2016	MAR 2018
ITEM 93 B	Underwater Insp.	—	—		
ITEM 93 C	Other:	YES	12	MAR 2016	MAR 2018

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	4	5	5	5	N	U
Current Inspection	4	5	5	5	N	8

Other Checks: (Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 2-393: Bridge 2574 inspection summary of March 7, 2017 (source: PRHTA)



Figure 2-394: Bridge 2574 inspection photos of March 7, 2017 (source: PRHTA)

2.18.3. Images before Hurricane Maria



Figure 2-395: Bridge 2574 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-396: Bridge 2574 photo from March 7, 2017 inspection (source: PRHTA)



Figure 2-397: Bridge 2574 photo from March 7, 2017 inspection (source: PRHTA)



Figure 2-398: Bridge 2574 photo from March 7, 2017 inspection (source: PRHTA)



Figure 2-399: Bridge 2574 photo from March 7, 2017 inspection (source: PRHTA)



Figure 2-400: Bridge 2574 photo from March 7, 2017 inspection (source: PRHTA)

2.18.4. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 2574 MUNICIPALITY: Maricao

DATE: 2/oct/2017 TIME: 12:24 PM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item #3 - 0 Impacto de los escombros ocasionó que la pilastra #1 se deslizara y se fracturó (colapsó) el cap beam y la columna aguas abajo. Puente esta deformado.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Estructura colapsada, cap beam y columna fallaron y la estructura esta deformada.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-401: Bridge 2574 inspection report from October 2, 2017 (source: PRHTA)

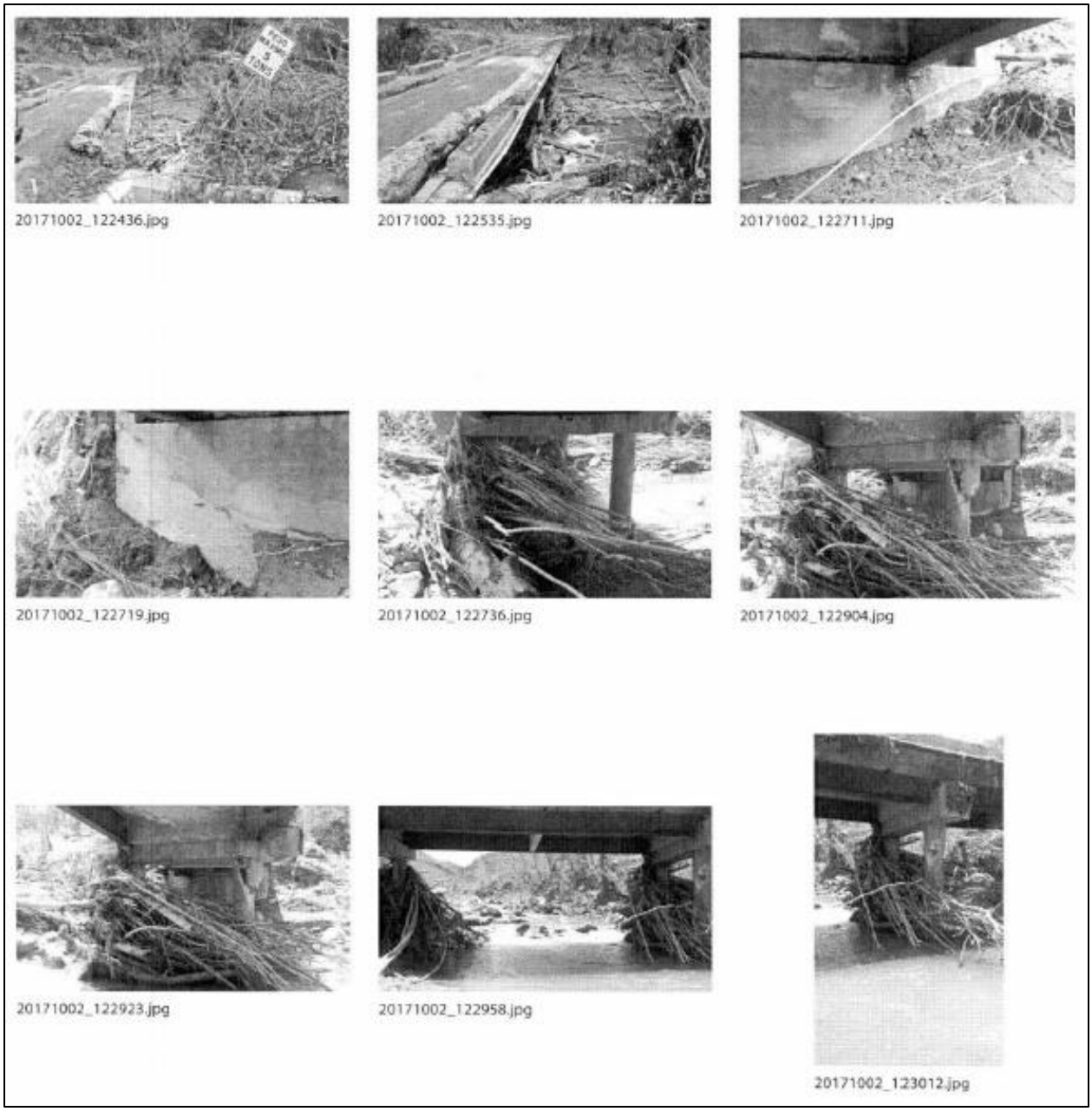


Figure 2-402: Bridge 2574 photos from October 2, 2017 inspection (source: PRHTA)

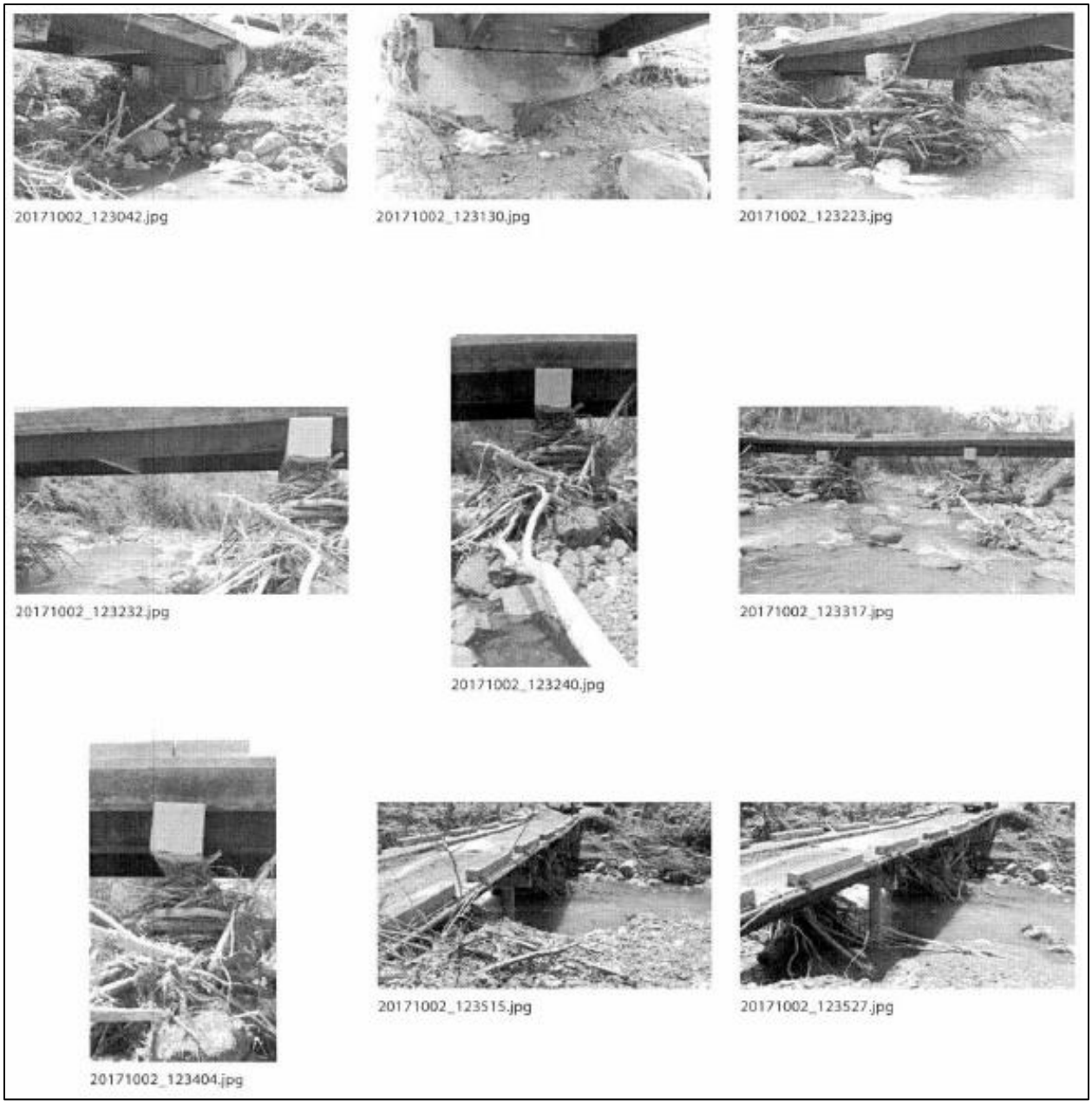


Figure 2-403: Bridge 2574 photos from October 2, 2017 inspection (source: PRHTA)

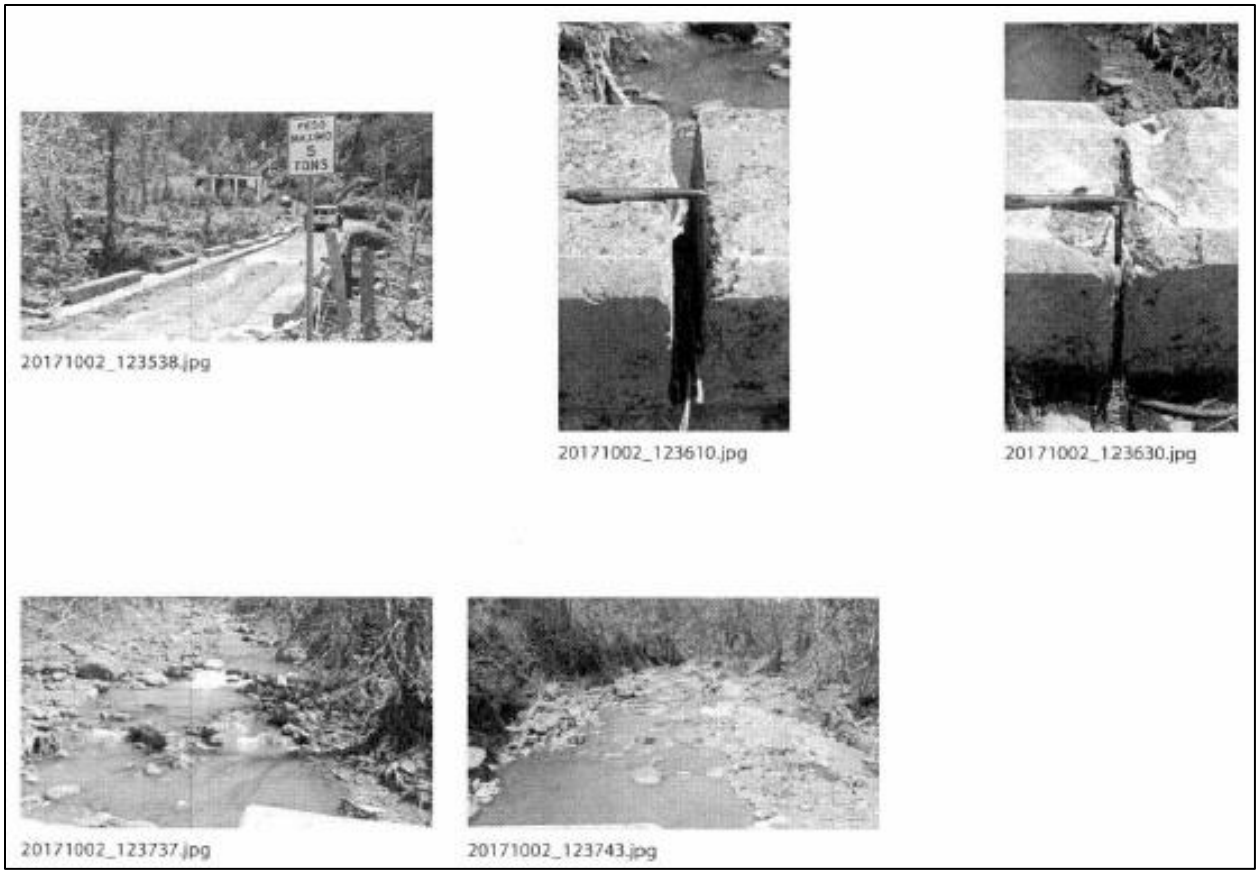
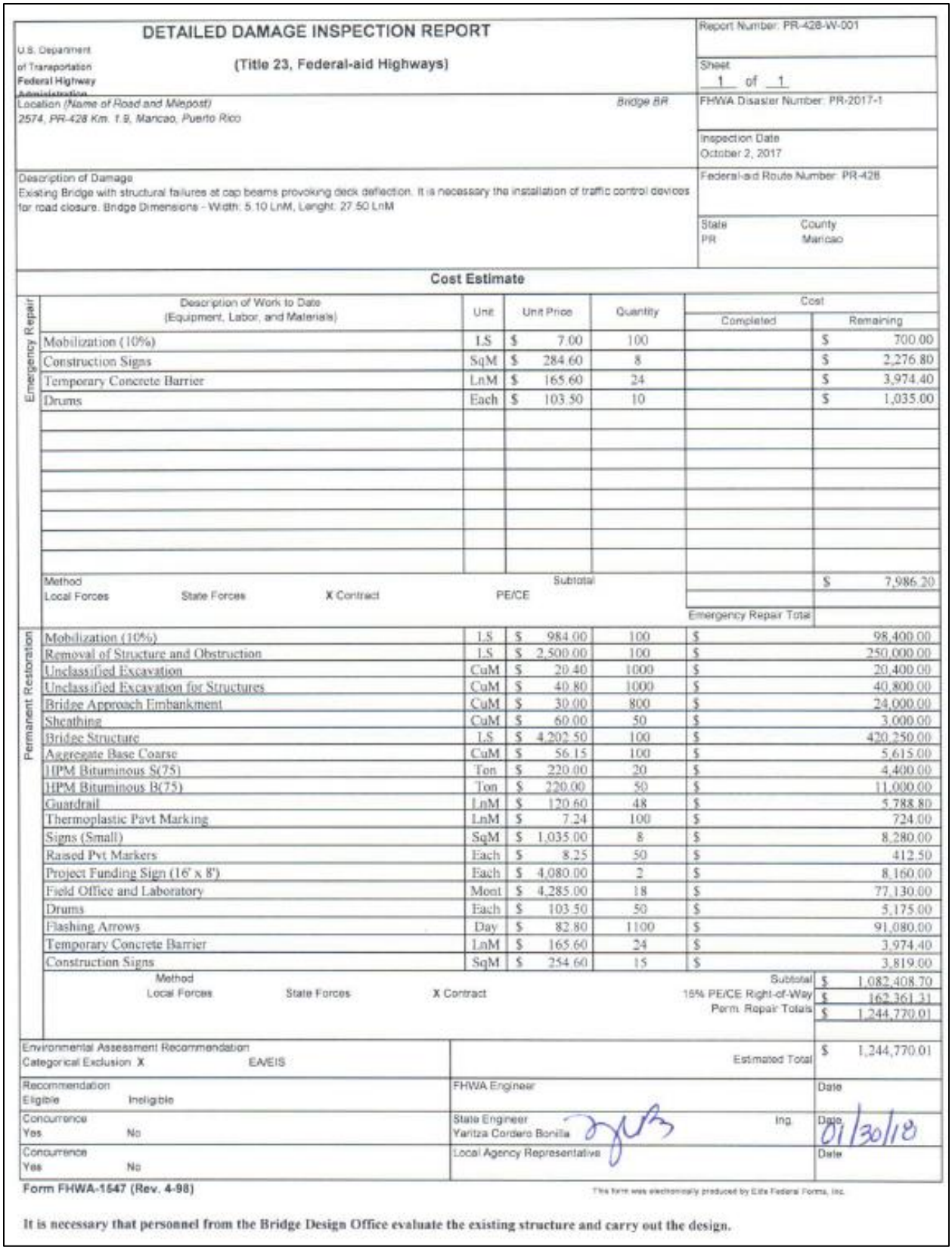


Figure 2-404: Bridge 2574 photos from October 2, 2017 inspection (source: PRHTA)



DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number: PR-428-W-001

Sheet 1 of 1

Location (Name of Road and Milepost)
2574, PR-428 Km. 1.9, Maricao, Puerto Rico

Bridge BR

FHWA Disaster Number: PR-2017-1

Inspection Date
October 2, 2017

Description of Damage
Existing Bridge with structural failures at cap beams provoking deck deflection. It is necessary the installation of traffic control devices for road closure. Bridge Dimensions - Width: 5.10 LnM, Lenght: 27.50 LnM

Federal-aid Route Number: PR-428

State: PR
County: Maricao

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Mobilization (10%)	LS	$ 7.00	100		$ 700.00
Construction Signs	SqM	$ 284.60	8		$ 2,276.80
Temporary Concrete Barrier	LnM	$ 165.60	24		$ 3,974.40
Drums	Each	$ 103.50	10		$ 1,035.00

Method: Local Forces — State Forces — X Contract — PE/CE

Subtotal: $ 7,986.20

Emergency Repair Total:

Permanent Restoration

Mobilization (10%)	LS	$ 984.00	100	$ 98,400.00
Removal of Structure and Obstruction	LS	$ 2,500.00	100	$ 250,000.00
Unclassified Excavation	CuM	$ 20.40	1000	$ 20,400.00
Unclassified Excavation for Structures	CuM	$ 40.80	1000	$ 40,800.00
Bridge Approach Embankment	CuM	$ 30.00	800	$ 24,000.00
Sheathing	CuM	$ 60.00	50	$ 3,000.00
Bridge Structure	LS	$ 4,202.50	100	$ 420,250.00
Aggregate Base Coarse	CuM	$ 56.15	100	$ 5,615.00
HPM Bituminous S(75)	Ton	$ 220.00	20	$ 4,400.00
HPM Bituminous B(75)	Ton	$ 220.00	50	$ 11,000.00
Guardrail	LnM	$ 120.60	48	$ 5,788.80
Thermoplastic Pavt Marking	LnM	$ 7.24	100	$ 724.00
Signs (Small)	SqM	$ 1,035.00	8	$ 8,280.00
Raised Pvt Markers	Each	$ 8.25	50	$ 412.50
Project Funding Sign (16' x 8')	Each	$ 4,080.00	2	$ 8,160.00
Field Office and Laboratory	Mont	$ 4,285.00	18	$ 77,130.00
Drums	Each	$ 103.50	50	$ 5,175.00
Flashing Arrows	Day	$ 82.80	1100	$ 91,080.00
Temporary Concrete Barrier	LnM	$ 165.60	24	$ 3,974.40
Construction Signs	SqM	$ 254.60	15	$ 3,819.00

Method: Local Forces — State Forces — X Contract

Subtotal: $ 1,082,408.70
15% PE/CE Right-of-Way: $ 162,361.31
Perm. Repair Totals: $ 1,244,770.01

Environmental Assessment Recommendation
Categorical Exclusion X — EA/EIS

Estimated Total: $ 1,244,770.01

Recommendation: Eligible — Ineligible

FHWA Engineer — Date

Concurrence: Yes — No

State Engineer: Yaritza Cordero Bonilla, Ing. — Date: 01/30/18

Concurrence: Yes — No

Local Agency Representative — Date

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

It is necessary that personnel from the Bridge Design Office evaluate the existing structure and carry out the design.

Figure 2-405: Bridge 2574 inspection report from October 2, 2017 (source: FHWA)

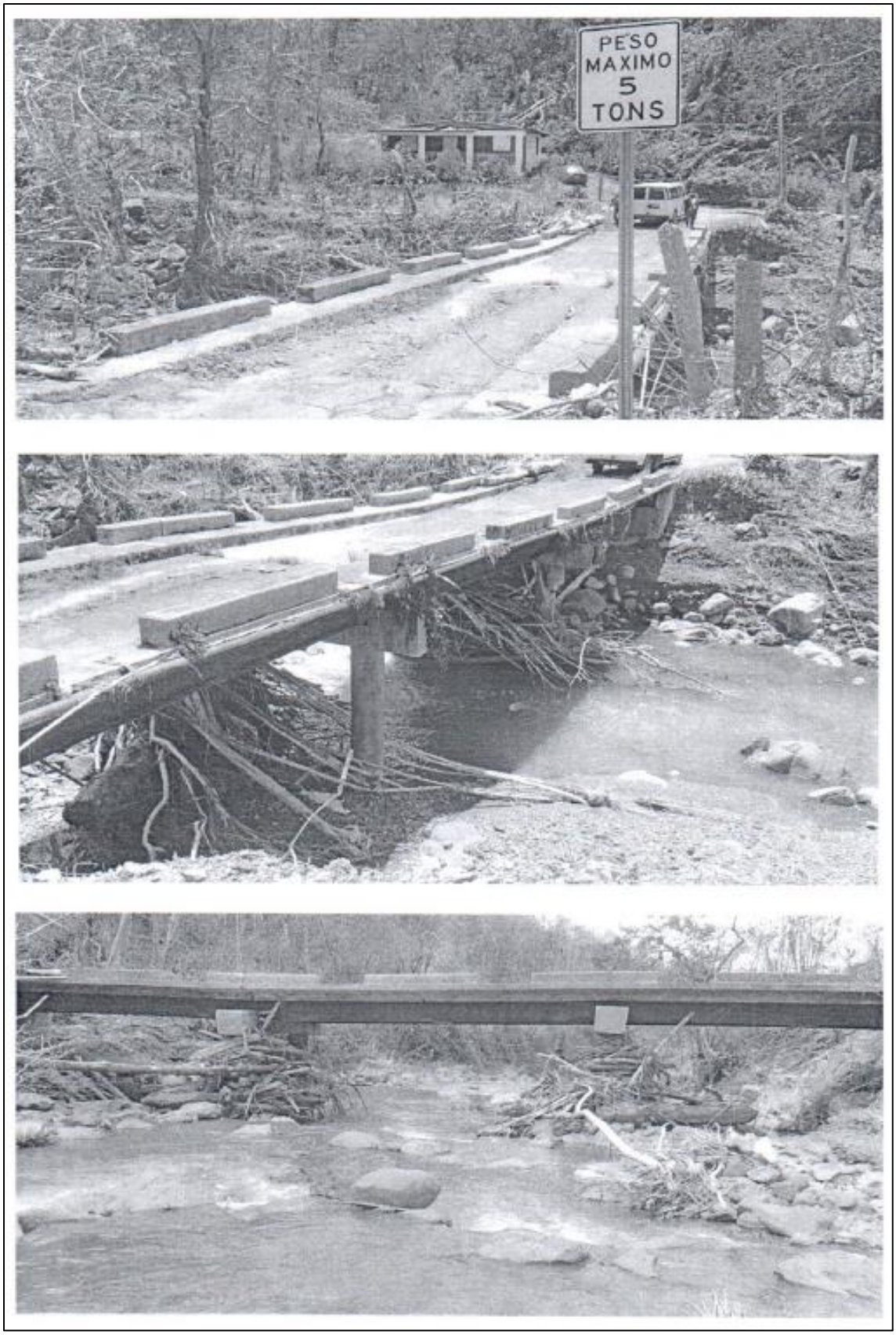


Figure 2-406: Bridge 2574 photos from October 2, 2017 inspection (source: FHWA)

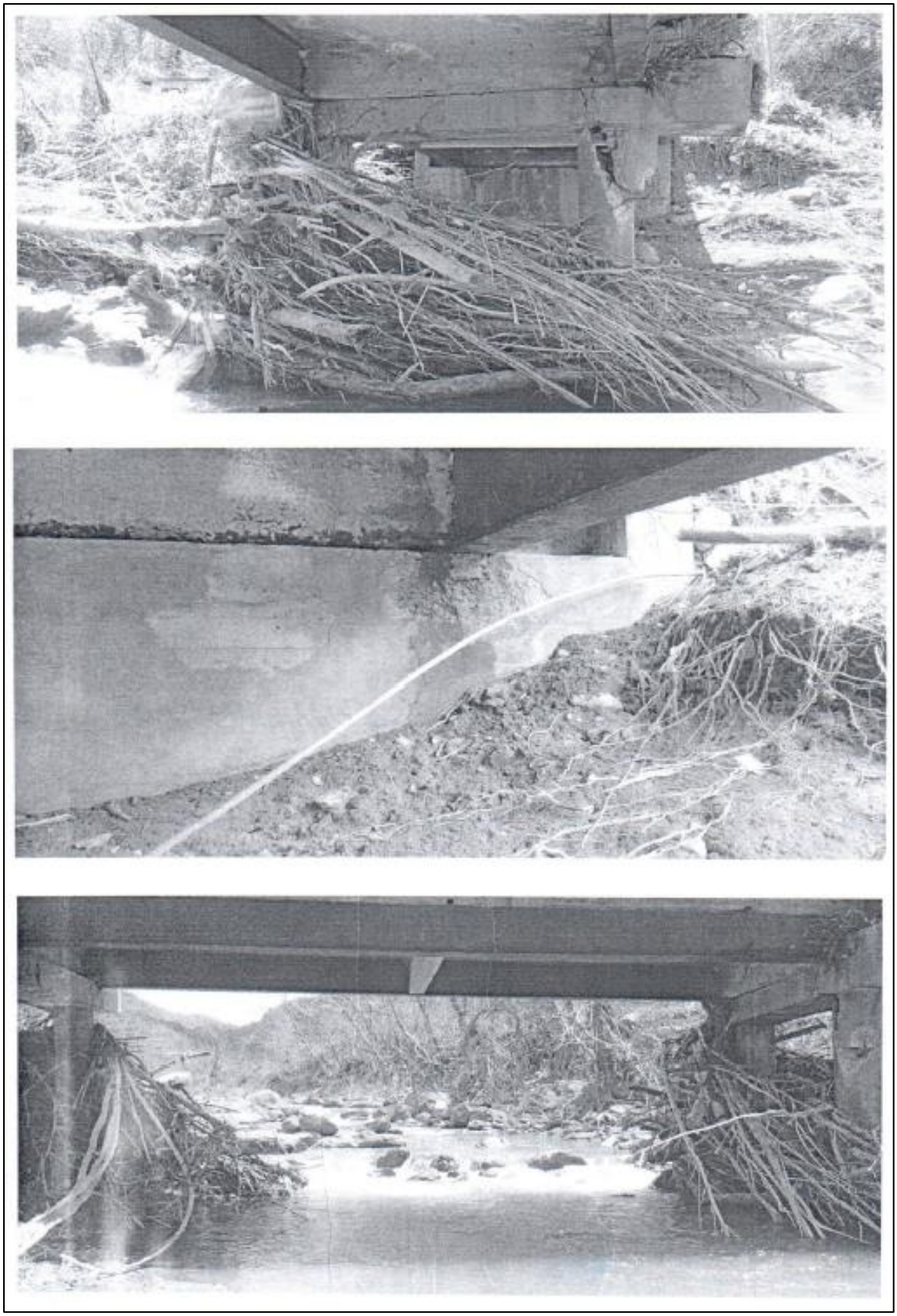


Figure 2-407: Bridge 2574 photos from October 2, 2017 inspection (source: FHWA)

2.18.5. Images after Hurricane Maria



Figure 2-408: Bridge 2574 satellite image after Hurricane Maria (source: NOAA)



Figure 2-409: Bridge 2574 satellite after Hurricane Maria (source: Google Earth Pro)

2.18.6. Temporary replacement



http://desja.net/tproyect.html

Figure 2-410: Bridge 2574 replacement (source: Desarrolladora J.A., Inc.)

2.19. Bridge 2842



(Extracted from Figure 2-429)

2.19.1. General information

Table 2-49: Bridge 2842 general information from BridgeReports.com

Name	LOCAL ROAD over GUAYO RIVER
Structure number	028421
Location	.01 km from PR 512 KM 4.3
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	12.1 ft
Total length	65.9 ft
Roadway width between curbs	27.6 ft
Deck width edge-to-edge	34.1 ft
Owner	City or Municipal Highway Agency
Year built	2006
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	-
Main spans material	Concrete Continuous
Main spans design	Culvert
Deck type	Concrete Cast-in-Place
Wearing surface	-

Table 2-50: Bridge 2842 general information from the PRHTA

ID	2842
Highway	Local Road
Municipality	Juana Diaz
Year Built	2006
Functionality	rural-local
Lanes	2
ADT	100
Maintenance	Municipal highway agency
Owner	Municipal highway agency
Up Service	Highway
Down Service	Waterway
Width	10.4 m
Length	20.1 m
Spans	1
Under clearance	0
Material	Concrete continuous
Design	Culvert
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	8 m
Bypass length	100 km
NBI Rating	2
NHS	0
Area	209.04 m^2

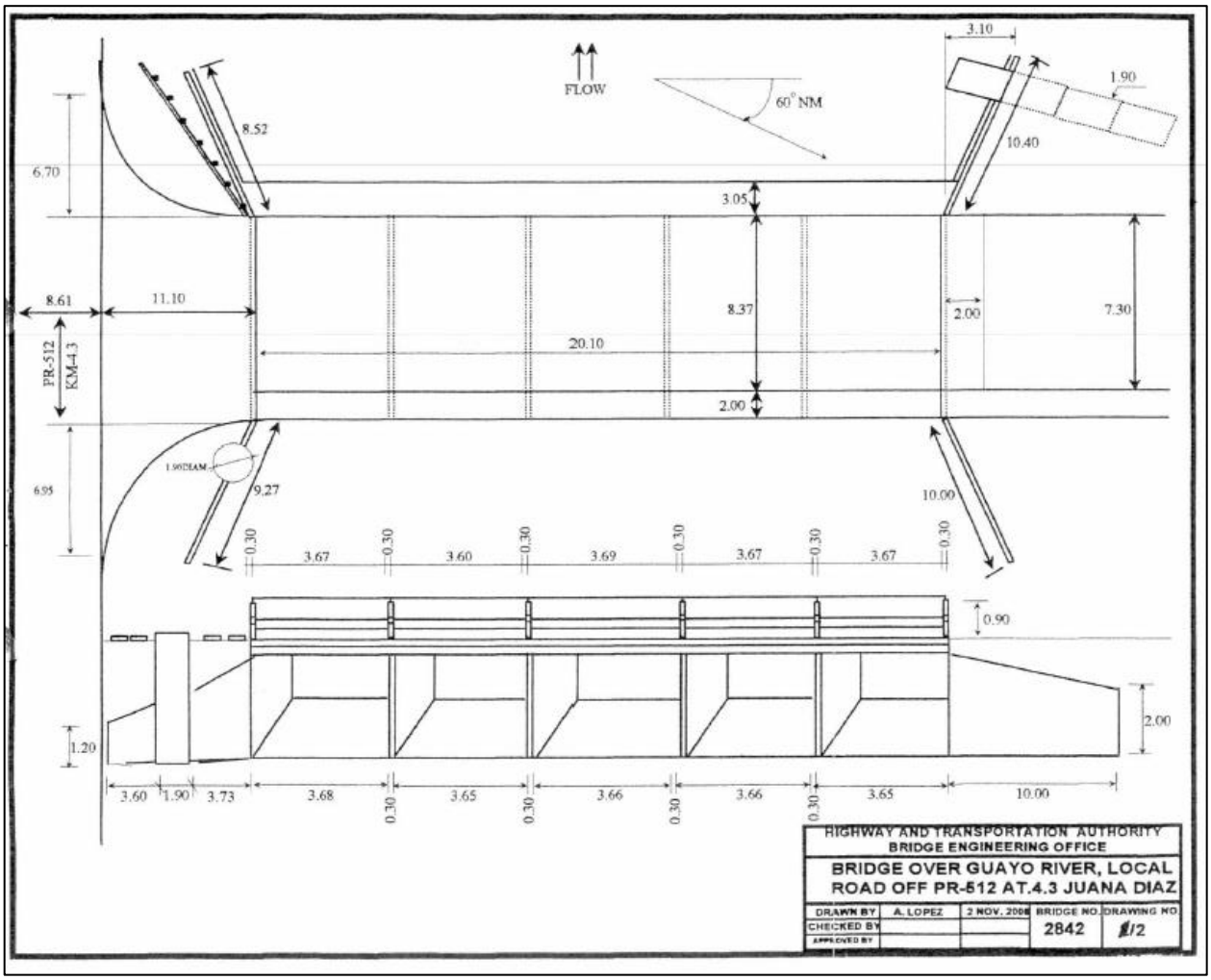


Figure 2-411: Bridge 2842 drawings (source: PRHTA)

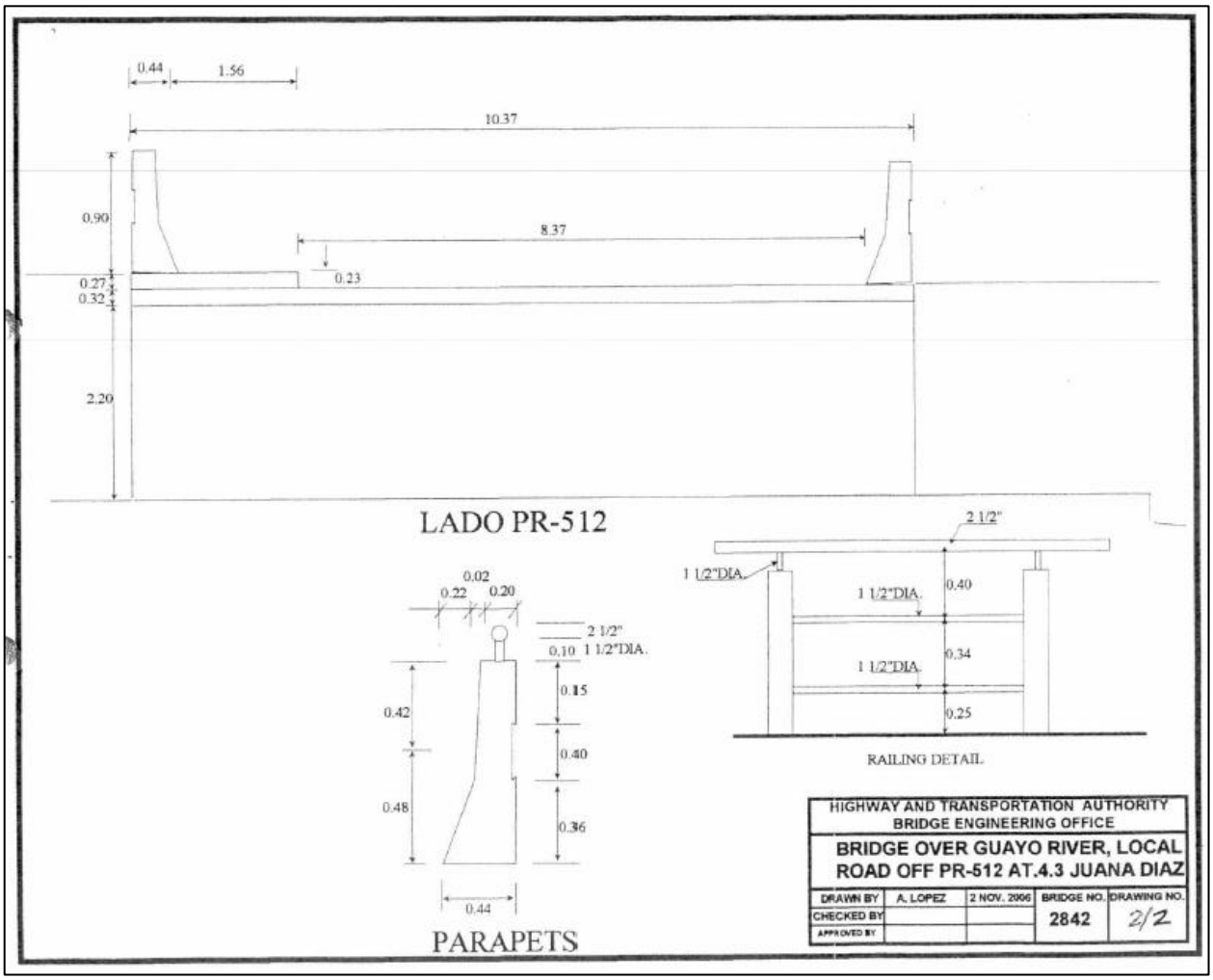


Figure 2-412: Bridge 2842 drawings (source: PRHTA)

2.19.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 2842

TEAM LEADER: Heriberto González Medina/Inspector: Angel T. López

INSP. DATE: 14-Octubre-2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	Oct. 2014	Oct. 2018
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other:	—			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	N	N	N	7	7	8
Current Inspection	N	N	N	7	7	8

Other Checks: (Y, N, NA)

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Review Comments:

- Fotos ✓

Reviewer: _____

Safety Eng.: _____

Figure 2-413: Bridge 2842 inspection summary of October 14, 2016 (source: PRHTA)

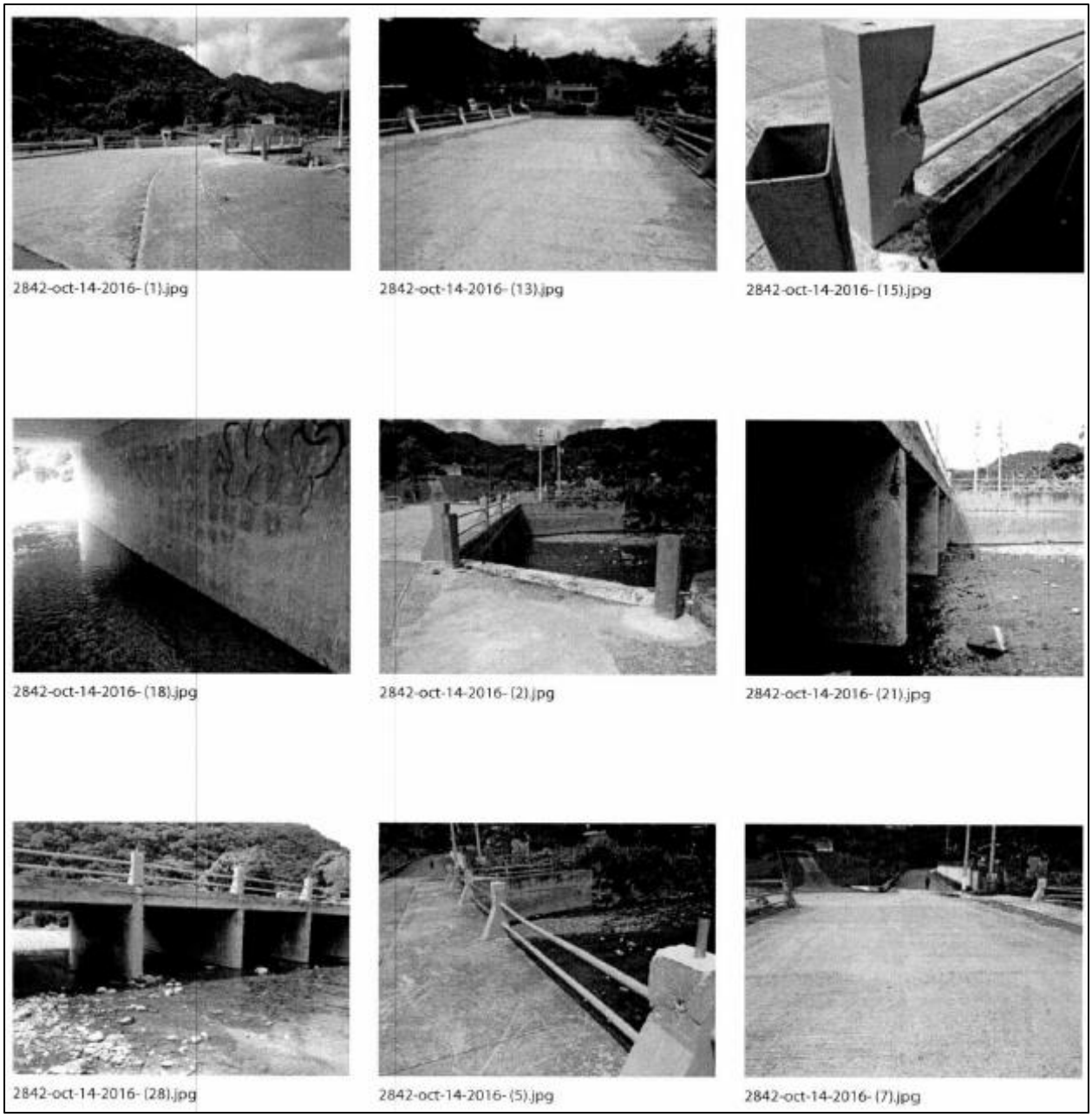


Figure 2-414: Bridge 2842 inspection photos of October 14, 2016 (source: PRHTA)

2.19.3. Images before Hurricane Maria



Figure 2-415: Bridge 2842 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 2-416: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-417: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-418: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-419: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-420: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-421: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)



Figure 2-422: Bridge 2842 photo from October 14, 2016 inspection (source: PRHTA)

2.19.4. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 2842 MUNICIPALITY: Juana Diaz

DATE: 10/17/17 TIME: 11:30 AM EVALUATOR NAME: Christian Berrios

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Bridge totally collapsed along with approach roadways and utilities. No detour available, residents crossing river with rope.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: Bridge already closed due to collapse. Reported to COE for further action.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 2-423: Bridge 2842 inspection report from October 17, 2017 (source: PRHTA)

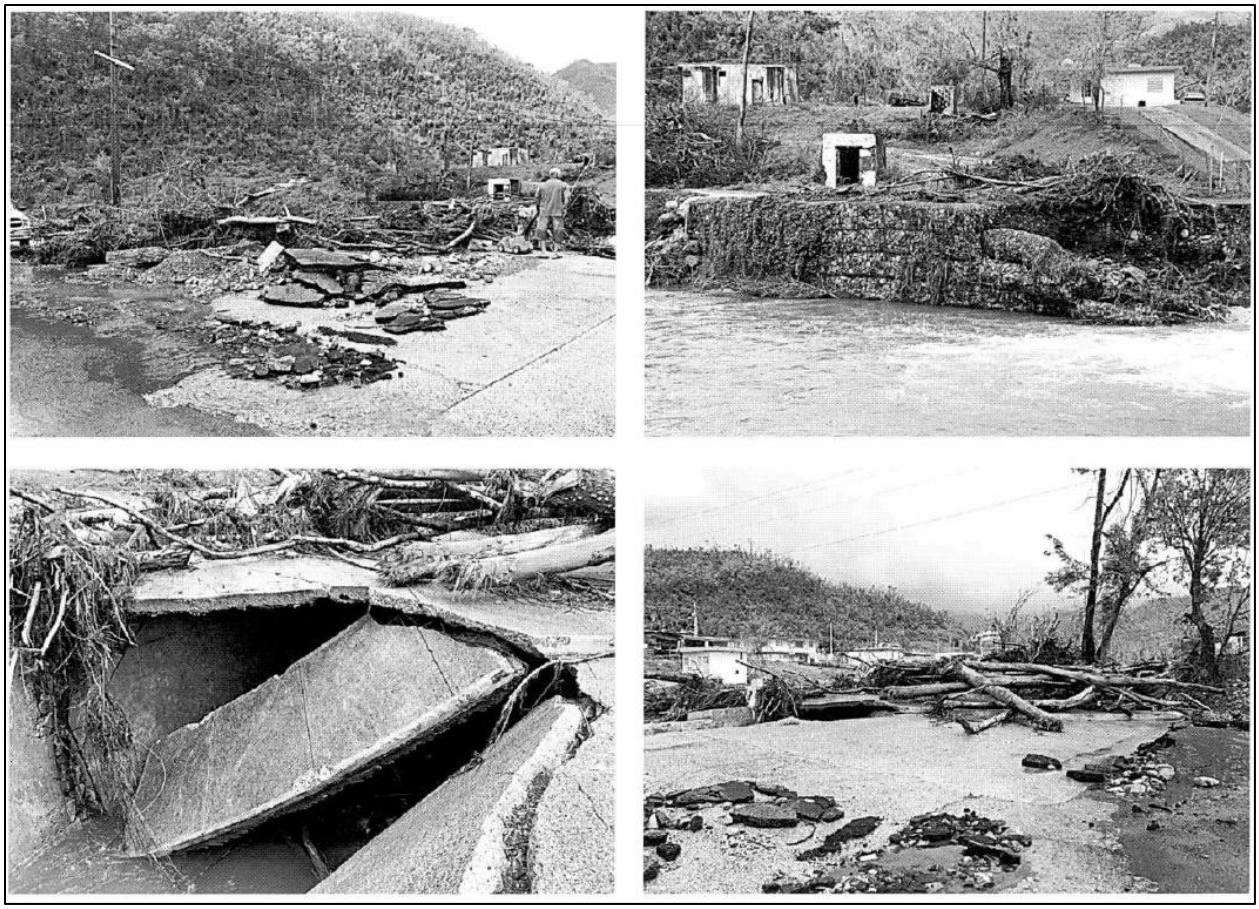


Figure 2-424: Bridge 2842 photos from October 17, 2017 inspection (source: PRHTA)

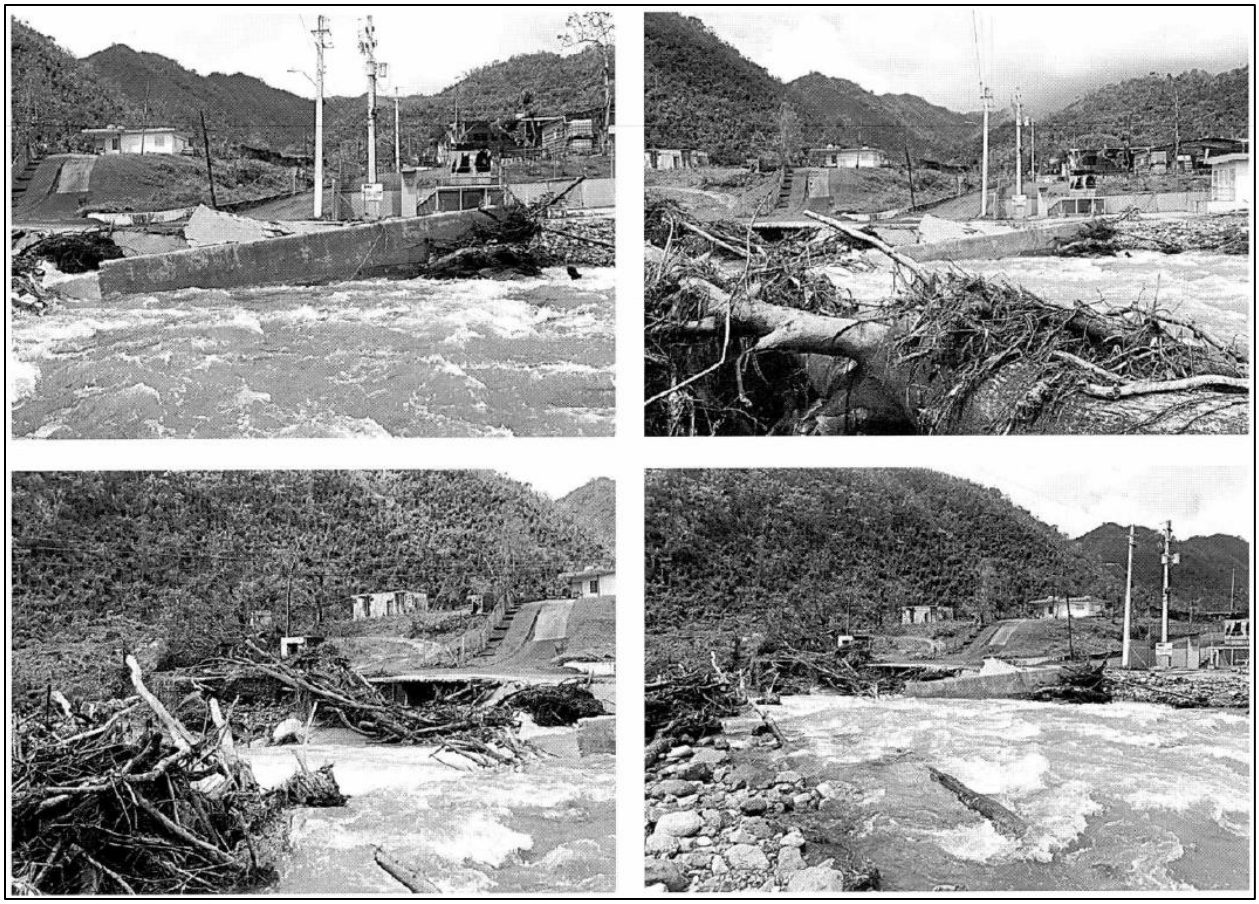


Figure 2-425: Bridge 2842 photos from October 17, 2017 inspection (source: PRHTA)

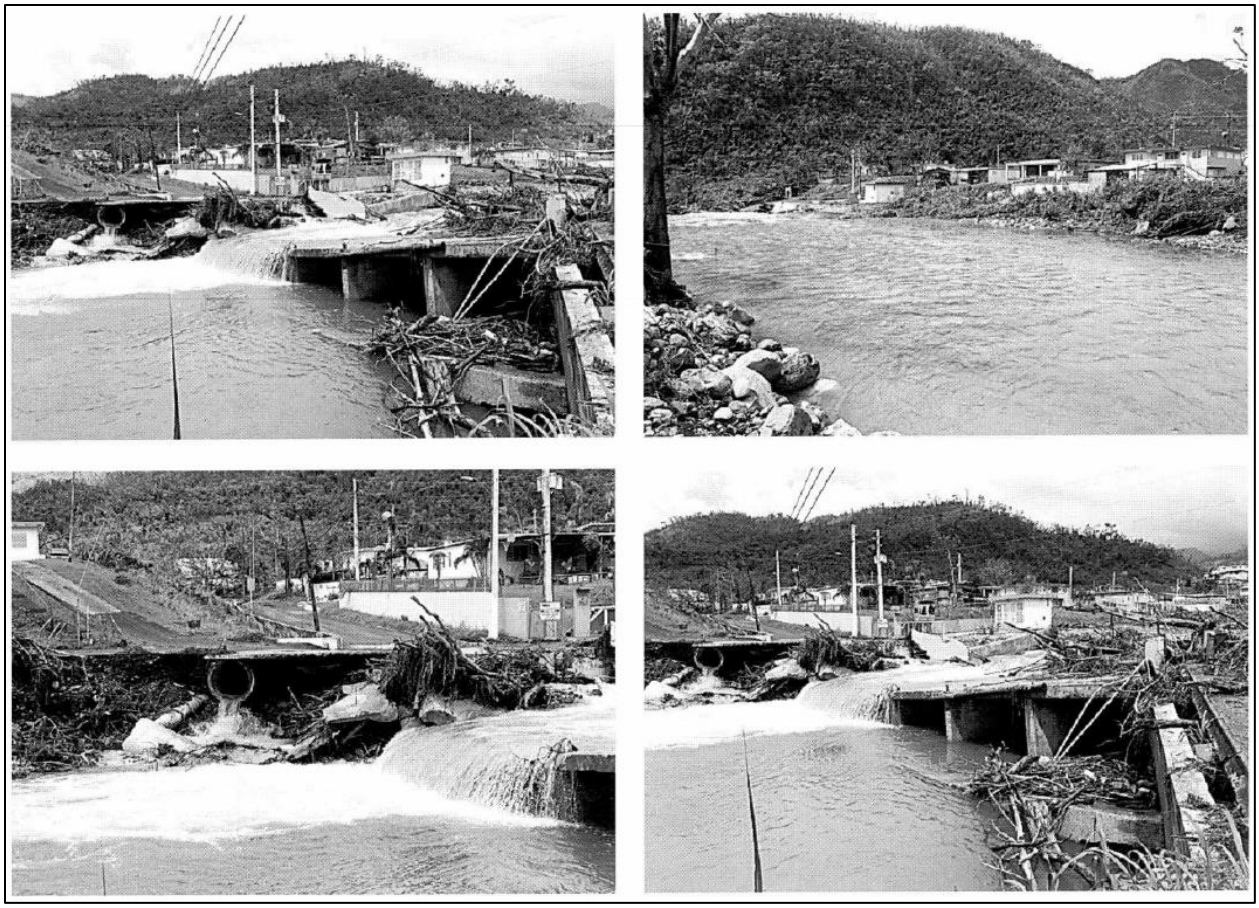


Figure 2-426: Bridge 2842 photos from October 17, 2017 inspection (source: PRHTA)

2.19.5. Images after Hurricane Maria



Figure 2-427: Bridge 2842 satellite image after Hurricane Maria (source: NOAA)



Figure 2-428: Bridge 2842 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.theoaklandpress.com/2017/10/17/pontiac-firefighter-reunites-families-in-puerto-rico-how-to-help-those-affected/

Figure 2-429: News report image of collapsed Bridge 2842 (source: Héctor Martínez)

2.19.6. Temporary replacement



Figure 2-430: Bridge 2842 replacement (source: PRHTA)

3. Approach roadway collapse

An approach is a segment of a roadway that connects directly to the end of a bridge. It is typically formed by an approach embankment with an approach slab on top. It is estimated that the approach roadway of about 60 bridges was affected by the high stream flows caused by Hurricane Maria. The severity of this type of damage varied greatly from minor erosion that did not affect the traffic over the bridge to complete collapse of the approach roadway.

The cases of complete approach roadway collapse varied themselves from cases that were quickly fixed to cases where the stream's causeway was so severely affected that a new bridge had to be put in place. The approach roadway collapse is sometimes confused with a bridge collapse, but the bridge structure itself is unaffected.

Table 3-1 lists three of the bridges which had an approach roadway collapse. For a complete list of the bridges that experienced approach roadway collapse, further analysis of the available data is required. The table does include two bridges that were originally reported to have collapsed: Bridges 606 and 1684. Bridge 606 ultimately replaced with temporary modular steel bridge, while satellite imagery from Google Earth Pro suggests that the repair of the approach of Bridge 1684 was completed at some point in 2020. Meanwhile, Bridge 635 had an approach collapse that was repaired within three months of the passing of Hurricane Maria through Puerto Rico. Each of the three bridges is dedicated to a section in this chapter, with the information organized in the same format used in the previous chapter.

Table 3-1: Some of the bridges with collapsed approach roadway due to Hurricane Maria

ID	Municipality	Name	Coordinates
606	Canóvanas	PR-962 over Canóvanas River	18°21'40.13"N 65°53'13.44"W
635	Toa Baja	PR-165 Cocal River	18°27'58.41"N 66°11'53.78"W
1684	Utuado	Local Road over Chiquito River	18°17'38.31"N 66°46'57.60"W

3.1. Bridge 606



(Extracted from Figure 3-15)

3.1.1. General information

Table 3-2: Bridge 606 general information from BridgeReports.com

Name	PR 962 over CANÓVANAS RIVER
Structure number	6061
Location	2.6 KM SOUTH OF CANOVANAS
Purpose	Carries highway over waterway
Route classification	Collector (Urban)
Length of largest span	30.2 ft
Total length	73.5 ft
Roadway width between curbs	19.7 ft
Deck width edge-to-edge	22.3 ft
Owner	State Highway Agency
Year built	1947
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	3
Main spans material	Concrete continuous
Main spans design	Slab
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 3-3: Bridge 606 general information from the PRHTA

ID	606
Highway	PR 962 km 1.6
Municipality	Canóvanas
Year Built	1947
Functionality	Urban-Collector
Lanes	2
ADT	3972
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway
Down Service	Waterway
Width	6.8 m
Length	22.4 m
Spans	3
Under clearance	0
Material	Concrete Continuous
Design	Slab
Scour Critical	3
Inspection Frequency	24 months
Approach Roadway Width	6 m
Bypass length	11 km
NBI Rating	2
NHS	0
Area	152.32 m^2

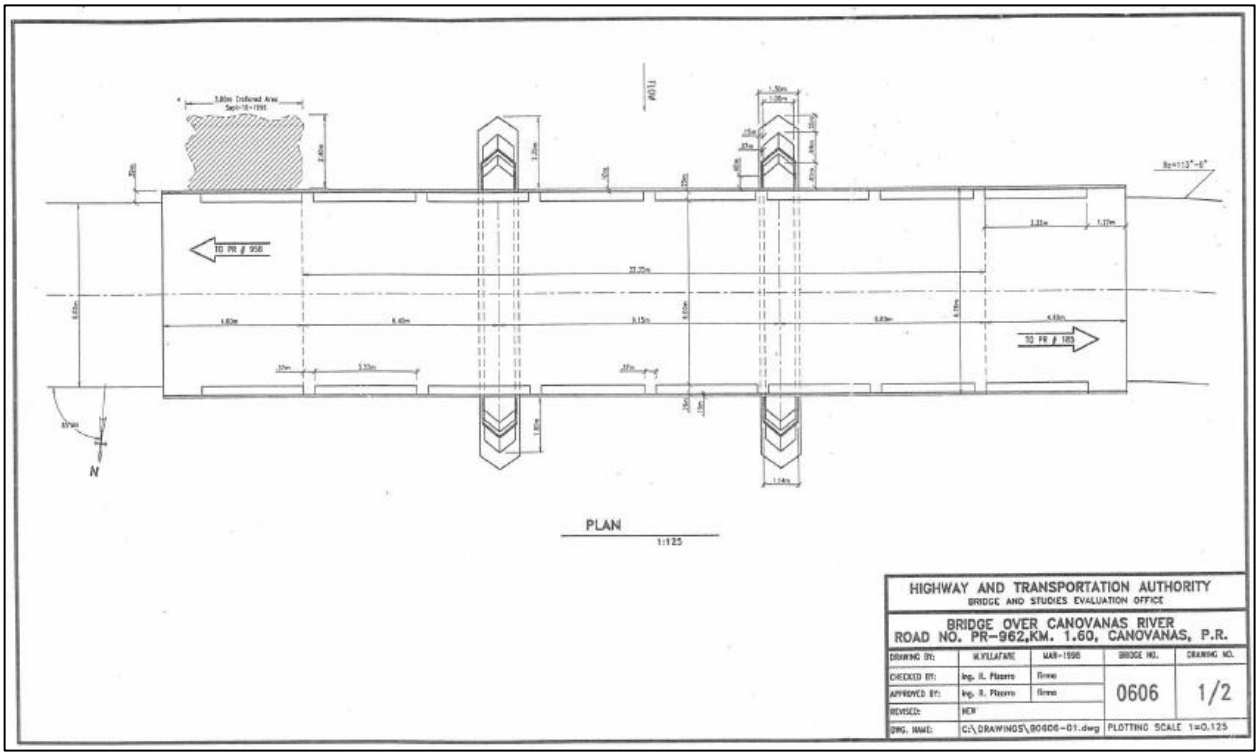


Figure 3-1: Bridge 606 drawings (source: PRHTA)

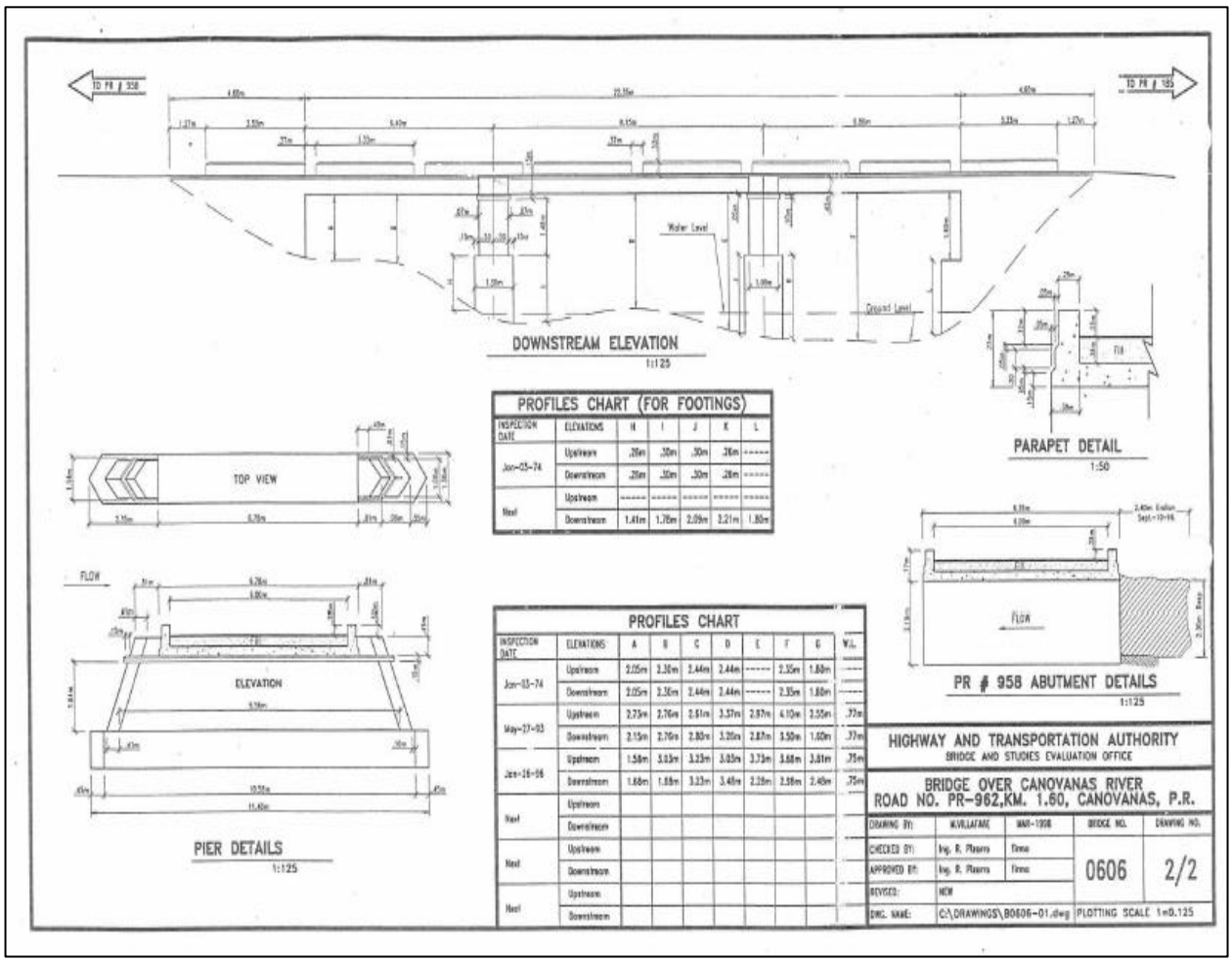


Figure 3-2: Bridge 606 drawings (source: PRHTA)

3.1.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 0606

TEAM LEADER: Mayra I. Zayas Rodríguez / AT López

INSP. DATE: Jul. 12. 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	24	Jun. 11. 2014	Jul. 12. 2016
ITEM 93 A	FC Inspection	N			
ITEM 93 B	Underwater Insp.	N			
ITEM 93 C	Other:	N			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	5	5	5	Co	N	3
Current Inspection	5	5	5	5	N	3

Other Checks: (Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Figure 3-3: Bridge 606 inspection summary of July 12, 2016 (source: PRHTA)



Figure 3-4: Bridge 606 inspection photos of July 12, 2016 (source: PRHTA)

3.1.3. Images before Hurricane Maria



Figure 3-5: Bridge 606 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 3-6: Bridge 606 photo from July 12, 2016 inspection (source: PRHTA)



Figure 3-7: Bridge 606 photo from July 12, 2016 inspection (source: PRHTA)



Figure 3-8: Bridge 606 photo from July 12, 2016 inspection (source: PRHTA)

3.1.4. Streamflow

Table 3-4: Peak streamflow at Canóvanas River Near Campo Rico monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-05-17	8.77	2,910
2011	2011-08-23	13.06	9,120
2012	2011-12-10	9.18	3,360
2013	2013-07-18	9.59	3,860
2014	2013-11-22	6.64	1,140
2015	2014-12-16	7.76	1,960
2016	2016-04-25	5.73	681
2017	2017-09-20	17.33	15,100

3.1.5. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 0606 MUNICIPALITY: Canóvanas

DATE: 09/26/17 TIME: 9:00 AM EVALUATOR NAME: Christian Berrios

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Hurricane María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: One span of bridge collapsed and elements carried away by river. Remaining span inaccesible but probably unstable.

ACTION REQUIRED (*PROVIDE COMMENTS*):

☑ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

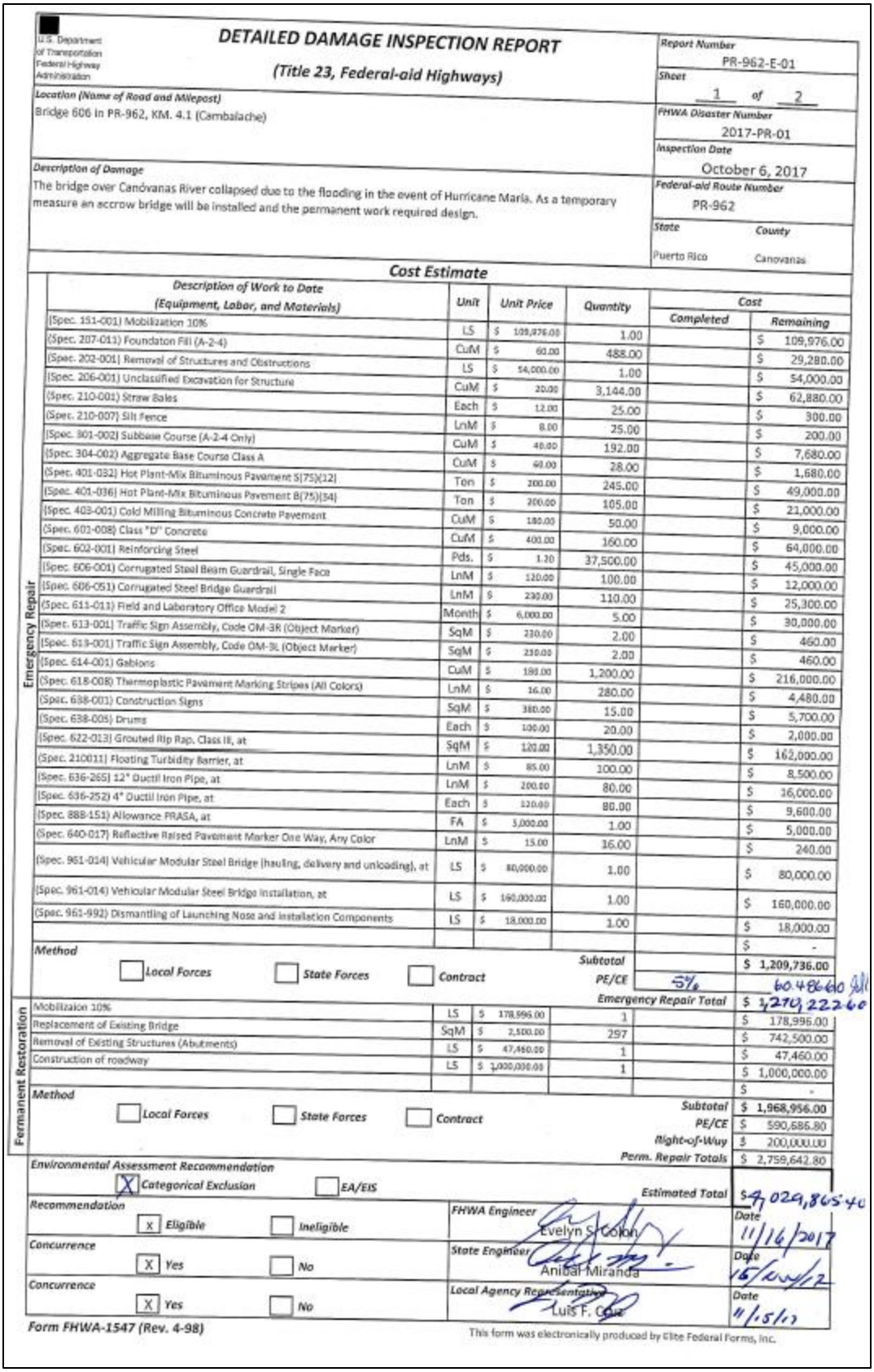
COMMENTS: Bridge already collapsed/closed along with 0.3 KM of PR-962. Reported to COE for immediate works.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 3-9: Bridge 606 inspection report from September 26, 2017 (source: PRHTA)



Figure 3-10: Bridge 606 photos from September 26, 2017 inspection (source: PRHTA)



U.S. Department of Transportation
Federal Highway Administration

DETAILED DAMAGE INSPECTION REPORT

(Title 23, Federal-aid Highways)

Report Number	PR-962-E-01
Sheet	1 of 2
FHWA Disaster Number	2017-PR-01
Inspection Date	October 6, 2017
Federal-aid Route Number	PR-962
State	Puerto Rico
County	Canovanas

Location (Name of Road and Milepost)
Bridge 606 in PR-962, KM. 4.1 (Cambalache)

Description of Damage
The bridge over Canóvanas River collapsed due to the flooding in the event of Hurricane Maria. As a temporary measure an accrow bridge will be installed and the permanent work required design.

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
(Spec. 151-001) Mobilization 10%	LS	$ 109,976.00	1.00		$ 109,976.00
(Spec. 207-011) Foundaton Fill (A-2-4)	CuM	$ 60.00	488.00		$ 29,280.00
(Spec. 202-001) Removal of Structures and Obstructions	LS	$ 54,000.00	1.00		$ 54,000.00
(Spec. 206-001) Unclassified Excavation for Structure	CuM	$ 20.00	3,144.00		$ 62,880.00
(Spec. 210-001) Straw Bales	Each	$ 12.00	25.00		$ 300.00
(Spec. 210-007) Silt Fence	LnM	$ 8.00	25.00		$ 200.00
(Spec. 301-002) Subbase Course (A-2-4 Only)	CuM	$ 40.00	192.00		$ 7,680.00
(Spec. 304-002) Aggregate Base Course Class A	CuM	$ 60.00	28.00		$ 1,680.00
(Spec. 401-032) Hot Plant-Mix Bituminous Pavement S(75)(12)	Ton	$ 200.00	245.00		$ 49,000.00
(Spec. 401-036) Hot Plant-Mix Bituminous Pavement B(75)(34)	Ton	$ 200.00	105.00		$ 21,000.00
(Spec. 403-001) Cold Milling Bituminous Concrete Pavement	CuM	$ 180.00	50.00		$ 9,000.00
(Spec. 601-008) Class "D" Concrete	CuM	$ 400.00	160.00		$ 64,000.00
(Spec. 602-001) Reinforcing Steel	Pds.	$ 1.20	37,500.00		$ 45,000.00
(Spec. 606-001) Corrugated Steel Beam Guardrail, Single Face	LnM	$ 120.00	100.00		$ 12,000.00
(Spec. 606-051) Corrugated Steel Bridge Guardrail	LnM	$ 230.00	110.00		$ 25,300.00
(Spec. 613-011) Field and Laboratory Office Model 2	Month	$ 6,000.00	5.00		$ 30,000.00
(Spec. 613-001) Traffic Sign Assembly, Code OM-3R (Object Marker)	SqM	$ 230.00	2.00		$ 460.00
(Spec. 613-001) Traffic Sign Assembly, Code OM-3L (Object Marker)	SqM	$ 230.00	2.00		$ 460.00
(Spec. 614-001) Gabions	CuM	$ 180.00	1,200.00		$ 216,000.00
(Spec. 618-008) Thermoplastic Pavement Marking Stripes (All Colors)	LnM	$ 16.00	280.00		$ 4,480.00
(Spec. 638-001) Construction Signs	SqM	$ 380.00	15.00		$ 5,700.00
(Spec. 638-005) Drums	Each	$ 100.00	20.00		$ 2,000.00
(Spec. 622-013) Grouted Rip Rap, Class III, at	SqM	$ 120.00	1,350.00		$ 162,000.00
(Spec. 210011) Floating Turbidity Barrier, at	LnM	$ 85.00	100.00		$ 8,500.00
(Spec. 636-265) 12" Ductil Iron Pipe, at	LnM	$ 200.00	80.00		$ 16,000.00
(Spec. 636-252) 4" Ductil Iron Pipe, at	Each	$ 120.00	80.00		$ 9,600.00
(Spec. 888-151) Allowance PRASA, at	FA	$ 5,000.00	1.00		$ 5,000.00
(Spec. 640-017) Reflective Raised Pavement Marker One Way, Any Color	LnM	$ 15.00	16.00		$ 240.00
(Spec. 961-014) Vehicular Modular Steel Bridge (hauling, delivery and unloading), at	LS	$ 80,000.00	1.00		$ 80,000.00
(Spec. 961-014) Vehicular Modular Steel Bridge Installation, at	LS	$ 160,000.00	1.00		$ 160,000.00
(Spec. 961-992) Dismantling of Launching Nose and Installation Components	LS	$ 18,000.00	1.00		$ 18,000.00
					$ -

Method: ☐ Local Forces ☐ State Forces ☐ Contract

Subtotal	$ 1,209,736.00
PE/CE 5%	60,486.80
Emergency Repair Total	$ 1,270,222.60

Permanent Restoration

Mobilization 10%	LS	$ 178,996.00	1		$ 178,996.00
Replacement of Existing Bridge	SqM	$ 2,500.00	297		$ 742,500.00
Removal of Existing Structures (Abutments)	LS	$ 47,460.00	1		$ 47,460.00
Construction of roadway	LS	$ 1,000,000.00	1		$ 1,000,000.00
					$ -

Method: ☐ Local Forces ☐ State Forces ☐ Contract

Subtotal	$ 1,968,956.00
PE/CE	$ 590,686.80
Right-of-Way	$ 200,000.00
Perm. Repair Totals	$ 2,759,642.80
Estimated Total	$ 4,029,865.40

Environmental Assessment Recommendation
☒ Categorical Exclusion ☐ EA/EIS

Recommendation
☒ Eligible ☐ Ineligible
FHWA Engineer: Evelyn S. Colon — Date: 11/16/2017

Concurrence
☒ Yes ☐ No
State Engineer: Anibal Miranda — Date: 11/15/17

Concurrence
☒ Yes ☐ No
Local Agency Representative: Luis F. Cruz — Date: 11/15/17

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-11: Bridge 606 inspection report from October 6, 2017 (source: FHWA)



Figure 3-12: Bridge 606 photos from October 6, 2017 inspection (source: FHWA)

3.1.6. Images after Hurricane Maria



Figure 3-13: Bridge 606 satellite image after Hurricane Maria (source: NOAA)



Figure 3-14: Bridge 606 satellite after Hurricane Maria (source: Google Earth Pro)



https://twitter.com/ivettesosaT2/status/911281729385746436

Figure 3-15: Social media image of collapsed approach of Bridge 606 (source: Ivette Sosa)

3.1.7. Videos after Hurricane Maria



https://youtu.be/spR6w1vUdhw

Video 3-1: News report showing collapsed approach of Bridge 606 (source: Notiséis 360)



https://youtu.be/3ESDnXjUZvw?t=577

Video 3-2: Drone video of damages in Canóvanas including Bridge 606 (source: Radazone)

3.1.8. Temporary replacement



https://www.facebook.com/municipio.canovanas/photos/pcb.860593040795462/860592964128803

Figure 3-16: Bridge 606 replacement (source: Canóvanas es más Facebook page)

3.2. Bridge 635



(Extracted from Figure 3-24)

3.2.1. General information

Table 3-5: Bridge 635 general information from BridgeReports.com

Name	PR 165 over COCAL RIVER
Structure number	6351
Location	7 KM EAST OF TOA BAJA
Purpose	Carries highway and pedestrian walkway over waterway
Route classification	Minor Arterial (Urban)
Length of largest span	65.3 ft
Total length	130.9 ft
Roadway width between curbs	28.2 ft
Deck width edge-to-edge	37.7 ft
Owner	State Highway Agency
Year built	1959
Historic significance	Bridge is not eligible for the National Register of Historic Places
Number of main spans	2
Main spans material	Prestressed concrete
Main spans design	Stringer/Multi-beam or girder
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 3-6: Bridge 635 general information from the PRHTA

ID	635
Highway	PR 165 km 25.4
Municipality	Toa Baja
Year Built	1959
Functionality	Urban-Minor Arterial
Lanes	2
ADT	20,300
Maintenance	State Highway Agency
Owner	State Highway Agency
Up Service	Highway-Pedestrian
Down Service	Waterway
Width	11.5 m
Length	39.9 m
Spans	2
Under clearance	0
Material	Prestressed concrete
Design	Stringer or girder
Scour Critical	8
Inspection Frequency	24 months
Approach Roadway Width	11.1 m
Bypass length	4 km
NBI Rating	1
NHS	1
Area	458.85 m^2

3.2.2. Images before Hurricane Maria

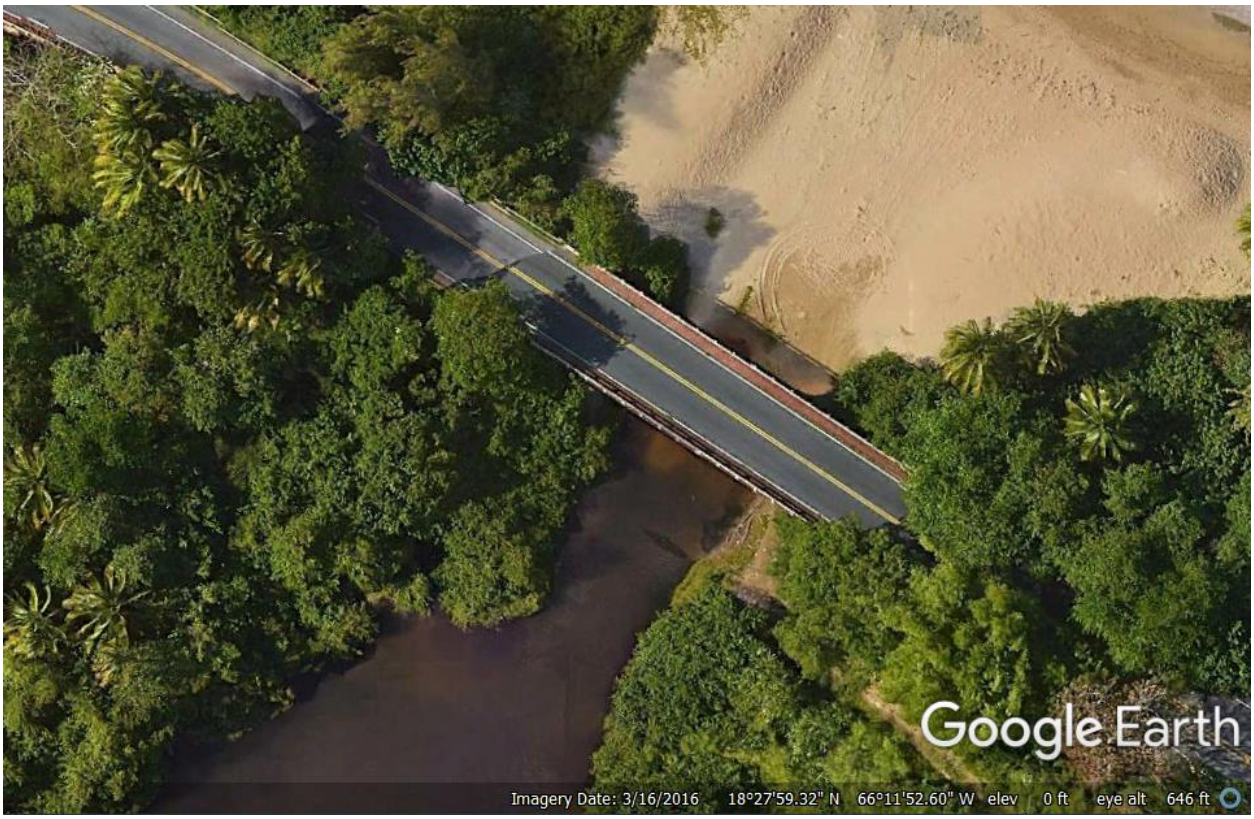
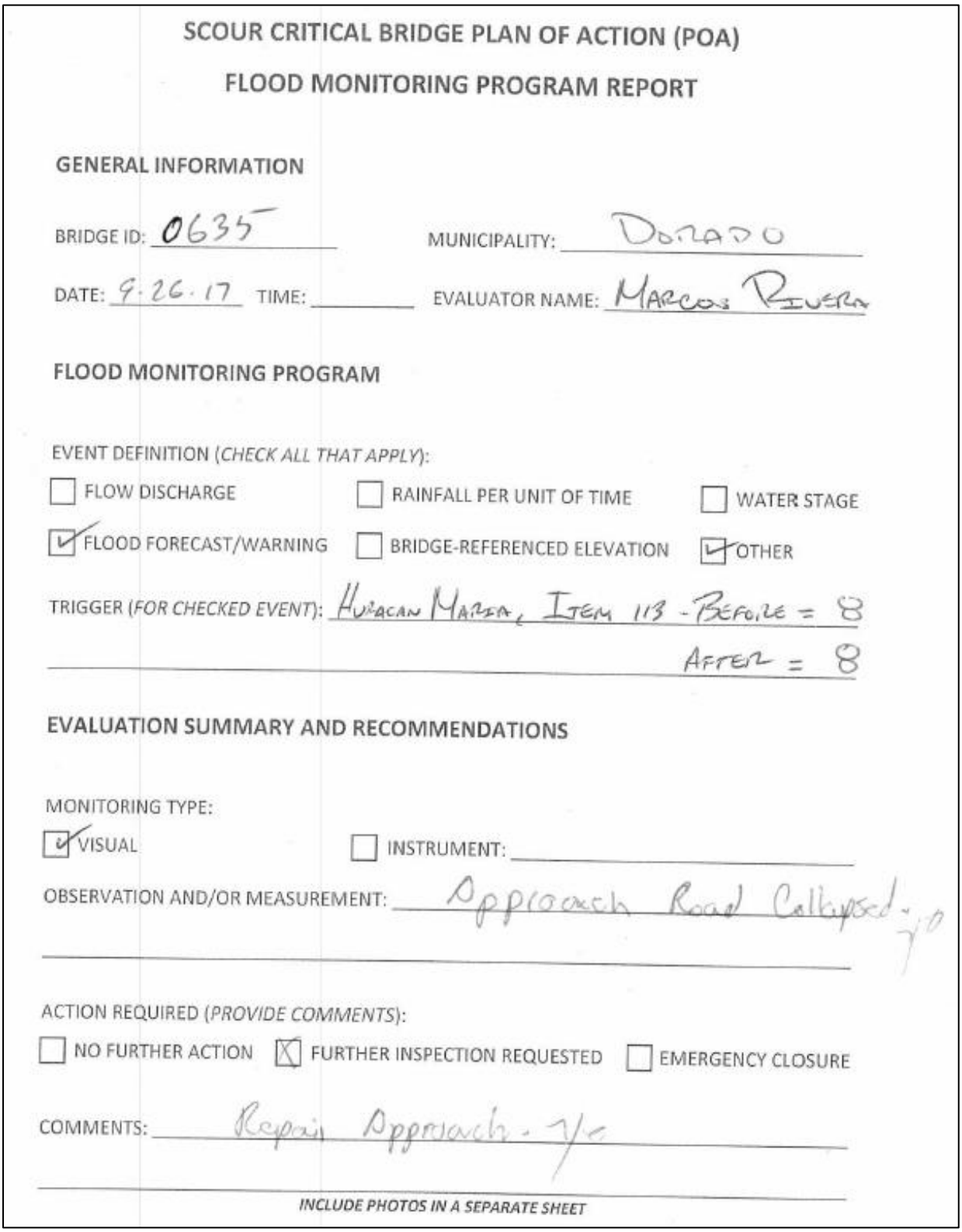


Figure 3-17: Bridge 635 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 3-18: Bridge 635 street view image from March 2016 (source: Google Earth Pro)

3.2.3. Inspections after Hurricane Maria



SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 0635 MUNICIPALITY: Dorado

DATE: 9.26.17 TIME: _____ EVALUATOR NAME: Marcos Rivera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☑ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracan Maria, Item 113 - Before = 8

After = 8

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT: _____

OBSERVATION AND/OR MEASUREMENT: Approach Road Collapsed - yo

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☒ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: Repair Approach - Y/e

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 3-19: Bridge 635 inspection report from September 26, 2017 (source: PRHTA)

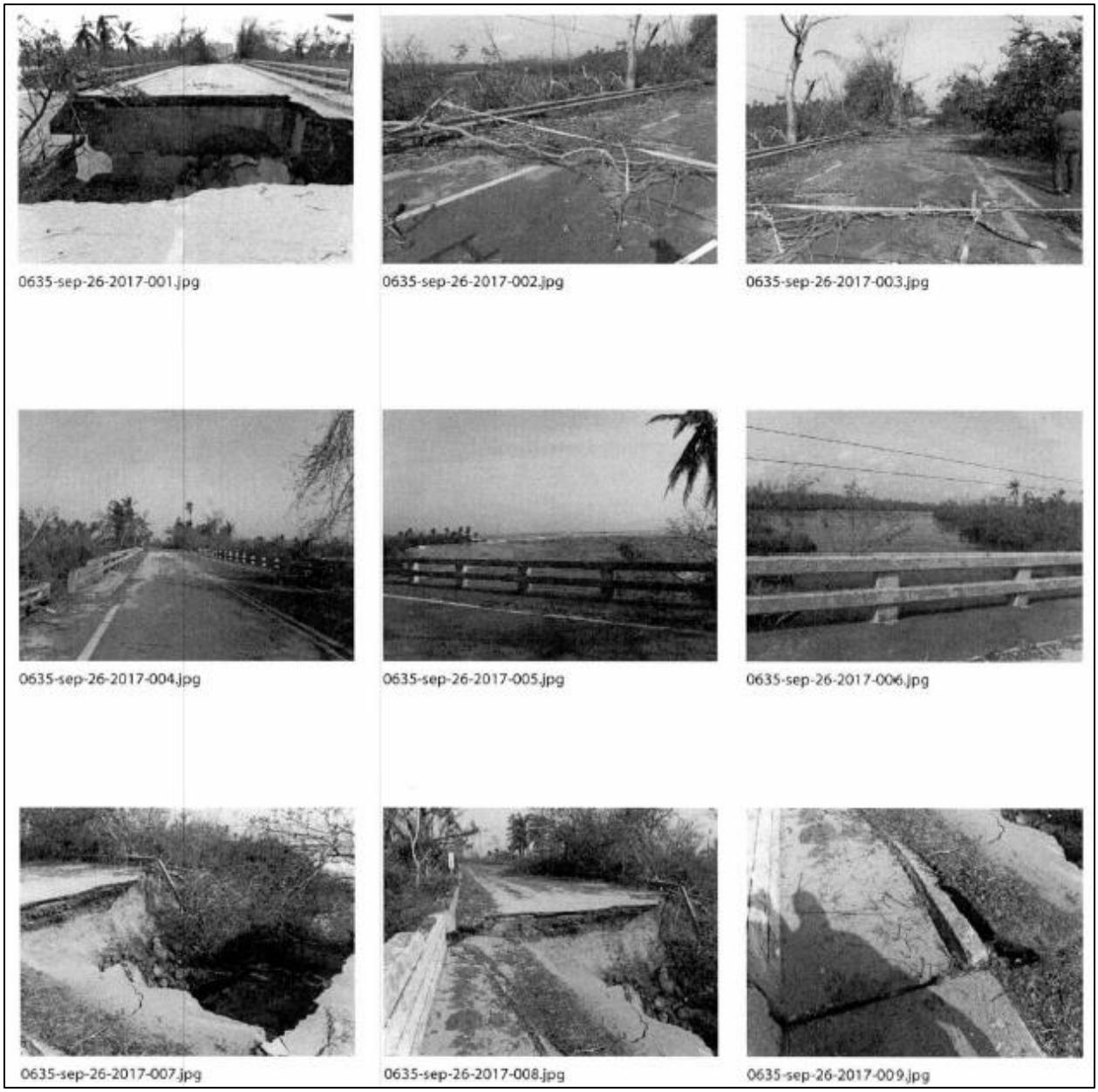


Figure 3-20: Bridge 635 photos from September 26, 2017 inspection (source: PRHTA)

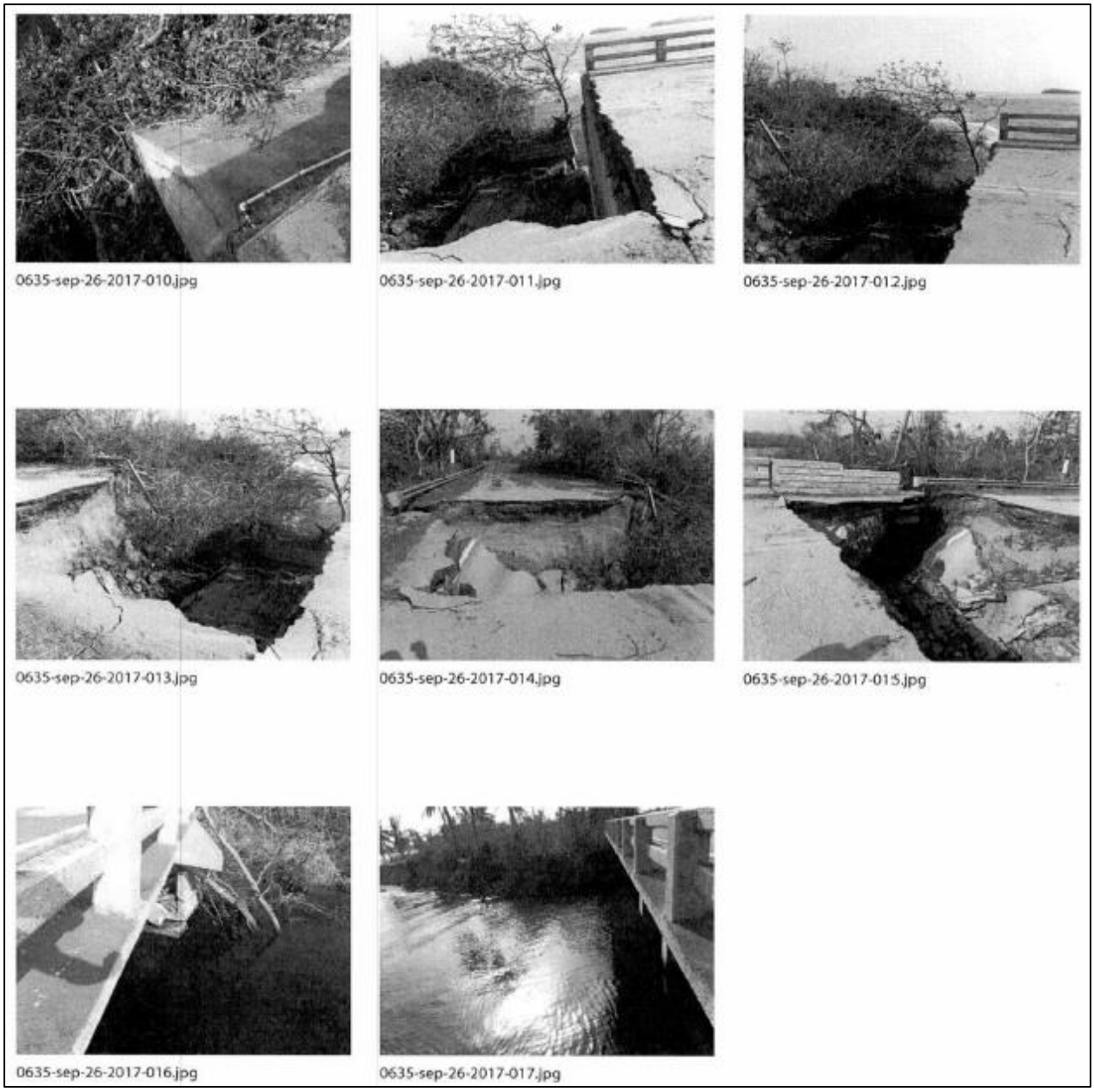


Figure 3-21: Bridge 635 photos from September 26, 2017 inspection (source: PRHTA)

3.2.4. Images after Hurricane Maria



Figure 3-22: Bridge 635 satellite image after Hurricane Maria (source: NOAA)



Figure 3-23: Bridge 635 satellite after Hurricane Maria (source: Google Earth Pro)



https://huracanmaria.elnuevodia.com/2017/municipio/toa-baja/

Figure 3-24: News report image of partial collapse of approach of Bridge 635 (source: El Nuevo Día)



http://www.cubadebate.cu/noticias/2017/09/26/puerto-rico-despues-de-maria-la-catastrofe-no-ha-terminado-fotos/

Figure 3-25: News report image of partial collapse of approach of Bridge 635 (source: Cuba Debate)

3.2.5. Repaired approach



Figure 3-26: Satellite view of Bridge 635's repaired approach (source: Google Earth Pro)

3.4. Bridge 1684



(Extracted from Figure 3-60)

3.4.1. General information

Table 3-7: Bridge 1684 general information from BridgeReports.com

Name	LOCAL ROAD over CHIQUITO RIVER
Structure number	016841
Location	0.6 KM OF PR 111 AT KM 14
Purpose	Carries highway over waterway
Route classification	Local (Rural)
Length of largest span	12.8 ft
Total length	27.2 ft.
Roadway width between curbs	13.5 ft.
Deck width edge-to-edge	13.5 ft
Owner	City or Municipal Highway Agency
Year built	1948
Historic significance	Bridge is not eligible for the national register of historic places
Number of main spans	2
Main spans material	Concrete continuous
Main spans design	Slab
Deck type	Concrete Cast-in-Place
Wearing surface	Bituminous

Table 3-8: Bridge 1684 general information from the PRHTA

ID	1684
Highway	Local Road
Municipality	Utuado
Year Built	1948
Functionality	Rural-local
Lanes	1
ADT	110
Maintenance	Municipal highway agency
Owner	Municipal highway agency
Up Service	Highway
Down Service	Waterway
Width	4.1 m
Length	8.3 m
Spans	2
Under clearance	0
Material	Concrete continuous
Design	Slab
Scour Critical	3
Inspection Frequency	24 months
Approach Roadway Width	5.6 m
Bypass length	199 km
NBI Rating	1
NHS	0
Area	34.03 m^2

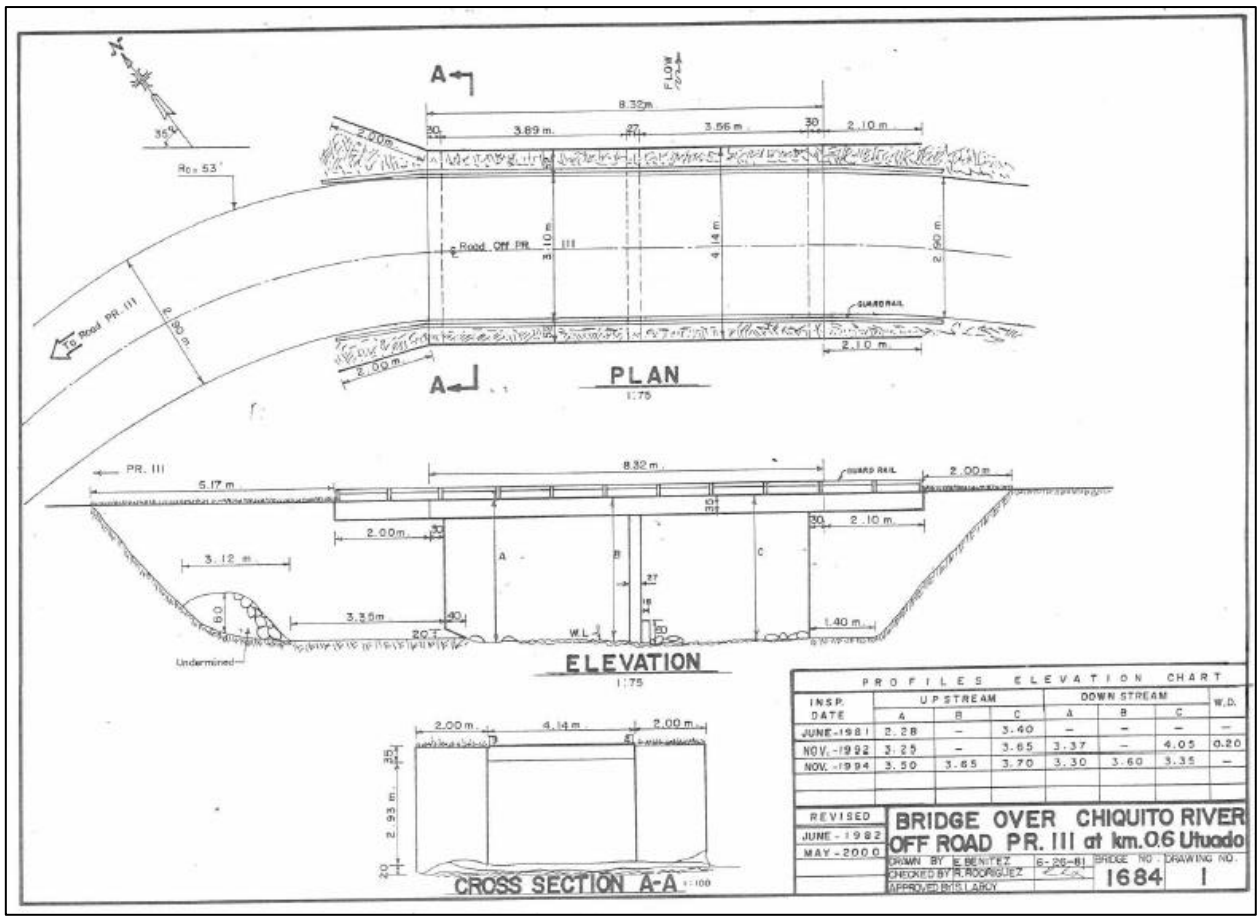


Figure 3-27: Bridge 1684 drawings (source: PRHTA)

3.4.2. Inspection before Hurricane Maria

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 1684

TEAM LEADER: Marcos Rivera

INSP. DATE: July 13, 2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	Yes	24	July-2014	July-2018
ITEM 93 A	FC Inspection	NA	-	-	-
ITEM 93 B	Underwater Insp.	NA	-	-	-
ITEM 93 C	Other:	NA	-	-	-

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	5	5	4	5	N	3
Current Inspection	5	5	4	5	N	3

Other Checks: (Y, N, NA)

_ Scour Critical (items 113 & 60)
✓ AASHTO Core's & NBI CD consistent
✓ Smart Flags (scour, steel plate, fire damage, etc)
_ Channel Profile/Clearance Table
✓ FC & Underwater Members Tables
_ Asphalt Overlay Thickness
✓ Drawings
✓ Photos
✓ Critical Finding
✓ Inspector & Team Leader Signature

Review Comments:

113 = 3, scour critical Analysis

Reviewer: _____

Safety Eng.: _____

Figure 3-28: Bridge 1684 inspection summary of July 13, 2016 (source: PRHTA)

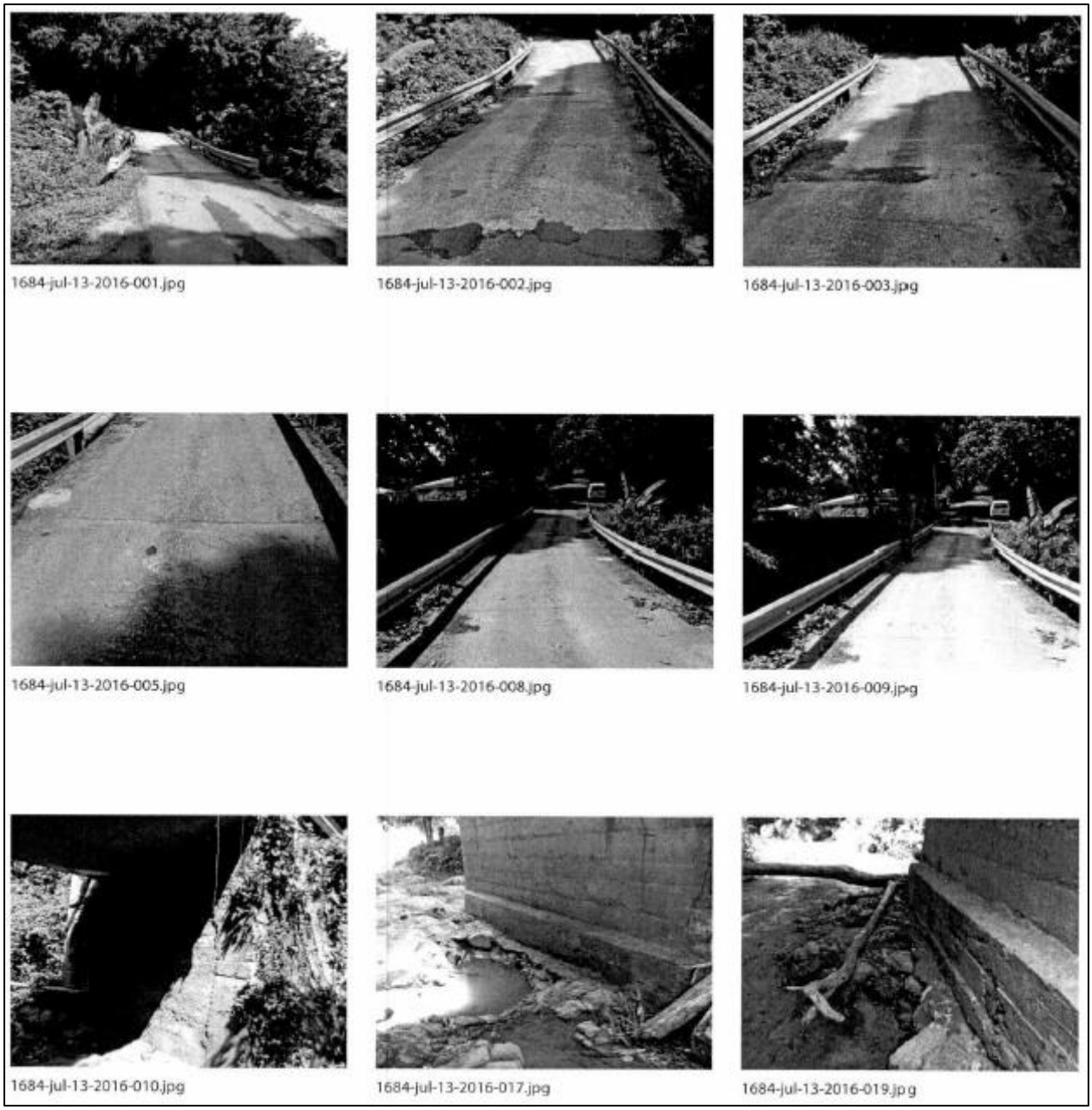


Figure 3-29: Bridge 1684 inspection photos of July 19, 2017 (source: PRHTA)

3.4.3. Images before Hurricane Maria



Figure 3-30: Bridge 1684 satellite image before Hurricane Maria (source: Google Earth Pro)



Figure 3-31: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-32: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-33: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-34: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-35: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-36: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)



Figure 3-37: Bridge 1684 photo from July 13, 2016 inspection (source: PRHTA)

3.4.4. Inspections after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 1684 MUNICIPALITY: Vtuado

DATE: 10/11/17 TIME: 5:00pm EVALUATOR NAME: José Marquez / Jacqueli Gonzalez

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☑ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☑ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT:

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☑ FURTHER INSPECTION REQUESTED ☐ EMERGENCY CLOSURE

COMMENTS: El puente colapsó, el Sa obstruyeron totalmente los 2 conos de flujo del puente y el agua socavó el approach embankment izquierdo

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 3-38: Bridge 1684 inspection report from October 11, 2017 (source: PRHTA)

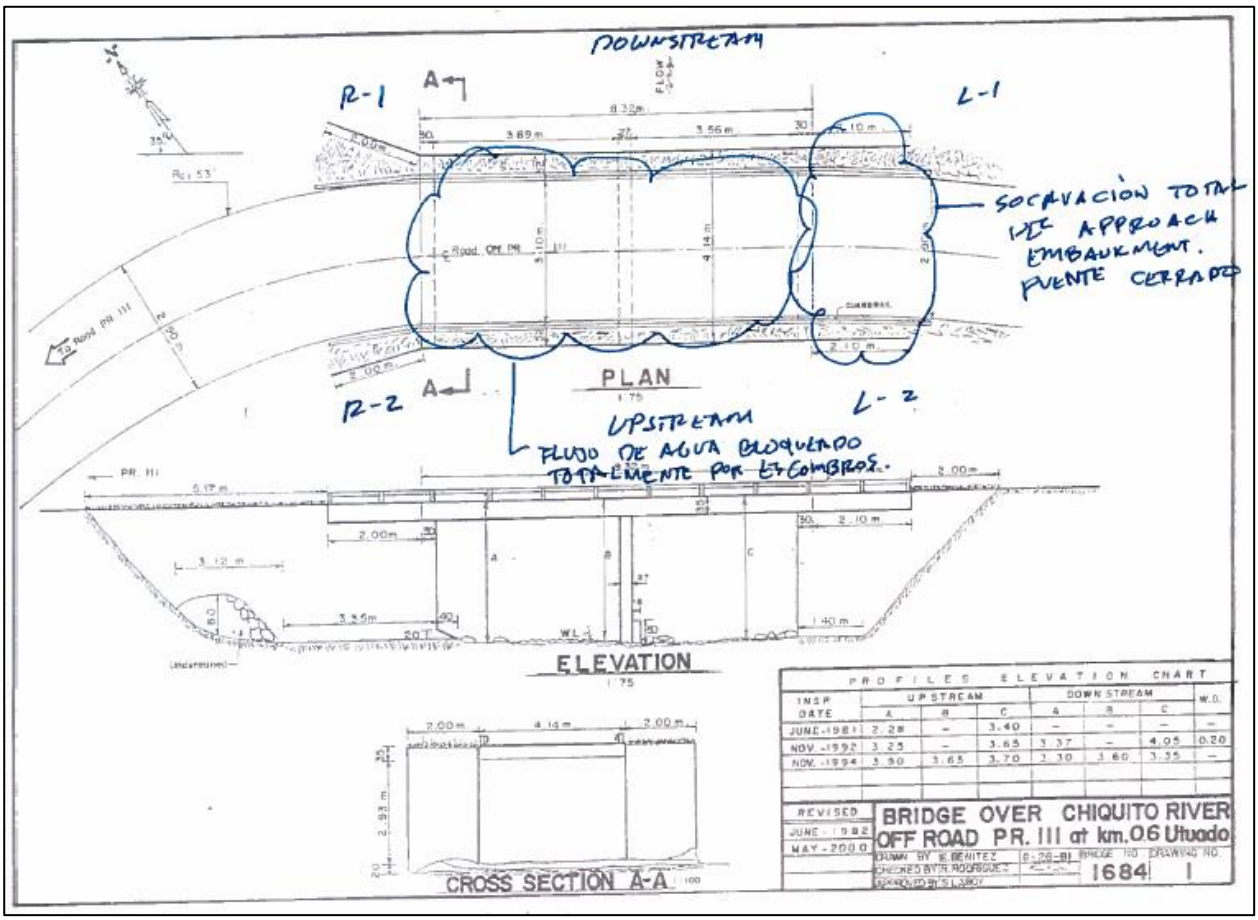


Figure 3-39: Bridge 1684 diagram from October 11, 2017 inspection (source: PRHTA)

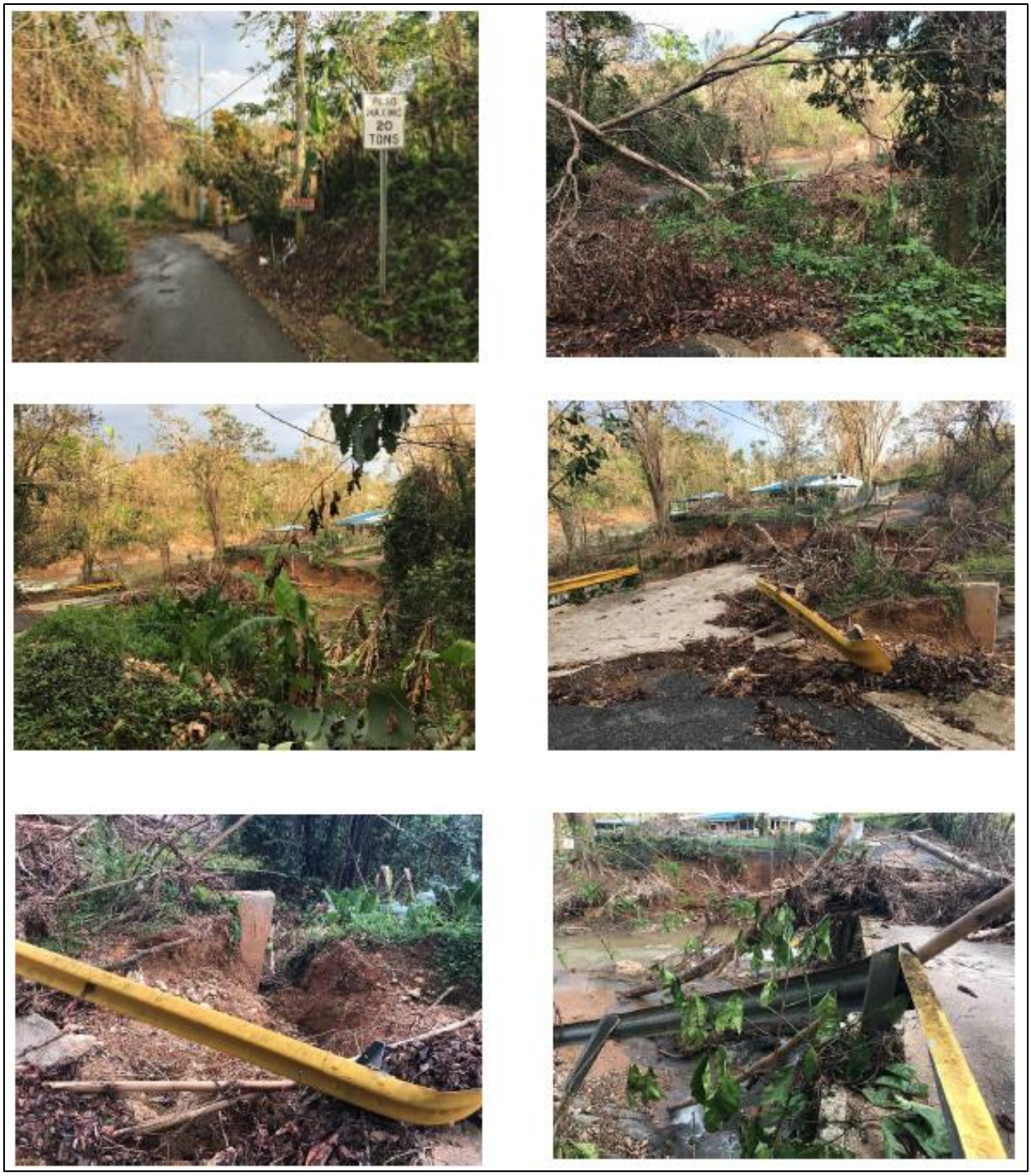


Figure 3-40: Bridge 1684 photos from October 11, 2017 inspection (source: PRHTA)



Figure 3-41: Bridge 1684 photos from October 11, 2017 inspection (source: PRHTA)



Figure 3-42: Bridge 1684 photos from October 11, 2017 inspection (source: PRHTA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 1 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.762632 (66° 46' 57.475")

FHWA Disaster Number

Inspection Date
November 5,2017

Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Federal-aid Route Number

State: PR County: Utuado

Cost Estimate

Emergency Repair

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
(Spec. 151-001) Mobilization 10%	LS	$ 8,060.14	1		$ 8,060.14
(Spec. 202-001) Removal of Structures and Obstructions	LS	$ 5,000.00	1		$ 5,000.00
(Spec. 202-002) Debris Removal	CY	$ 40.04	50		$ 2,001.91
(Spec. 203-002) Borrow Class D	CY	$ 11.68	50		$ 583.97
(Spec. 206-001) Unclassified Excavation Structures	CY	$ 31.15	10		$ 311.45
(Spec. 401) HPM Bituminous	TON	$ 220.00	10		$ 2,200.00
(Spec. 601-002) Class D Concrete	CY	$ 576.53	60		$ 34,591.60
(Spec. 602-001) Reinforcing Steel	LB	$ 2.10	9000		$ 18,900.00
(Spec. 606-001) Guardrail	LF	$ 43.16	80		$ 3,452.80
(Spec. 622-001) Rip Rap	CY	$ 80.08	50		$ 4,003.82
(Spec. 638-003) Temporary Concrete Barriers	LF	$ 126.41	40		$ 5,056.49
(Spec. 638-004) Construction Signs	SQFT	$ 26.45	25		$ 661.25
					$ -
					$ -
(Spec. 613-001) Management of Traffic	LS	$ 3,838.16	1		$ 3,838.16
					$ 88,661.59
					$ 13,299.24
				Emergency Repair Total	$ 101,961.00

Method: Local Forces / State Forces / Contract / PE/CE — Subtotal

Permanent Restoration

Method: Local Forces / State Forces / Contract

Subtotal
PE/CE Right-of-Way
Perm. Repair Totals

Environmental Assessment Recommendation
Categorical Exclusion EA/EIS

Estimated Total

Recommendation
Eligible Ineligible — FHWA Engineer — Date

Concurrence
Yes No — State Engineer — Date

Concurrence
Yes No — Local Agency Representative — Date

Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-43: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 2 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.782632 (66° 46' 57.475")

FHWA Disaster Number -
PR Emergency Damage Assessement

Inspection Date
November 5,2017

Federal-aid Route Number

State: PR County: Utuado

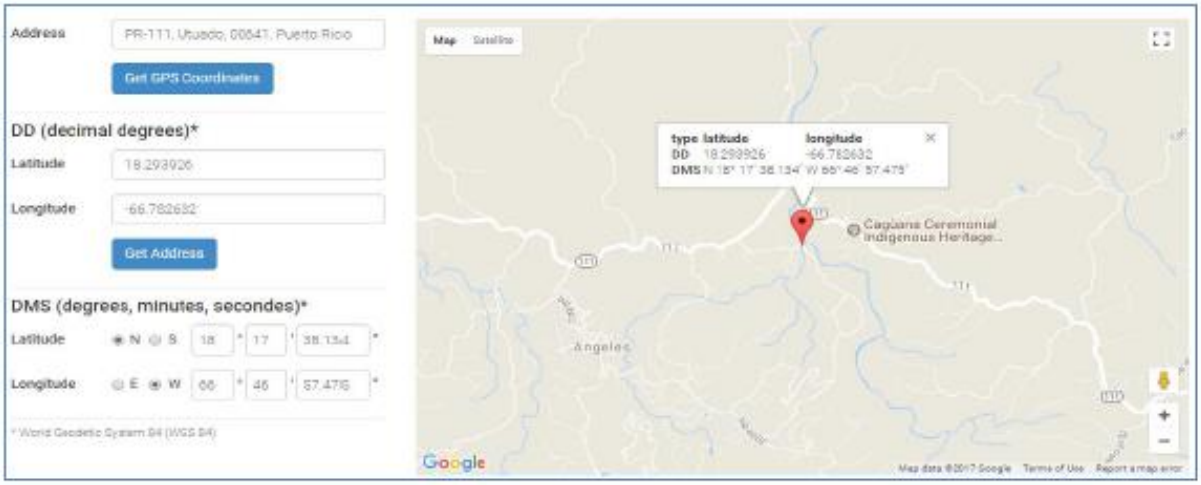
Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Photo 1 - Location Maps for Bridge 1683





Form FHWA-1547 (Rev. 4-96)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-44: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 3 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.782632 (66° 46' 57.475")

FHWA Disaster Number -
PR Emergency Damage Assessement

Inspection Date
November 5,2017

Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Federal-aid Route Number

State: PR County: Utuado

Photo 2 - Before event photo : Photo 3 - Aerial view after event





Form FHWA-1547 (Rev. 4-98)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-45: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 4 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.782632 (66° 46' 57.475")

FHWA Disaster Number -
PR Emergency Damage Assessement

Inspection Date
November 5,2017

Federal-aid Route Number

State: PR County: Utuado

Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Photo 4 - Looking West, asphalt washout: Photo 5 - Looking West, road approach washout



Form FHWA-1547 (Rev. 4-96)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-46: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 5 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest Intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.782632 (66° 46' 57.475")

FHWA Disaster Number -
PR Emergency Damage Assessement

Inspection Date
November 5,2017

Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Federal-aid Route Number

State: PR County: Utuado

Photo 6 - Looking North, existing bridge : Photo 7 - Asphalt washout East approach





Form FHWA-1547 (Rev. 4-96)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-47: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

DETAILED DAMAGE INSPECTION REPORT

U.S. Department of Transportation
Federal Highway Administration

(Title 23, Federal-aid Highways)

Report Number

Sheet 6 of 6

Location (Name of Road and Milepost)
Bridge # 1684- Nearest Intersection PR 111 KM 47
Crossing creek near Tanama River
Coordinates: N 18.293926 (18° 17' 38.134") & W 66.782632 (66° 46' 57.475")

FHWA Disaster Number -
PR Emergency Damage Assessement

Inspection Date
November 5,2017

Description of Damage
Bridge No. 1684 over creek close to Tanama river with damages caused by hurricane Maria on September 20, 2017. This is a 2 span bridge measuring 40 ft. Debris blocked the flow of the water through the bridge resulting in the washout of the West approach. This left a 40 ft span between the bridge abutment and the road. The river migrated.

Critical finding: Bridge abutments were damaged
Need to demolish and remove failing structure.

Proposed emergency repair:
Build a 40 ft, 2 span bridge similar to the existing
Place riprap at the abutment sides.

Federal-aid Route Number

State: PR County: Utuado

Photo 8 - River channel migration



Form FHWA-1547 (Rev. 4-96)

This form was electronically produced by Elite Federal Forms, Inc.

Figure 3-48: Bridge 1684 inspection report of November 5, 2017 (source: FHWA)

3.4.5. Images after Hurricane Maria



Figure 3-49: Bridge 1684 satellite after Hurricane Maria (source: NOAA)



Figure 3-50: Bridge 1684 satellite after Hurricane Maria (source: Google Earth Pro)



Figure 3-51: Bridge 1684 image from PRHTA inspection report



Figure 3-52: Bridge 1684 image from PRHTA inspection report



Figure 3-53: Bridge 1684 image from PRHTA inspection report



Figure 3-54: Bridge 1684 image from PRHTA inspection report



Figure 3-55: Bridge 1684 image from PRHTA inspection report



Figure 3-56: Bridge 1684 image from PRHTA inspection report



Figure 3-57: Bridge 1684 image from PRHTA inspection report



https://flic.kr/p/211KVD7

Figure 3-58: Social media image of damaged Bridge 1684 (source: Julia Maldonado)



https://flic.kr/p/ZKKLK6

Figure 3-59: Social media image of collapsed approach of Bridge 1684 (source: Julia Maldonado)



https://flic.kr/p/HaxXvp

Figure 3-60: Social media image of collapsed approach of Bridge 1684 (source: Julia Maldonado)

3.4.6. Repaired approach



Figure 3-61: Satellite image of Bridge 1684 with repaired approach (source: Google Earth Pro)

4. Bridges not in inventory

There is an unknown number of bridges in Puerto Rico that are not in the PRHTA inventory. Among the possible reasons for this is that the bridge might have been constructed by the municipality or by the local community and it was never reported to the PRHTA.

Table 4-1 lists four bridges that were not in the PRHTA inventory before Hurricane Maria made landfall in Puerto Rico and that might have collapsed due to the storm. At the time this research project was conducted, two of these bridges had been given an ID number by the PRHTA; therefore, reports of inspections conducted by PRHTA after Hurricane Maria were available for these two bridges. This project gained knowledge of the other two bridges without ID number through internet research of news reports and social media. There might be other bridges that are not in the PRHTA inventory and that collapsed due to Hurricane Maria.

Each of the four bridges listed in Table 4-1 is dedicated a section, in a similar format to the one used in previous chapters. As they were not in the inventory, there are very few photographs of the bridges' condition and no inspection reports before Hurricane Maria. Also, there are no inspection reports after Hurricane Maria for the bridges that had not been given an ID number. Clarification comments have been added for Bridges 3051 and 3053 to offer the reader relevant information that might help decide if these bridges should be counted toward the total number of bridges that collapsed due to the hurricane.

Table 4-1: Some of the bridges that were not in inventory when affected by Hurricane Maria

ID	Municipality	Name	Coordinates
3051	Ciales/Orocovis	Off PR-149 @ 42.3 over Toro Negro River	18°10'57.36"N 66°30'46.02"W
3053	Yauco	Off PR-372 @ 9.2 over Los Muertos Creek	18°06'14.00"N 66°50'56.88"W
La Riviera Sector	Corozal	Off PR-803 over Mavilla River	18°18'00.72"N 66°17'43.04"W
Seis Bocas	San Sebastian	PR-451 over Guajataca River	18°19'49.46"N 66°54'57.12"W

4.1. Bridge 3051



(Extracted from Figure 4-8)

4.1.1. Image before Hurricane Maria



Figure 4-1: Bridge 3051 satellite image before Hurricane Maria (source: Google Earth Pro)

4.1.2. Inspection after Hurricane Maria

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 3051 MUNICIPALITY: Ciales – Orocovis

DATE: 28/oct/2017 TIME: 4:53 PM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

☐ FLOW DISCHARGE ☐ RAINFALL PER UNIT OF TIME ☐ WATER STAGE

☐ FLOOD FORECAST/WARNING ☐ BRIDGE-REFERENCED ELEVATION ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

☒ VISUAL ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, fundaciones expuestas estribo PR-149 colapsó

ACTION REQUIRED (*PROVIDE COMMENTS*):

☐ NO FURTHER ACTION ☐ FURTHER INSPECTION REQUESTED ☒ EMERGENCY CLOSURE

COMMENTS: Estructura inestable, colapso inminente Se recomienda cierre

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 4-2: Bridge 3051 inspection report from October 28, 2017 (source: PRHTA)



Figure 4-3: Bridge 3051 photos from October 28, 2017 inspection (source: PRHTA)

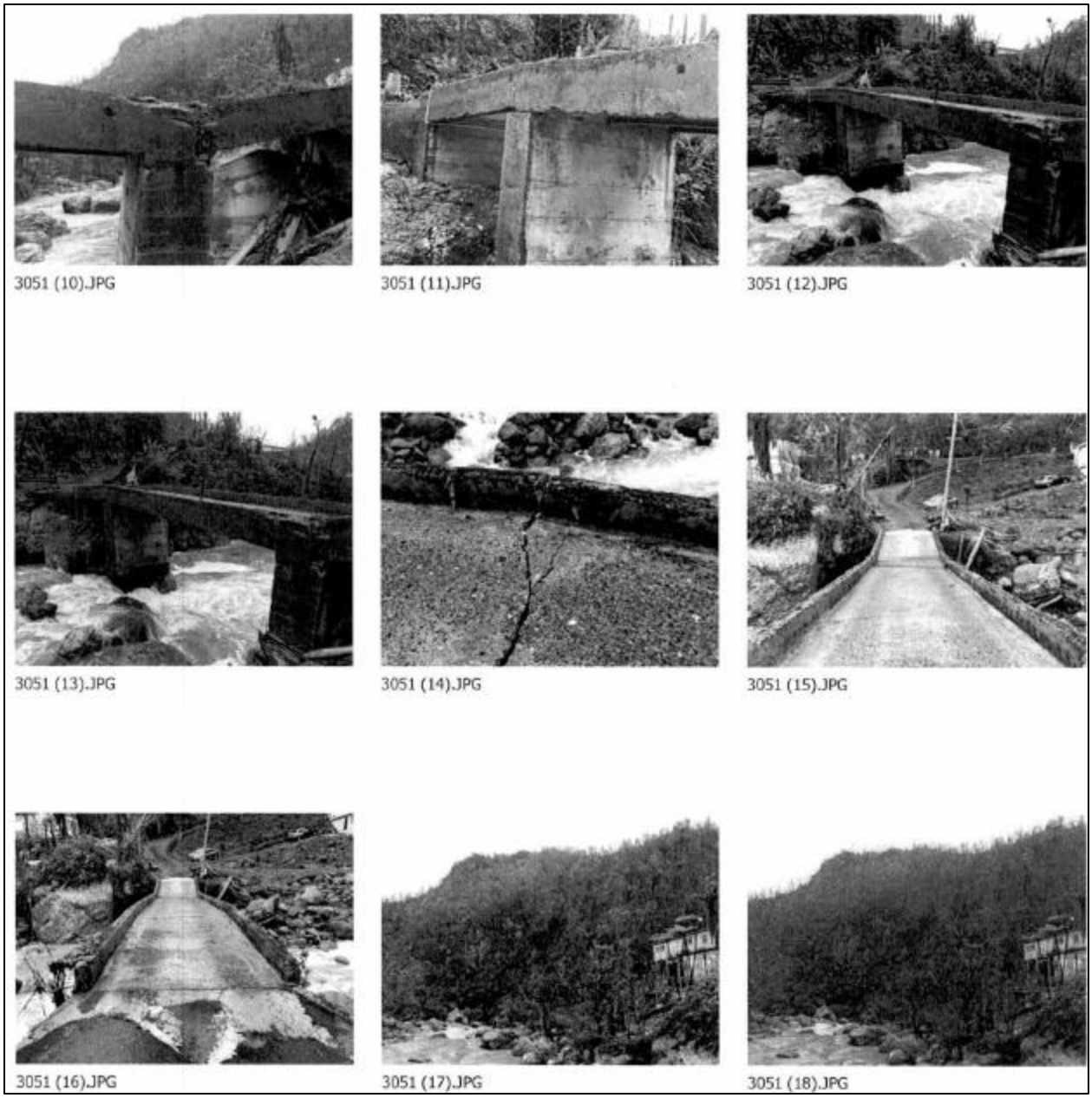


Figure 4-4: Bridge 3051 photos from October 28, 2017 inspection (source: PRHTA)

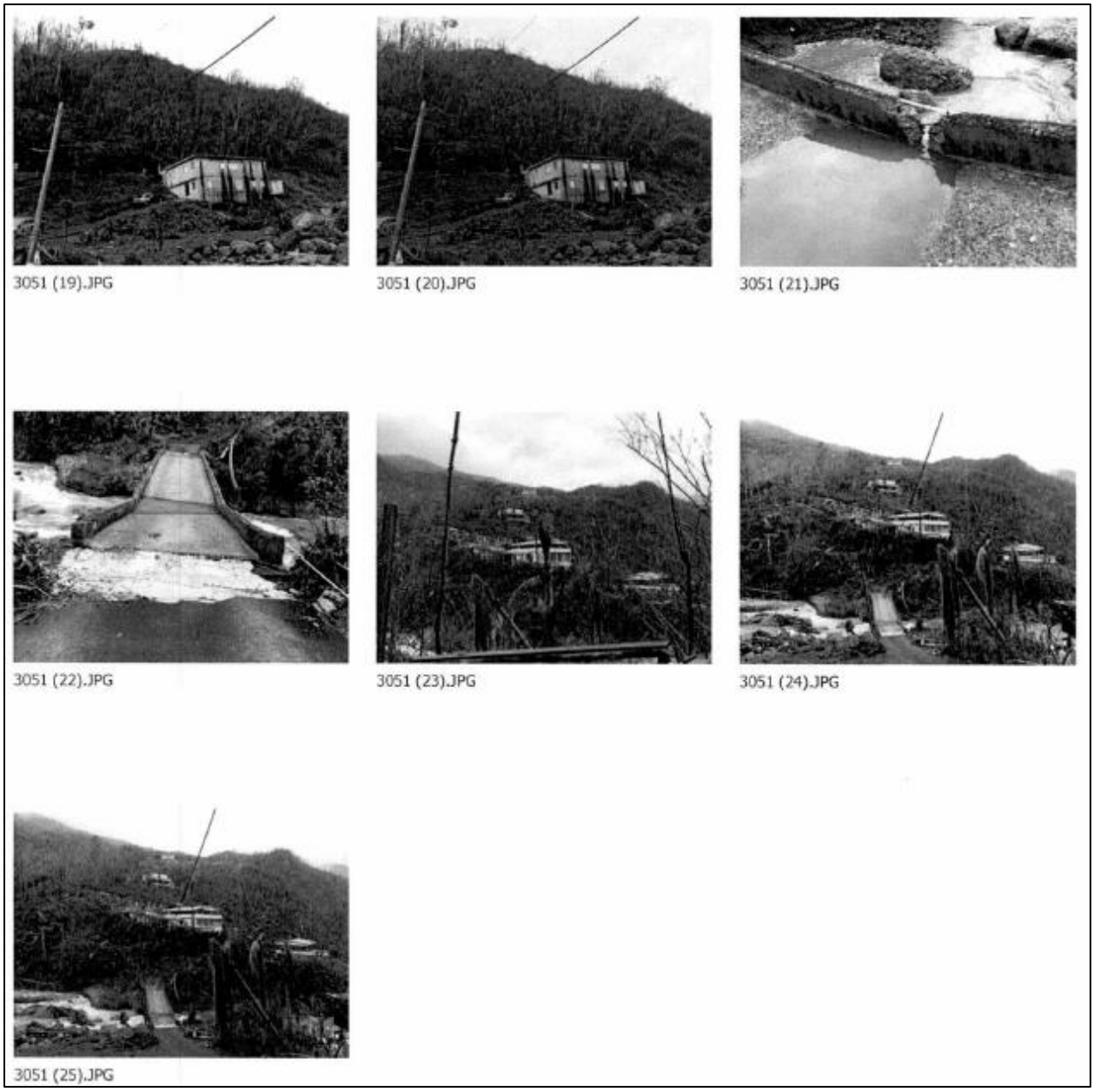


Figure 4-5: Bridge 3051 photos from October 28, 2017 inspection (source: PRHTA)

4.1.3. Images after Hurricane Maria



Figure 4-6: Bridge 3051 satellite image after Hurricane Maria (source: NOAA)



Figure 4-7: Bridge 3051 satellite after Hurricane Maria (source: Google Earth Pro)



https://www.elnuevodia.com/noticias/locales/notas/vecinos-de-ciales-viven-angustiados-por-puente-agrietado-tras-maria/

Figure 4-8: News report image of Bridge 3051 (source: El Nuevo Día)

4.1.4. Comments

The engineer that conducted the inspection after Hurricane Maria indicated in the report that one of the abutments had collapsed, that the bridge was unstable, and that collapse was imminent. He recommended that the bridge be closed.

According to a newspaper article (Mora Pérez, 2018), residents that regularly used the bridge indicated that the bridge was already in bad conditions before Hurricane Maria, but that the hurricane aggravated the condition of the bridge. They also indicated that river caused the movement of a "retaining wall" that supported the bridge.

4.2. Bridge 3053



(Extracted from Figure 4-11)

4.2.1. Image before Hurricane Maria

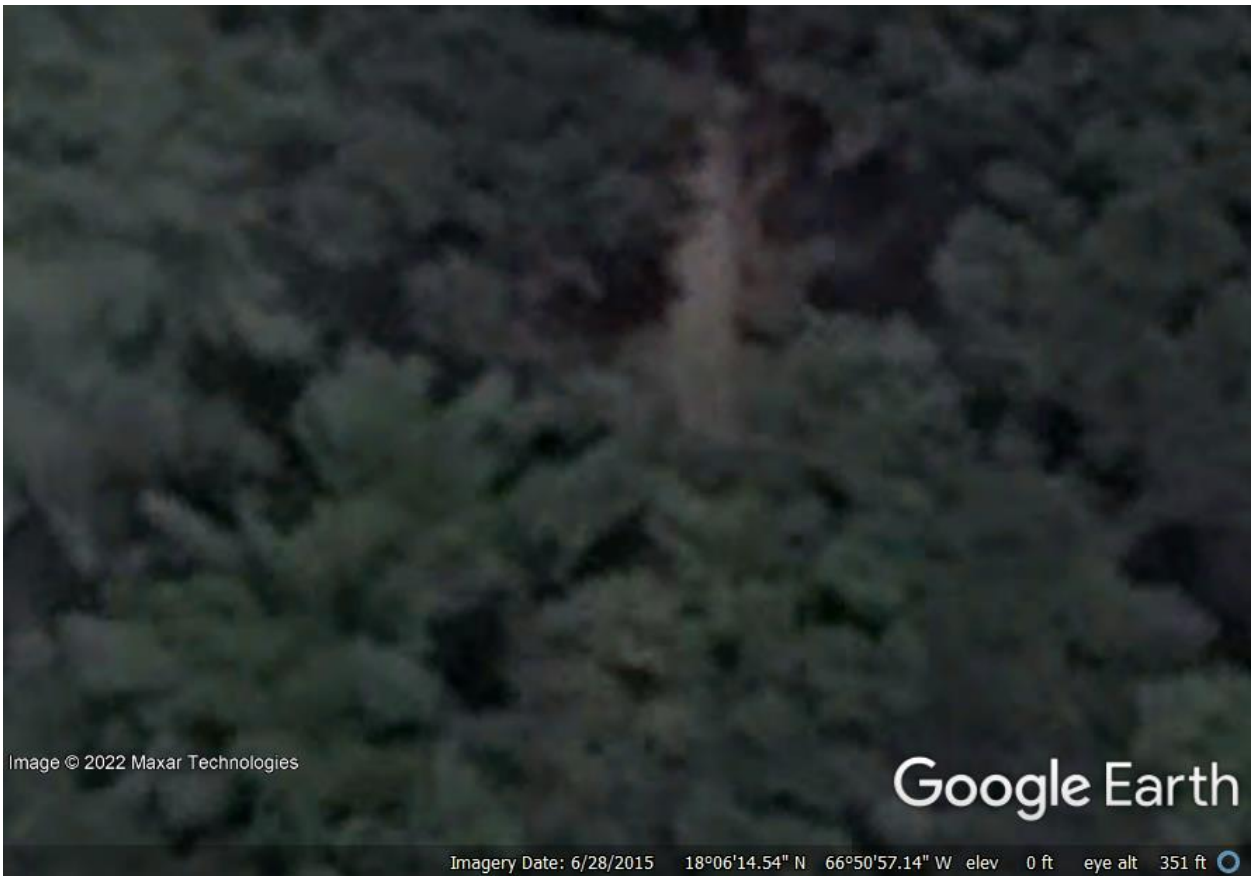


Figure 4-9: Satellite image of Bridge 3031 before Hurricane Maria (source: Google Earth Pro)

SCOUR CRITICAL BRIDGE PLAN OF ACTION (POA)

FLOOD MONITORING PROGRAM REPORT

GENERAL INFORMATION

BRIDGE ID: 3053 MUNICIPALITY: Off PR-372 @ Km 9.2 Yauco, Quebrada "Los Muertos"

DATE: Oct/12/2017 TIME: 10:25 AM EVALUATOR NAME: Eric W. Ríos Mera

FLOOD MONITORING PROGRAM

EVENT DEFINITION (*CHECK ALL THAT APPLY*):

- ☐ FLOW DISCHARGE
- ☐ RAINFALL PER UNIT OF TIME
- ☐ WATER STAGE
- ☐ FLOOD FORECAST/WARNING
- ☐ BRIDGE-REFERENCED ELEVATION
- ☒ OTHER

TRIGGER (*FOR CHECKED EVENT*): Huracán María

EVALUATION SUMMARY AND RECOMMENDATIONS

MONITORING TYPE:

- ☒ VISUAL
- ☐ INSTRUMENT:

OBSERVATION AND/OR MEASUREMENT: Item 113-0, Estructura colapsó

ACTION REQUIRED (*PROVIDE COMMENTS*):

- ☐ NO FURTHER ACTION
- ☐ FURTHER INSPECTION REQUESTED
- ☒ EMERGENCY CLOSURE

COMMENTS: Estructura colapsó, falló estribo PR-372 y un tramo.

INCLUDE PHOTOS IN A SEPARATE SHEET

Figure 4-10: Bridge 3053 inspection report from October 12, 2017 (source: PRHTA)



Figure 4-11: Bridge 3053 photos from October 12, 2017 inspection (source: PRHTA)

4.2.2. Images after Hurricane Maria



Figure 4-12: Bridge 3053 satellite image after Hurricane Maria (source: NOAA)



Figure 4-13: Bridge 3053 satellite image after Hurricane Maria (source: Google Earth Pro)



Figure 4-14: Photo of Bridge 3053 taken June 8, 2022



Figure 4-15: Photo of Bridge 3053 taken June 8, 2022



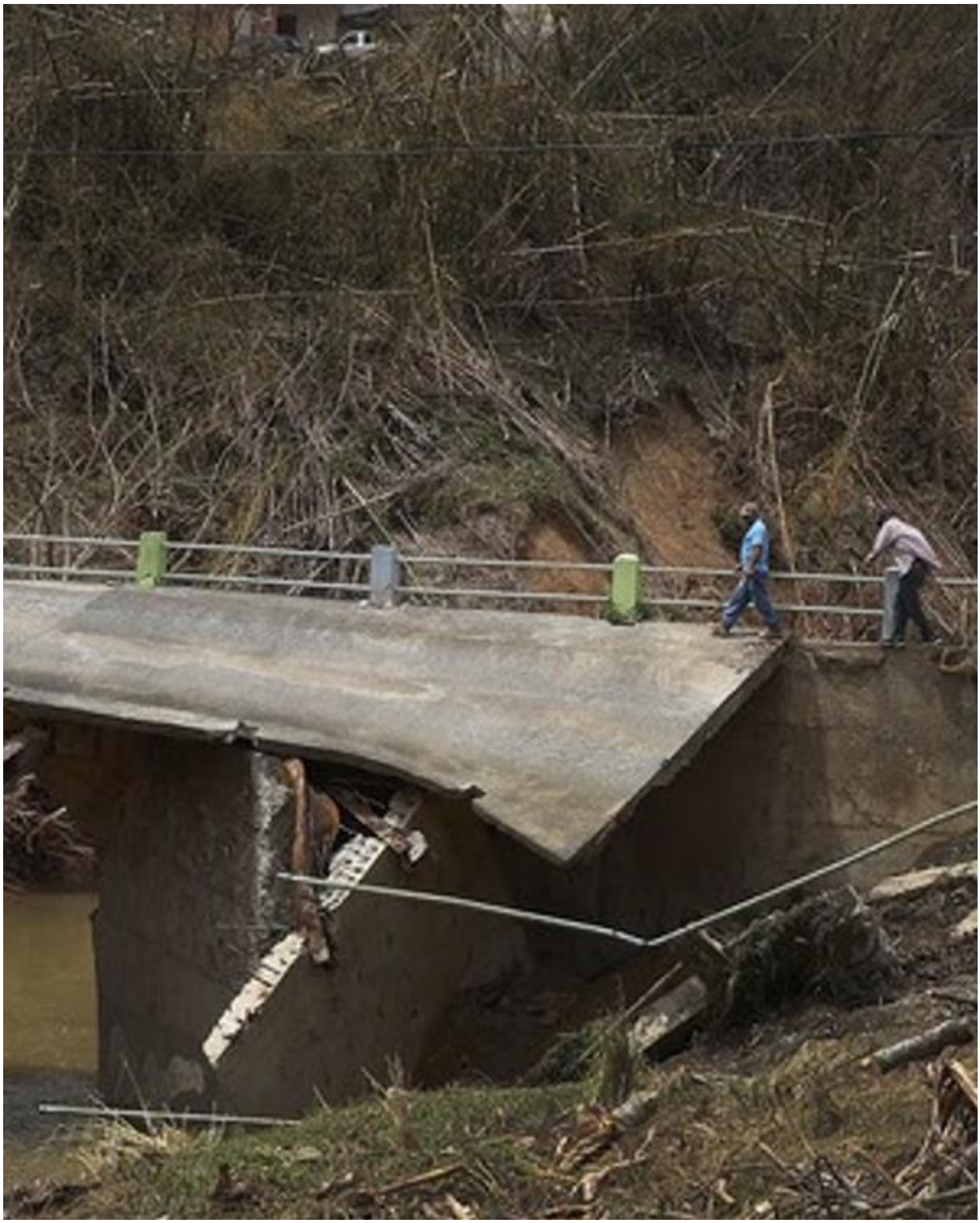
Figure 4-16: Photo of Bridge 3053 taken June 8, 2022

4.2.3. Comments

The engineer that conducted the inspection after Hurricane Maria indicated that one abutment and one span of the bridge had collapsed. Photos from the inspection report show a collapsed slab.

In June 2022, a member of the research project visited this structure. Residents from the area indicated that the bridge had collapsed due to Hurricane Maria. From this inspection another theory was raised: that no span had collapsed, that this was a case of collapsed approach roadway, and that the approach slab had originally been poured together with the bridge's deck. Without drawings or photos of the bridge before Hurricane Maria, the type of failure remains uncertain.

4.3. La Riviera Sector Bridge



(Extracted from Figure 4-20)

4.3.1. Images Before Hurricane Maria



Figure 4-17: La Riviera Sector Bridge satellite image before Hurricane Maria (source: Google Earth Pro)

4.3.2. Images after Hurricane Maria



Figure 4-18: La Riviera Sector Bridge satellite image after Hurricane Maria (source: NOAA)



Figure 4-19: La Riviera Sector Bridge satellite image after Hurricane Maria (source: Google Earth Pro)



https://www.abcactionnews.com/news/photos-puerto-rico-devastated-after-hurricane-maria#id12

Figure 4-20: News report image of collapsed La Riviera Sector Bridge (source: ABC)



https://wtop.com/media-galleries/2017/09/photos-scenes-devastation-puerto-rico-maria/

Figure 4-21: News report image of collapsed La Riviera Sector Bridge (source: WTOP News)



https://www.facebook.com/RafaelJuneRivera/posts/pfbid02wH6BNWc7iWYSjFheEJCquWH9wNwcDJms5e18E25RctyuMhMQMqoP4CkWMs8rRisBl

Figure 4-22: Social media image of collapsed La Riviera Sector Bridge (source: Rafael June Rivera)



https://www.facebook.com/geovanny.t.rivera/posts/pfbid022YDyqYjT4CieANDwcxM9uzPeYEGFHFXMPwtwpW1o7xevY8Z4o6yJfRBn77j7cgoDl

Figure 4-23: Social media image of collapsed La Riviera Sector Bridge (source: Geovanny Torres Rivera)



https://www.facebook.com/geovanny.t.rivera/posts/pfbid022YDyqYjT4CieANDwcxM9uzPeYEGFHFXMPwtwpW1o7xevY8Z4o6yJfRBn77j7cgoDl

Figure 4-24: Social media image of collapsed La Riviera Sector Bridge (source: Geovanny Torres Rivera)

4.3.3. Videos after Hurricane Maria



https://www.telemundopr.com/noticias/puerto-rico/familias-en-peligro-tras-colapso-de-puente_tlmd-puerto-rico/1908340/

Video 4-1: News report of collapsed La Riviera Sector Bridge (source: Telemundo PR)



https://www.wapa.tv/noticias/locales/ponen-en-riesgo-sus-vidas-para-entrar-y-salir-de-sus-hogares_20131122436760.html

Video 4-2: News report of collapsed La Riviera Sector Bridge (source: Noticentro)

R)



https://www.wapa.tv/noticias/locales/vecinos-de-corozal-pide-restauren-el-unico-puente-que-les-da-acceso-a-la-zona-urbana_20131122466773.html

Video 4-3: News report of collapsed La Riviera Sector Bridge (source: Noticentro)

4.4. Seis Bocas Bridge



(Extracted from Figure 4-27)

4.4.1. Image before Hurricane Maria



Figure 4-25: Bridge Seis Bocas satellite image before Hurricane Maria (source: Google Earth Pro)



https://www.noticel.com/la-calle/20170413/final-tragico-para-menores-arrastrados-por-rio-en-san-sebastian/

Figure 4-26: News report image of Bridge Seis Bocas (source: Noticel)

4.4.2. Streamflow

Table 4-2: Peak streamflow at Guajataca River Below Guajataca Lake monitoring station (source: USGS)

Year	Date	Gage Height (ft)	Streamflow (cfs)
2010	2010-06-07	8.61	674
2011	2011-06-04	8.94	730
2012	2012-04-14	8.72	692
2013	2013-05-14	8.48	647
2014	2013-10-09	7.92	513
2015	2015-09-23	8.87	702
2016	2016-07-27	8.41	609
2017	2017-09-20	17.10	10,800

Note: USGS has another monitoring station at the Guajataca River that was closer to the Seis Bocas Bridge, but there is not streamflow data offered from 2003 to 2016, and only the gage height is offered for 2017.

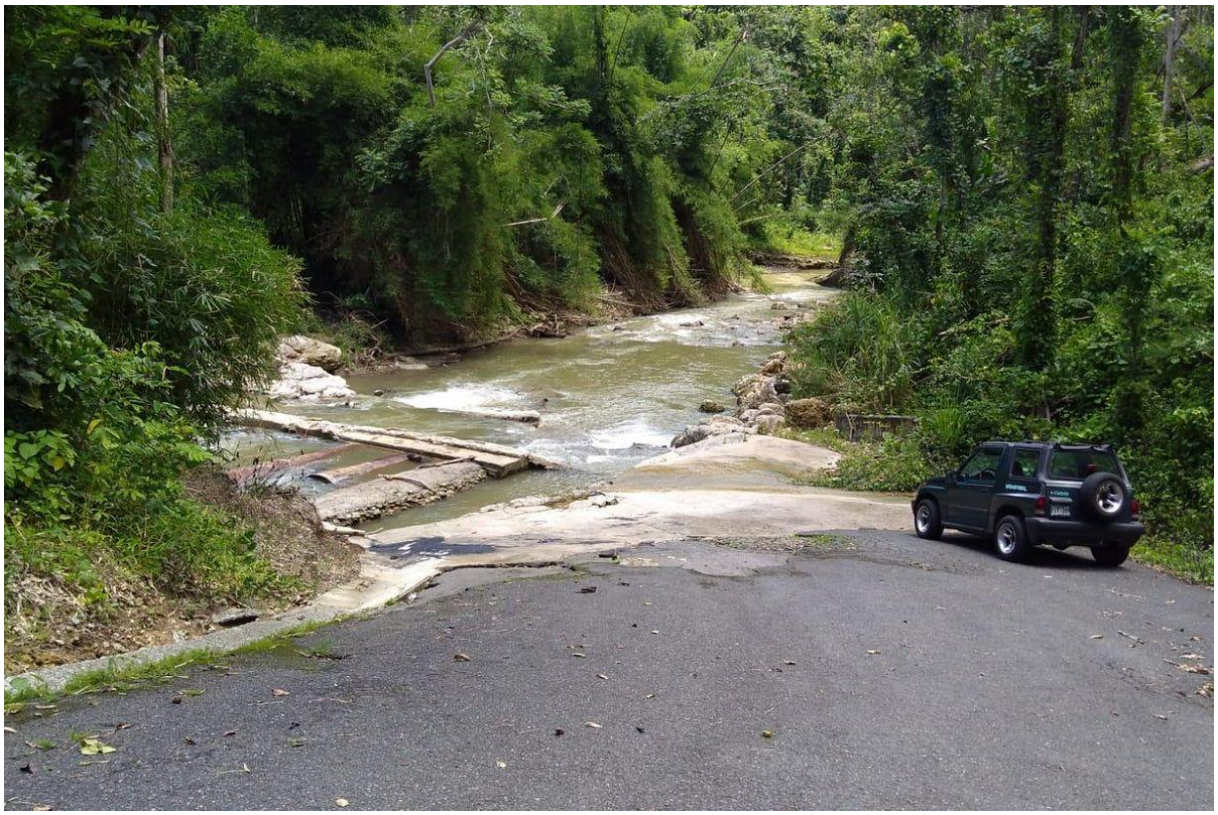
4.4.3. Images after Hurricane Maria



Figure 4-27: Bridge Seis Bocas satellite image after Hurricane Maria (source: NOAA)



Figure 4-28: Bridge Seis Bocas satellite image after Hurricane Maria (source: Google Earth Pro)



https://www.wapa.tv/noticias/locales/llevan-mas-de-un-ano-sin-puente-en-san-sebastian_20131122439526.html

Figure 4-29: News report image of collapsed Bridge Seis Bocas (source: Noticentro)



https://www.elnuevodia.com/noticias/locales/notas/comunidad-en-san-sebastian-lleva-mas-de-un-ano-esperando-por-un-puente-provisional/

Figure 4-30: News report image of collapsed Bridge Seis Bocas (source: El Nuevo Día)



https://www.metro.pr/pr/noticias/2018/10/28/sector-abrahonda-espera-puente.html

Figure 4-31: News report image of collapsed Bridge Seis Bocas (source: Metro)



https://www.metro.pr/pr/noticias/2018/12/06/exigen-fema-agilizar-ayuda-reparar-puente-seis-bocas-san-sebastian.html

Figure 4-32: News report image of collapsed Bridge Seis Bocas (source: Metro)



https://laislaoeste.com/exigen-a-fema-agilizar-ayuda-para-reparar-puente-seis-bocas-en-san-sebastian/

Figure 4-33: News report image of collapsed Bridge Seis Bocas (source: La Isla Oeste)

5. Other cases

This chapter presents other effects that Hurricane Maria had on vehicular bridges and that may be of interest to the reader.

5.1. Other bridges that were replaced

Table 5-1 lists four bridges that were ultimately replaced due to Hurricane Maria. None of these bridges were considered to have collapsed or to had one of its approach collapse.

Table 5-1: Other bridges that were replaced due to Hurricane Maria

ID	Municipality	Name	Coordinates
122	Naguabo	PR-3 over Santiago River	18°11'18.24"N 65°43'30.23"W
878	Utuado	PR-111 over Viví River	18°15'32.67"N 66°41'7.03"W
2681	Coamo	PR-555 over Coamo River	18°08'31.06"N 66°21'48.71"W
3048	Moca	PR-111 over creek	18°22'13.50"N 67°03'55.00"W

Following is a summary of the conditions that lead to each bridge being replaced:

- Bridge 122 was constructed in 1918, therefore it was 99 years old when Hurricane Maria made landfall in 2017. It has been reported that the bridge was already in bad condition before the arrival of Hurricane Maria and that there were plans for it being replaced (Santiago Caraballo, 2013; Díaz Torres, La mayoría de los puentes impactados por el huracán María ya estaban en estado crítico por falta de mantenimiento, 2020). After Hurricane Maria, the bridge did not collapse, as shown in Figure 5-1 and remained open. A temporary steel bridge was built over Bridge 122, as shown in Figure 5-2. It has been reported that Hurricane Maria increased scouring problems that the bridge had, which lead to the construction of the steel structure (Díaz Torres, 2019).

- Bridge 878 was made of concrete and constructed in 1965. Before Hurricane Maria made landfall in Puerto Rico, Bridge 878 was already in bad condition and had a temporary modular steel bridge constructed over it, as shown in Figure 5-3. According the inspection reports, Hurricane Maria caused the collapse of one of the piers and two spans of the deck of the original concrete structure, as well as the erosion of one the bridges embankments, as shown in Figure 5-4 and Figure 5-5. A note in the PRHTA inventory appears to indicate that the collapse of the concrete structure caused some damages to the steel structure. The temporary steel structure was removed and replaced with another temporary modular steel bridge over the original concrete structure.
- Bridge 2681 was a concrete structure constructed in 1951. The images of the inspection report conducted after the hurricane show that the bridge did not collapse, but that one of its approaches was damaged, as shown in Figure 5-6. The inspection report indicates that the bridge had lost some segments of its parapets and indicated a scouring critical rating of 3. The bridge was partially demolished and replaced with a temporary modular steel bridge (Primera Hora, 2018), as shown in Figure 5-7.
- Bridge 3048 was a steel modular bridge that was not in the PRHTA inventory at the time Hurricane Maria hit Puerto Rico. Figure 5-8 and Figure 5-9 show photos from an inspection conducted after Hurricane Maria. The inspection report indicates that the river impacted the embankment, which endangers the bridge stability. The temporary steel structure was removed and used to replace collapsed Bridge 1733, which was further down the roadway (Rodríguez, 2018). A new temporary modular steel bridge was constructed at Bridges 3048's location, as shown in Figure 5-10.



Figure 5-1: Bridge 122 photo from November 2, 2017 inspection (source: PRHTA)



Figure 5-2: New steel bridge over Bridge 122 (source: Centro de Periodismo Investigativo)

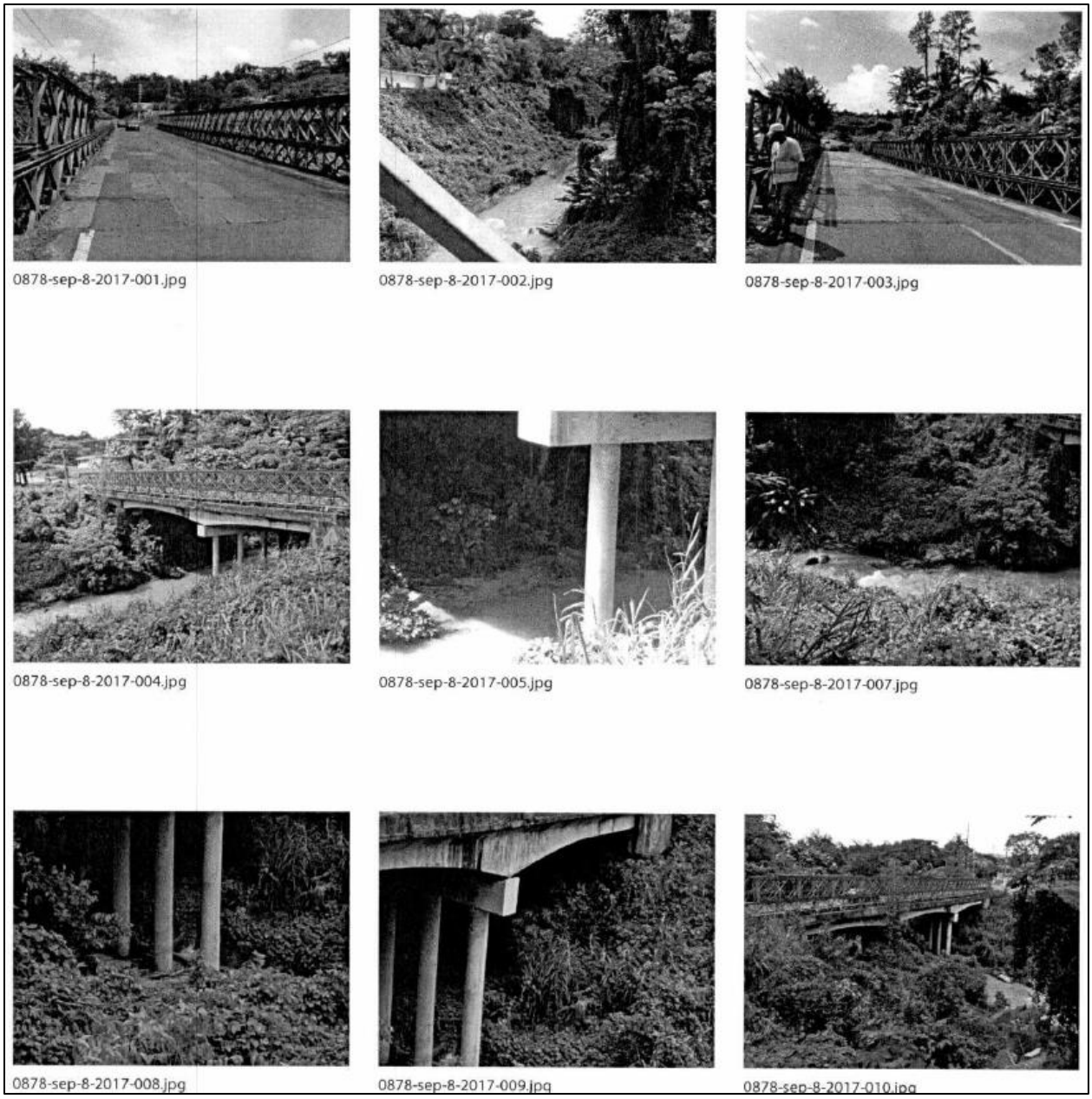


Figure 5-3: Bridge 878 photos from September 8, 2017 inspection (source: PRHTA)

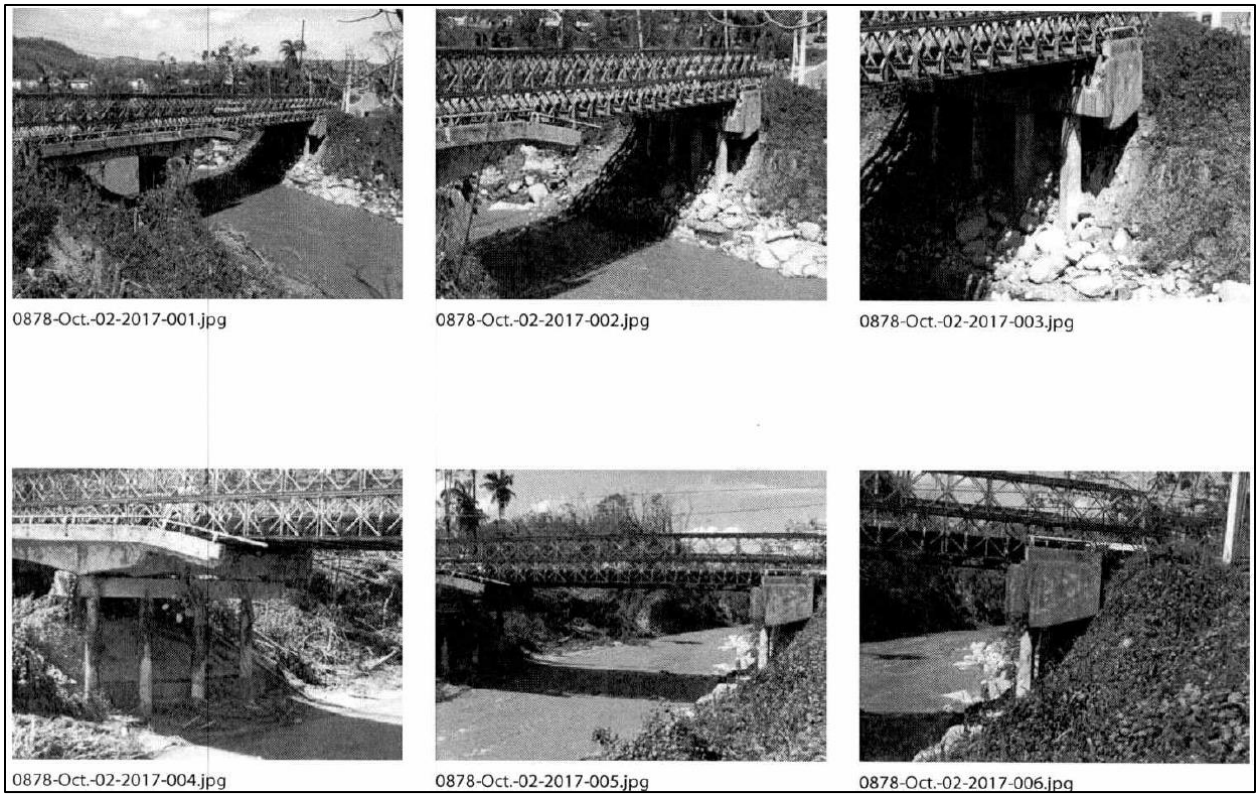


Figure 5-4: Bridge 878 photos from October 2, 2017 inspection (source: PRHTA)



Figure 5-5: Bridge 878 photos from October 5, 2017 inspection (source: PRHTA)



Figure 5-6: Bridge 2681 photos from October 5, 2017 inspection (source: PRHTA)



https://www.primerahora.com/noticias/puerto-rico/notas/construyen-un-puente-mas-seguro-en-coamo/

Figure 5-7: Bridge 2681 replacement (source: Primera Hora)

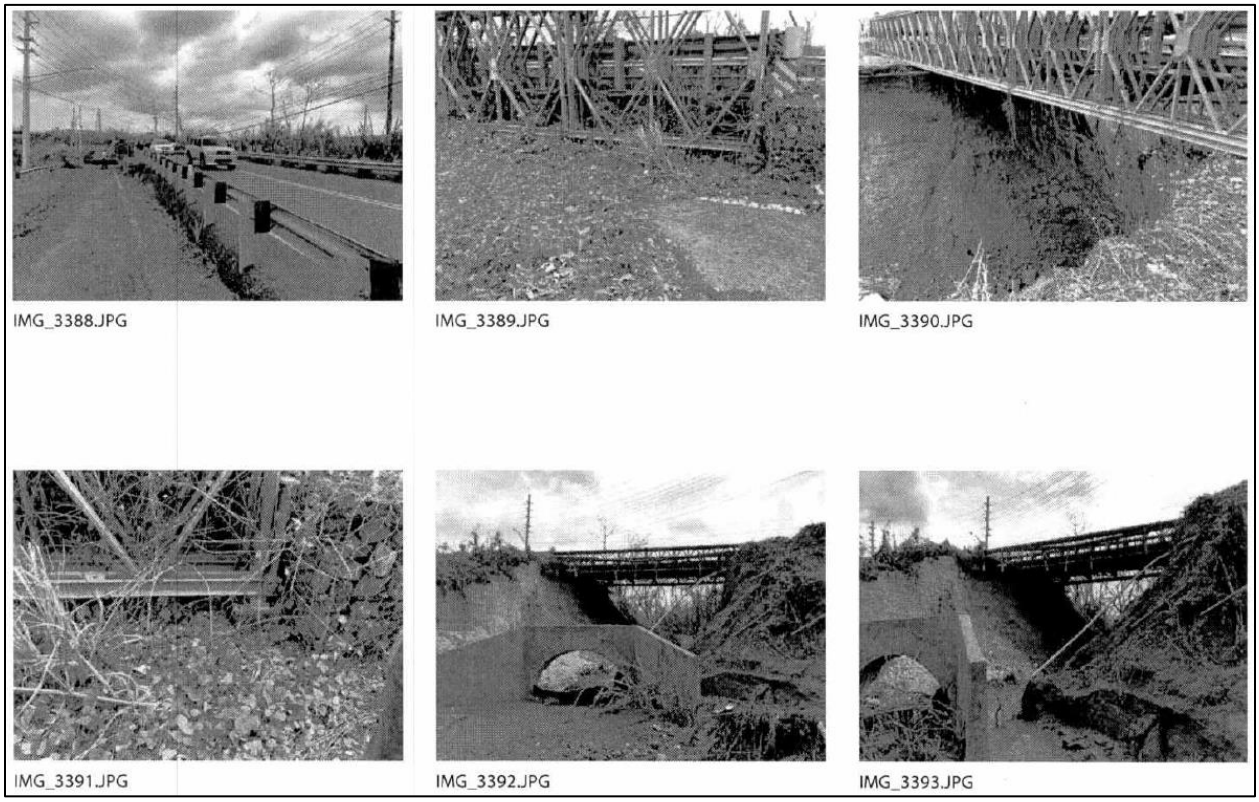


Figure 5-8: Bridge 3048 photos from September 29, 2017 inspection (source: PRHTA)

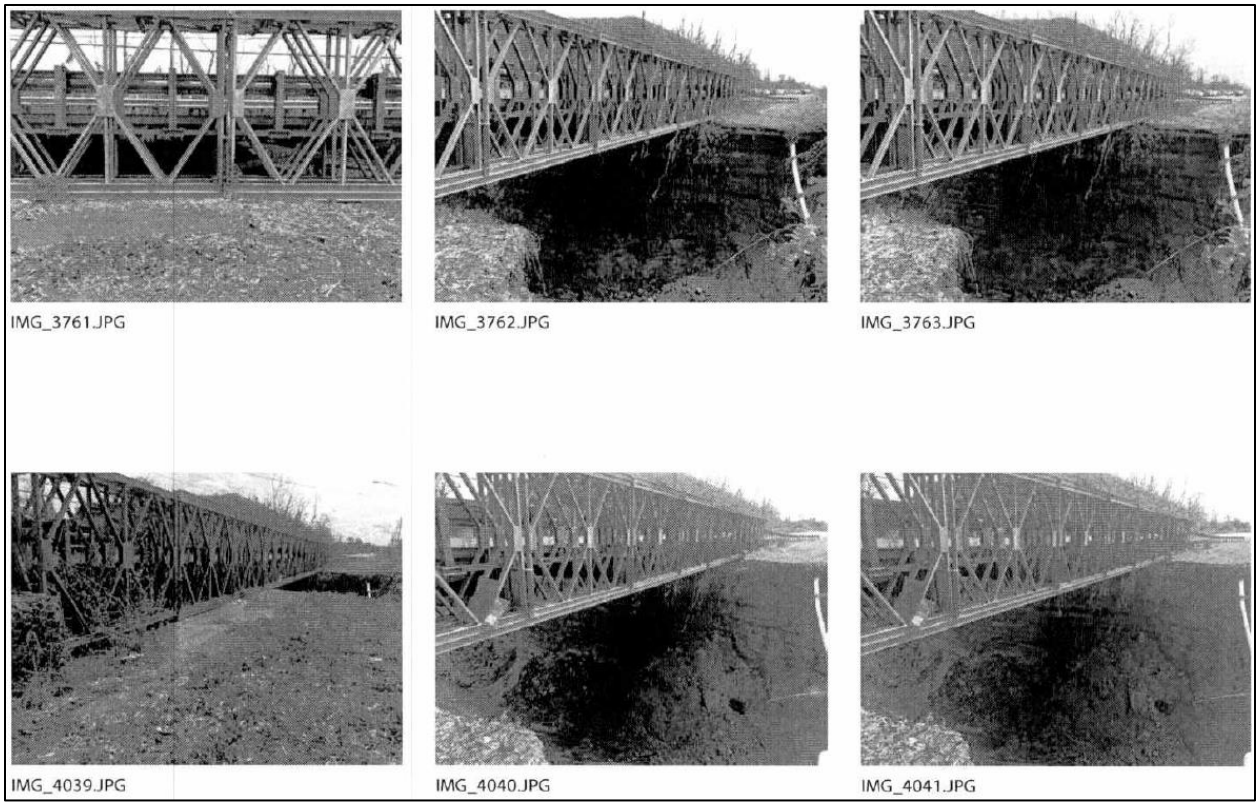


Figure 5-9: Bridge 3048 photos from September 29, 2017 inspection (source: PRHTA)



https://laislaoeste.com/listos-los-puentes-para-reapertura-de-pr-111-en-moca-video/

Figure 5-10: Bridge 3048 replacement (source: La Isla Oeste)

5.2. Bridges closed temporarily due to scouring

Several bridges were temporarily closed due to scouring problems caused by Hurricane Maria. An example of this is Bridge 863, located in the municipality of Bayamón. One of the piers of its bridge had it piles exposed due to scouring, as shown in Figure 5-11. Other bridges that received media attention due to being in main highways were Bridge 1078 in Juan Díaz and Bridge 1309 in Canóvanas. Further research would have to be conducted to determine the total number of bridges that were closed temporarily due to scouring.



Figure 5-11: Bridge 863 photos from October 4, 2017 inspection (source: PRHTA)

5.3. Wingwall collapse

In several inspection reports, problems with wingwalls were indicated. The problems with wingwalls range from the loss of backfill material to complete collapse. An example of a collapsed wingwall is shown in Figure 5-12. Most of the time, the problem with wingwalls did not lead to the closing of bridges. The mechanisms that cause problems with wingwalls are probably related to the ones that lead to approach roadway collapse.



Figure 5-12: Photo of collapsed wingwall of Bridge 1629 taken during October 20,2017 inspection (source: PRHTA)

5.4. Debris accumulation

During the examination of photographs done for this research it was observed that many bridges had debris accumulation in their upstream side after Hurricane Maria. This was a very common occurrence in both damaged and undamaged bridge. The main components of the debris appear to be vegetative material and soil. An example of a mostly undamaged bridge with debris accumulation is shown in Figure 5-13. Is possible that debris accumulation led to the collapse of several bridges as well as the collapse of approach roadways.



https://www.nbcnews.com/storyline/puerto-rico-crisis/puerto-ricans-find-solace-fresh-water-roadside-spout-n808246

Figure 5-13:Debris accumulation in a bridge in Utuado (source: NBC News)

6. Conclusions and Recommendations

This research identified a total of 19 bridges from the PRHTA inventory that collapsed or have severe structural damage due to the effects of Hurricane Maria. The compiled data and images of these structures suggest that the principal causes of the collapse were:

- Scouring of the piers and abutments, and
- Hydrodynamic pressure combined with debris impact.

Of the 19 bridges, 17 were replaced with temporary structures. For future permanent bridges it would be advisable to review hydrologic and hydraulic (H&H) studies to revise:

- The required span and abutment location to reduce souring.
- The required elevation to reduce hydrodynamic impact.

An alternative on how to deal with debris is an area of opportunity for research.

Crowdsourcing and social media data could give valuable graphical information to assess damages under extreme events. Automated and real time collection and processing tools are an area of opportunity further research and development.

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Note: This reference list does not include the pictures and videos of bridges included in this report. For photos and videos obtained from the internet, the URL is provided directly below the media item.