

NIST HURRICANE MARIA STUDY,
HURRICANE MARIA RECOVERY OF INFRASTRUCTURE PROJECT:
INFRASTRUCTURE INTERDEPENDENCY INSTRUMENT:
INTERVIEW GUIDE COMPONENT 1: WATER

OMB Control #0693-0078
Expiration Date: 07/31/2025
[PENDING OMB APPROVAL]

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Introduction

In this interview, we want your insights into how a water system recovers from a major hurricane. We are especially interested in understanding how disruptions in other infrastructure systems, such as power and transportation, impact its recovery. We are conducting similar interviews with PREPA/LUMA and DTOP to learn the same for power and transportation systems.

We are specifically interested in the recovery of water systems from Hurricanes Irma and Maria, which made landfall in September 2017.

We are going to ask you about the time before and the time after Hurricanes Irma and Maria. We recognize that the two events occurred within two weeks of one another and that it may be difficult to remember back that far or to separate the effects of the two storms from one another.

Please answer to the best of your ability.

We use some terms in this survey to keep the questions consistent across interviews with all infrastructure types. We refer, for example, to “your organization.” We recognize that you may more

naturally refer to your “department”, “office”, “agency,” “company,” or “utility.” But for uniformity in conducting interviews for all infrastructure types, we use the generic term “organization”.

Section A. Confirm screening

1. Can you confirm the organization on behalf of which you are providing answers:
 - PRASA
 - Other: _____
2. Can you confirm the geographical area, or as we'll refer to it in this interview, “service region”, for which you are providing answers:
 - The entire area in which your organization operates within the island of Puerto Rico
 - *PRASA Region Metro*
 - *PRASA Region North*
 - *PRASA Region East*
 - *PRASA Region West*
 - *PRASA Region South*
 - Adjuntas
 - Aguas Buenas
 - Aibonito
 - Bayamón
 - Caguas
 - Carolina
 - Catano
 - Ciales
 - Cidra
 - Guaynabo
 - Gurabo
 - Humacao
 - Jayuya
 - Juncos
 - Lares
 - Las Piedras
 - Maunabo
 - Mayagüez
 - Naguabo
 - Ponce
 - San Juan
 - San Lorenzo
 - Toa Baja
 - Trujillo Alto
 - Utuado
 - Yabucoa
 - Other: _____

Please assume we are only asking about your organization's operations within this specific service region, even when it is not explicitly mentioned.

In addition, we will refer to “your system.” By “your system”, we mean your organization’s physical assets, systems, and networks, such as water intakes, wells, pipes, pumps, tanks, administrative buildings, etc., located within your service region.

Section B. Introductory questions

The first set of questions asks about your service region.

3. Are there any major critical buildings in your service region? The building type “critical buildings” includes but is not limited to hospitals, fire stations, police stations, emergency operations centers, and public buildings used as shelters, such as schools.
[Open-ended]
4. Are there any major commercial buildings in your service region? The building type “commercial buildings” includes but is not limited to buildings in financial and business centers/districts, and manufacturing plants.
[Open-ended]
5. How many residents or households are served?
[Open-ended]
6. What are the water sources located within your service region?
[Open-ended]

Next, we ask questions about your professional involvement in the water industry.

7. How many years in the water industry have you worked? (years) ____
8. How many years have you worked in your current organization (in any position)? (years) ____
9. Please state your job title and give a brief description of your job.
[Open-ended]

Section C. Service assessment

In what follows, we will ask questions about the water service provided by your organization in various periods of time before and after Hurricane Maria.

[Interviewer: Show (or have them retrieve) Table A]

Table A. Extent to which your organization provides/provided a specific attribute of service to different types of buildings

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

We want to make sure you become familiar with Table A since we will use this table more than once. In what follows, we are going to ask you the extent to which your organization provided specific attributes of water service to different building types. You'll be asked to select an extent ranging from "Completely" to "Not at all". You'll be asked to do this for "All buildings", "Critical buildings", "Commercial buildings", and "Residential buildings". Table A should be used to help you to answer the questions.

You will reference Table A more than once because we ask about different attributes of water service and we ask about different periods of time.

Condition before hurricanes

10. Before the two hurricanes made landfall, your organization supplied the demanded amount of water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

11. Before the two hurricanes made landfall, your organization provided potable water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						

Commercial buildings						
Residential buildings						

12. Before the two hurricanes made landfall, your organization provided water at all times of the day for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

Condition one week after Hurricane Maria

We now ask the same questions but now ask about the time one week after Hurricane Maria landfall. __

13. One week after Hurricane Maria's landfall, your organization supplied the demanded amount of water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

14. One week after Hurricane Maria's landfall, your organization provided potable water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

15. One week after Hurricane Maria's landfall, your organization provided water at all times of the day for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

Time to return to pre-hurricane level of service after Hurricane Maria

Now we ask how long it took for your organization to resume service.

[Interviewer: Show (or have them retrieve) Table B]

Table B. Time to return to pre-Hurricane Maria level of service

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	Not yet returned	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

We are going to ask you how long it took your organization to resume service to the levels they were before Hurricane Maria. You'll be asked to select from different time periods of time, ranging from "Within a month" to "4-7 years"; "Not yet returned" is also an option. You'll be asked to do this for each building type. Table B should be used to help you to answer the questions.

You will reference Table B more than once because we ask about the same attributes of water service as we did in the earlier set of questions.

16. Following Hurricane Maria's landfall, how long did it take before your organization supplied the demanded amount of water at the pre-Hurricane Maria level for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	Not yet returned	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

17. Following Hurricane Maria's landfall, how long did it take before your organization provided potable water at the pre-Hurricane Maria level for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	Not yet returned	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

18. Following Hurricane Maria's landfall, how long did it take before your organization provided water at all times of the day at the pre-Hurricane Maria level for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	Not yet returned	Not applicable
All buildings								
Critical buildings								
Commercial buildings								

Residential buildings								
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Section D. Dependencies on other systems—Effect of disruptions on service recovery

In this next set of questions, we ask you to identify disruptions that had an impact on your organization's recovery of service, either by delaying specific steps of recovery, making recovery proceed slower than it otherwise would ("throwing sand in the gears"), presenting obstacles that had to be overcome or gotten around, or in any other way frustrating efforts to recover service. We ask all infrastructure service providers about the extent of impact to service recovery of disruptions in goods and services in six categories: communications, transportation, water, energy, economy, and government. We take them up one category at a time.

[Interviewer: Show (or have them retrieve) Table C]

Table C. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	Not applicable (NA)	Don't know (DK)
Item 1						
Item 2						

In answering, please consider...

Impact on recovery of service to pre-Hurricane Maria levels

the entire period of service recovery, from just before landfall through repairs (temporary or permanent) necessary to recover service

only direct impacts on service recovery

We'll ask you to indicate the extent to which disruptions in each of a set of items impacted service recovery, with responses ranging from "Not at all" to "To a great extent."

In answering, please consider the period from the leadup to landfall, landfall, damage assessment, through to completion of the repairs necessary to recover to pre-Hurricane levels all service attributes, including: supplying the demanded amount of water, providing potable water, and providing water at all times of the day.

Further, we ask that you consider only **direct** impacts. To illustrate what we mean by **direct**, consider the following example. Suppose that outages of traffic signals impacted your organization's recovery of

service. Even though you may know this resulted from a power outage, in this example, the transportation system directly impacts recovery of service (the power system only indirectly).

Communications

First, we will consider the impact of disruptions in *Communications*.

19. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
Wired phone service						
Wired internet service						
Wireless texting						
Wireless phone service						
Wireless internet						
Radio						
Quality of information shared						

Transportation

Next, we will consider the impact of disruptions in *Transportation*.

20. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
Primary roads						
Secondary roads						
Municipal roads						
Transportation- other, e.g.s,						

airports, shipping ports, public transit						
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Water

Next, we will consider the impact of disruptions in the *Water* sector.

Your organization provides a service that matches one or more items within the Water category. When we encounter such an item, consider disruptions in items only to include those not under your organization's control. Items not under your organization's control may include, for example, water piped in from neighboring service regions to your service region or water made available from other providers in your service region. If none exist, please indicate 'Not Applicable'.

21. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
Sewer or stormwater, drainage, or flood control						
Wastewater system						
Water supply system						

Energy

Next, we will consider the impact of disruptions in the *Energy* sector.

22. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
PREPA (now Luma) electric power						
Availability of temporary power sources (generators,						

batteries, etc.)						
Availability of fuel (diesel, gasoline, ...)						
Maintenance/repair service for temporary power sources, e.g., generators						

Economy

Next, we will consider the impact of disruptions of the broader *Economy*. This includes disruptions in goods and services that were not previously called out.

23. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
Labor hiring pool						
Financial system						
Suppliers to the water industry						
Durable goods suppliers (heavy or light equipment not specific to the water industry)						
General consumables (not fuel, not specific to the water industry)						
Services (contracting, engineering, ...)						

Government

Finally, we will consider the impact related to disruptions or general functioning of the *Government*.

24. To what extent did disruptions in the following impact service recovery?

	Not at all	Very little	Somewhat	To a great extent	NA	DK
General government operations, including law enforcement, permitting, ...						
Government funding programs						
Government planning processes						

In this section, we want you to consider when disruptions in each of the six categories we just covered greatly impacted service recovery.

[Interviewer: Show (or have them retrieve) Table D]

Table D. In which periods of time did disruptions in the following **greatly** impact service recovery?

	Landfall to 1 week	1-4 weeks	5-8 weeks	9-12 weeks	More than 12 weeks
Communications					
Transportation					
Water					
Energy					
Economy					
Government					

Note: OK to indicate more than one period of time in each row.

We are going to ask you to select the periods of time in which disruptions **greatly** impacted service recovery. The responses range from “Landfall to 1 week” to “More than 12 weeks”.

25. In which periods of time did disruptions in the following **greatly** impact service recovery? Please mark all that apply.

	Landfall to 1 week	1-4 weeks	5-8 weeks	9-12 weeks	More than 12 weeks
Communications					
Transportation					
Water					
Energy					
Economy					
Government					

Now we ask you to rank each category by how much disruptions within the category impacted service recovery.

26. Please rank the six categories with ‘1’ being the most impactful and ‘6’ being the least impactful on service recovery.

- Communications
- Transportation
- Water
- Energy
- Economy
- Government

[Programmer note: please leave their ranking choices visible when answering 29 and 30]

27. Can you describe your reasoning for the ranking? Please use examples.

[Open-ended]

28. How confident are you in the ranking? Why so?

[Open-ended]

29. You ranked disruptions in [Ranked #1 Impact] as the [#1] category impacting service recovery.

As of today, what actions, if any, has your organization taken to reduce the extent to which future disruptions in [Ranked #1 Impact] will impact service recovery?

[Open-ended]

30. Did the actions taken help recover service following Hurricane Fiona? *How so?*
[Open-ended]

31. You ranked disruptions in [Ranked #2 Impact] as the [#2] category impacting service recovery.–
As of today, what actions, if any, has your organization taken to reduce the extent to which
future disruptions in [Ranked #2 Impact] will impact service recovery?
[Open-ended]

32. Did the actions taken help recover service following Hurricane Fiona? *How so?*
[Open-ended]

33. You ranked disruptions in [Ranked #3 Impact] as the [#3] category impacting service recovery.–
As of today, what actions, if any, has your organization taken to reduce the extent to which
future disruptions in [Ranked #3 Impact] will impact service recovery?
[Open-ended]

34. Did the actions taken help recover service following Hurricane Fiona? *How so?*
[Open-ended]

[Programmer: re-show their ranking from Q28]

35. [Interviewer: Remind them of their ranking] Would you have ranked the six categories
differently for Hurricane Fiona? If so, why?
[Open-ended]

Section E: Present-day assessment

Now we turn to conditions as they are today.

We begin by asking how your system and organization have changed since Hurricane Maria.

36. Since Hurricane Maria, how much has your system and your organization improved or worsened
with respect to the following?

	Much better now	Slightly better now	Neither better nor worse now	Slightly worse now	Much worse now
Hazard resistance of your system					
Inventory of input, inventory of					

replacement parts, product storage					
System redundancy (e.g., redundant/new/altern ative sources and/or connections/lines)					
Technology for monitoring and control					
Training of personnel for hurricane season					
Plans/protocols for hurricane season					
Codes and Standards					
Number and Quality of personnel					

Condition today

Now we turn to your organization's water service today.

[Interviewer: Once more, please show (or have them retrieve) Table A]

Again, please refer to Table A to see the range of potential responses.

We will ask similar questions to those asked earlier. We will ask about the extent to which your organization provides various service attributes. Specifically, the extent to which it supplies the demanded amount of water, provides potable water, and provides water at all times of the day.

37. Today, your organization supplies the demanded amount of water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

38. Today, your organization provides potable water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

39. Today, your organization provides water at all times of the day for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

40. Had Hurricane Fiona not happened, would today's level of service have been any different? Can you explain?
[Open-ended]

Expected condition one week after if a hurricane of a magnitude similar to Hurricane Maria were to make landfall today

Next, we consider the hypothetical case of another hurricane of a magnitude similar to Hurricane Maria.

41. Today, if a hurricane of a magnitude similar to Hurricane Maria were to make landfall, one week from now, your organization would supply the demanded amount of water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential						

buildings						
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42. Today, if a hurricane of a magnitude similar to Hurricane Maria were to make landfall, one week from now, your organization would provide potable water for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

43. Today, if a hurricane of a magnitude similar to Hurricane Maria were to make landfall, one week from now, your organization would provide water at all times of the day for...

	4 (Completely)	3	2	1	0 (Not at all)	NA
All buildings						
Critical buildings						
Commercial buildings						
Residential buildings						

44. What factors best explain service levels one week after the landfall of a hurricane? Please give two examples.
[Open-ended]

45. Did these same factors influence service levels one week after Hurricane Fiona? How so?
[Open-ended]

Expected time to return to pre-hurricane level of service if a hurricane were to strike today

Next, we continue this hypothetical of another hurricane of a magnitude similar to Hurricane Maria making landfall today, but now asking how long you expect it will take for your organization to return to providing service *to the same extent that it exists today*.

*[Interviewer: we are *not* asking about a return to pre-Hurricane Maria but instead to today's levels]*

[Interviewer: Please show (or have them retrieve) Table E]

Please refer to Table E to see the range of potential responses. Responses range from “Within a month” to “More than 7 years”.

Table E. Time to return to today's levels of service

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	More than 7 yrs	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

46. If a hurricane of the same magnitude as Hurricane Maria made landfall today, how long before your organization would return to supplying the demanded amount of water at today's levels for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	More than 7 yrs	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

47. If a hurricane of the same magnitude as Hurricane Maria were to occur today, how long before your organization would return to providing potable water at today's levels for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	More than 7 yrs	Not applicable

All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

48. If a hurricane of the same magnitude as Hurricane Maria were to occur today, how long before your organization would return to providing water at all times of the day at today's level for...

	Within a month	1-6 months	6-12 months	1-2 years	2-4 years	4-7 years	More than 7 yrs	Not applicable
All buildings								
Critical buildings								
Commercial buildings								
Residential buildings								

49. What factors best explain the amount of time to recover service following the landfall of a hurricane? Please give two examples.
[Open-ended]

50. Did these same factors influence the time to recover service following Hurricane Fiona? How so?
[Open-ended]

Now we ask the final question of this interview.

51. What is most needed to increase your organization's ability to withstand the disruptions brought on by a disaster like Hurricane Maria and to rapidly recover from it?
[Open-ended]