PUERTO RICO
PLANNING BOARD
GOVERNMENT OF PUERTO RICO

2026

LOCAL HAZARD MITIGATION PLAN

Municipality of Salinas

LOCAL HAZARD MITIGATION PLANS

Protect Through Planning

AtkinsRéalis - Baseline / Référence

PROFESSIONAL LICENSED PLANNER CERTIFICATION

As per Act 160-1996 as amended (20 L.P.R.A § 3501 - 20 L.P.R.A § 3515), I _____, who bears Puerto Rico professional planning license number___, certify that this document has been prepared using the best available sources and is in accordance with the best practices of the planning profession as of _____, 2026. And I certify this herewith my professional sea

FEMA Approval

This Local Hazard Mitigation Plan for the Municipality of Salinas was approved by FEMA on

_____

Statement of Funding

This Local Hazard Mitigation Plan was prepared for the Municipality of Salinas and the Puerto Rico Planning Board by the consulting firm AtkinsRéalis Caribe, LLP as per the stipulations of contract number 2026-000032 and any amendment thereof, duly registered in Puerto Rico's Office of the Comptroller.

Language Requirement

In Accordance with Presidential Executive Order #14224, the 2026 version of the Salinas Local Hazard Mitigation Plan has been prepared in English for submission and consideration of FEMA.

A non-certified translation of the final draft for public discussion and the final approved LHMP to Spanish was prepared for the benefit of the population that is not English proficient.

Should any discrepancy arise between the English and the Spanish text, the English one shall prevail.

Statement on maps

The maps presented on this document are related to a planning exercise. It is not the intention of these maps to establish any regulatory requirement, procedure or benefit.

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Table of Contents

PROFESSIONAL LICENSED PLANNER CERTIFICATION i
FEMA Approval i
Government Officials iii
Collaborators iv
Table of Contents v
List of Maps xiii
List of Tables xiv
List of Figures xv
List of Acronyms xvii
Executive Summary 1
1. Introduction and Background 1
1.1 Applicable Public Policies 2
1.1.1 Federal Policies 2
1.1.1.1 Federal Laws 2
2.1.1.1 Federal Regulations 4
1.1.2 Government of Puerto Rico Policies 8
1.1.2.1 Puerto Rico Laws 8
1.1.2.2 Puerto Rico Regulations 10
1.1.3 Municipal Policies 13
1.2 Scope and Previous Versions 15
1.2.1 Primary Objectives 15
1.2.2 LHMP Organization 16
1.3 Changes to the Salinas LHMP (E2-a) 17
2. Planning Process 0
2.1 Planning Process Regulation 0
2.2 History of the LHMP 0
2.3 Plan Preparation, Revision Schedule and Methodology (a1-a) 0
2.4 Planning Committee (A1-a, A1-b) 1
2.5 Citizen participation (A3-a) 2
2.5.1 Community Outreach and Public Participation Strategies 2
2.5.2 Community Outreach and Public Participation Results 3
2.6 Stakeholder involvement (A2-a) 4

2.7 Hazard Analysis Data Sources....4
2.8 FEMA Lifelines....5
3. Municipal Profile....6
3.1 Data Sources for Municipal Profiles....6
3.2 Brief Historical Background....7
3.3 Geography....8
3.3.1 Physiography....12
3.3.2 Geology....14
3.3.3 Soils....14
3.3.4 Hydrography....15
3.3.5 Precipitation....20
3.3.6 Temperature....20
3.3.7 Natural Resources....20
3.4 Demographics....22
3.4.1 Current Population....22
3.4.2 Socio-economic Characteristics....27
3.4.2.1 Employment....27
3.4.2.2 Employment by Industry....27
3.4.2.3 Poverty Level....30
3.4.2.4 Income....30
3.4.2.5 Population with disabilities....31
3.4.2.6 Population receiving supplemental nutritional support....31
3.4.2.7 Health Insurance Coverage....32
3.4.3 Housing stock and other related details....32
3.5 Critical Infrastructure....34
3.5.1 Lifeline: Food, Hydration and Shelter....35
3.5.2 Lifeline: Health and Medicine....36
3.5.3 Lifeline: Energy....37
3.5.4 Lifeline: Communications....37
3.5.5 Lifeline: Transportation....38
3.5.6 Lifeline: Hazardous Materials....40
3.5.7 Lifeline: Water Systems....40
3.6 Recent Development (E1-a)....44
4. Hazard Profiles and Risk Assessment....48

4.1 Note on the Discussion of Hazards 48
4.2 Regulatory Requirements 48
4.3 Hazards that can Affect the Municipality 49
4.4 Chronology of Events 52
4.5 Risk Assessment Methodology 52
4.5.1.1 HAZUS 6.1 52
4.5.1.2 Alternative GIS modeling 53
4.5.1.3 Stochastic Risk Assessment 53
4.6 Earthquake 54
4.6.1 Description (B1-a) 54
4.6.1.1 Affected Area (B1-b) 56
4.6.1.2 Risk Magnitude (B1-c) 63
4.6.1.3 Past Events (B1-d) 64
4.6.1.4 Future Event Probabilities (B1-e) 71
4.6.2 Risk Analysis (B2-a, B2-b) 72
4.6.2.1 Estimated Losses 72
4.6.2.2 Lifelines and Critical Infrastructure 73
4.6.2.3 Social Vulnerabilities 79
4.6.2.4 Natural and Cultural Resources 82
4.6.2.5 Future Conditions (E1-a) 82
4.7 Landslides 86
4.7.1 Description (B1-a) 86
4.7.1.1 Affected Area (B1-b) 87
4.7.1.2 Risk Magnitude (B1-c) 89
4.7.1.3 Past Events 90
4.7.1.4 Future Event Probabilities 91
4.7.2 Risk Analysis 92
4.7.2.1 Estimated Losses 92
4.7.2.2 Lifelines and Critical Infrastructure 93
4.7.2.3 Social Vulnerabilities 95
4.7.2.4 Natural and Cultural Resources 97
4.7.2.5 Future Conditions 98
4.8 Tsunami 99

4.8.1 Description (B1-a) 99
4.8.1.1 Affected Area (B1-b) 100
4.8.1.2 Risk Magnitude (B1-c) 101
4.8.1.3 Past Events (B1-d) 103
4.8.1.4 Future event probabilities (B1-e) 105
4.8.2 Risk Analysis (B2-a, B2-b) 106
4.8.2.1 Estimated Losses 106
4.8.2.2 Critical Infrastructure and Lifelines 106
4.8.2.3 Social Vulnerabilities 110
4.8.2.4 Natural and Cultural Resources 112
4.8.2.5 Future Conditions (E1-a) 113
4.9 Flooding 114
4.9.1 Description (B1-a) 114
4.9.1.1 Affected Area 117
4.9.1.2 Risk Magnitude (B1-c) 129
4.9.1.3 Past Events (B1-d) 131
4.9.1.4 Special Consideration: Floods by Stormwater Management Deficiencies 141
4.9.1.5 Future Event Probabilities (B1-e) 143
4.9.2 Risk Analysis (B2-a, B2-b) 143
4.9.2.1 Estimated Losses 143
4.9.2.2 Lifelines and Critical Infrastructure 149
4.9.2.3 Social Vulnerabilities 153
4.9.2.4 Natural and Cultural Resources 156
4.9.2.5 Special Consideration: Repetitive Losses and Severe Repetitive Losses 156
4.9.2.6 Future Conditions (E1-a) 157
4.10 Tropical Cyclones and other Extreme Wind Events 159
4.10.1 Description (B1-a) 159
4.10.1.1 Affected Area (B1-b) 160
4.10.1.2 Risk Magnitude (B1-c) 161
4.10.1.3 Past Events (B1-d) 163
4.10.1.4 Future event probabilities (B1-e) 171
4.10.2 Risk Analysis (B2-a, B2-b) 171

4.10.2.1 Estimated Losses 171
4.10.2.2 Lifelines and Critical Infrastructure 178
4.10.2.3 Social Vulnerabilities 179
4.10.2.4 Natural and Cultural Resources 179
4.10.2.5 Future Conditions (E1-a) 179
4.11 Storm Surge 179
4.11.1 Description 179
4.11.1.1 Affected Area 180
4.11.1.2 Risk Magnitude 183
4.11.1.3 Past Events 184
4.11.1.4 Future Events Probability 184
4.11.2 Risk Analysis 185
4.11.2.1 Estimated Losses 185
4.11.2.2 Critical Infrastructure and Lifelines 185
4.11.2.3 Social Vulnerabilities 189
4.11.2.4 Natural and Cultural Resources 193
4.11.2.5 Future Conditions 194
4.12 Extreme Heat 196
4.12.1 Description (B1-a) 196
4.12.1.1 Affected Area (B1-b) 198
4.12.1.2 Risk Magnitude (B1-c) 199
4.12.1.3 Past Events (B1-d) 200
4.12.1.4 Future event probabilities (B1-e) 201
4.12.2 Risk Analysis (B2-a, B2-b) 201
4.12.2.1 Estimated Losses 201
4.12.2.2 Lifelines and Critical Infrastructure 202
4.12.2.3 Social Vulnerabilities 203
4.12.2.4 Natural and Cultural Resources 203
4.12.2.5 Future Conditions 204
4.13 Drought 205
4.13.1 Description (B1-a) 205
4.13.1.1 Affected Area 206

4.13.1.2 Risk Magnitude (B1-c) 207
4.13.1.3 Past Events (B1-d) 207
4.13.1.4 Future event probabilities (B1-e) 209
4.13.2 Risk Analysis (B2-a, B2-b) 210
4.13.2.1 Estimated Losses 210
4.13.2.2 Critical Infrastructure and Lifelines 210
4.13.2.3 Social Vulnerabilities 211
4.13.2.4 Natural and Cultural Resources 211
4.13.2.5 Future Conditions 212
4.14 Wildfire (E1-a) 212
4.14.1 Description (B1-a) 212
4.14.1.1 Risk Magnitude 213
4.14.1.2 Affected Area (B1-b) 215
4.14.1.3 Risk Magnitude (B1-c) 215
4.14.1.4 Past Events (B1-d) 216
4.14.1.5 Future Event Probability (B1-e) 220
4.14.2 Risk Analysis (B2-a, B2-b) 220
4.14.2.1 Estimated Losses 220
4.14.2.2 Critical Infrastructure 221
4.14.2.3 Social Vulnerability 222
4.14.2.4 Natural and Cultural Resources 222
4.14.2.5 Future Conditions (E1-a) 224
4.15 Long term Coastal Dynamics 224
4.15.1 Description ..... **Error! Bookmark not defined.**
4.15.1.1 Affected Area 227
4.15.1.2 Risk Magnitude 233
4.15.1.3 Past Events 240
4.15.1.4 Future Events Probability 242
4.15.2 Risk Analysis 243
4.15.2.1 Estimated Losses 243
4.15.2.2 Lifelines and Critical Infrastructure 243
4.15.2.3 Social Vulnerabilities 247

4.15.2.4 Natural and Cultural Resources 248
4.15.2.5 Future Conditions 248
4.16 Pandemic/Epidemic 249
4.16.1 Description (B1-a) 249
4.16.1.1 Affected Area (B1-b) 249
4.16.1.2 Risk Magnitude (B1-c) 249
4.16.1.3 Past Events (B1-d) 250
4.16.1.4 Future Events Probability (B1-e) 253
4.16.2 Risk Assessment (B2-a, B2-b) 253
4.16.2.1 Estimated Losses 253
4.16.2.2 Critical Infrastructure and Lifelines 254
4.16.2.3 Social Vulnerability 254
4.16.2.4 Natural and Cultural Resources 255
4.16.2.5 Future Conditions (E1-a) 256
4.17 Hazard Prioritization 257
4.18 Planning Mechanism 257
4.18.1 Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (2023) 258
4.18.2 Special Flood Hazards Areas Regulation (2021) 259
4.18.3 Puerto Rico Building Code 259
4.18.4 Regulation for the Design, Operation Criteria and Maintenance of Stormwater Systems in Puerto Rico 260
4.18.5 Salinas Territorial Plan (2012) 260
4.18.6 National Flood Insurance Program 261
4.18.7 National Pollutant Discharge Elimination System (NPDES) 262
4.18.8 Operational Guidelines for Determining Damages and Substantial Improvements in Puerto Rico (2025) 263
4.18.9 Green Infrastructure and Nature Based Solutions 263
4.18.10 Four – Year Investment Program 265
5. Municipal Capacities 266
5.1 Regulatory and Planning Mechanism (C1-a**)** 266
5.2 Technical and Administrative Capacities (C1-a) 266
5.3 Financial Capacity (C1-a) 268
5.3.1 FEMA Funding Streams 268

5.3.2 Non-FEMA Federal Funding Streams....271
5.3.3 Local Funds....273
5.4 Outreach and Communications Capacity (C1-a)....273
5.5 Capacity Development (C1-b)....274
6. Mitigation Action Plan....276
6.1 Mitigation Goals (C3-a)....276
6.1.1 Municipal Goals and Objectives....276
6.1.2 National Mitigation Investment Strategy....276
6.2 Mitigation Strategy Selection Criteria....277
6.3 Mitigation Strategy Categorization....278
6.4 Mitigation Strategies (C4-a, C4-b, C5-a, C5-b, E2.b)....280
6.5 Participation in the NFIP....305
7. Plan Maintenance....306
7.1 Point of Contact....306
7.2 Continuous Public Participation (D1-a)....306
7.3 LHMP Oversight (D2-a)....307
7.4 LHMP Evaluation and Monitoring....308
7.5 LHMP Update and Revision (D2-c, D3-a)....309
7.5.1 Revision Following a Major Disaster....309
7.5.2 Five-Year Comprehensive Update....309
7.6 Integration with Other Planning Mechanisms (D3-a)....310
8. Adoption and Approval (F1-a, F1-b)....310
8.1 LHMP Adoption....310
8.2 LHMP Approval....310
Selected References....312
Appendix A: Adoption and Approval....321
Adoption....321
Approval by FEMA....321
FEMA APA Letter FEMA....322
Review Tool Sheet....323
Appendix B: Planning Committee....324
Letter of Agreement Municipality and Puerto Rico Planning Board....324
Planning Committee Appointments....325
First Planning Committee Meeting....327
Presentation....327

Documentation 330
Appendix C – Public Participation and Outreach 335
First Public Meeting Notification 335
Documentation 337
Presentation 342
Appendix D: Stakeholder Involvement 347

List of Maps

Map 1: Salinas Geographic Area 10
Map 2: Salinas Wards Subdivision 11
Map 3: Salinas Physiography 13
Map 4: Hydrography 17
Map 5: Watershed 18
Map 6: Sub Watersheds 19
Map 7: Salinas Population Density by Census Tract 26
Map 8: Critical Infrastructure by Lifeline 42
Map 9: Salinas Roadways 43
Map 10: Recent Developments 2020 - 2023 46
Map 11: Recent Developments 2024 - 2026 47
Map 12: Earthquake: Spectral Acceleration at 1.0 sec 59
Map 13: Earthquake: Spectral Acceleration at 0.3 sec 60
Map 14: Earthquake Spectral Displacement at 1.0 sec 61
Map 15: Earthquake: Spectral Displacement at 0.3 sec 62
Map 16: Earthquake Critical Facilities Exposure to Spectral Acceleration at 1.0 sec 77
Map 17: Earthquake - Critical Facilities exposure to spectral acceleration at 0.3 sec 78
Map 18: Earthquake: Population Exposed to Spectral Acceleration at 1.0 (g) sec 80
Map 19: Earthquake: Population Exposure to Spectral Acceleration at 0.3 (g) sec 81
Map 20: Earthquake: Recent Development Exposure to Spectral Acceleration at 1.0 sec 84
Map 21: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec 85
Map 22: Landslide Susceptibility 89
Map 23: Landslides related to Hurricane María 91
Map 24: Landslide: Critical Infrastructure Exposure 95
Map 25: Landslide: Population Exposure 97
Map 26: Landslide: Recent Development Exposure 99
Map 27: Tsunami Impact Area 103
Map 28: Tsunami: Critical Infrastructure Exposure 110
Map 29: Tsunami: Population Exposure 112
Map 30: Tsunami: Recent Development Exposure 114
Map 31: Flood Hazard Zones 118
Map 32 HAZUS Analysis for 500 – Year Flood Event 129
Map 33: Building Loss to Flood Exposure 500 – year flood 145
Map 34: Building Loss to Flood Exposure 100 – year flood 146

Map 35: Flood Critical Facilities Exposure 500 yrs flood 152
Map 36: Flood: Critical Facilities Exposure to 100 yrs flood 153
Map 37: Flood Population Exposure 155
Map 38: Recent Development and Flood Risks 159
Map 39: Total Damaged Buildings 100 – Year Event 173
Map 40: Total Damaged Building 500 - Year Event 174
Map 41: Total Economic Loss 100 Year 176
Map 42: Total Economic Loss 500 Year 177
Map 43: Category 1 Storm Surge Area 182
Map 44: Category 5 Storm Surge Impact Area 183
Map 45: Critical Infrastructure affected by a Cat 1 Storm Surge 188
Map 46: Affected Critical Infrastructure Cat 5 Hurricane 189
Map 47: Storm Surge Population Exposure to Category 1 Surge 192
Map 48: Strom Surge Population Exposure to Category 5 Surge 193
Map 49: Storm Surge Recent Development Exposure Category 1 195
Map 50: Storm Surge Recent Development Exposure Category 5 196

List of Tables

Table 1: LHMP Organization 16
Table 2: Changes to the Salinas LHMP 17
Table 3: LHMP Planning Committee 1
Table 4: Hazard and Risk Assessment of Data Sources 4
Table 5 Population by Age Group 2024 ACS vs 2019 ACS 23
Table 6: Salinas Current Labor Force Statistics 27
Table 7: Employment by Industry 2024 ACS vs 2018 ACS 28
Table 8: 2024 ACS Poverty Level 30
Table 9: Salinas 2025 ACS Income and Benefits per Household 30
Table 10: Salinas Population living with disabilities 31
Table 11: Population receiving food aid 32
Table 12: 2025 ACS Health Insurance Data 32
Table 13: 2024 ACS - Housing Units Year of Construction 33
Table 14: 2025 ACS - Vehicle per occupied housing unit 33
Table 15: Approved Construction Permits 2020-2026 45
Table 16: Hazards Inventories 49
Table 17: Hazards to be included in the Salinas 2026 LHMP 49
Table 18: Order of Hazards to be Assessed 51
Table 19: Moment - Magnitude Scale 64
Table 20: Puerto Ric Seismic Activity 2013-2024 65
Table 21: Exposure to Earthquake Hazard 73
Table 22: Expected Annual Loss to Earthquake 73
Table 23: Landslide Risk Categories 90
Table 24: Tsunami events in Puerto Rico 104
Table 25: Tsunami Exposure 106
Table 26: Expected Annual Loss to Tsunami 106
Table 27: Puerto Rico Flood Zones 116
Table 28: Major flooding events in Puerto Rico 2010-2025 132

Table 29: Flood Exposure 146
Table 30: Expected Annual Loss to Flood 147
Table 31: Total Structures at Risk 148
Table 32: Aggregated Loss of dollars for 1% (100-year) and 0.2% (500 - year) events 148
Table 33: Detailed Loss for Non-Residential Buildings 148
Table 34: Detailed Loss for Residential Buildings 148
Table 35: NFIP Policies in force and coverage 156
Table 36: NFIP Repetitive Losses 157
Table 37: NFIP Severe Repetitive Losses 157
Table 38: Saffir-Simpson Hurricane Scale 162
Table 39: Tropical Cyclone Disaster Declarations since 2025 165
Table 40: Tropical Cyclone Exposure 171
Table 41: Expected Annual Loss to Tropical Cyclones 171
Table 42: Types of Droughts 205
Table 43: US Drought Monitor Categories 207
Table 44: Registered Wildfires 217
Table 45: Puerto Rico Sea Level Observations 238
Table 46: Pandemics and Epidemic in Puerto Rico 1855 - 2020 250
Table 47: Number of People in Salinas without Healthcare Coverage 255
Table 48: Hazard Prioritization 257
Table 49: Hazard Prioritization Municipal Technical and Administrative Human Resources 267
Table 50: Outreach and Communications Tools 274
Table 51: Mitigation Strategies - Prevention 282
Table 52: Mitigation Strategies - Property Protection 296
Table 53: Mitigation Strategies - Structural Projects 299
Table 54: Mitigation Strategies - Emergency Services 302
Table 55: Mitigation Strategies: Education and Outreach 303
Table 56: Preliminary Planning Committee Meeting Schedule 308

List of Figures

Figure 1: Cover of FEMA's Local Mitigation Planning Policy Guide 4
Figure 2: Cover of FEMA's Local Mitigation Planning Handbook 5
Figure 3: National Disaster Recovery Framework Cover 6
Figure 4: PUT-PR Coversheet 10
Figure 5: Puerto Rico SHMP Cover 11
Figure 6:: Puerto Rico Mitigation Action Plan Cover 12
Figure 7: All Hazard Mitigation 13
Figure 8: Salinas Municipal Recovery Plan – Cover 15
Figure 9: Salinas Population by Sex (2024 ACS) 22
Figure 10: Population by Age Group (ACS 2023) 24
Figure 11: Population Pyramid (2024 ACS) 25
Figure 12: Approved Construction Permits 2020-2025 45
Figure 13: PRSN - 2024 Earthquakes Epicenter screengrab (PRSN, 2025) 65
Figure 14: Mean Annual Rainfall 1991-2020 (PR & USVI) 92
Figure 15: Tsunami Evacuation Map 100
Figure 16: National Flood Hazard Layer FIRMette 121

Figure 17: National Flood Hazard Layer 122
Figure 18: National Flood Hazard Layer FIRMette 123
Figure 19: National Flood hazard Layer 124
Figure 20: National Flood Hazard Layer FIRMette 125
Figure 21 ABFE vs FIRM 1% (100 years) 127
Figure 22: Hurricane Tracks 1989-2017 (only Cat 2-5) 160
Figure 23: Hurricane María (2017) as it approaches Puerto Rico 161
Figure 24: Heat Island Effect Diagram (EPA, 2025) 200
Figure 25: Municipality's Percent Area in U.S. Drought Monitor Categories 209
Figure 26: Overview of areas of Puerto Rico, Vieques and Culebra under different levels of wildlife incidence accounting to SFLA 215
Figure 27 State of the Beach Study 228
Figure 28: State of the Beach (Erosion vs. Accretion) 230
Figure 29: Change in Width of Beach (July 2018) 232
Figure 30: NOAA's Relative Sea Level Trend Map 237
Figure 31: NOAA's Relative Sea Level Trend Map (Zoom to Puerto Rico) 238
Figure 32: Relative Sea Level Trend 9759110 Magueyes Island, PR 239
Figure 33: Relative Sea Level Trend 9755371 San Juan, PR 240
Figure 34 - Historical Shoreline Changes 242
Figure 35: Joint Regulation Cover 258
Figure 36: Regulation 40 Cover 260
Figure 37: Salinas Land Land Use Plan Cover Page 261
Figure 38: Operational Guidelines Cover 263
Figure 39: Unique Id Nomenclature 281

List of Acronyms

ABFE	Advisory Base Flood Elevation
ACS	American Community Survey
AMMED	Municipal Agency for Disaster and Emergency Management, by its Spanish Acronym
BLE	Base Flood Engineering
BRIC	Building Resilient Infrastructure and Communities
CDBG-DR	Community Development Block Grant - Disaster Recovery
CDBG-MIT	Community Development Block Grant - Mitigation
CEACC	Committee of Experts and Advisors on Climate Change, by its Spanish Acronym
COR3	Central Office for Recovery, Reconstruction and Resiliency
DHS	Department of Homeland Security
DNER	Department of Natural and Environmental Resources
DPS	Department of Public Safety
DTPW	Department of Transportation and Public Works
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
HAZUS	Hazards United States
HMGP	Hazard Mitigation Grant Program
HUD	U.S. Department of Housing and Urban Development
ICS	Incident Command System
IFRC	International Federation of the Red Cross
IRRM	Interim Risk Reduction Measures
LHMP	Local Hazard Mitigation Plan
LUMA	Luma Energy
MHHW	Mean Higher High Water
mph	Miles per hour
NDRF	National Disaster Recovery Framework
NIMS	National Incident Management System
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration

NTHMP	National Tsunami Hazard Mitigation Program
OMME	Municipal Emergency Management Office
OPM	Municipal Public Works, by is Spanish acronym
PRASA	Puerto Rico Aqueduct and Sewers Authority
PREMB	Puerto Rico Emergency Management Bureau
PREPA	Puerto Rico Electric Power Authority
PRHTA	Puerto Rico Highway and Transportation Authority
PRPB	Puerto Rico Planning Board
PRSN	Puerto Rico Seismic Network
PT	Territorial Plan, by its Spanish acronym
PUT-PR	Puerto Rico Land Use Plan, by its Spanish acronym
SHMO	State Hazard Mitigation Officer
SFLA	Southern Federal Land Assessment
UHI	Extreme Heat Island
USACE	United States Army Corps of Engineers
USDOT	United States Department of Transportation
USGS	United States Geological Survey
VSL	Value of Statistical Life
WUI	Wildland-Urban Interface

Executive Summary

This document is the 2026 update of the Local Hazard Mitigation Plan (LHMP) for the Municipality of Salinas, Puerto Rico. It is prepared to reduce risks associated with natural hazards and enhance community resilience by identifying hazards, assessing risks, and proposing mitigation strategies. The plan complies with federal regulations, including the Stafford Act and Disaster Mitigation Act of 2000, and incorporates public participation and interagency coordination. It is funded by a grant from the Puerto Rico Planning Board and prepared by AtkinsRéalis Caribe, LLP.

Introduction and Background

The Municipality of Salinas and the Puerto Rico Planning Board are committed to protecting residents by updating the LHMP, which provides a structured approach to hazard mitigation consistent with federal, state, and local policies. The plan identifies natural hazards, evaluates risks, and supports land use planning to achieve sustainability and resilience. It also complies with FEMA requirements to maintain eligibility for federal funding and is regularly updated to reflect evolving conditions.

This plan follows the following objectives

- Identify and evaluate natural hazards threatening the municipality.
- Establish strategies to reduce risks to life, property, and services.
- Promote interagency coordination and community involvement

Public Policy

The plan aligns with federal, Puerto Rico, and municipal policies guiding hazard mitigation and resilience for example.

- The Stafford Act and its Hazard Mitigation Grant Program provide funding for cost-effective mitigation.
- The Disaster Mitigation Act of 2000 requires LHMP adoption for federal funding eligibility.
- The National Flood Insurance Act establishes the NFIP to provide flood insurance and encourages floodplain management.
- FEMA's regulations (44 CFR Part 201) and planning guides outline requirements

and procedures for mitigation planning.
- The National Disaster Recovery Framework guides recovery coordination.
- The National Earthquake Hazards Reduction Program and National Incident Management System that support seismic risk reduction and emergency response.

Puerto Rico Policies

- Act No. 161-2009 reforms the permitting system to improve efficiency.
- Act No. 33-2019 mandates mitigation and resilience measures in response to changing weather patterns.
- Act No. 107-2020 (Municipal Code) which gives municipalities some powers for regulating land use.
- The Puerto Rico Land Use Plan (that PUT-PR) classifies land and guides sustainable development.
- The Puerto Rico State Natural Hazard Mitigation Plan (2021) provides a jurisdiction-wide framework.
- The Puerto Rico Mitigation Action Plan (CDBG-DR MIT) directs federal mitigation funds post-hurricanes Irma and María.
- The Salinas LHMP (2020) and Municipal Recovery Plan establishes prior mitigation frameworks and recovery priorities.

Planning Process

The 2026 LHMP update follows FEMA guidelines and includes a Planning Committee with municipal officials, public outreach through meetings and notifications, and stakeholder involvement. Public participation included three community meetings with opportunities for feedback. The plan integrates FEMA Lifelines (Safety and Security, Food, Hydration and Shelter, Health and Medicine, Energy, Communications, Transportation, Hazardous Materials, Water Systems) to prioritize critical services.

Municipal Profile

Salinas is a coastal municipality in southwest Puerto Rico, with 6 wards (barrios). It has a rich historical background from Indigenous Taíno culture through Spanish colonial times, with a historic urban core featuring significant architectural heritage. Geography includes the Sabana Grande Valley and surrounding hills, influencing settlement and hazard exposure. The municipality covers about 181.3km². Key findings of the municipal assessment include:

Demographics

According to the 2024 ACS, the Municipality of Salinas has an estimated population of 25,079 residents, composed of 48.38 percent males and 51.62 percent females. The municipality's demographic profile reflects important considerations for hazard mitigation planning, particularly because 42.08 percent of the population is considered vulnerable due to being under 19 years of age or over 65 years of age. The age distribution also indicates a declining youth population and a growing elderly population, a trend that may increase the demand for targeted emergency preparedness, evacuation assistance, health services, and long-term resilience measures.

Socioeconomic Conditions

Socioeconomic conditions further shape the municipality's exposure and capacity to prepare for, respond to, and recover from hazard events. Labor force participation is estimated at 42 percent, with an unemployment rate of 7.2 percent. Major employment sectors include education, healthcare, retail trade, and professional services. At the same time, 47.9 percent of individuals live below the poverty level, the median household income is $18,317, and 21.9 percent of households earn less than $10,000 annually. These conditions indicate that a substantial portion of the population may have limited financial resources to undertake preparedness measures, retrofit homes, relocate from hazard-prone areas, or recover after disasters.

Additional indicators of social vulnerability include the increase in the number of individuals living with disabilities, which rose to 7,845 people, representing a 23.97 percent increase. In addition, 52.8 percent of households receive food assistance and approximately 5.7 percent of the population is uninsured. These factors underscore the importance of prioritizing mitigation actions that strengthen access to essential services, improve continuity of operations, and address the needs of residents who may require additional support before, during, and after emergency events.

Housing

Housing and infrastructure conditions are also central to the municipality's risk profile. Salinas has 7,973 housing units, of which 23.5 percent are vacant. A significant share of the housing stock was constructed before the adoption of current building codes, with 97.4 percent of units built prior to 2011. This condition may increase structural

vulnerability to earthquakes, tropical cyclones, flooding, and other hazards. Transportation access is another important consideration, as 11.4 percent of households have no vehicle available, which may affect evacuation capacity and access to emergency services.

Critical Infrastructure and FEMA Lifelines

The LHMP assesses municipal infrastructure in alignment with FEMA Lifelines, including safety and security; food, hydration, and shelter; health and medical services; energy; communications; transportation; hazardous materials; and water systems. Critical facilities such as hospitals, police facilities, emergency centers, shelters, and related assets are mapped and evaluated to understand their exposure and role in supporting emergency response and community recovery. This lifeline-based approach helps identify where mitigation investments can protect essential services and reduce cascading impacts during hazard events.

Recent Development

Recent development patterns were also reviewed as part of the municipal profile. From 2020 through mid-2026, construction permits averaged approximately 64 permits per year, with development activity distributed primarily near the historic center and other urbanized areas. Understanding where recent development has occurred allows the municipality to evaluate whether new growth is taking place in or near hazard-prone areas and to integrate mitigation considerations into land use, permitting, infrastructure planning, and future investment decisions.

Hazard Profiles and Risk Assessment

The LHMP evaluates eight prioritized hazards: earthquake, landslides, flooding, tropical cyclones/extreme winds, extreme heat, drought, wildfire, and pandemic/epidemic. Each hazard is described with its characteristics, affected areas, risk magnitude, past events, future probabilities, risk analysis, social vulnerabilities, and impacts on natural and cultural resources.

Earthquake

Puerto Rico is located within a tectonically active region characterized by multiple fault systems, making earthquake risk a significant concern for Salinas. The assessment

considers earthquake intensity, magnitude, spectral acceleration, and ground motion as key indicators of potential impacts. The highest spectral acceleration zones are located in the northern portion of the municipality, including areas near the historic urban core, where older structures and cultural resources may be especially vulnerable.

Estimated annualized earthquake losses are approximately $3.4 million, reflecting the potential for substantial damage to buildings, infrastructure, and essential services. Earthquakes may affect all FEMA Social vulnerability is heightened by poverty, aging infrastructure, limited household resources, and the presence of residents who may require additional assistance during response, and recovery.

Recent seismic activity, including the significant 2020 southwestern Puerto Rico earthquake sequence, demonstrates that earthquake hazards remain an ongoing concern for the municipality. Because of Puerto Rico's tectonic setting, future earthquake risk is expected to remain high, requiring continued attention to structural resilience, emergency preparedness, critical facility protection, and mitigation measures that reduce potential damages and service disruptions.

Landslides

Landslides in Salinas are primarily triggered by intense rainfall and are influenced by slope conditions, soil characteristics, geology, land cover, drainage patterns, and human activity. The most susceptible areas are generally located in the mountainous northern wards, where steep terrain and infrastructure access constraints can increase both exposure and response challenges.

Although precise monetary loss estimates are not available for landslides, the hazard can disrupt transportation corridors, utility systems, emergency access, and other essential services. Social vulnerability is closely tied to geographic isolation, road access limitations, infrastructure fragility, and the ability of residents to receive timely assistance during and after hazard events.

Past landslide impacts were notably observed after Hurricane María in 2017, when intense rainfall produced slope failures across many areas of Puerto Rico. Given the municipality's terrain, rainfall patterns, and the presence of development in susceptible areas, landslide risk is expected to continue and should remain a priority for mitigation, land use planning, infrastructure maintenance, and emergency response coordination.

Tsunami

Tsunamis are rapid-onset coastal hazards generally caused by undersea earthquakes, although submarine landslides and volcanic activity may also generate them. While they travel quickly and remain relatively low in deep water, their speed decreases and wave height rise sharply near shore, producing destructive flooding, strong currents, erosion, and debris impacts. Natural warning signs may include sudden sea withdrawal or rise and a loud ocean roar; because the hazard cannot be prevented, effective risk reduction depends on alert systems, evacuation planning, public education, drills, and coordinated initiatives such as the National Tsunami Hazard Mitigation Program and NOAA's TsunamiReady Program.

In Salinas, the principal areas exposed to tsunami inundation are the Las Mareas, Playita, Playa, Las Ochenta, San Felipe, Aguirre, Barrio Pueblo and Río Jueyes wards, where coastal morphology could amplify wave effects; modeling indicates possible Puerto Rico's historical record—including the destructive tsunamis of 1867, 1918, and 1946—demonstrates the hazard's potential for fatalities, displacement, structural damage, and rapid inland flooding. Although tsunamis are infrequent and cannot be predicted precisely, the island's surrounding offshore seismic zones create a continuing possibility that a strong earthquake could generate another event, reinforcing the importance of Salinas's evacuation map and TsunamiReady certification.

Tsunami consequences can cascade across community lifelines by disrupting emergency services, housing, healthcare, power, communications, transportation, ports, and water and wastewater systems, while also damaging coastal ecosystems and cultural resources. National Risk Index data identify a small, exposed area and population but substantial total exposure value, even though modeled expected annual losses are reported as zero; the document also notes that Salinas's port facilities are the most notable critical infrastructure concern and that overall population exposure is limited. Nevertheless, lower-income residents, older adults, people with disabilities, households without reliable transportation, and socially isolated populations may face greater evacuation and recovery challenges, while the scarcity of approved construction permits within the modeled impact area from 2020 through 2026 suggests that recent development has generally avoided the highest-risk zone.

Flooding

Flooding in Salinas includes both general flooding and flash flooding, most often associated with tropical weather systems and intense rainfall events. Flood hazard areas are mapped extensively along the Nigua River, Nigua floodplain and Nigua watershed, where floodwaters can affect residential areas, infrastructure, transportation routes, and critical services.

The risk assessment identifies flooding as a high-probability hazard with the potential to cause significant property damage, health risks, and infrastructure impacts. Estimated flood exposure includes more than $263 million in building value. While flood control projects are present and the municipality participates in the NFIP with 133 policies in force, including some repetitive loss properties, flooding remains a persistent concern that requires continued mitigation, floodplain management, and public preparedness actions.

Social vulnerability to flooding is especially high among low-income residents, mobility-limited populations, and households with limited access to transportation or financial resources. These conditions can affect the ability of residents to evacuate, protect property, obtain insurance, or recover after flood events. As a result, flood mitigation remains a central priority for reducing losses, protecting public health, and strengthening community resilience.

Tropical Cyclones/Extreme Winds

Tropical cyclones and extreme wind events represent some of the most frequent and damaging hazards affecting Salinas. These events range from tropical storms to Category 5 hurricanes, as classified by the Saffir-Simpson Hurricane Wind Scale. The entire municipality is considered exposed to their impact.

Historic hurricanes, including Irma and María in 2017, demonstrate the municipality's exposure to severe wind that can cause power outages, infrastructure damage, economic disruption, and extended recovery needs. The risk assessment maps estimated building damage and economic losses for both 100-year and 500-year events, illustrating the potential severity of future hurricane impacts.

Because tropical cyclones can affect all FEMA Lifelines, including energy, communications, transportation, safety and security, health and medical services, food and shelter, water systems, and hazardous materials, their impacts can cascade

across the community. Social vulnerability is considered widespread due to the municipality-wide exposure of residents, housing, infrastructure, and essential services.

Storm Surge

Storm surge is the abnormal inland movement of seawater caused primarily by the strong winds and low atmospheric pressure associated with hurricanes and tropical storms. Its magnitude depends on storm intensity, size, speed, angle of approach, coastal configuration, topography, and bathymetry, with the most severe impacts occurring when surge coincides with high tide and strong wave action. Salinas is particularly susceptible due to its southern coastal location and history of exposure to tropical cyclones, and mapped scenarios indicate that a Category 5 storm surge could extend inland across portions of Aguirre and the coastal plain surrounding Barrio Pueblo, affecting agricultural lands, critical infrastructure, and segments of the PR-3 corridor that provide access to the coastal communities of Las Mareas, Playita, Playa, Las Ochenta, and San Felipe.

The hazard could produce cascading impacts on Salinas's community lifelines and critical infrastructure. Flooding could disrupt roads, bridges, port operations, communications, electric power, fuel distribution, healthcare, water and wastewater services, and emergency response. The Salinas port and petroleum storage facility face especially serious risks, including damage to docks, tanks, pipelines, pumping systems, and electrical controls; a major failure could interrupt fuel supplies, delay recovery operations, and release petroleum into coastal waters and nearby ecosystems.

Although the mapped population and recent development directly exposed to storm surge appear limited, impacts could fall disproportionately on low-income households, older adults, residents with limited transportation or healthcare access, and communities with fewer recovery resources. Storm surge may also damage agriculture through crop loss and soil salinization, degrade wetlands, mangroves, beaches, fisheries, and water quality, and threaten cultural sites and coastal community identity. Future planning should therefore integrate hazard mitigation, lifeline stabilization, protection of natural and cultural resources, equitable recovery, and measures to reduce hazardous-material releases and long-term economic disruption.

Extreme Heat

Extreme heat is defined as prolonged periods of temperatures above 90 degrees Fahrenheit combined with high humidity, conditions that can increase health risks and place stress on infrastructure systems. Developed areas may experience higher temperatures due to the urban heat island effect, increasing exposure for residents in more urbanized portions of the municipality.

Extreme heat can affect public health, energy demand, transportation systems, communications, and other essential services. Older adults and other vulnerable populations may face elevated risk, particularly when risk perception is low or when access to cooling, medical care, or reliable transportation is limited. Health impacts may include heat-related illness and increased mortality among sensitive populations.

Future projections indicate that temperatures and the frequency of extreme heat events are expected to rise, reinforcing the need for mitigation actions such as public outreach, urban greening, shade improvements, cooling strategies, and infrastructure adaptation. These measures can reduce exposure, improve preparedness, and protect vulnerable residents during periods of excessive heat.

Drought

Drought in Salinas is characterized by prolonged precipitation deficits that can affect water supply, agricultural activity, economic conditions, and the continuity of essential services. This hazard may occur as a meteorological, agricultural, hydrological, or socioeconomic drought. All these types of droughts can impact water availability and community functions.

Drought conditions can lead to water rationing, affect economic and agricultural activities, increase stress on households and businesses, and contribute to increased wildfire potential. Previous drought events have been documented through federal declarations, demonstrating that the hazard has affected Puerto Rico in the past and remains relevant to local mitigation planning.

Future drought frequency is expected to increase, reinforcing the need to strengthen water conservation, emergency water supply planning, infrastructure resilience, public awareness, and coordination with regional water providers. Social vulnerability is

particularly important for elderly residents and low-income households, which may have fewer resources to adapt to water interruptions, higher utility costs, or related public health and economic impacts.

Wildfire

Wildfire consists of uncontrolled fires that may occur in vegetated or dry forest areas and may be intensified by drought conditions and long-term climate trends. Wildfire behavior may include surface fires, crown fires, ground fires, and interface fires where developed areas meet wildland vegetation, creating potential risks to residents, structures, infrastructure, and natural resources.

Salinas has historically experienced a relatively low incidence of wildfire; however, some areas near municipal borders present higher potential risk. Wildfires can threaten natural ecosystems, cultural resources, public infrastructure, transportation access, and nearby communities. Recent 2024 wildfire data identified multiple small incidents, indicating that the hazard should continue to be monitored as part of the municipality's risk profile.

Social vulnerability to wildfire is associated with poverty, disability prevalence, limited evacuation capacity, and constraints on household preparedness. Although current wildfire incidence is comparatively low, future risk may increase as dry conditions become more frequent and vegetation stress intensifies. Mitigation measures such as public education, defensible space practices, vegetation management, emergency access improvements, and interagency coordination can reduce potential impacts.

Long Term Coastal Dynamics

Long-term coastal dynamics are the gradual processes that reshape coastlines through erosion, accretion, sediment movement, and variations in mean sea level. Unlike isolated storm impacts, these processes unfold over years or decades and progressively alter shoreline position, coastal stability, and exposure to flooding and wave action. Their combined effects can reduce beach width, weaken dunes and other natural buffers, and cause the shoreline to migrate inland, making them an important consideration in hazard mitigation, land-use planning, and infrastructure investment.

Salinas has approximately 53 kilometers of coastline, of which about 57 percent is composed of mangrove shoreline. Post-Hurricane María assessments documented

significant but uneven shoreline change across the municipality. While approximately 64 percent of beaches exhibited accretion immediately following the storm, increased erosion was observed by July 2018. Coastal monitoring identified landward shoreline migration primarily near Punta Salinas and the Río Nigua coastal area, highlighting the dynamic nature of Salinas' coastline and the continued importance of erosion and shoreline-change monitoring.

Coastal erosion may occur episodically during major storms or chronically through persistent sediment deficits, rising water levels, land subsidence, altered river sediment delivery, coastal development, and damage to natural protective systems. Accretion may temporarily or persistently widen beaches and strengthen dunes, but it is not uniform or necessarily permanent and may reflect sediment transferred from another shoreline segment. Human interventions, including coastal structures, dredging, development, and beach nourishment, can modify both erosion and accretion patterns and may create benefits in one area while increasing vulnerability elsewhere.

Observed sea-level trends reinforce the municipality's long-term coastal risk. Puerto Rico tide gauges cited in the document show increasing relative sea levels, with trends of approximately 2.06 millimeters per year at Magueyes Island and 2.16 millimeters per year at San Juan through 2025. Gradual increases in the coastal water-level baseline can intensify routine tidal flooding, accelerate shoreline adjustment, expose low-lying areas, and reduce the effectiveness of natural and engineered protective features even without a major storm.

These dynamics threaten multiple Community Lifelines, including emergency services, water and wastewater systems, healthcare access, energy, communications, transportation, and hazardous-material facilities. They also disproportionately affect low-income households, renters, older adults, people with disabilities or chronic health conditions, and communities dependent on coastal livelihoods, while endangering beaches, dunes, wetlands, mangroves, coral reefs, historic sites, and other cultural resources. Because future coastal change in Salinas is considered highly likely, the document supports sustained shoreline monitoring, nature-based solutions, land-use controls, resilient infrastructure siting, adaptive shoreline management, and mitigation actions that protect essential services and vulnerable populations.

Pandemic/Epidemic

Pandemic and epidemic hazards include localized disease outbreaks as well as

widespread events that can extend across regions, nations, or globally. For planning purposes, the entire municipality is considered vulnerable because infectious disease impacts can affect residents, institutions, workplaces, schools, healthcare providers, and essential services throughout Salinas.

Puerto Rico has experienced several historic outbreaks, including cholera in 1855, measles in 1917, the Spanish Flu in 1918, polio in 1960, as well as, dengue, chikungunya, Zika, and COVID-19 in recent years. The COVID-19 pandemic produced significant health, economic, and social impacts locally and illustrated how disease events can disrupt normal community functions, increase demand for public health services, and affect vulnerable populations.

During pandemic and epidemic events, the healthcare lifeline is typically the most directly affected; however, other FEMA Lifelines may also experience disruptions, including communications, transportation, food supply, shelter operations, public safety, and continuity of government functions. Future pandemic risk remains elevated due to changing environmental conditions, population characteristics, travel patterns, and the continued emergence of infectious diseases. Mitigation and preparedness efforts should therefore emphasize public health coordination, risk communication, continuity planning, support for vulnerable populations, and sustained emergency management capacity.

Hazard Prioritization

The Planning Committee used the results of the hazard profiles and risk assessment to establish mitigation priorities for the Municipality of Salinas. Based on the analysis, earthquakes, landslides, flooding, tropical cyclones and extreme winds, extreme heat, drought, and wildfire were identified as high-priority hazards. Pandemic and epidemic hazards were categorized as mid-priority. This prioritization exercise conducted with the planning committee was a qualitative exercise which takes into consideration the municipality's exposure, potential impacts to people and property, effects on critical infrastructure and FEMA Lifelines, and the needs of socially vulnerable populations.

Municipal Capabilities

The LHMP is supported by a range of planning mechanisms, regulatory frameworks, and municipal capacities that guide land use, permitting, floodplain management, infrastructure investment, emergency response, and long-term resilience. These include the Joint Regulation for Permits, the Special Flood Hazard Areas Regulation, the

Puerto Rico Building Code, the Stormwater Systems Regulation, the Salinas Territorial Plan, and the Salinas Emergency Operation Plan. The municipality also participates in the National Flood Insurance Program and complies with the Clean Water Act's NPDES program. In addition, the plan recognizes the value of green infrastructure and nature-based solutions for stormwater management, while the Four-Year Investment Program (PICA) serves as a tool to align public investment with hazard mitigation priorities.

Salinas's technical and administrative capacity is supported by municipal offices with responsibilities related to planning, land use, emergency management, and federal programs. These include a staffed Planning and Land Use Office, Emergency Management Office, and Federal Programs Office, with engineering and specialized technical expertise procured as needed. The municipality's financial capacity is strengthened by positive fund balances and access to federal funding sources, including FEMA's Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Building Resilient Infrastructure and Communities (BRIC), and HUD's CDBG-DR and CDBG-MIT programs.

Public outreach and capacity development are also central components of the LHMP. The municipality uses social media, printed materials, and community meetings to inform residents, gather input, and promote public participation in the mitigation planning process. Capacity-building efforts include staff training and collaboration with academic institutions, supporting the municipality's ability to implement mitigation actions and strengthen institutional knowledge. The plan emphasizes clear, inclusive, and accessible communication to improve hazard awareness, encourage preparedness, and increase community participation.

Mitigation Action Plan

The Mitigation Action Plan establishes goals and objectives to reduce hazard impacts, protect life and property, strengthen infrastructure, increase public knowledge, and improve recovery capacity. Its objectives include preventing loss of life and property, improving municipal program implementation, educating residents and businesses about hazard risks, and strengthening emergency response and intergovernmental coordination. Mitigation strategies are organized into categories such as prevention, property protection, natural resource protection, structural mitigation, emergency services, and public awareness and outreach. These strategies include updating land use and emergency management plans, improving stormwater management, conducting hazard drills, supporting infrastructure resilience, and addressing extreme

heat through urban greening and response planning among others.

Overall, the 2026 Salinas LHMP update integrates hazard assessments, policy frameworks, municipal capabilities, community input, and actionable mitigation strategies into a comprehensive planning tool. Through this integrated approach, the municipality seeks to reduce risk, protect essential services, guide future investments, and strengthen resilience to natural hazards and public health emergencies over the coming years.

1. Introduction and Background

The Municipality of Salinas and the Puerto Rico Planning Board (PRPB) are dedicated to protecting the well-being of Puerto Ricans by fostering cultural, social, and economic growth while prioritizing public health and safety. In this effort, the Municipality and the PRPB have agreed on a joint effort to update the Municipality's Local Hazard Mitigation Plan (LHMP). The LHMP provides a structured and comprehensive approach to reducing risks associated with natural hazards and strengthening overall community resilience. In recent years, Salinas has faced considerable impacts from natural disasters, emphasizing the urgent need for proactive actions to reduce vulnerabilities and safeguard critical infrastructure. These experiences highlight the importance of implementing a coordinated and systematic hazard mitigation strategy that is consistent with federal, state, and local policies.

An LHMP identifies and evaluates potential natural hazards and defines actions designed to reduce or eliminate risks to people, property, and the environment. The plan supports the municipality's land use planning efforts by establishing measures that assist Salinas in achieving its long-term sustainability and resilience objectives.

This LHMP complies with the requirements set forth by the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and the federal regulations derived from it. Under this legislation, local governments in states and territories are required to develop and formally adopt a hazard mitigation plan as a condition for eligibility to receive certain types of funding administered by the Federal Emergency Management Agency (FEMA).

Risk mitigation plays a critical role in guiding future development and enhancing existing municipal infrastructure. To ensure an effective mitigation strategy, the LHMP is regularly updated to reassess natural hazards that may threaten the lives and property of residents and to incorporate appropriate and responsive mitigation measures.

This document represents the second revision of the LHMP for the Municipality of Salinas. The original plan received FEMA approval in 2014, followed by the first update in June 2020. This 2026 update reflects evolving conditions and circumstances that have influenced the municipality over the past five years and incorporates newly enacted laws, programs, and regulatory requirements. Through this update, Salinas

aims to preserve its eligibility for federal mitigation funding prior to future catastrophic events and to present a strengthened plan aligned with current standards and best practices.

The development of this plan was conducted through a coordinated process that incorporated input from state and local agencies, non-governmental organizations, and the public. The overarching goal is to enhance the municipality's capacity to anticipate, reduce, and effectively respond to natural hazards that may affect its jurisdiction.

The primary objectives of the LHMP are to:

- Identify and evaluate natural hazards that pose risks to the municipality.
- Establish strategies and actions to reduce or eliminate long-term threats to life, property, and critical services.
- Encourage interagency coordination and promote community involvement in disaster preparedness and mitigation initiatives.

1.1 Applicable Public Policies

This section outlines the relevant federal and state public policies that guide the development of the 2026 Salinas LHMP. The overview provided is not intended to be comprehensive. Additional public policies are referenced throughout the document, particularly in Section 5.1.

1.1.1 Federal Policies

1.1.1.1 Federal Laws

Stafford Act and Disaster Mitigation Act of 2000

The Stafford Act is primarily aimed at reducing loss of life and property, alleviating human suffering, minimizing economic impacts, and lowering the costs associated with disaster assistance. In 1988, Congress amended the Act to create the Hazard Mitigation Grant Program (HMGP), which became the principal source of federal mitigation funding following a disaster declaration by the President of the United States. Through this program, funds are made available to states and territories to implement cost-effective measures that reduce the risk of damage and losses from future hazard events.

Disaster Mitigation Act of 2000

Enacted on October 30, 2000, the Disaster Mitigation Act of 2000 (DMA 2000) further amended the Stafford Act to enhance disaster planning, response, and recovery at all levels of government. This legislation establishes eligibility requirements for municipalities to access federal mitigation funding, including the preparation and adoption of a Local Hazard Mitigation Plan (LHMP). An LHMP demonstrates a jurisdiction commitment to reducing risks associated with natural hazards and serves as a decision-making tool for implementing preventive and mitigation actions. It also provides a framework for the State to deliver technical assistance and establish funding priorities.

In accordance with DMA 2000 requirements, this LHMP is comprehensive and coordinated, incorporating the participation of state, local, and regional agencies, non-governmental organizations, and members of the public.

National Flood Insurance Act

The National Flood Insurance Act established the National Flood Insurance Program (NFIP) to provide affordable flood insurance coverage to homeowners, businesses, and renters located in flood-prone areas. The program was designed to reduce the financial burden on individuals and the federal government in the aftermath of flood-related disasters.

The Act also encourages participating communities to adopt and enforce minimum floodplain management standards aimed at reducing future flood risks. Communities that comply with these requirements become eligible for NFIP benefits and programs.

Access to flood insurance enables property owners to recover more rapidly following flood events without relying solely on federal disaster assistance. Supporting legislation, such as the Flood Disaster Protection Act of 1973, further requires federally regulated lenders to mandate flood insurance coverage for properties located in high-risk flood zones and financed through federally backed mortgages.

The Federal Emergency Management Agency (FEMA) has recognized the Municipality as part of the region that is within the PRPB's coverage within the National Flood Insurance Program. The municipality can request updates and amendments to flood hazard maps utilized by the NFIP through the PRPB.Additionally, through participation

in the Flood Mitigation Assistance Program, the municipality has identified specific mitigation strategies to reduce flood-related risks. Funding has also been allocated for the acquisition of structures located in high-risk flood areas as part of ongoing efforts to decrease vulnerability and exposure to future flood events.

2.1.1.1 Federal Regulations

Mitigation Planning - 44 CFR Part 201

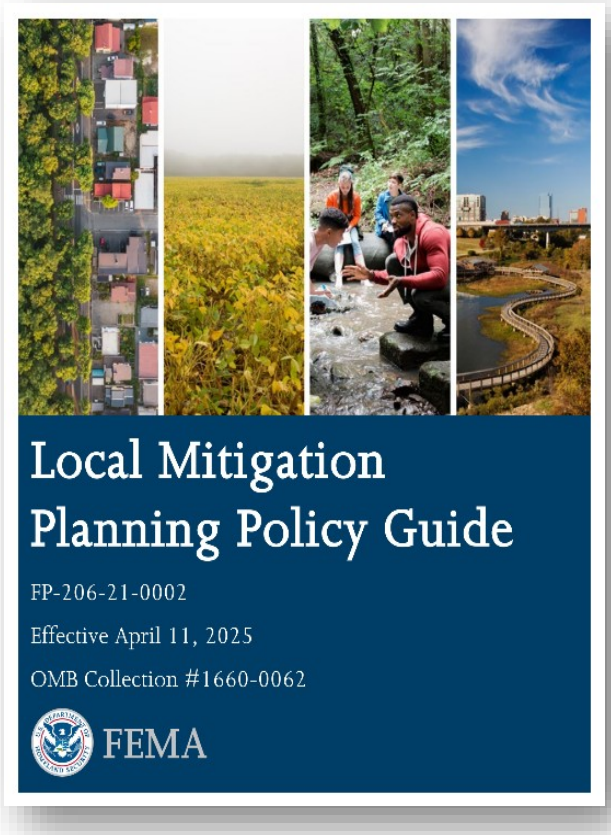
This section of the Code of Federal Regulations describes the rules and procedures governing hazard mitigation planning as mandated under the Stafford Act. It outlines the requirements for the preparation and adoption of mitigation plans, which serve as the primary tool for reducing risks posed by natural hazards at the local level. Additionally, this section establishes the policies and planning processes that guide hazard mitigation efforts, underscoring the role of mitigation plans in directing the effective allocation of resources for disaster risk reduction.

FEMA Local Hazard Mitigation Planning Guide

The Local Hazard Mitigation Planning Policy Guide published by FEMA establishes the official framework and guidance that local governments are required to follow when preparing, reviewing, and updating their Local Hazard Mitigation Plans (LHMPs). This guidance is designed to ensure compliance with the requirements set forth in the Code of Federal Regulations (44 CFR Part 201).

The policy guide emphasizes data-driven planning tailored to local capacities, while prioritizing equity and inclusive stakeholder participation. It encourages communities to integrate hazard mitigation into broader planning and decision-making processes, thereby strengthening long-term resilience

Figure 1: Cover of FEMA's Local Mitigation Planning Policy Guide

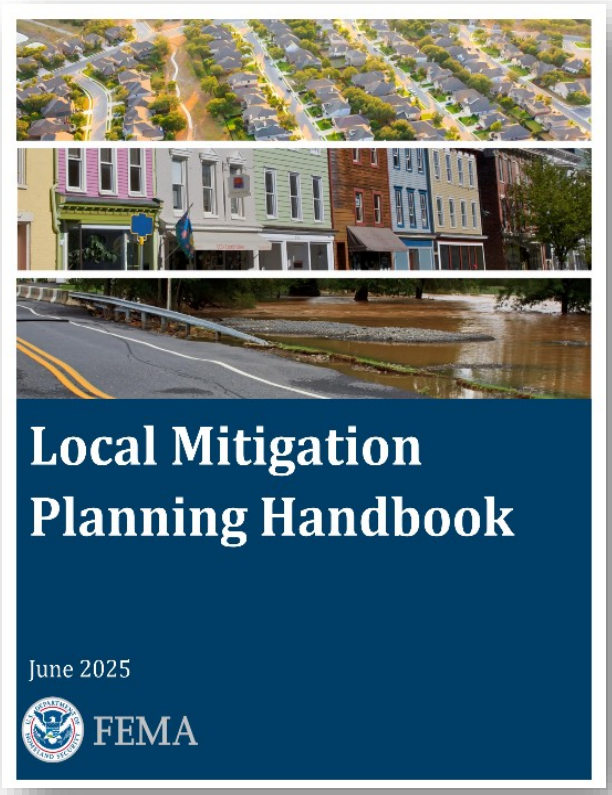


and reducing vulnerability to natural hazards ((FEMA, Local Mitigation Planning Policy Guide, 2025).

The guide identifies the essential components that every mitigation plan is required to address. In addition, it provides practical resources such as resolution templates, checklists, and plan review criteria to support local governments throughout the planning process. The guide also explains FEMA's plan review and approval process, which may result in full approval, conditional approval pending formal adoption, or return of the plan for revisions and corrections.
Local Mitigation Planning Handbook

FEMA Local Mitigation Planning Handbook

Figure 2: Cover of FEMA's Local Mitigation Planning Handbook



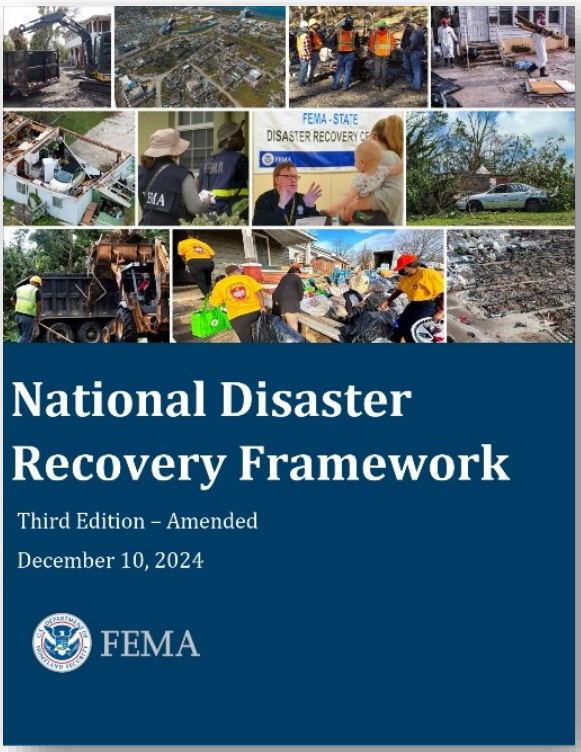
The *Local Mitigation Planning Handbook* is an operational resource developed by FEMA to assist local governments, including municipalities and special districts, in the development or update of their Local Hazard Mitigation Plans. This handbook serves as a companion to FEMA's mitigation planning policy guidance and offers a detailed, step-by-step methodology for complying with the requirements outlined in Title 44 of the Code of Federal Regulations, Part 201.

The primary purpose of the handbook is to support communities in identifying the natural hazards they face, evaluating institutional and administrative capabilities, and formulating effective strategies to reduce disaster-related impacts (FEMA, 2025). Ultimately, the handbook promotes the creation of safer and more resilient communities that are better prepared to anticipate, withstand, and recover from adverse events.

National Disaster Recovery Framework

The National Disaster Recovery Framework (NDRF) is a guide created by FEMA in the United States that establishes how recovery should be organized and coordinated after a disaster. Its main objective is to help affected communities rebuild in a stronger, more equitable, and more resilient way, involving all levels of government—local, state, tribal, territorial, and federal—along with private and community organizations.

Figure 3: National Disaster Recovery Framework Cover



This framework promotes recovery that not only restores what was lost but also improves pre-disaster conditions. To achieve this, the NDRF defines guiding principles, specific roles for the actors involved, and coordination structures that facilitate collaboration among agencies. It also emphasizes the importance of planning before a disaster occurs and ensuring that recovery goals are defined by the affected communities themselves.

National Flood Insurance Program

The National Flood Insurance Program (NFIP), administered by FEMA, provides affordable flood insurance coverage to property owners, renters, and businesses while encouraging effective floodplain management practices to reduce future flood risks. Established in 1968, the NFIP supports communities in minimizing flood-related losses by requiring the adoption and enforcement of local floodplain management regulations. The program also offers insurance coverage for both structures and their contents in more than 22,000 participating communities nationwide.

Because most standard homeowners' insurance policies do not cover flood damage, the NFIP plays a critical role in protecting lives and property while reducing long-term disaster recovery costs. Additional information regarding the Municipality of Salinas participation in the NFIP is provided in Section 4.2 of this plan.

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established under the Earthquake Hazards Reduction Act of 1977 to advance the development, dissemination, and application of knowledge, tools, and practices that reduce risks associated with seismic events. This objective is achieved through coordinated, multidisciplinary, and interagency collaboration among NEHRP's participating federal agencies and partners, including local jurisdictions such as the Municipality of Salinas.

The National Institute of Standards and Technology (NIST), within the U.S. Department of Commerce, serves as the lead agency for NEHRP. The program is further supported by three cooperating federal agencies: the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the United States Geological Survey (USGS). Each agency contributes expertise and complementary activities related to research, preparedness, mitigation, and public safety.

National Incident Management System

The National Incident Management System (NIMS) is a standardized framework developed by the U.S. Department of Homeland Security and administered by FEMA to guide incident management across the nation. Its purpose is to enable effective coordination and cooperation among governmental agencies, private sector organizations, and community-based entities at all jurisdictional levels during the prevention, preparedness, response, and recovery phases of emergencies and disasters.

NIMS establishes a common organizational structure, terminology, and set of processes to ensure seamless coordination regardless of the incident's type, size, or complexity. Core components of the system include resource management, interoperable communications, ongoing preparedness activities, and the Incident Command System (ICS), which defines clear roles, responsibilities, and command structures during emergency operations.

Implementation of NIMS is also a prerequisite for jurisdictions seeking access to certain federal preparedness and response funding. By adopting NIMS, jurisdictions enhance operational efficiency, reduce duplication of efforts, and promote the effective and coordinated use of available resources.

1.1.2 Government of Puerto Rico Policies

1.1.2.1 Puerto Rico Laws

Act No. 161-2009, as Amended

Act No. 161-2009, known as the *Puerto Rico Permits Reform Act*, establishes a modern legal and administrative framework designed to comprehensively restructure the Commonwealth's permitting system. The primary goal of the Act is to create a transparent, efficient, and streamlined process for the submission, evaluation, approval, or denial of permits issued by the Government of Puerto Rico.

To accomplish this objective, the law created the Office of Permits Management (OPM), consolidating permitting responsibilities that were previously distributed across multiple agencies. This centralization reduced procedural delays and improved consistency in the application of permitting standards. The Act also introduced specialized roles—including Authorized Professionals, Permit Managers, Service Representatives, and Permit Officers—each with defined responsibilities intended to expedite reviews and professionalize the permitting process.

A further objective of Act No. 161-2009 is to enhance oversight, accountability, and transparency within the permitting system. By strengthening internal controls and standardizing procedures, the Act seeks to ensure compliance while reducing administrative inefficiencies.

From a public policy perspective, the Act aims to promote economic development while safeguarding environmental protection. Legislative intent emphasizes that an efficient permitting system is essential to attract investment, encourage construction activity, support long-term job creation, and eliminate bureaucratic barriers that previously hindered economic growth. Analyses of the Act also highlight its role in centralizing governmental functions and implementing an Integrated Permitting System to reduce fragmentation, improve interagency coordination, and ensure regulatory uniformity throughout Puerto Rico.

Act No. 33-2019, as Amended

Act No. 33-2019 establishes the public policy of the Government of Puerto Rico regarding mitigation, adaptation, and resilience in response to observed variations in temperature and precipitation patterns. The legislation formally recognizes the need

for integrated governmental action, including at the municipal level, to address the impacts of environmental instability.

This Act calls for the incorporation of concrete mitigation, adaptation, and resilience measures into territorial and land use planning instruments. By doing so, it promotes a proactive approach that strengthens communities' capacity to withstand environmental stressors and reduces long-term risks to public safety, infrastructure, and natural resources.

Act No. 107-2020, as Amended

Act No. 107-2020, as amended, known as the *Puerto Rico Municipal Code*, significantly expands the authority, responsibilities, and operational autonomy of municipal governments. The Code promotes local self-governance and enhances municipalities' capacity to manage their own affairs, including disaster preparedness and risk reduction.

Among the responsibilities granted to municipalities is the authority to design and implement programs and measures to prevent, respond to, and recover from emergencies, natural disasters, catastrophic accidents, and other hazardous events. This expanded role reinforces the importance of municipal governments in protecting public safety and community well-being.

The Municipal Code also grants municipalities enhanced autonomy over land use regulation within their jurisdictions. This authority includes the application of tools such as the transfer of development rights and the evaluation and issuance of construction permits, enabling municipalities to incorporate hazard mitigation principles directly into development decisions. These powers are essential for reducing exposure to natural hazards and safeguarding lives and property.

Overall, the Municipal Code recognizes territorial planning as a critical instrument for risk mitigation and establishes a legal framework that enables municipalities to take proactive, locally tailored actions to protect their communities from natural hazards and other adverse events.

1.1.2.2 Puerto Rico Regulations

Puerto Rico Land Use Plan (PUT-PR by its Spanish acronym) - 2015

In compliance with Act No. 550-2004, as amended, the Puerto Rico Land Use Plan (PUT, by its Spanish acronym) constitutes the primary territorial planning instrument prepared by the Puerto Rico Planning Board. The Plan is intended to direct land use, development, and conservation activities throughout the island in a coordinated, sustainable, and resilient manner, guided by a long-term planning horizon of ten (10) years (PRPB, 2015).

Figure 4: PUT-PR Coversheet



One of the primary functions of the Puerto Rico Land Use Plan (PUT) is to classify land throughout the Commonwealth into specific land use categories. Land classification serves as a land administration framework that establishes the types of zoning districts and allowable uses that may be applied to individual parcels. Under the PUT, land is classified according to the following scheme:

- Urban Land (SU, by its Spanish acronym):
  This category includes areas that are already developed and served by the necessary infrastructure and public services.
- Land for Development:
  This classification applies to land identified as suitable for future development and is subdivided into two categories:
    - Programmed Development Land (SUP, by its Spanish acronym): Land scheduled for development under established programs or plans.
    - Non-Programmed Development Land (SUNP, by its Spanish acronym): Land available for development that has not yet been assigned to a

specific development program.

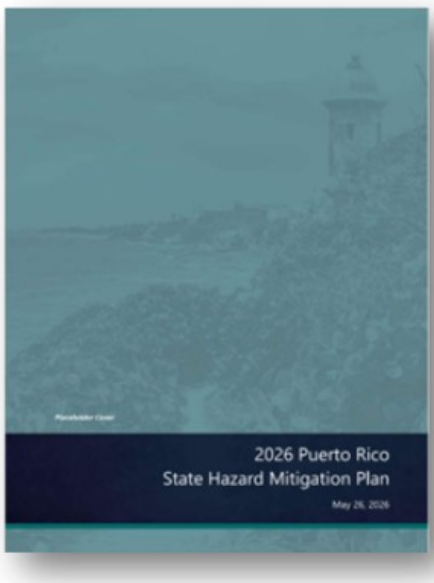
- Rustic Land: Rustic lands are designated for protection, conservation, or limited use due to their environmental, agricultural, or ecological value. This classification is further subdivided into:
- Common Rustic Land (SRC, by its Spanish acronym): Areas suitable for limited, low-intensity uses.
- Specially Protected Rustic Land (SREP, by its Spanish acronym): Areas subject to heightened protection due to their environmental, natural, or cultural significance.

The PUT-PR aims to coordinate and harmonize land use planning efforts among state agencies and municipalities. It serves as the foundation for the preparation of municipal Land Use Plans (Planes de Ordenación Territorial, POT, by its Spanish acronym), which are adopted for an eight-year planning period (PRPB, 2015).

Currently, the PUT-PR is in the process of being updated for the 2026 -2032 planning cycle. This revision will incorporate robust citizen participation, clearly defined compliance and performance metrics, and an inclusive planning approach that integrates economic development, green infrastructure, sustainable transportation systems, and the conservation of natural resources.

Puerto Rico State Natural Hazard Mitigation Plan (2026)

Figure 5: Puerto Rico SHMP Cover



Just as with the requirements applicable to local jurisdictions, the Stafford Act requires states and territories to develop a hazard mitigation plan that covers their entire jurisdiction. In the case of Puerto Rico, the most recent State Hazard Mitigation Plan was completed in 2026. The 2026 Puerto Rico State Natural Hazard Mitigation Plan establishes long-term strategies to address natural hazards that have the potential to disrupt daily activities, damage property, and threaten human life. These hazards may become disasters that affect not only individuals, but also entire communities, with broad impacts on public health, infrastructure, economic stability, and natural ecosystems (NMEAD, 2026).

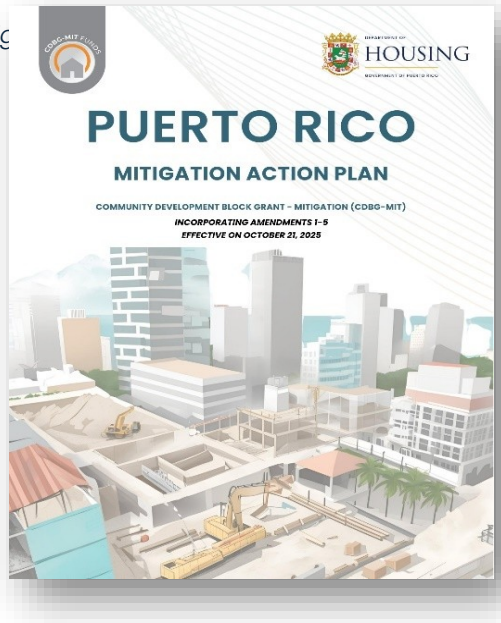
This plan provides a comprehensive framework for identifying risks and implementing actions aimed at reducing vulnerability to these hazards. Through its emphasis on mitigation, the plan seeks to increase community resilience, protect critical infrastructure and systems, and promote sustainable development throughout Puerto Rico (NMEAD, 2026).

The Municipality of Salinas reviewed the 2026 Puerto Rico State Hazard Mitigation Plan during the preparation of this LHMP update. The relevant risk profiles, state capabilities, mitigation goals, and state actions were considered during the risk assessment, capability assessment, and development of the municipal mitigation strategy.

Puerto Rico Mitigation Action Plan, CDBG-DR MIT (2021, 2025)

Originally approved by the U.S. Department of Housing and Urban Development (HUD) in 2021 and subsequently amended in August 2025, the Puerto Rico Mitigation Action Plan for the Community Development Block Grant–Mitigation (CDBG-MIT) Program is a strategic planning document prepared by the Puerto Rico Department of Housing (DV). The plan establishes the framework for the administration and management of federal mitigation funds allocated by HUD under the CDBG-MIT program.

Its primary objective is to reduce risks and vulnerabilities to future disasters by enhancing the resilience of infrastructure, communities, and critical systems. Although these funds were appropriated by Congress to Puerto Rico following Hurricanes Irma and María in 2017, CDBG–MIT funding differs from CDBG–Disaster Recovery (CDBG-DR) in that it is specifically focused on preventing and mitigating future impacts. Accordingly, CDBG-MIT resources are directed toward sustainable, high-impact mitigation projects and are not required to be directly linked to disaster recovery activities associated with those hurricanes (PRDOH, 2025). This plan is designed to reduce exposure to hazards, safeguard lives and property, and enhance emergency response capabilities through targeted investments in infrastructure, housing,



and land-use planning (PRDOH, 2025).
Other relevant planning regulations will be discussed as part of subchapter 5.1

1.1.3 Municipal Policies

Salinas Local Hazard Mitigation Plan (2020)

Figure 7: All Hazard Mitigation Plan Cover



Adopted by the Municipality on June 4, 2020, and approved by FEMA on June 19, 2020, the **Salinas Local Hazard Mitigation Plan (2020)** provides a comprehensive assessment of natural hazards affecting the municipality and establishes strategies to reduce future losses of life, property, infrastructure, and environmental resources. The plan was developed in accordance with the Disaster Mitigation Act of 2000 (DMA 2000) and FEMA requirements for local hazard mitigation planning.

The update was prepared through a collaborative process involving municipal departments, state and federal agencies, technical specialists, and community stakeholders. Public participation was incorporated through planning committee meetings, community workshops, public notices, and opportunities for public review and comments.

The planning process emphasized identifying local vulnerabilities, evaluating risks, and developing practical mitigation actions to improve community resilience.
The plan identifies the following significant natural hazards affecting Salinas:

- Climate Change and Sea Level Rise
- Drought
- Earthquakes and Liquefaction
- Flooding
- Landslides
- Strong Winds and Tropical Cyclones
- Tsunamis
- Storm Surge
- Coastal Erosion
- Wildfires

These hazards were evaluated based on their probability of occurrence, potential impacts on people and infrastructure, environmental consequences, and future conditions. The plan identifies flooding, drought, earthquakes, strong winds, tsunamis, storm surge, and wildfires as high-priority hazards for the municipality.

The plan also includes a detailed inventory of critical facilities, municipal assets, emergency services, schools, government buildings, public safety facilities, and utilities that support community operations during and after disasters. Vulnerability assessments were conducted using GIS-based analyses, HAZUS modeling, historical records, and local knowledge to estimate potential impacts and losses associated with each hazard.

Some of the mitigation strategies proposed by this plan are:

- **Flooding:** Improvement of stormwater drainage systems, channelization and maintenance of waterways, replacement of culverts and drainage infrastructure, and implementation of flood mitigation projects in vulnerable communities.
- **Strong Winds and Hurricanes:** Installation of backup power systems at critical facilities, strengthening of public infrastructure, protection of critical facilities through shutters and structural improvements, and undergrounding of utility systems were feasible.
- **Earthquakes:** Structural reinforcement of buildings, promotion of seismic-resistant construction practices, public education, and identification of facilities vulnerable to liquefaction hazards.
- **Tsunamis:** Maintenance of tsunami evacuation planning, support for TsunamiReady certification, installation and maintenance of warning systems, and identification of vertical evacuation options.
- **Storm Surge and Coastal Hazards:** Restriction of development in high-risk coastal areas, shoreline protection projects, and implementation of land use policies to reduce exposure.
- **Drought:** Development of rainwater collection and water storage systems, protection of water resources and aquifers, and public education on water conservation.
- **Landslides:** Slope stabilization measures, vegetation planting, erosion control practices, and identification of high-risk areas for monitoring and mitigation.
- **Wildfires:** Public awareness campaigns, wildfire prevention education, inventory and tracking of wildfire incidents, and coordination with emergency management and fire response agencies.

- **Climate Change and Sea Level Rise:** Integration of hazard information into land use planning, protection of critical facilities, preservation of open space, and limitation of development in areas vulnerable to future inundation and coastal impacts.

Salinas Municipal Recovery Plan

As part of the CDBG-DR funds assigned by Congress to Puerto Rico in the aftermath of hurricanes Irma and María, municipalities were able to develop a recovery plan to guide recovery efforts and resiliency in the event of future stressors. In essence the Municipal Recovery Plans:

Figure 8: Salinas Municipal Recovery Plan – Cover



- Identify local post-disaster needs created or worsened by Irma and María
- Establish short-, medium-, and long-term recovery priorities
- Integrate resilience and hazard mitigation strategies
- Serve as a policy and project roadmap for future funding decisions

Each Municipal Recovery Plan has a list of recovery and resiliency projects that might be considered as new mitigation strategies for the LHMP.

1.2 Scope and Previous Versions

1.2.1 Primary Objectives

The primary objectives of the LHMP are to:

- Identify and assess natural hazards that pose a risk to the municipality.

- Develop strategies and actions to reduce or eliminate long-term risks to life, property, and essential services.
- Promote interagency coordination and community engagement in disaster preparedness and mitigation efforts.

1.2.2 LHMP Organization

Table 1 shows the layout for the 2026 of Salinas LHMP. To help LHMP reviewers and the public understand compliance, the table includes a column specifying which FEMA-required element (FEMA, 2025) is addressed by each section.

Table 1: LHMP Organization

Chapter #	Title	Description	Review Tool Elements met
N/A	Executive Summary	This section summarizes the most important findings from the planning process and explains how they are addressed in the LHMP.	Local Element
Chapter 1:	Introduction and Background	This chapter discusses the planning background for Salinas It explains the organization of the LHMP and the most significant changes in the 2026 version compared to the 2020 version. It also addresses the public policies relevant to the update of the LHMP.	E2-a, A1-a, A1-b, A4-a, A2-a, A3-a
Chapter 2	Planning Process	Describes the process to prepare and update the LHMP. It discusses the planning committee, stakeholder involvement, public participation efforts, hazard data sources, and the incorporation of FEMA Community Lifelines into the planning process.	A1-a, A1-b, A2-a, A3-a, A4-a.
Chapter 3	Municipal Profile	The municipal profile describes the municipality's relevant characteristics, including physical features, infrastructure, and demographic and socioeconomic traits.	E1-a
Chapter 4	Hazard Profiles and Risk Analysis	This section is the most extensive in the plan. It covers the hazards identified for Salinas and examines the risks associated with each one.	B-1a, B-1b, B1-c, B1-d, B-e, B2-a, B2-b, E1-a

Chapter #	Title	Description	Review Tool Elements met
Chapter 5	Mitigation Capabilities	This chapter elaborates on the municipality's capabilities to implement the mitigation strategies that will be proposed in Chapter 6.	C1-a, C-1b
Chapter 6	Mitigation Action Plan	This chapter establishes the mitigation goals of the Plan and the actions the municipality will take to reduce the risks associated with the identified natural events. It also serves to update the status of the mitigation actions included in the 2020 Plan.	C3-a, C4-a, C4-b, C5-a, C5-b, E2-b
Chapter 7	Plan Maintenance	This chapter addresses the process for evaluating the effectiveness of the plan. It also explains the procedure for making modifications or updates to the plan.	D1-a, D2-a, D2-6, D2-c, E2-c
Chapter 8	Adoption and Approval	This section includes information on the adoption of the plan by the municipality, FEMA's approval, and the expiration date of the 2026 Local Hazard Mitigation Plan.	F1-a, F1-b
N/A	Selected References	This section presents the sources used in updating the plan.	A4-a
N/A	Appendixes	This section includes all appendices and supplementary information related to the planning process of the Plan.	

1.3 Changes to the Salinas LHMP (E2-a)

Table 2 shows the most significant changes that the 2026 version has from the 2020 version.

Table 2: Changes to the Salinas LHMP

Element	Justification
Plan Language	Following Presidential Executive Order #14224, the 2026 version of Salinas LHMP has been originally prepared in English for submission and consideration of FEMA. An official translation of the final draft for public discussion and the final approved LHMP to Spanish will be prepared for the benefit of the population that are not English proficient.
Plan organization	The organization and chapters of the document have been modified to follow the template used in local mitigation plans

Element	Justification
	prepared by the Puerto Rico Planning Board. However, this template has been adapted in the current plan to comply with current federal public policy.
Discussion of FEMA Lifelines	As per the Local Hazard Mitigation Policy, FEMA Lifelines are discussed as well as the strategies to mitigate hazard impacts on them.
Elimination of non-applicable public policy	For clarity and better readability, references to redundant public policy have been removed.
Change to the name of extreme winds	The hazard identified in the 2020 Plan as "extreme wind" has been changed to "Tropical Cyclones" to the current HAZUS capability to model tropical cyclones for Puerto Rico.
Update of census data	The municipality and PRPB have chosen to use the most recent version of the American Community Survey for evaluating demographic data. In this case it has chosen to evaluate the data sets from the 2024 five-year American community survey.
Action Plan	The tables of mitigation strategies that were in different sections in the 2020 Plan are now located in a single section (section 6.2). The table format has been modified to be easier to read, and several columns have also been added to provide valuable information for the reader.
All the LHMP	Attention has been given to ensure that the content of the Plan does not reveal any personally identifiable information (PII).
Other changes can be included in the plan progress.	

2. Planning Process

2.1 Planning Process Regulation

This LHMP was updated following the above-mentioned applicable public policies and procedures mentioned in Chapter 1.

This LHMP seeks to aid municipality in the task of preventing loss of life and property by the effects of natural hazards. Chapter 1 serves as a general introduction, Chapter 2 discusses the planning process followed, as well as stakeholder and public participation involvement. The LHMP identifies a general profile of the municipality using information provided by the US Census, such as population distribution, employment, housing stock, etc. (see Chapter 3 for more information). After describing the Municipalities general profile, the Plan goes on to evaluate all identifiable natural hazards that can affect the municipality and its population, including the effects on lifelines, properties, population exposure, natural resources, etc. (see Chapter 4 for more information).

Chapter 5 defines the capabilities that the municipality has for implementing the LHMP. While Chapter 6, establishes the mitigation actions that the municipality will execute for the next five years. Chapter 7 discusses the provisions for LHMP Maintenance and Chapter 8 discusses the adoption and approval of the LHMP. The various appendixes hold supporting information.

2.2 History of the LHMP

The original LHMP was approved by FEMA in 2014. The first revision was approved in 2020. This new 2026 version responds to changes in conditions and circumstances that have affected the municipality over the past five years. It also reflects changes based on updated FEMA Guidelines published in 2025.

2.3 Plan Preparation, Revision Schedule and Methodology (A1-A)

The planning process for the 2026 update of the Salinas Local Hazard Mitigation Plan (LHMP) follows federal law requirements that LHMPs must be updated every five (5)

years for the municipality to remain eligible for federal mitigation funding. This process officially began with the execution of a Letter of Agreement between the Municipality of Salinas and the Puerto Rico Planning Board (PRPB), which was signed on December 16, 2025. A copy of the signed agreement is included in Appendix B. Subsequently, a kickoff meeting was held on February 6, 2026, bringing together representatives from the Municipality and the PRPB to discuss the planning process, project objectives, and coordination efforts. Later a consulting firm, AtkinsRéalis Caribe LLP, was retained by the PRPB to support the mitigation planning efforts.

The Municipality and its consultants followed the natural hazard mitigation planning process as established by FEMA in the Local Hazard Mitigation Planning Guide and the Local Hazard Mitigation Planning Handbook, as well as the recommendations provided by the mitigation planning staff of COR3. The Local Mitigation Plan Review Tool provides a summary of FEMA's current minimum standards to comply with mitigation planning requirements and identifies where each requirement is addressed within this Plan.

The revision phase reached completion upon the official delivery of the final draft to the State Hazard Mitigation Officer (SHMO), within the Central Office for Recovery, Reconstruction and Resiliency (COR3), on Click or tap to enter a date.. The revision process lasted ___ days.

2.4 Planning Committee (A1-a, A1-b)

To support the revision of the Salinas LHMP, a Planning Committee was established, comprised of representatives from several municipal dependencies who were designated to guide the process. The members of the Committee are:

Table 3: LHMP Planning Committee

Name	Position
Gilberto Vega Braciale	OMME Director
Nailin M. Santiago Pérez	Deputy Director of Territorial Planning
Pedro L. Burgos Romero	Director of Public Works Office
Yarida Oppenheimer Sánchez	Director of Federal Programs
Lercy E. Pastrana Cruz	Executive Assistance
María L. Rivera González	Administrative Aide OMME
Raúl Torres	Planner Consultant

The designation letter for the Planning Committee is included in Appendix B. This

appendix also compiles the meeting minutes, documentation of the materials discussed throughout the process, and accompanying photographic evidence.

2.5 Citizen participation (A3-a)

2.5.1 Community Outreach and Public Participation Strategies

The public participation approach selected for this LHMP revision incorporated the following activities:

- **Distribution of notification letters** to agencies, neighboring municipalities, community leaders, nonprofit organizations, neighborhood associations, business or industrial groups, and other interested stakeholders, informing them that the LHMP revision process had commenced and inviting their input. Documentation of these communications is included in Appendix C.
- **Publication of notices on the Municipality's website and official social media platforms** to inform the public that the LHMP revision was underway. These postings also provided an email address for submitting comments and made available a virtual survey to gather information regarding the community's experiences with natural hazards. Evidence of these public notices is also maintained on Appendix C.
- **Convening an initial community meeting** to introduce the LHMP revision process. This step involved:
    - Issuing a public announcement in a newspaper, on the Municipality's website, and across official social media channels at least 15 days before the meeting.
    - Providing notice of an additional 15-day period for the public to submit comments or suggestions via email or hand – delivered to the municipality.
- **Holding a second community meeting** to present the draft LHMP for public review and discussion. This stage included:
    - Publishing a newspaper announcement and posting notices on the Municipality's website and official social media outlets at least 15 days before the meeting.
    - Confirming in the announcement that the draft plan was available for review in printed and online versions.
    - Providing an additional 7-day comment window for the community to offer feedback, either by email or by visiting the designated address.

2.5.2 Community Outreach and Public Participation Results

First Public Meeting Results

A public meeting notification announcing the initiation of the LHMP update process was published on 2/24/2026 via public notice issued by the Puerto Rico Planning Board in the El Vocero Newspaper. The notification informed the public that the meeting would be held on 3/12/2026 in the Teatro de la Escuela Luis Muñoz Rivera, Salinas, Puerto Rico at 6:00PM.

During this meeting, participants expressed the following concerns: flooding and drainage issues in multiple neighborhoods, wildfire risks, and potential environmental and industrial hazards.

In response, the Municipality implemented several measures to address the issues raised by the community. Appendix C includes the notes documented by the planning consulting firm during the activity, along with supporting evidence. All documentation complies with PII protection requirements

Second Public Meeting Results

A public meeting notification to present to present the draft of LHMP was published on **Click or tap to enter a date.** via _____. The notification informed the public that the meeting would take place on **Click or tap to enter a date.** in _____ at _____. It also stated that a printed copy of the draft LHMP would be available at _____ during regular work hours. Additionally, the public had the option of accessing the draft LHMP through the webpage www.jp.gov.pr. Copies of the public notification are included in Appendix C.

During this meeting, participants expressed the following concerns: _____
The Municipality took the following measures to address these concerns: _____. Appendix C includes the notes documented by the planning consulting firm during the activity, along with supporting evidence. All documentation complies with PII protection requirements.

2.6 Stakeholder involvement (A2-a)

The Municipality carried out outreach efforts to external stakeholders, including government agencies and neighboring municipalities, through formal correspondence addressed to agency heads and mayors. Copies of these invitation letters are provided in Appendix D. Stakeholders were encouraged to submit input either via email or by participating in the public involvement process.

Input from internal stakeholders was obtained through the Planning Committee. Appendix D also includes any written responses or correspondence received from stakeholders during this outreach process.

2.7 Hazard Analysis Data Sources

The following table presents the datasets utilized for the evaluation of each hazard. Table 4 identifies the hazards considered in this LHMP and the corresponding data sources used to support their assessment.

Table 4: Hazard and Risk Assessment of Data Sources

Hazard	Data Sources	Comments
Earthquake	USGS, FEMA	
Landslides	USGS	
Tsunami	NOAA, FEMA	
Flooding	FEMA	
Tropical Cyclone/Extreme Winds	FEMA	
Storm Surge	NOAA	
Extreme Heat	NOAA	
Drought	NDIM	
Wildfires	Puerto Rico Fire Bureau	
Long – Term Coastal Dynamics	NOAA, UPR- COREPI	
Pandemic/Epidemic	PR Department of Health	

2.8 FEMA Lifelines

The *Local Mitigation Planning Handbook* and the *Local Hazard Mitigation Planning Policy Guide* highlight the importance of integrating critical lifelines into the hazard mitigation planning process. FEMA defines lifelines as essential services that sustain public safety, economic stability, and the continuity of government and daily life before, during, and after an emergency or disaster. These lifelines serve as a framework for prioritizing resources and actions that are essential to reducing loss of life and property and supporting efficient and rapid recovery following hazard events (FEMA, 2023).

The *Local Mitigation Planning Handbook* and the *Local Hazard Mitigation Planning Policy Guide* highlight the importance of integrating critical lifelines into the hazard mitigation planning process. FEMA defines lifelines as essential services that sustain public safety, economic stability, and the continuity of government and daily life before, during, and after an emergency or disaster. These lifelines serve as a framework for prioritizing resources and actions that are essential to reducing loss of life and property and supporting efficient and rapid recovery following hazard events (FEMA, 2023).

FEMA identifies eight (8) primary lifelines:

- Safety and Security: Includes law enforcement, fire services, search and rescue operations, government services, and community safety functions.
- Food, Hydration, and Shelter: Encompasses food systems, water access, emergency shelter, and agricultural resources.
- Health and Medical: Includes medical care, public health services, patient movement, medical supply chains, and healthcare facility management.
- Energy: Covers the electrical power grid and fuel supply systems.
- Communications: Includes communications infrastructure, responder communications, alert and warning systems, financial services, 911 operations, and emergency dispatch.
- Transportation: Encompasses highways, motor vehicle systems, mass transit, railways, aviation, and maritime transportation.
- Hazardous Materials: Includes facilities and systems associated with hazardous materials, pollutants, and contaminants.
- Water Systems: Includes potable water infrastructure and wastewater collection and treatment systems.

Each of these lifelines is supported by sub-lifelines that allow jurisdictions to more

precisely identify vulnerabilities and prioritize recovery actions. Together, they enable emergency managers and decisionmakers to rapidly assess conditions, focus response operations on the most critical needs, and coordinate actions that directly affect human life and community stability.

By monitoring the status and functionality of lifelines, jurisdictions can respond more effectively during emergencies, minimize cascading impacts, and accelerate more resilient recovery. A detailed discussion of lifelines and their relevance to the Municipality of Salinas is provided in Section 4.5.

3. Municipal Profile

The Municipality of Salinas is a Coastal municipality located in southern Puerto Rico. It borders the following municipalities: to the north, Coamo, Aibonito and Cayey; to the east, Guayama; to the south, Caribbean Sea; and to the west, Santa Isabel. Salinas is further subdivide into six (6) Wards: Lapa, Palmas, Quebrada Yeguas, Río Jueyes, Aguirre y Barrio Pueblo. Map 1 shows the municipality of Salinas and adjacent municipalities. Map 2 shows the Wards (*barrios*) into which the municipality of Salinas is subdivided.

3.1 Data Sources for Municipal Profiles

The Salinas LHMP has been updated using the most current demographic and socioeconomic data available. Municipal profiles and risk assessments rely primarily on the 2020–2024 Five-Year American Community Survey (ACS). When specific information is not available through the ACS, alternative data sources are identified and cited in the corresponding footnotes.

In addition, the plan reflects the most up-to-date knowledge on hazards and mitigation practices. References to relevant plans, studies, and technical reports are provided in page-level footnotes and consolidated in the References section.

GIS layers included in Chapter 3 were mostly provided by the PRPB's GIS Office.

3.2 Brief Historical Background

The territory of Salinas was named by Europeans as Abeyno, given that the region was ruled by an Indigenous cacique known as Abey. The river and the large salt deposits on the coast were likewise recognized with the cacique's name: Río de Abey and Las Salinas de Abey. Subsequently, the Taíno–Spanish war of the year 1511 resulted in the exile of Abey to Santo Domingo, together with fifteen (15) other caciques. As a result of the conflict, the annihilation of Taíno society took place. The new settlers began to inhabit the land of Salinas, and by the seventeenth century they occupied the area, dedicating themselves to agriculture, fishing, and salt extraction. These settlers formed a community of families which, by the year 1776, was referred to as the barrio de Las Salinas de Coamo. Due to the social and economic growth of Las Salinas, interest arose in separating from Coamo in order to achieve better control over the affairs of the barrio. Consequently, in March of 1840, Agustín Colón Pacheco was appointed Capitán General, with the mission of organizing the Municipal Government of the new town of Salinas (Municipio de Salinas, 2020).

The territory of Salinas belonged to the parish of Coamo, and by Royal Decree of 1847, it was incorporated into the territory of Guayama. However, in 1851, was declared an independent parish and consisted of the following seven (7) wards: Pueblo, Quebrada Honda, Quebrada Yeguas, Aguirre, Collado, Río Jueyes, and Palmas. The commemorative date of the founding of Salinas is taken from the establishment of the first Junta de Vecinos, known today as the Municipal Legislature, when the administration of the new town was established on July 22, 1841.

Due to economic difficulties affecting its development, in 1847 the region of Salinas was annexed to Guayama until 1851, when the municipality was reinstated. The Municipality of Salinas was founded on July 22, 1851, and its name originates from the extraction of salt in the salt flats located on the municipality's coast, known as Las Salinas de Abey. Likewise, the municipality is popularly known as Pueblo del Mojo Isleño, in honor of the sauce prepared by Euladia Correa, a resident of the municipality born in 1898. However, on September 30, 1898, as a result of the Spanish–American War, the United States Army took possession of the municipality, and in 1902 the new regime dissolved it and incorporated it again into Guayama, until the year 1905 (Municipio de Salinas, 2020).

In 1945, the Planning Board of Puerto Rico organized the current official map of Salinas, where the urban zone was expanded and parts of rural wards were included, namely:

(1) Aguirre; (2) Lapa; and (3) Río Jueyes. The rural ward of Aguirre was subdivided into four (4) communities: Central Aguirre, Coquí, San Felipe, and Aguirre (Municipio de Salinas, 2020).

The municipality is located within the Southern Coastal Plains, formed by the consolidation of valleys and hills descending from the Central Mountain Range of Puerto Rico. However, it should be noted that areas in the northern part of the municipality are situated within the Sierra de Cayey, which is a region of the Central Mountain Range located toward the southeast. The flat lands of the municipality extend from the wards of Aguirre and Río Jueyes to the ward of Lapa. In the wards of Lapa, and Quebrada Yeguas, there is rugged topography, a characteristic feature of the Island's Central Mountain Range (Municipio de Salinas, 2020).

Regarding the municipality's coastal shoreline, it extends from Bahía Jobos, Playa Salinas, Punta Arenas, Mar Negro, and Punta Colchones, reaching Punta Rodeo in the surrounding areas of the municipality of Santa Isabel. Likewise, the Municipality of Salinas possesses several islets or cays considered resources of high scenic and touristic value for the municipality, such as the cays Ratones, Mata, and Morillo (Municipio de Salinas, 2020).

3.3 GEOGRAPHY

The Municipality of Salinas covers an area of 46,140 *cuerdas*[1], equivalent to 70.00 square miles. Its municipal territory extends from the Caribbean coastline northward into the Sierra de Cayey, giving Salinas a predominantly north–south orientation typical of Puerto Rico's South Coastal Plain municipalities.

Following a north-to-south trajectory, three geographic regions can be distinguished:

- An alluvial coastal plain, characterized by low relief and Quaternary deposits influenced by riverine and coastal processes.
- A hilly transitional belt (piedmont), where relief increases toward the interior.
- A mountainous zone in the northern sector, where Salinas reaches the foothills and peaks associated with the Sierra de Cayey.

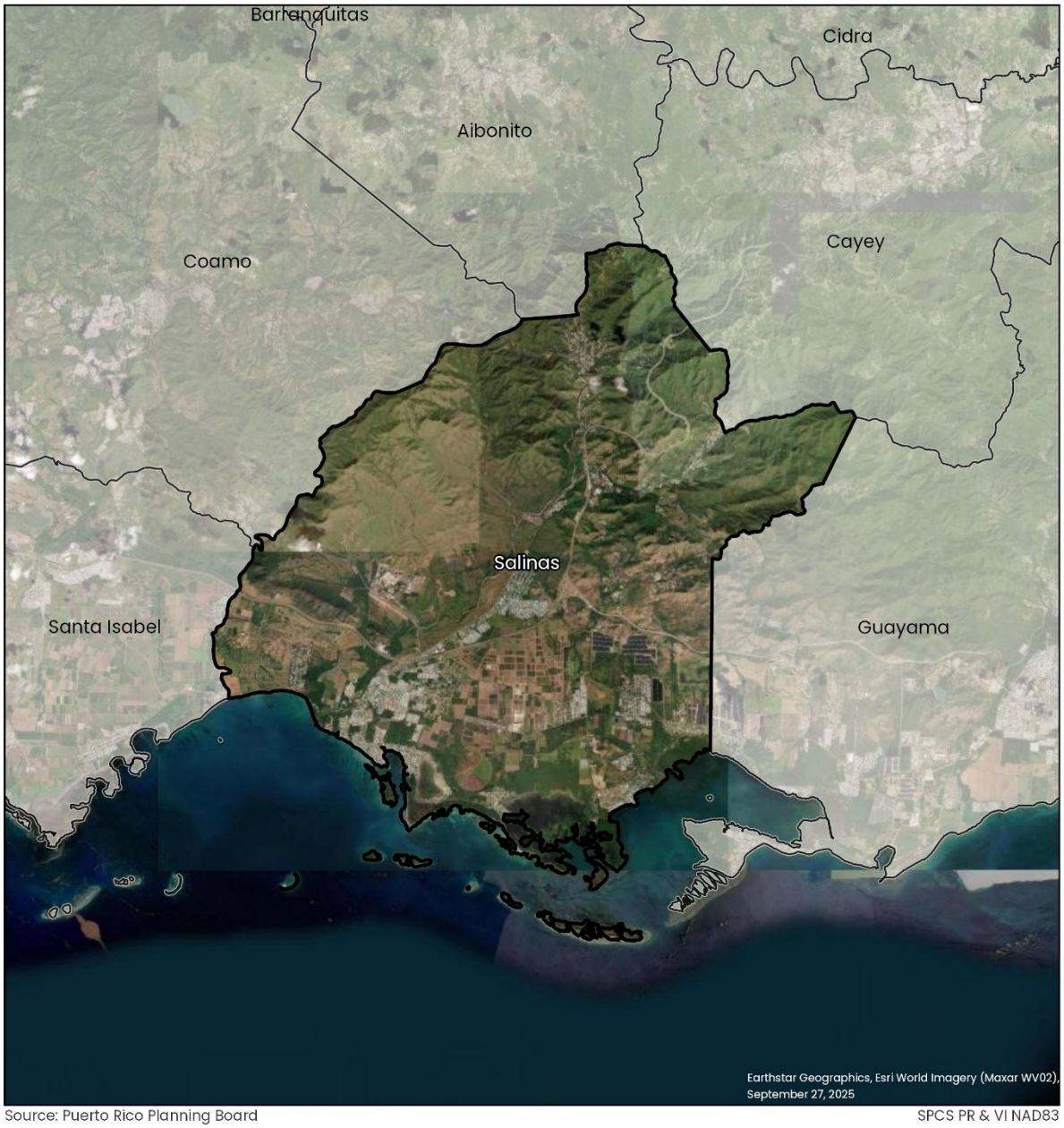
[1] In Puerto Rico, a *cuerda* is a traditional unit of land measurement. It's similar to an acre but slightly smaller. 1 cuerda = about 3,930 square meters (m^2). In acres, that's roughly 0.97 acres. In hectares, it's about 0.393 hectares.

Salinas' terrain transitions from coastal mangrove-fringed lowlands and alluvial fans (e.g., along the Nigua River) to rugged topography in Palmas and Quebrada Yeguas near the northern boundary.

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Map 1: Salinas Geographic Area

Geographic Area



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Municipality of Salinas
Neighboring Municipalities



N

Scale: 1:150,000

0 2,000 4,000 Meters

Map 2: Salinas Wards Subdivision

Wards Boundaries



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Wards
Municipality of Salinas
Neighboring Municipalities



N

Scale: 1:100,000

0 1,250 2,500

Meters

3.3.1 PHYSIOGRAPHY

Salinas has a topographic relief characteristic of the South Coastal Plain region of Puerto Rico. In the northern region, the municipality contains elevations belonging to the Sierra de Cayey, which is considered an extension of the Central Mountain Range. The highest elevation of this system is Cerro Las Tetas, which reaches an altitude of 840 meters (2,756 feet) above sea level and rises between the boundaries of the Cayón ward of the Municipality of Aibonito and Lapas of Salinas

Following this elevation is La Peña, also known as Peñón de los Soldados, with an elevation of 790 meters (2,592 feet), located at the point where the boundaries of the Palmas and Quebrada Yeguas Wards of the Municipality of Salinas and the Cercadillo Ward of Cayey converge. Likewise, the highest point of the Sierra de Jájome reaches an elevation of 730 meters (2,395 feet) above sea level and is located where the boundaries of the Quebrada Yeguas Ward of Salinas, the Jájome Alto Ward of Cayey, and the Carmen Ward of Guayama converge. Cerro de los Cielos, with an elevation of 570 meters (1,870 feet) above sea level, is located between the southeastern portions of the Palmas and Quebrada Yeguas Wards

(Municipio de Salinas, 2020).

Additional elevations exist toward the west, such as the Cuchilla Las Piedras Chiquitas, which separates Salinas from the Cuyón ward of Coamo; Cerro Cariblanco, located between that Coamo ward and the Río Jueyes ward of Salinas, with a height of approximately 556 meters (1,824 feet); and the hills Pío Juan, Raspaldo, and Modesto, all located in the Río Jueyes ward, with elevations of 460, 185, and 126 meters (1,509, 607, and 413 feet) above sea level, respectively.

To the east, along the boundary between the Quebrada Yeguas Ward of Salinas and the Pozo Hondo Ward of Guayama, Cerro Garau rises to an elevation of 438 meters (1,437 feet) above sea level

(Municipio de Salinas, 2020).

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Map 3: Salinas Physiography

PHYSIOGRAPHY



Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Elevation (Meters)
847.303
-16.8603

Wards
Municipality of Salinas
Neighboring Municipalities



N

Scale: 1:100,000

0 1,250 2,500 Meters

3.3.2 Geology

The predominant geology in the municipality of Salinas belongs to the Quaternary period, which extends from approximately 1.6 million years ago to the present and is composed mainly of alluvium. However, other geological formations composed of calcareous, clayey, or volcanic-origin material can also be observed in the municipality. The Nigua River, for its part, forms an alluvial fan in the municipality, which produces a landform of gentle slope in the shape of a cone or fan, caused by the deposition of material carried by the river from the interior and deposited at the base of the mountains over thousands of years (Municipio de Salinas, 2020).

Likewise, the municipality is underlain by other materials from the Quaternary period, such as beach deposits, which consist of sand, gravel, and wetland deposits. However, in the barrio Lapa, small regions composed of landslide deposits can be observed (Municipio de Salinas, 2020).

Along the coastal shoreline of the municipality, lagoon, swamp, beach, and alluvial deposits can be observed, which are mostly covered by mangroves (Municipio de Salinas, 2020).

Additionally, the Cariblanco Formation also predominates in the municipality in the northwestern area, between the barrios Río Jueyes and Lapa. This formation consists of: (1) rounded grains of volcanic rock that have been transported; (2) sandstone, constituted by fragments the size of sand and whose predominant composition is quartz; and (3) siltstone, which is a fine-grained, hard, fissile, and resistant rock. In addition, this formation contains lava and limestone, and its maximum estimated thickness is 1,000 meters; it belongs to the Late Cretaceous period (Municipio de Salinas, 2020).

3.3.3 Soils

According to the Soil Survey conducted by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture, twenty-three (23) soil series have been identified within the Municipality of Salinas. In general, these soils are predominantly clayey. Soil series are established by grouping soils that exhibit similar profiles and characteristics.

Soil in the northern portion of the municipality are characterized by steep slopes, while those in the southern portion are generally flatter and include depositional environments associated with coastal deposits. Most soils are well drained; however, poorly drained soils are generally found within river floodplains or alluvial fans in the region. Poor drainage can contribute to soil loss and may also create limitations for land use and development.

Within the Municipality of Salinas, the natural fertility of most soils ranges from moderate to high. Because the soils are predominantly clayey, they tend to expand when wet and contract during dry periods. This physical characteristic should be considered when assessing risks associated with soil conditions and future land development, as shrink-swell behavior may adversely affect structures, potentially resulting in damage such as cracking.

Map 4 shows the hydrographic system of the Municipality of Adjuntas. Major rivers and creeks are identified by name. Map 5 shows the present in the municipality, while Map 6 shows the sub-watershed basins.

3.3.4 Hydrography

Generally, the rivers of southern Puerto Rico have short channels due to the short distance between their origin in the Central Mountain Range and their discharge along the coasts. Most of these rivers and streams are intermittent, and their constant flow is limited to rainy seasons or to atypical atmospheric events that bring intense rainfall during periods of drought. In alluvial valleys, infiltration and evapotranspiration consume most of the water, causing the channels to dry out even in the case of rivers that exhibit flowing water for most of the year in the upper parts of the slopes. In the Municipality of Salinas, the Niguas River and the Jueyes River flow through the area, as well as the streams Honda, Amorós, and Aguas Verdes (Municipio de Salinas, 2020).

With respect to groundwater bodies, the region contains the South Coast Province, better known as the Great Southern Aquifer. This groundwater system is composed of a series of alluvial aquifers, separated by rivers into principal and hydraulically independent segments. The alluvial aquifers in these areas are the following: Patillas to Salinas, Coamo (Santa Isabel–Coamo), Juana Díaz to Ponce, Tallaboa (Peñuelas), Guayanilla, and Yauco (Municipio de Salinas, 2020).

The use of these waters is conditioned on ensuring that the quantity of groundwater

extracted does not exceed its natural recharge, unless the recharge is artificially increased. In this way, significant reductions in water levels, problems of saltwater intrusion, increases in dissolved solids, and deterioration of water quality due to contamination, among other issues, are avoided (Municipio de Salinas, 2020).

Map 4 shows the hydrographic system of the Municipality of Salinas. Major rivers and creeks are identified by name. Map 5 shows the watersheds in the municipality, while Map 6 shows the sub-watershed basins.

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Map 4: Hydrography

HYDROGRAPHY



Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Hydrography
Reservoirs
Municipality of Salinas
Neighboring Municipalities



N

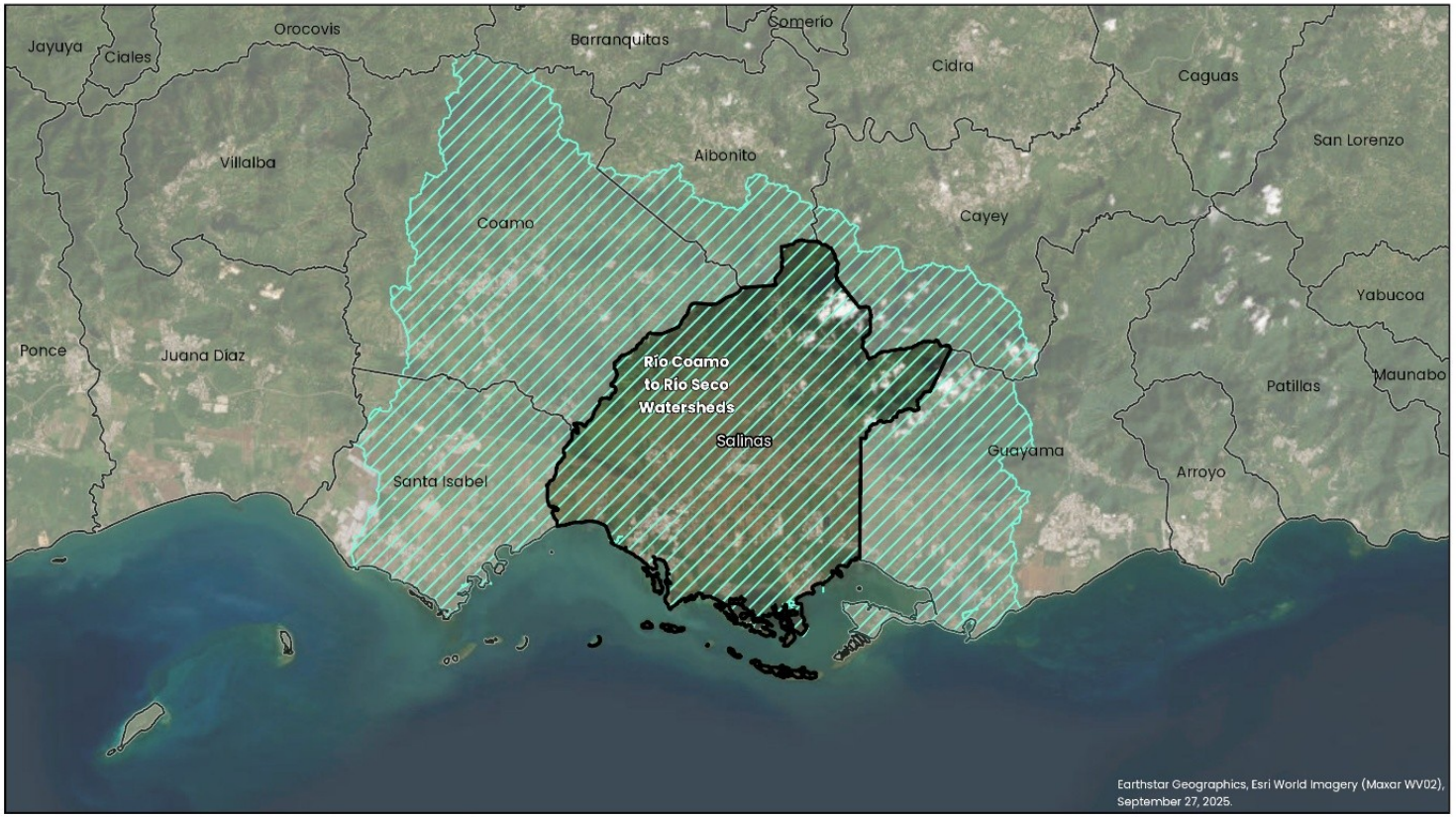
Scale: 1:100,000

0 1,250 2,500

Meters

Map 5: Watershed

Hydrographic Watersheds



Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Watersheds

Río Coamo to Río Seco Watersheds

Municipality of Salinas

Neighboring Municipalities



N

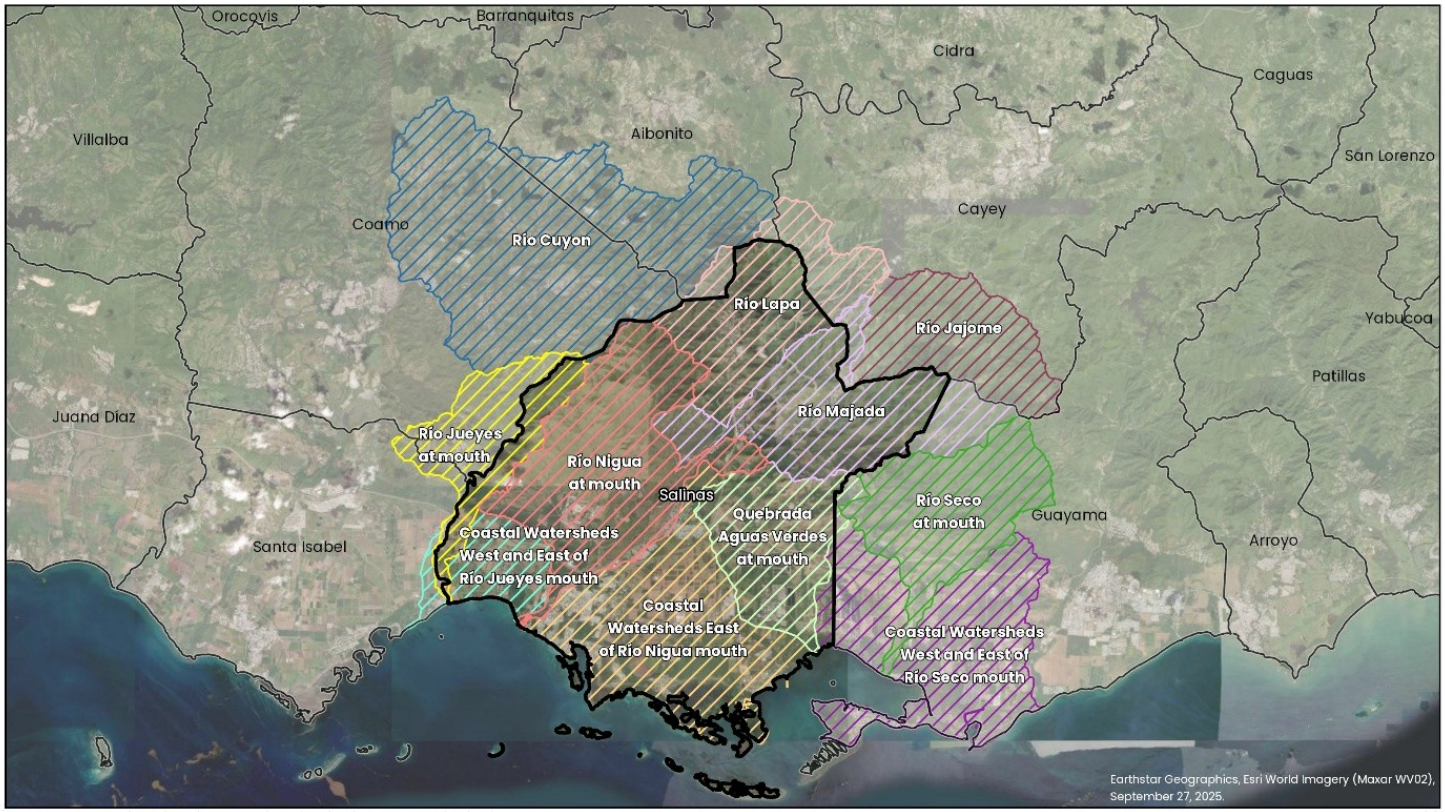
Scale: 1:250,000

0 3,000 6,000

Meters

Map 6: Sub Watersheds

HYDROGRAPHIC SUBWATERSHEDS



Source: Puerto Rico Planning Board and United States Geological Survey

SPCS PR & VI NAD83

Subwatersheds

- Coastal Watersheds East of Río Nigua mouth
- Coastal Watersheds West and East of Río Jueyes mouth
- Coastal Watersheds West and East of Río Seco mouth
- Quebrada Aguas Verdes at mouth
- Río Cuyon
- Río Jajome
- Río Jueyes at mouth
- Río Lapa
- Río Majada
- Río Nigua at mouth
- Río Seco at mouth
- Municipality of Salinas
- Neighboring Municipalities



N

Scale: 1:195,000

0 2,500 5,000 Meters

3.3.5 Precipitation

In Puerto Rico, the season of greatest precipitation begins between the months of August and October. However, the frequency, amount, and distribution of rainfall are subject to factors such as topography and the effect produced by the trade winds. For example, on the southern coast of Puerto Rico, the climate is more arid and there is less precipitation than in the northern region of the Island (Municipio de Salinas, 2020).

Based on historical data provided by the Southeast Regional Climate Center, between the years 1971–2000, the average precipitation reported at a meteorological station located in Central Aguirre in Salinas was 39.28 inches annually. Maximum precipitation was reported in the month of September, with 6.82 inches, and the minimum in March with 1.15 inches.

3.3.6 Temperature

During the same period, an average maximum temperature of 87.7°F annually was reported. The month of August was the hottest, when a temperature of 89.7°F was recorded, and the month of January was the coldest, when the temperature dropped to 65.8°F (Municipio de Salinas, 2020).

3.3.7 Natural Resources

The Region contains a great diversity of natural resources, some of which are protected under various mechanisms. The mangrove zone, composed of the Jobos Bay, Punta Pozuelo–Cayos Caribe, and Mar Negro, is an area subject to strong usage pressures and one that has experienced deterioration over recent years. Of this zone, the Mar Negro mangrove area extends over the Municipality of Salinas (Municipio de Salinas, 2020).

Likewise, the region possesses several protected natural areas, among which are the Toro Negro State Forest and the Aguirre Coastal State Forest, which consists of 2,463.8 *cuerdas* of land and is categorized as a subtropical dry forest. Among the natural reserves are: the Guayama Reefs Natural Reserve and the Piedras del Collado Natural Reserve. In addition, in the region there is the natural reserve located between Salinas and Cayey, known as the *Cerro Las Planadas Natural Reserve*, designated under Act No. 192 of 2007, "[t]o declare the area comprising Cerro Las Planadas and its adjacent

areas in Cayey and Salinas as a Natural Reserve of the Commonwealth of Puerto Rico (Municipio de Salinas, 2020)."

Additionally, the region hosts the only National Estuarine Research Reserve in the Caribbean, known as JOBANERR. This reserve was designated in September 1981 as a natural reserve through an agreement between the Department of Natural and Environmental Resources (hereinafter, DRNA) and the National Oceanic and Atmospheric Administration (hereinafter, NOAA). JOBANERR covers an area of 1,140 hectares (2,800 acres) and includes the coastal lands of the Las Mareas community and the town of Aguirre in Salinas. This reserve has a Management Plan adopted by the Planning Board in the year 2000 (Municipio de Salinas, 2020).

Agricultural Corridor of the Southern Coast of Puerto Rico: Approximately 65,000 *cuerdas* of land between the municipalities of Sabana Grande and Patillas comprise the Agricultural Corridor of the Southern Coast of Puerto Rico. This corridor was designated under Act No. 242 of 2008, known as the Agricultural Reserves Act, in the lands included within the Agricultural Corridor on the Southern Coast of Puerto Rico. This corridor encompasses lands in which vegetables, fruits, root crops, grains, as well as ornamental plants are cultivated. Likewise, livestock and poultry enterprises of great importance for the Island's food security are located in the area. Additionally, other lands with high agricultural potential have been identified, which must be conserved according to studies carried out by the Department of Agriculture (Municipio de Salinas, 2020).

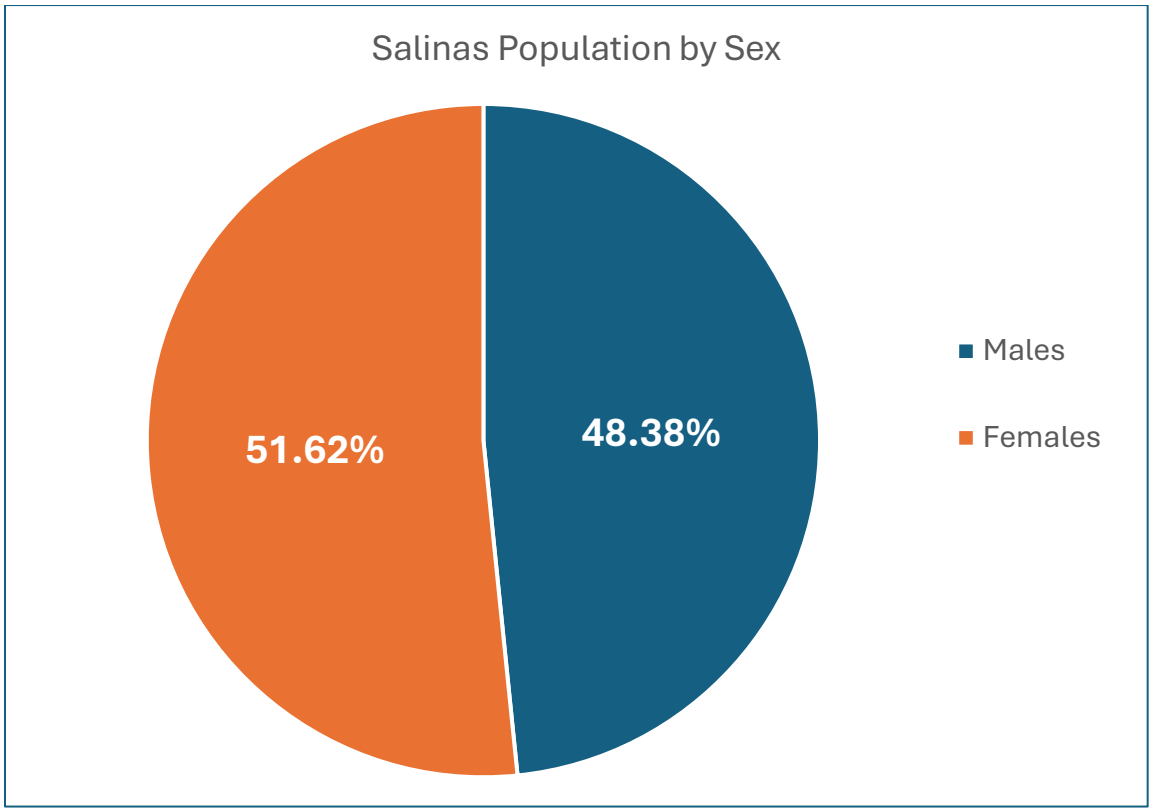
Critical Wildlife Areas: In 2005, DRNA published the document titled *Puerto Rico Critical Wildlife Areas*, which includes a review and update of documents developed in 1979 and 1988. The document identified eighty-seven (87) critical wildlife areas. The Municipality of Salinas extends over four (4) of these, namely: Cerro El Gato and adjacent lands; Aguirre State Forest, Punta Pozuelo, Cayos Caribe and La Barca; Punta Arenas; and Campamento Santiago. Other significant ecosystems for the municipality include the Úcar Forest, Piedras Chiquitas, and the Scenic Easement of Montes Oscuros, which forms part of the system of Protected Areas of the Puerto Rico Conservation Trust (Municipio de Salinas, 2020).

3.4 Demographics

3.4.1 Current Population

According to the 2020-2024 American Community Five-Year Survey (ACS 2024)[2] the total population of Salinas is 25,079. Of these 12,134 individuals are male and 12,945 are female. The percentage split is 48.38% male, 51.62% female. The sex ratio is of 93.74 males per 100 females (US Census Bureau, 2025).

Figure 9: Salinas Population by Sex (2024 ACS)



According to 2024 ACS a total of 5,646 individuals in Salinas were 65 or older. This constitutes over one-fifth (22.40%) of the total population of Salinas. While 2,674 individuals (10.60%) of the population are 75 years old or older.

[2] Unless otherwise stated, all data and analysis are from the 2024 Five-Year American Community Survey (ACS) Data Set for Salinas.

On the younger age groups, Salinas has 4,908 (19.60%) individuals that are 19 years old or younger. On the older age groups, Salinas has 5,646 (22.51%) individuals that are 65 years or more. This LHMP considers people younger than 19 and older than 65 as vulnerable. As such we find that 10,554 residents of Salinas (42.08% of the population) are especially vulnerable to the effects of a natural disaster.

Table 5 distributes the current population of Salinas by age groups as established in ACS Demographic and Housing Estimates of four years. Table 5 compares the data of the 2024 ACS with that of the 2015-2019 ACS (2019 ACS). Same age group distribution in a bar chart form. Figure 10 shows the population pyramid for Salinas, as can be seen in Figure 10 the irregular population pyramid shows the higher population share of the older groups versus the younger groups in the municipality.

Table 5 Population by Age Group 2024 ACS vs 2019 ACS

Age Cohort	Population 2024		Percentage 2024	Population 2019	Percentage 2019	Net change	Rate of change
Under 5 years	799		3.20%	1,319	4.7%	-520	-39.42%
5 to 9 years	1,202		4.80%	1,695	6.0%	-493	-29.09%
10 to 14 years	1,407		5.60%	1,831	6.5%	-424	-23.16%
15 to 19 years	1,500		6.00%	2,125	7.6%	-625	-29.41%
20 to 24 years	1,646		6.60%	1,935	6.9%	-289	-14.94%
25 to 29 years	1,741		6.90%	1,809	6.4%	-68	-3.76%
30 to 34 years	1,636		6.50%	1,567	5.6%	69	4.40%
35 to 39 years	1,480		5.90%	1,544	5.5%	-64	-4.15%
40 to 44 years	1,551		6.20%	2,012	7.2%	-461	-22.91%
45 to 49 years	1,622		6.50%	1,794	6.4%	-172	-9.59%
50 to 54 years	1,634		6.50%	1,741	6.2%	-107	-6.15%
55 to 59 years	1,757		7.00%	1,731	6.2%	26	1.50%
60 to 64 years	1,458		5.80%	1,746	6.2%	-288	-16.49%
65 to 69 years	1,742		6.90%	1,432	5.1%	310	21.65%
70 to 74 years	1,230		4.90%	1,619	5.8%	-389	-24.03%
75 to 79 years	1,164		4.60%	1,017	3.6%	147	14.45%
80 to 84 years	836		3.30%	609	2.2%	227	37.27%
85 years and over	674		2.70%	583	2.1%	91	15.61%
Total	25,079			28,109		-3,030	-10.78%

Table 5 shows that in Salinas the biggest negative rate change in age group has been with the < 5 years group (-39.42%), followed by the 5 to 9 (-29.09%) and 15 to 19 (-29.41%) age groups. While the biggest positive rate cases were with the 80-to-

84-year (37.27%), followed by the 65 to 69 (21.65%) and the 85 years and over (15.61%) age groups. Overall, the municipality experience a negative growth of -3,030 people (-10.78%).

Figure 10: Population by Age Group (ACS 2023)

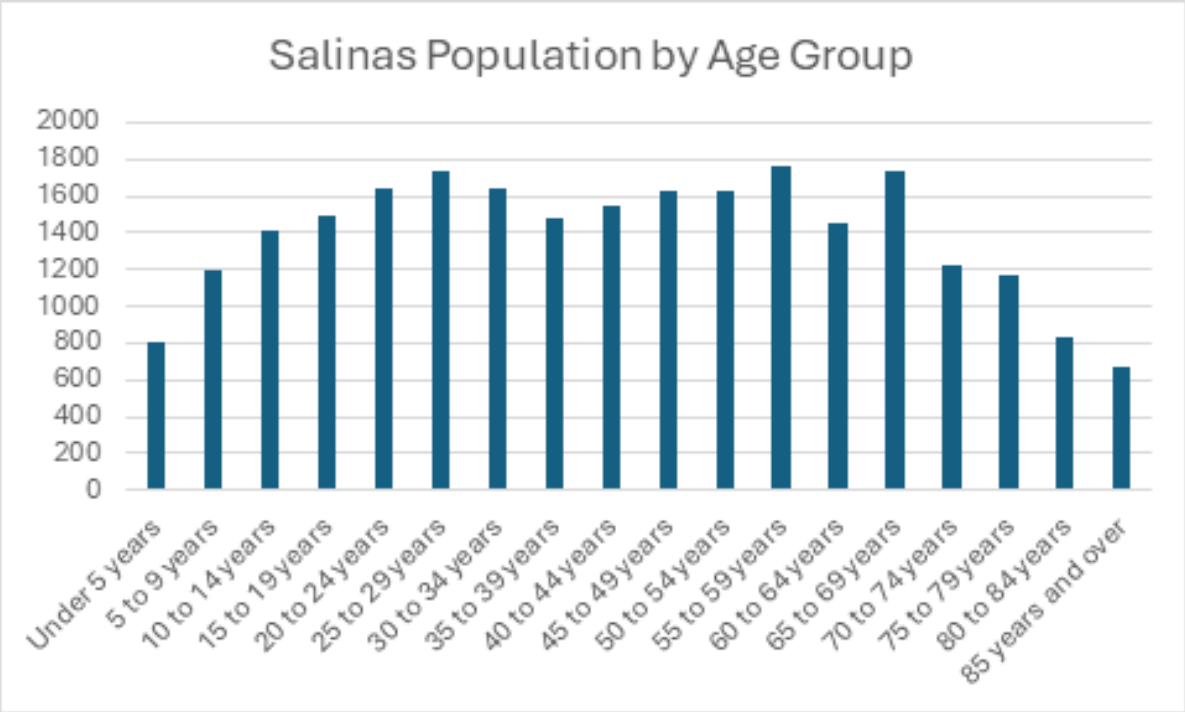
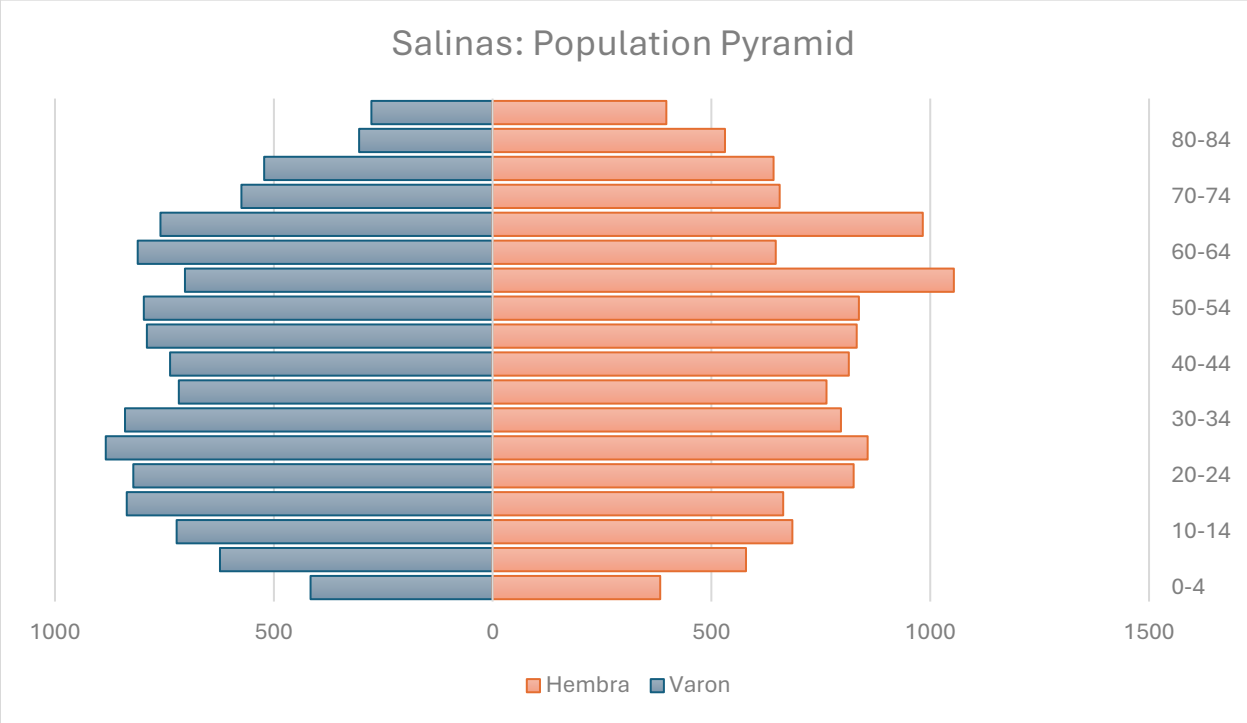


Figure 9 shows the same age group distribution in a bar chart form. Figure 10 shows the population pyramid for Salinas. As can be seen in Figure 10 the irregular population pyramid shows the higher population share of the older groups versus the younger groups in the municipality.

Figure 10 shows the same age group distribution in a bar chart form. Figure 11 shows the population pyramid for Salinas. As can be seen in Figure 11, the irregular population pyramid shows the higher population share of the older groups versus the younger groups in the municipality.

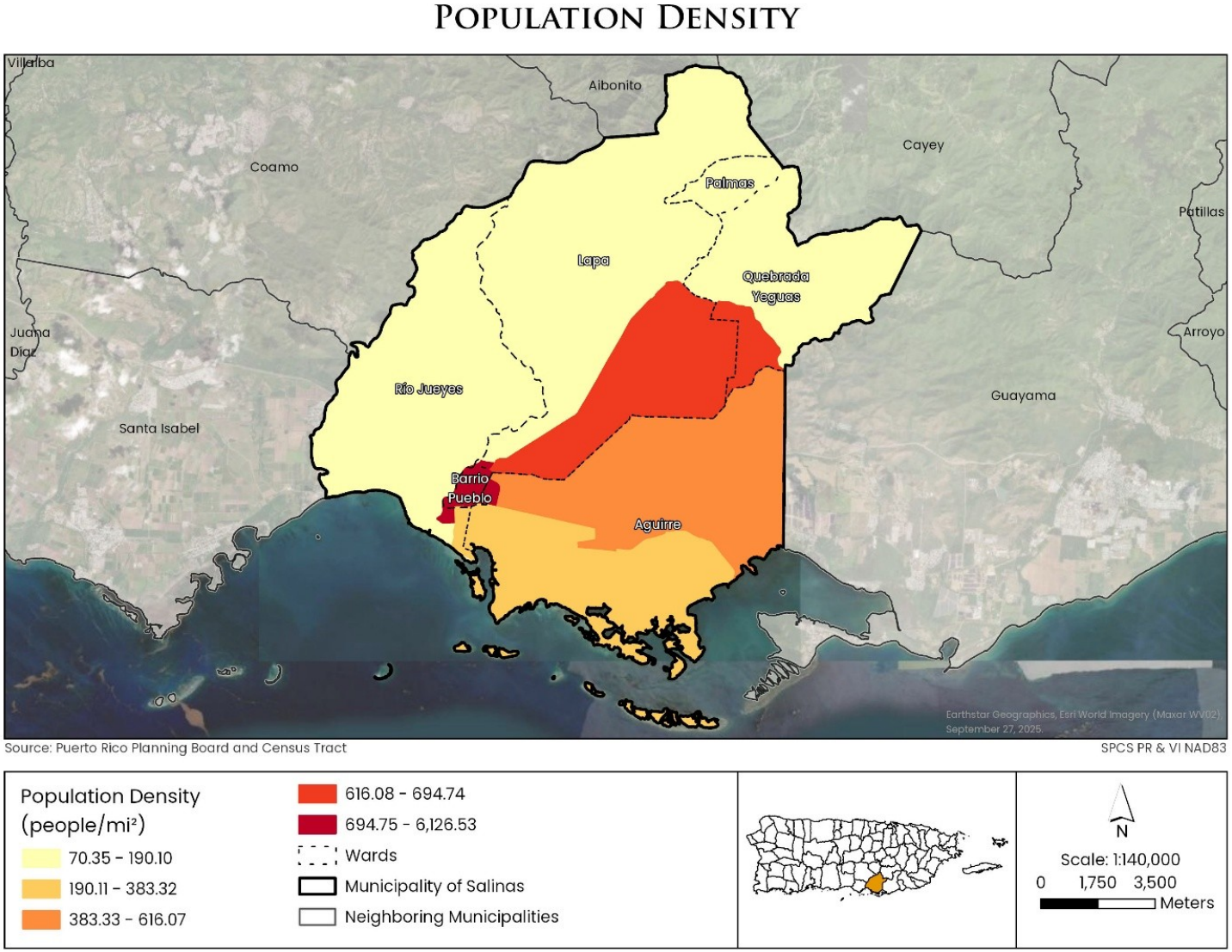
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Figure 11: Population Pyramid (2024 ACS)



The following map of the population density of Salinas by census tract, shows that the densest census tracts are located in the town center of the municipality.

Map 7: Salinas Population Density by Census Tract



3.4.2 Socio-economic Characteristics

3.4.2.1 Employment

Table 6 shows the employment status for the municipality according to the 2020 - 2024 Five-Year ACS.

Table 6: Salinas Current Labor Force Statistics[3]

Variable	Estimate	Percentage
Population 16 years and over	21,487	
In Labor Force	9,033	42.00%
Civilian Labor Force	9,033	42.00%
Employed	8,381	39.00%
Unemployed	652	3.00%
Armed Forces	0	0.00%
Not in Labor Force	12,454	58.00%
Unemployment rate		7.20%

Source: US Census

The census data shows that the population in the labor force for Salinas is lower than population that is not in the labor force (42.00% in labor force vs 58.00% not in labor force). When comparing with the 2015-2019 Five-Year ACS, the percentage of population in the labor force increase by 5% (42.00% in 2024 vs 37.00% in 2019). Compared with Puerto Rico as a whole, Salinas has a lower percentage of its population in the labor force (42.0% in Salinas compared with 46.4% in Puerto Rico).

The 2024 ACS showed an unemployment rate for the municipality of 7.20%. This represents an increase of 1.9% compared with 2015-2019 Five-Year ACS (7.20% in 2024 vs 5.30% in 2019). Compared with Puerto Rico as a whole, Salinas has a lower percentage of its unemployed population (7.20% for Salinas vs 10.7% for Puerto Rico).

3.4.2.2 Employment by Industry

The following table presents employment by industry within the municipality, comparing data from the 2020–2024 Five-Year ACS with the 2015-2019 Five-Year ACS. The final column reflects the percentage change in employment by industry between the two survey periods.

[3] US Census Table DP03: Selected Economic Characteristics

Table 7: Employment by Industry 2024 ACS vs 2018 ACS

Industry	ACS 2024 Five Year	Percentage 2024	ACS 2019 Five Year	Percentage 2019	Delta between 2024 and 2019[4]
Agriculture, Forestry, fishing and hunting and mining	452	5.40%	473	6.00%	-4.44%
Construction	698	8.30%	431	5.40%	61.95%
Manufacturing	1,109	13.20%	1,156	14.60%	-4.07%
Wholesale Trade	116	1.40%	84	1.10%	38.10%
Retail Trade	1,069	12.80%	1,102	13.90%	-2.99%
Transportation and warehousing, and utilities	376	4.50%	318	4.00%	18.24%
Information	0	0.00%	63	0.80%	-100.00%
Finance and Insurance, and real estate and rental and leasing	174	2.10%	116	1.50%	50.00%
Professional, scientific, and management, and administrative and waste management services	735	8.80%	532	6.70%	38.16%
Educational services, health care and social assistance	1,489	17.80%	1,719	21.70%	-13.38%
Arts, entertainment, recreation, and accommodation and food services	758	9.00%	992	12.50%	-23.59%
Other services, except public administration	754	9.00%	370	4.70%	103.78%
Public administration	651	7.80%	572	7.20%	13.81%
Total employee Population 16 years and over	8,381		7,928		5.71%

Source: US Census

Table 7 shows the following employment characteristics for Salinas:

- The industry with the highest level of employment in Salinas in 2024 is the "Educational services, healthcare and social assistance" industry occupying 17.80% of Salinas workforce. This increase can be attributed to the rise in the older adult population within the municipality, which has generated greater

[4] Rate of percentage change is calculated as $Percentage\ Change = \frac{new\ value - original\ value}{original\ value} \times 1$

demand for healthcare and social assistance services, contributing to the growth of employment in this industry.

- The other two industries that occupy more than 10% of the employee population are Manufacturing (13.20%) and Retail Trade (12.80%).
- The industries that had negative growth between the 2019 and the 2024 surveys are:
    - Information (-63 individuals or -100.00% rate change)
    - Arts, entertainment, recreation, and accommodations and food services(-234 individuals or -23.59% rate change)
    - Agriculture, forestry, fishing and hunting, and mining (-21 individuals or a -4.44% rate change)
    - Manufacturing (-47 individuals or -4.07% rate change)
    - Retail Trade (-33 individuals or -2.99% rate change)
- The industry that had the highest net growth was "Other services, except public administration with a net increase of 384 individuals. This represents a percentage rate change of 103.78%
- Other industries that had a positive percentage change rate are:
    - Construction (267 individuals or 61.95% rate of change)
    - Professional, scientific, and management, and administrative and waste management services (203 individuals or 38.16% rate of change)
    - Public administration (79 individuals or 13.81% rate of change)
    - Transportation and warehousing, and utilities (58 individuals or 18.24% rate of change)
    - Finance and Insurance, and real estate and rental and leasing (58 individuals or 50.00% rate of change)
    - Wholesale trade (32 individuals or 38.10% rate of change)
- Overall, the employed population of the municipality increased by 453 individuals, this represents a rate change of 5.71% between 2019 and 2024.
- A notable trend is observed in the "Other services, except public administration" industry, which recorded the largest workforce expansion across all sectors, adding 384 new employees a remarkable growth rate of 103.78%. Despite not being one of the traditionally dominant industries in the municipality, it more than doubled its workforce between 2019 and 2024.
- Although the Manufacturing industry remains one of the three largest employment sectors in the municipality providing jobs to 1,109 individuals, in 2024 it experienced a net loss of 47 workers compared to 2019, reflecting a -4.07% decline. This means that even some of the historically stable industries show early signals of contraction.
- The "Information" industry experienced the most dramatic contraction of all

sectors, losing all 63 of its previously employed workers representing a -100% decline between 2019 and 2024. This complete disappearance from the local labor market suggests a structural shift or relocation of these activities outside the municipality.

3.4.2.3 Poverty Level

The table below shows the estimated percentage of poverty status for individuals over the past twelve (12) months. This information is used to evaluate the economic well-being of individuals and families. The table is essential for understanding the economic conditions of different groups and for guiding the development and implementation of policies aimed at reducing poverty as well as the vulnerability of the population

Table 8: 2024 ACS Poverty Level

Total Population	Number of Individual below the poverty level during the last 12 months	Percentage of the Population below the poverty level in the last twelve months
24,906	11,939	47.90%

Source: US Census

3.4.2.4 Income

According to the 2024 ACS the median household income for Salinas was $18,317, while the mean household income was $29,612. The following table shows the estimated income and benefits for households in the municipality.

Table 9: Salinas 2025 ACS Income and Benefits per Household

Category	Number of Households	Percentage
Less than $10,000	2,354	21.90%
$10,000 to $14,999	1,551	14.40%
$15,000 to $24,999	1,902	17.70%
$25,000 to $34,999	1,491	13.90%
$35,000 to $49,999	1,499	13.90%
$50,000 to $74,999	1,083	10.10%
$75,000 to $99,999	478	4.40%
$100,000 to $149,999	281	2.60%
$150,000 to $199,999	51	0.50%
$200,000 or more	71	0.70%
Total households	10,761	100%

Source: US Census

This table shows that slightly less than a quarter of all households (21.90%) in Salinas earn less than $10,000 per year. While 54.00% of households earn less than $25,000 per year. In comparison for the 2015-2019 ACS 29.00% of households earn less than $10,000and 62.20% of households earn less than $25,000.

3.4.2.5 Population with disabilities

Table 10 presents data on individuals living with disabilities based on the 2019–2023 and 2014–2018 Five-Year American Community Survey datasets

Table 10: Salinas Population living with disabilities

Age Group	2024	2019	Net change	Rate of change
Under 5 years	45	0	45	0.00%
5 to 17 years	663	775	-112	-14.45%
18 to 34 years	1,196	705	491	69.64%
35 to 64 years	3,059	2,612	447	17.11%
65 to 74 years	1,331	1,070	261	24.39%
75 years and over	1,551	1,166	385	33.03%
Total Population living with a disability	7,845	6,328	1,517	23.97%

Source: US Census

Table 10 shows that overall, there was a net increase of 1,517 individuals living with a disability in the municipality. All age groups experienced growth except for the 5- to 17-year-old cohort, which showed a -14.45% decrease. The most significant increases were observed among adults ages 18 to 34, as well as older adults ages 65 and over. This information is particularly important for the LHMP update, as the relevant literature consistently shows that people with disabilities are especially vulnerable to natural hazard events.

3.4.2.6 Population receiving supplemental nutritional support

Table 11 Provides information on households in Salinas that receive food assistance, based on data from the 2020–2024 and 2015–2019 American Community Survey (US Census Bureau, 2025).

Table 11: Population receiving food aid

Data Set	2024	2019	Net Change	Rate of Change
Total Households in the municipality	10,761	10,036	725	7.22%
Households receiving food assistance	5,687	4,775	912	19.10%
Percent of Households receiving food assistance	52.80%	47.60%	_	_

Source: US Census

As shown in this table, the number of households in Salinas receiving food assistance is 5,687. The total number of households receiving food assistance increased by 19.10% since 2019 ACS. The table shows that 52.80% of households in Salinas receive food assistance and thus can be considered as experiencing food insecurity.

3.4.2.7 Health Insurance Coverage

The next table shows the 2020-2024 health insurance coverage for the municipality.

Table 12: 2025 ACS Health Insurance Data

Variable	Estimate	Percentage
Civilian noninstitutionalized population	24,944	
With health insurance coverage	23,521	94.30%
With private health insurance	6,568	26.30%
With public coverage	17,963	72.00%
No health insurance coverage	1,423	5.70%

The data shows that 1,423 people (5.70%) in Salinas have no health insurance coverage, while near three-quarters (72.00%) rely on public health coverage. This data will be revisited when discussing the hazard of pandemic/epidemic.

3.4.3 Housing stock and other related details

According to 2024 ACS Salinas had a total of 7,937 housing units of those a total of 1,868 were vacant. This constitutes almost a quarter (23.50%) of the total housing stock of the municipality. According to the 2024 ACS of the 6,069 occupied housing units, 4,109 units were occupied by owners and 1,960 by renters.

The next table shows the year of construction of the housing units by range.

Table 13: 2024 ACS - Housing Units Year of Construction

Year Structure Built	Housing Units	Percentage
Built 2020 or later	0	0.00%
Built 2010 to 2019	209	2.60%
Built 2000 to 2009	817	10.30%
Built 1990 to 1999	1,180	14.90%
Built 1980 to 1989	1,658	20.90%
Built 1970 to 1979	1,853	23.30%
Built 1960 to 1969	1,190	15.00%
Built 1950 to 1959	515	6.50%
Built 1940 to 1949	242	3.00%
Built 1939 or earlier	273	3.40%
Total	7,973	100%

Source: US Census

The 2024 ACS shows that more than half of the housing stock was built between 1960 and 1999. The latest Building Code was adopted by the government of Puerto Rico in 2018, before that the most recent version of the Building Code was adopted in 2011. This means that at least 87.00% of the housing stock was built before the current and immediately before the previous building code.

Other data offered by the 2024 ACS is that of the 6,069 occupied housing units, 5,882 (77.90%) were occupied by the owner and 1,666 (22.10%) were occupied by renters.

Finally, Table 14 shows the vehicle available per occupied housing units.

Table 14: 2025 ACS - Vehicle per occupied housing unit

Variable	Occupied Housing Units	Percentage
No vehicle available	693	11.40%
1 vehicle available	2,342	38.60%
2 vehicles available	2,032	33.50%
3 or more vehicles available	1,002	16.50%
Total Occupied Housing Units	6,069	

Source: US Census

The 2024 ACS shows that there are 693 housing units that do not have available vehicles. This represents a critical matter since the development pattern in the municipality is rural and/or suburban, where vehicular transportation is necessary for mobility.

3.5 Critical Infrastructure

Infrastructure refers to the essential physical and organizational systems that support the effective functioning of a society or economy. It includes critical networks such as transportation systems (roads, bridges, railways), energy generation and distribution, water supply, telecommunications, and other services that sustain economic activity and daily life. Collectively, infrastructure serves as the foundational framework that enables communities and economies to operate reliably and efficiently (NIST, n.d.). Infrastructure is commonly classified into two categories: hard infrastructure and soft infrastructure.

Hard infrastructure refers to the physical facilities and networks that underpin the functioning of a modern society and economy. This includes transportation systems such as roads, bridges, railways, and airports, as well as water systems, electrical grids, and telecommunications networks. These tangible assets enable the movement of people and goods, the distribution of energy and water, and the transmission of information.

Soft infrastructure refers to the institutions, services, and systems that support economic stability, public health, social order, and cultural development. This category includes educational institutions, healthcare systems, law enforcement agencies, emergency response services, parks, and recreational facilities. Unlike hard infrastructure, soft infrastructure is characterized by organizational frameworks and human-centered services that contribute to community well-being and effective governance.

As described in Section 2, FEMA defines *Community Lifelines* as the most essential services and systems necessary to sustain the uninterrupted operation of critical government and business functions, while also protecting public health, safety, and economic security. These lifelines constitute the fundamental components of a community and, once stabilized, enable all other sectors of society to function effectively. During disaster events, any disruption to these lifelines requires immediate and coordinated action to restore stability and reduce cascading impacts. Accordingly, the assessment of existing infrastructure will be conducted in alignment with FEMA's Community Lifelines framework.

3.5.1 Lifeline: Safety and Security



The purpose of the Safety and Security Lifeline is to protect life and property while maintaining social stability during emergency situations. This lifeline focuses on reducing immediate risks to public safety and personal security through the operation of public safety agencies, controlled access to affected areas, and the prevention of crime, civil unrest, and violence. It also encompasses ensuring safety and security at emergency shelters, distribution centers, and other critical facilities during disaster response and recovery operations.

FEMA indicates that disruption of this lifeline can result in social disorder and heightened community vulnerability, making rapid restoration a critical priority. Response actions require close coordination among federal, state, and local agencies, the deployment of security personnel, the implementation of traffic control measures, and the protection of critical infrastructure.

Map 8 shows the identified safety and security facilities according to the latest information provided by the PRPB. As shown on the map, facilities associated with this lifeline are primarily concentrated within the municipality's urbanized coastal sectors, with the greatest concentrations located in Pueblo and Lapa ward. The highest concentration is observed within Approach Area 1, where several facilities are located near major transportations corridors, including PR-1 and PR-3.

3.5.2 Lifeline: Food, Hydration and Shelter



The Food, Hydration, and Shelter Lifeline is intended to ensure that disaster-affected populations have prompt access to essential necessities, including food, potable water, and safe shelter. This lifeline encompasses the provision of ready-to-eat meals, water distribution, the establishment of temporary shelters, and coordination with governmental and volunteer organizations to meet basic human needs. Disruptions to this lifeline pose an immediate threat to life; therefore, rapid response actions are prioritized to restore food availability and housing stability as quickly as possible.

. As shown on Map 8, facilities associated with the Food, Hydration, and Shelter lifeline

are primarily concentrated within the municipality's southern urbanized areas. The greatest concentration is observed within Approach Area 1, particularly in and around Pueblo ward and near the PR-1 and PR-3 transportation corridors. Additional facilities are located within Approach Area 2 in the Aguirre area, along or near PR-3.

The location of the emergency shelters in the municipality is strategically distributed to provide access to residents from the most populated and hazard-prone communities. Based on the Municipal Hazard Mitigation Plan, the designated shelters are primarily located in areas outside of the identified high-risk coastal zones and are accessible through the municipality's principal transportation network. These shelters include educational facilities located in the urban and inland sectors of Salinas, allowing for the relocation of residents from vulnerable coastal communities such as Las Mareas, Playita, Playa, Las Ochenta, Aguirre, and San Felipe during emergencies. Their location provides safe access routes and supports emergency evacuation, response, and recovery operations throughout the municipality.

3.5.3 Lifeline: Health and Medicine



The purpose of this lifeline is to ensure the continuity of essential medical services and the protection of public health during emergencies and disasters. It focuses on stabilizing healthcare delivery, ensuring access to hospitals, clinics, medications, and healthcare personnel, and maintaining the capacity to respond effectively to life-threatening conditions

FEMA indicates that disruption of this lifeline can have serious consequences; therefore, priority actions focus on restoring medical facilities, deploying emergency response teams, ensuring the availability of critical medical supplies, and coordinating efforts among federal, state, and local agencies.

Map 8 shows the identified health and medicine facilities according to the latest information provided by the PRPB. As can be shown on the map, health and medical sites are primarily located within the southern portion of the municipality, concentrated in the urbanized communities of Pueblo, Aguirre, and Río Jueyes. Several facilities are clustered along the municipality's primary transportation corridors, including PR-1, PR-52, and PR-53, providing accessibility to the main population centers. Additional health and medical facilities are distributed throughout the Aguirre

sector, supporting residents in the eastern portion of Salinas. The overall distribution of these facilities enhances access to healthcare services and strengthens the municipality's capacity to respond to emergencies and post-disaster recovery needs.

3.5.4 Lifeline: Energy



Energy Lifeline is designed to ensure the reliable and safe delivery of electricity, gas, and essential fuels during emergencies and disaster events. This lifeline is vital to sustaining the operation of critical facilities and services, including hospitals, water and wastewater systems, telecommunications, and other infrastructure that depend on uninterrupted energy supply.

FEMA recognizes that disruptions to energy services pose a direct threat to life safety and community stability. Accordingly, priority response actions include the rapid restoration of the electrical grid, the deployment of generators to critical facilities, coordination with fuel suppliers, and the implementation of temporary measures to maintain service continuity. Map 8 illustrates the distribution of gas stations within the municipality and indicates a notable lack of fueling facilities in the southwestern portion of the jurisdiction.

Map 8 shows the identified energy facilities according to the latest information provided by the PRPB. As shown on the map, facilities associated with Energy Lifeline are distributed throughout the municipality, with several located within the southern and more urbanized sectors of Salinas. Of particular importance is the energy infrastructure located in the Aguirre area, including the Aguirre Power Generation Complex. Given the presence of this power generation infrastructure within the municipality, the Energy Lifeline represents an important component of Salinas's critical infrastructure and should be considered in evaluating potential exposure and vulnerability to natural hazards.

3.5.5 Lifeline: Communications

The purpose of this lifeline is to ensure the availability and reliability of essential communication systems during emergencies and disaster events. These systems include telephone networks, internet services, radio, television, and public alert and warning platforms, all of which are critical for coordinating response activities,



disseminating timely information, and maintaining communication between authorities and the public.

FEMA indicates that disruption of the Communications Lifeline can severely impair life-saving operations and effective resource management. Accordingly, priority actions include the restoration of telecommunications infrastructure, deployment of temporary communication solutions such as satellite systems, ensuring redundancy within critical networks, and maintaining accessible communication channels for the public.

Map 8 shows the identified communication sites according to the latest information provided by the PRPB. As can be shown in the map, communication sites are primarily located within the central and northern portions of the municipality, with a concentration along the PR-52 corridor and within the communities of Palmas, Aguirre, and Pueblo. Additional communication facilities are strategically distributed near major transportation routes and population centers, providing coverage to both the urban core and outlying sectors of Salinas. Their location supports the continuity of emergency communications and coordination functions during disaster response and recovery operations.

3.5.6 Lifeline: Transportation

The purpose of the Transportation Lifeline is to ensure the safe and efficient movement of people, goods, and essential services during emergencies and disaster events. This lifeline supports the continued operation or rapid restoration of land, air, and maritime transportation routes, enabling access to critical resources such as food, potable water, medical care, and emergency response equipment.

FEMA indicates that disruptions to transportation systems directly affect the ability to save lives and distribute essential supplies. Accordingly, priority actions include reopening roadways, repairing damaged bridges, restoring airport and port operations, and coordinating with state and private entities to maintain the logistics chain. Map 9 illustrates the roadway network of the Municipality of Salinas. The primary transportation corridors within the municipality are described below.

Access and Connectivity – The transportation network is further supported by

secondary roads, including PR-701, PR-703, PR-705, PR-706, PR-712, and PR-713, which provide access to residential communities, critical facilities, recreational areas, and coastal sectors. Most of the municipality's critical infrastructure and public facilities are located in proximity to these major transportation corridors, enhancing accessibility during routine operations as well as emergency response and evacuation activities.

Transportation Challenges – While Salinas benefits from direct access to the island-wide highway system through PR-52, several coastal and low-lying communities remain vulnerable to disruptions caused by flooding, storm surge, and coastal hazards. Road segments serving communities such as Las Mareas, Playita, Playa, Las Ochenta, and portions of Aguirre may experience temporary loss of accessibility during major hazard events, highlighting the importance of maintaining evacuation routes and transportation infrastructure resilience.

- North to South – The municipality is primarily connected through the PR-52 (Luis A. Ferré Expressway) corridor, which traverses Salinas from the northern municipal boundary toward the southern coastal plain. PR-52 serves as the principal regional transportation route, linking Salinas with the municipalities of Cayey and Aibonito to the north and continuing toward Ponce and the southern region of Puerto Rico. The corridor provides direct access to several municipal sectors through interchanges that connect with local roads serving the communities of Lapa, Palmas, Aguirre, and Pueblo. In addition, PR-1 functions as an important parallel route, connecting residential, commercial, and community facilities located throughout the municipality.

- East to West – The municipality is traversed by the PR-1 and PR-3 corridors, which constitute the primary east-west transportation network. PR-1 provides regional connectivity between Salinas and the neighboring municipalities of Santa Isabel and Guayama, while PR-3 serves the coastal communities and provides access to the urban center and coastal sectors such as Aguirre, Las Mareas, Playa, and Playita. These corridors support the movement of residents, emergency services, goods, and visitors throughout the municipality.

3.5.7 Lifeline: Hazardous Materials



The purpose of this lifeline is to prevent hazardous material releases, control spills, and protect communities located near industrial facilities, chemical plants, and hazardous materials transportation corridors.

FEMA indicates that disruption or failure of the Hazardous Materials Lifeline can result in severe consequences, including widespread contamination and the impairment of essential services. Accordingly, priority actions include identifying hazardous materials, activating specialized Hazardous Materials (HazMat) response teams, coordinating with federal and state agencies, and implementing rapid response protocols. Although hazardous materials may be present throughout the municipality, incidents involving hazardous materials are more likely to occur within industrial areas.

Map 8 shows the location of industrial areas in Salinas. The principal concentration of industrial and economic facilities in Salinas is located within the Aguirre sector, extending along the PR-3 corridor in the southeastern portion of the municipality. This area contains several economic and industrial facilities associated with the municipality's historical industrial development and benefits from direct access to PR-3, which serves as the primary east-west transportation route connecting Salinas with Guayama and Santa Isabel. Additional economic facilities are dispersed throughout the Pueblo and Río Jueyes sectors, where they are integrated with the municipality's commercial and service activities. The proximity of these facilities to major transportation corridors, including PR-1, PR-3, PR-52, and PR-53, facilitates the movement of goods, services, employees, and emergency resources. However, several facilities located near the coastal zone and low-lying areas may be vulnerable to flooding, storm surge, and other coastal hazards, emphasizing the importance of maintaining resilient transportation access and infrastructure connections.

3.5.8 Lifeline: Water Systems

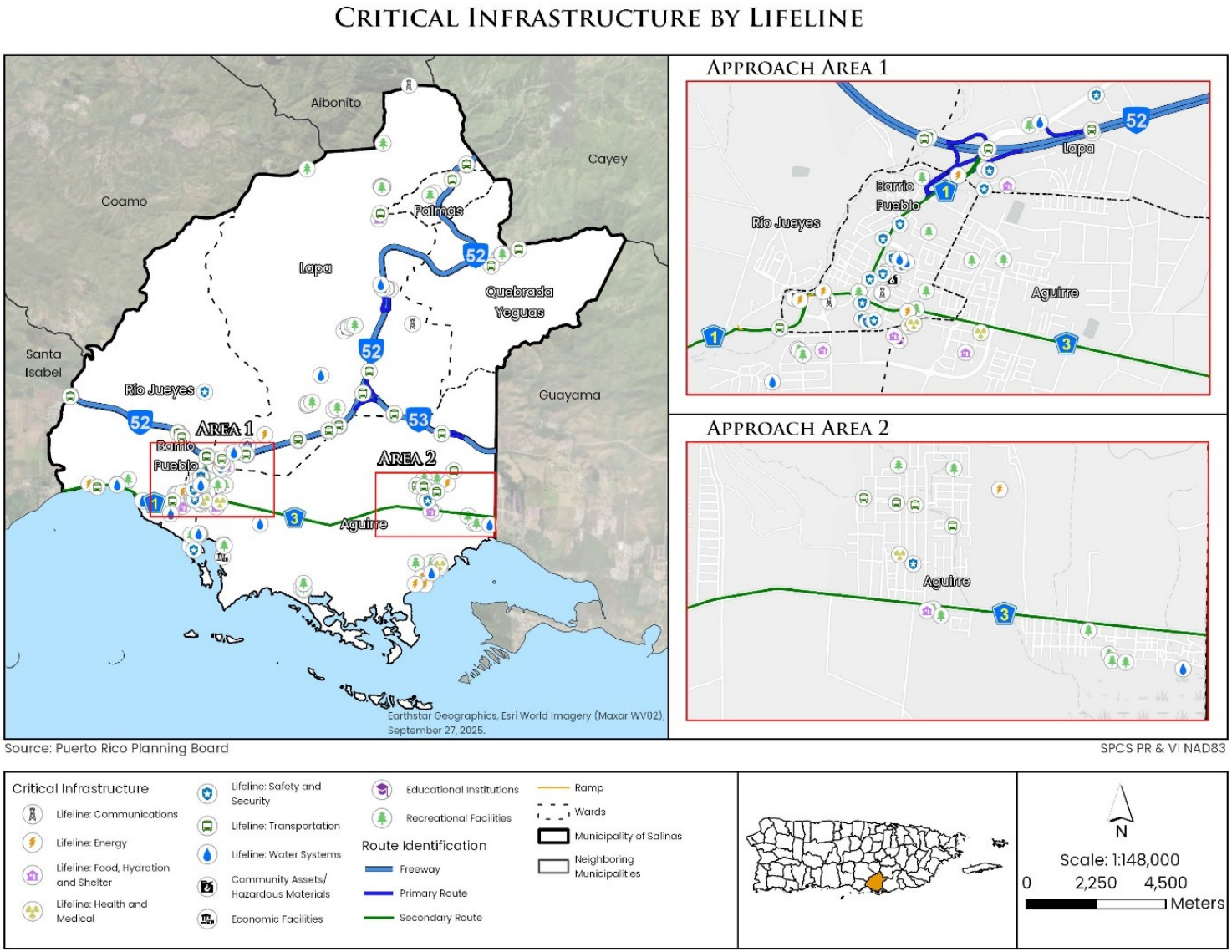


This lifeline highlights the critical role of water infrastructure in disaster response and recovery. Its primary objective is to ensure reliable access to and the timely restoration of drinking water and wastewater services, which are essential to public health, safety, and economic stability. The Water Systems Lifeline is structured

around two core components: Potable Water Infrastructure, which includes water intake, treatment, storage, and distribution; and Wastewater Management, encompassing the collection, storage, treatment, and discharge of wastewater. By prioritizing the protection and functionality of water systems, FEMA seeks to maintain sanitation, support healthcare services, and minimize cascading impacts on food safety and overall community resilience.

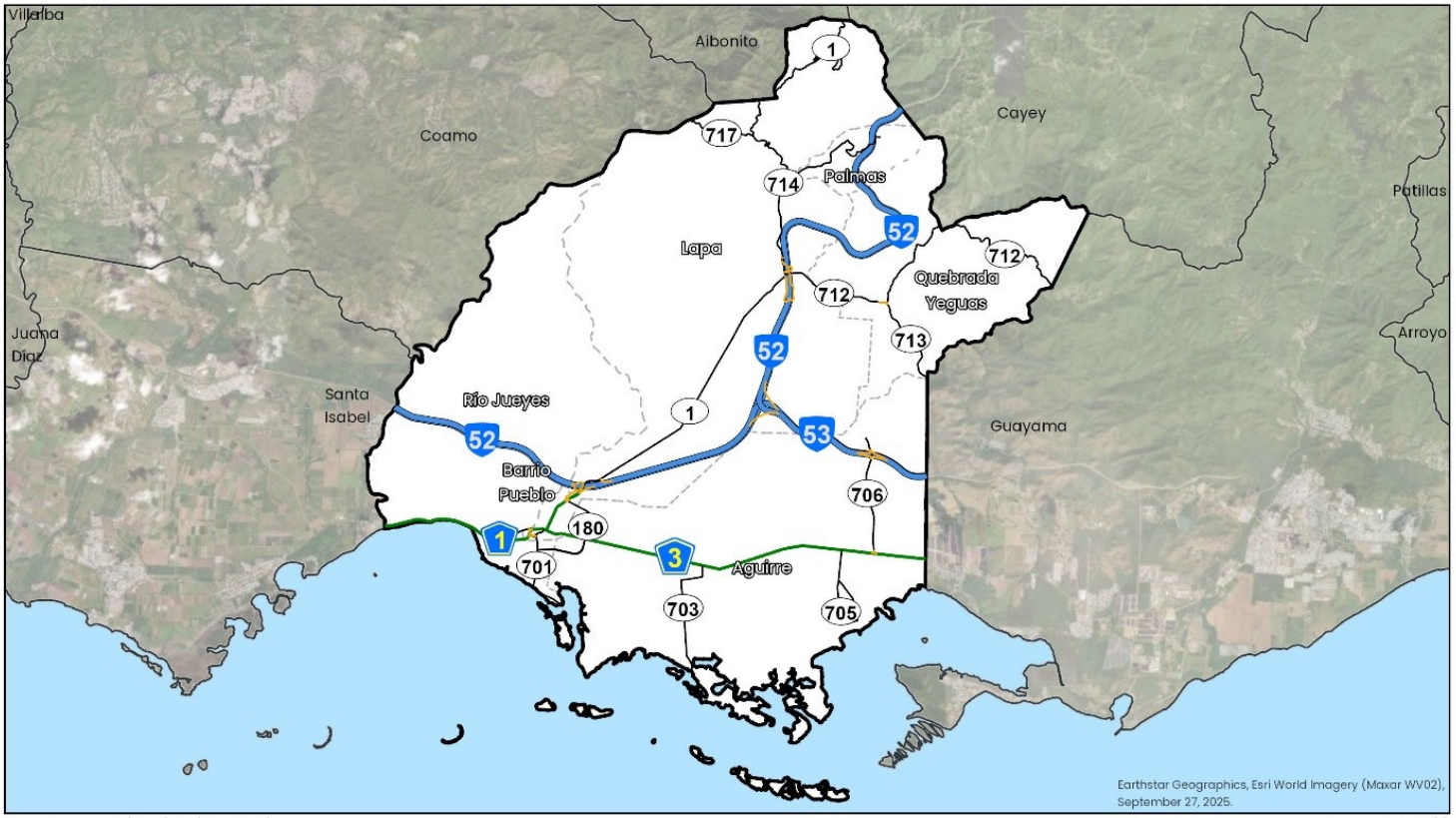
Map 8 shows the potable water infrastructure in Salinas. As expected, there are several water system assets distributed throughout the municipality, particularly along the PR-52 corridor and within the communities of Pueblo, Aguirre, Río Jueyes, Lapa, and Palmas, where multiple water-related facilities are identified. The map shows that water infrastructure, including water tanks and pump stations, is strategically located near the municipality's principal transportation routes to support residential, commercial, and industrial sectors. In addition, several water system facilities are located within the Aguirre sector and the urban core of Salinas, providing service coverage to the most densely populated areas. While the map also illustrates the distribution of other critical infrastructure lifelines, the water system network appears closely integrated with the municipality's transportation corridors, enhancing operational accessibility and emergency response capabilities.

Map 8: Critical Infrastructure by Lifeline



Map 9: Salinas Roadways

ROADS



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Route Identification
- Freeway
- Secondary Route
- Tertiary Route
- Ramp

- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

Scale: 1:140,000

0 1,750 3,500 Meters

3.6 Recent Development (E1-a)

Hazard mitigation planning must also account for future development conditions. To evaluate anticipated development trends within the Municipality of Salinas, historical construction activity was reviewed using data on permits approved between 2020 and 2026. This period represents the years following the adoption of the previous Local Hazard Mitigation Plan and provides an overview of recent growth patterns throughout the municipality.

The available data indicates a steady increase in construction activity between 2022 and 2025, with approved permits increasing from 56 permits in 2022 to 76 permits in 2025, representing the highest number of permits issued during the study period. For 2026, 51 permits have been approved to date; however, this figure represents a partial year and is therefore not directly comparable with the annual totals for previous years. Based on the available information for the 2022-2026 period, the Municipality of Salinas records an average of approximately 64 permits per year and a median of 66 permits per year.

The spatial distribution of approved permits demonstrates that development activity is concentrated primarily within the Pueblo, Aguirre, Río Jueyes, Palmas, and Quebrada Yeguas wards, with a notable concentration along the municipality's major transportation corridors and urbanized coastal sectors. Development patterns observed in both periods show continued growth within established communities and along existing infrastructure networks, while more limited activity is evident in the mountainous interior areas of the municipality. Recent permit activity is also visible within portions of the northern wards, particularly near Palmas and along the municipal boundary with Aibonito, reflecting continued residential and rural development. The maps further illustrate sustained development within the Aguirre sector and the urban center of Salinas, areas that contain a significant concentration of residential, commercial, and community facilities.

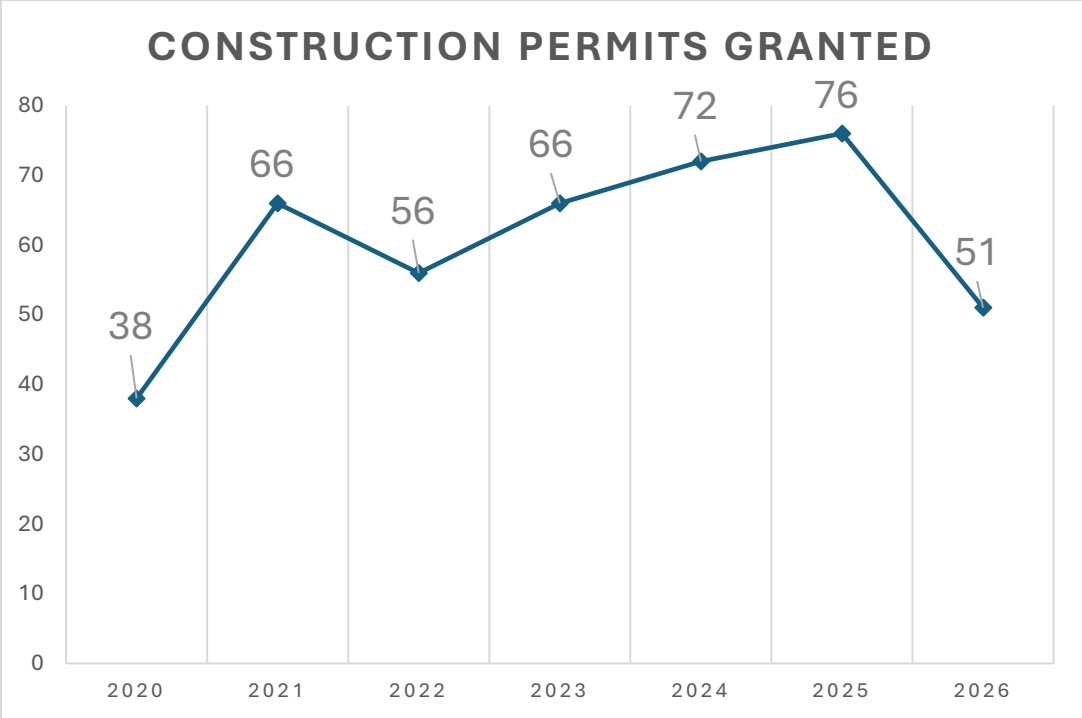
Table 15 and Figure 12 present the number and geographic distribution of construction permits approved between 2020 and 2026. To improve readability, the permits are displayed on two separate maps: one illustrating permits approved between 2020 and 2023 (Map 10), and a second map illustrating permits approved between 2024 and 2026 (Map 11),. These maps provide an indication of recent development trends and help identify areas where future growth may influence vulnerability to natural hazards and the need for mitigation measures.

Table 15: Approved Construction Permits 2020-2026

Approved Construction Permits 2020-2026	
Year	# of Permits Approved
2020	38
2021	66
2022	56
2023	66
2024	72
2025	76
2026	51

Source: Puerto Rico Planning Board

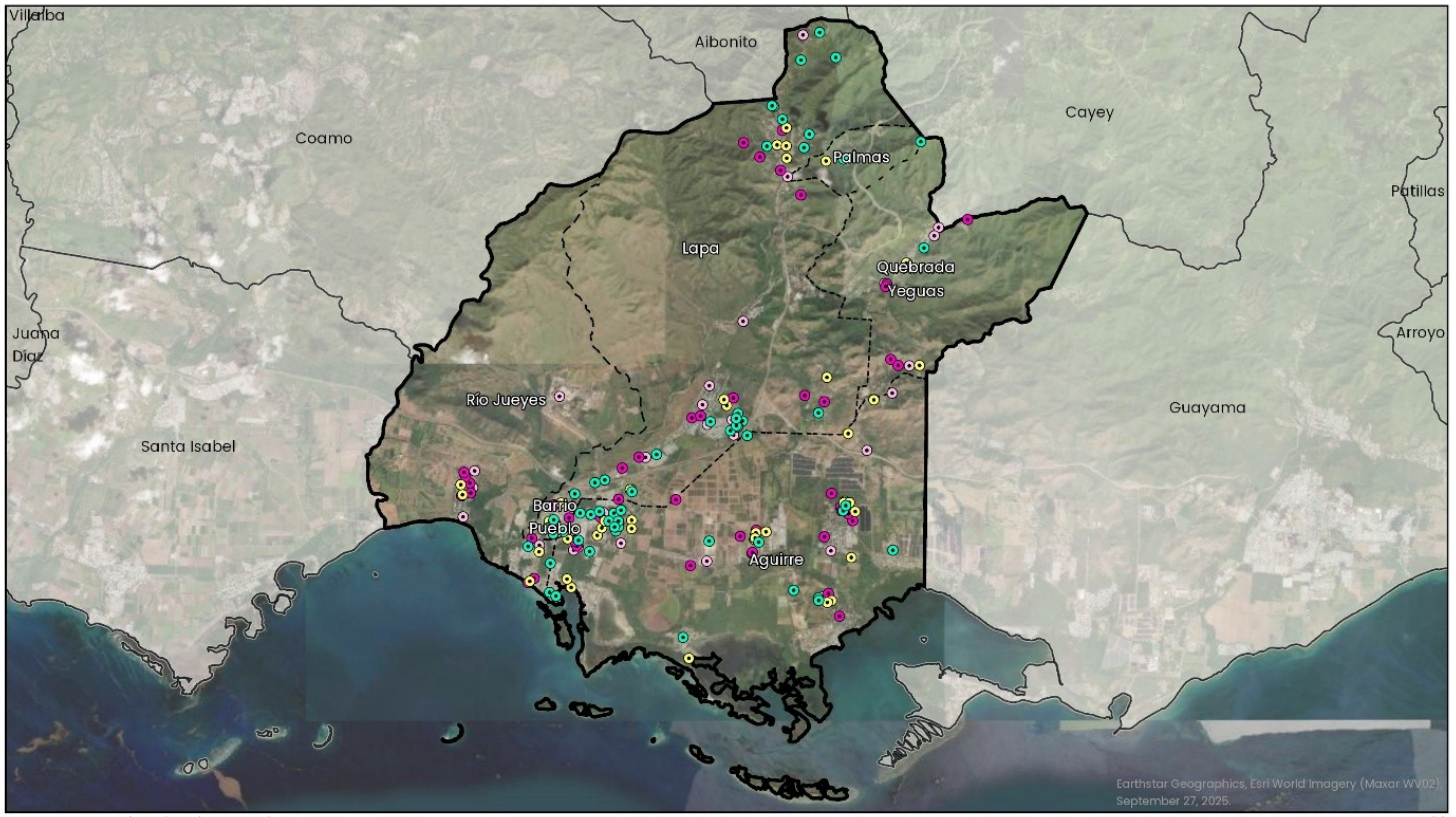
Figure 12: Approved Construction Permits 2020-2025[5]



[5] 2025 total only accounts for permits up to November 12, 2025

Map 10: Recent Developments 2020 - 2023

Recent Development 2020 - 2023



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Construction Permits Granted

Year Created and Count

- 2020 (38)
- 2021 (64)
- 2022 (55)
- 2023 (66)
- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

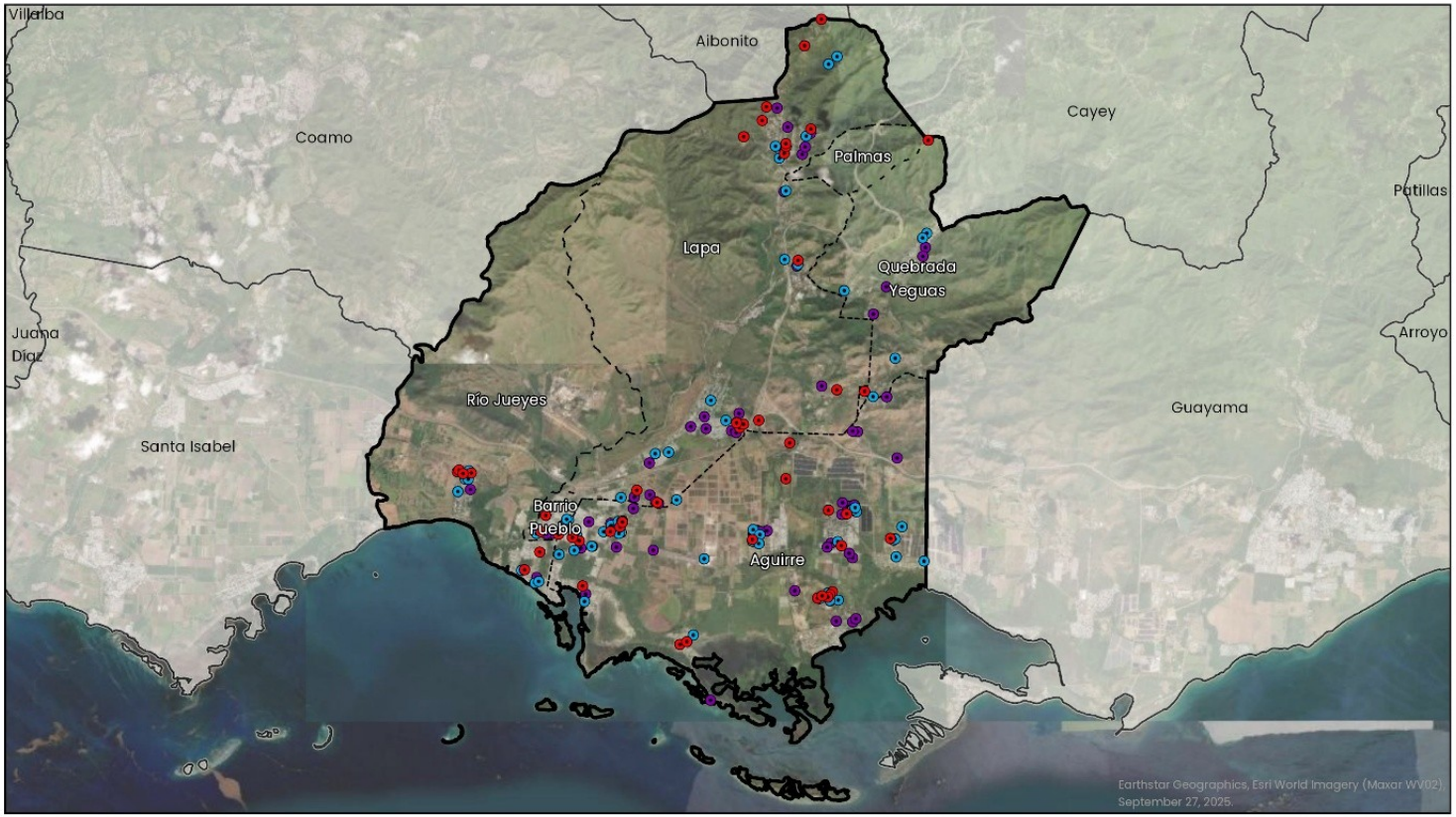
Scale: 1:140,000

0 1,750 3,500

Meters

Map 11: Recent Developments 2024 - 2026

Recent Development 2024 - 2026



Source: Puerto Rico Planning Board

SPCS PR & VI NAD83

Construction Permits Granted

Year Created and Count

- 2024 (71)
- 2025 (76)
- 2026 (51)

- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

Scale: 1:140,000

0 1,750 3,500

Meters

4. Hazard Profiles and Risk Assessment

4.1 Note on the Discussion of Hazards

The 2020 LHMP divided the discussion of the considered hazards into two separate and non-continuous sections. This arrangement made the analysis of the hazard cumbersome since the reader had to go back and forth between two different sections of this large document. In order to improve this, this new LHMP discusses both the profile of the hazard and the risk associated in one single section.

4.2 Regulatory Requirements

Federal regulation 44 C.F.R. § 201.6(c)(2) establishes the requirements related to hazard identification and risk assessment for LHMP. The Plan LHMP must include the following:

- An assessment that provides the basis for identifying the proposed activities aimed at reducing losses associated with the identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses related to the identified hazards. The hazard assessment must include:
    - A description of the type, location, and extent of all natural hazards that may affect the jurisdiction. It must contain information on previous occurrences of hazard events and the probability of future hazards.
    - A description of the jurisdiction's vulnerability to the identified hazards. This description must include a comprehensive summary of each hazard and its impact on the community. This Plan must describe vulnerability in terms of:
        - The number of existing structures, infrastructure, and critical facilities located within identified hazard areas;
        - An estimate of the potential monetary losses to structures identified as vulnerable, along with a description of the methodology used to prepare the estimate; and, lastly,
        - A general description of land use and development patterns within the community so that mitigation options can be considered in future land-use decisions.
    - A description of all structures insured under the National Flood Insurance Program (NFIP) that have experienced repetitive damage from different

flood events. It must explicitly indicate whether the community participates in the NFIP and complies with its regulations. It must also include a table showing repetitive property losses along with a table of NFIP claims and losses.

4.3 Hazards that can Affect the Municipality

To determine the hazards to be addressed in this LHMP, the Municipality reviewed and integrated information from the 2026 Puerto Rico State Hazard Mitigation Plan, the 2020 Salinas Local Hazard Mitigation Plan, and the latest LHMP's of the municipalities that share a boundary with Salinas. The following table summarizes the hazards addressed in these Hazard Mitigation Plans. A check mark indicates that the hazard was included in the corresponding plan, while an "X" denotes that it was not.

Table 16: Hazards Inventories

Hazard	2026 PRSHMP	2020 Salinas LHMP	Neighboring Municipalities
Earthquake/Liquefaction	✓	✓	✓
Landslides	✓	✓	✓
Tsunami	✓	✓	✓
Flooding	✓	✓	✓
Storm Surge	✓	✓	✓
Coastal Erosion	✗	✗	✓
Sea Level Rise	✗	✗	✓
Extreme Winds Hazard	✓	✓	✓
Extreme Heat	✗	✓	✓
Drought	✓	✓	✓
Wildfire	✓	✗	✓
Tropical Cyclones	✓	✓	✗

After reviewing the hazard profiles contained in these documents, the Municipality of Salinas determined that the following hazards shall be assessed and evaluated as part of the 2026 LHMP:

Table 17: Hazards to be included in the Salinas 2026 LHMP

Hazard	Included in Salinas 2026 LHMP?	Comments
Earthquake	Yes	It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity.
Landslides	Yes	It is included given the high propensity for landslides in Salinas's territory.
Tsunami	Yes	It is included given Puerto Rico's location among major fault lines and the 2020 Seismic activity.
Flooding	Yes	It is included given the presence of extensive flood zones in the municipality that host critical infrastructure.
Tropical Cyclones/Extreme Winds	Yes	It is included given that the southeastern region of Puerto Rico has been the most recurrent point-of-entry for hurricanes that make landfall in Puerto Rico in recorded history. (National Oceanic and Atmospheric Administration, 2026)
Storm Surge	Yes	It is included given the presence of extensive coastal flood plains and critical infrastructure that is exposed to this hazard.
Long – Term Coastal Dynamics	Yes	It is included given there is critical infrastructure that is exposed to this hazard.
Extreme Heat	Yes	A new inclusion, various of Salinas neighboring

Hazard	Included in Salinas 2026 LHMP?	Comments
		communities included this hazard. The Municipality understands that the inclusion of this hazard in the updated LHMP is warranted.
Drought	Yes	It is included given the 2014-2016 droughts and recent periods of moderate drought
Wildfire	Yes	Various of Salinas neighboring communities included in this hazard. The Municipality understands that the inclusion of this hazard in the updated LHMP is warranted.
Pandemic/Epidemic	Yes	The municipality of Salinas included this in the previous AHMP. It will be considered by the LHMP update given the COVID -19 emergency declaration of 2020.
High Hazard Potential Dam	No	This risk was not evaluated in this plan as the municipality has no direct risk exposure within its territory or from neighboring municipalities.

For the rest of this document, the hazards shall be evaluated in the following order:

Table 18: Order of Hazards to be Assessed

Classification	Hazard
	Earthquake

Classification	Hazard
Geological Hazards	Landslides
	Tsunami
Hydrological Hazards	Flooding
Meteorological Hazards	Tropical Cyclone/Extreme Winds
	Extreme Heat
	Drought
Environmental Hazards	Wildfire
	Long Term Coastal Modifications
Biological Hazards	Pandemic/Epidemic

4.4 Chronology of Events

To prevent duplication of data and for easy reference in the discussion of each hazard profile the reader will find a chronology of events in the discussion of the hazard itself.

4.5 Risk Assessment Methodology

This section describes the methodologies employed to evaluate the identified hazards. Given that each hazard presents distinct characteristics, data needs, and levels of uncertainty, multiple analytical approaches were utilized to ensure a thorough, accurate, and comprehensive risk assessment.

4.5.1.1 *HAZUS 6.1*

HAZUS is a Geographic Information System (GIS)–based risk assessment tool developed by FEMA to estimate potential losses associated with natural hazards. The software applies scientific modeling and spatial datasets to evaluate the impacts of events such as earthquakes, floods, hurricanes, and tsunamis on buildings, infrastructure, population, and the local economy. HAZUS generates detailed estimates of physical damage, economic losses, and social consequences, thereby supporting hazard mitigation planning, emergency preparedness, and recovery efforts. By integrating data on hazard intensity, exposure, and vulnerability, HAZUS enables decision-makers to prioritize mitigation strategies and allocate resources

effectively. The following hazards were evaluated using the HAZUS 6.1 platform:

- Earthquake
- Tropical Cyclone/Extreme Winds
- Tsunami
- Flooding

4.5.1.2 Alternative GIS modeling

Certain hazards are not currently modeled in HAZUS; however, they can be evaluated using alternative GIS-based techniques. ESRI® ArcGIS Pro™ 3.6 was utilized to assess hazard vulnerability by incorporating digital risk datasets and the hazard information database previously described. Using these spatial data layers, vulnerability was estimated by identifying the number of critical facilities and buildings located within hazard-prone areas. It is important to note that this method may overestimate exposure levels. In this LHMP, the following hazards were assessed using this GIS-based approach:

- Landslides
- Storm surge

4.5.1.3 Stochastic Risk Assessment

The stochastic risk assessment methodology was applied to evaluate hazards that are not addressed by existing hazard models or GIS-based analyses. This method is particularly appropriate for hazards that lack defined geographic boundaries and therefore cannot be reliably examined through spatial analysis. The approach allows for the incorporation of estimated annual losses and impact data; however, the accuracy of the results is highly dependent on the availability and quality of the underlying datasets.

In the case of this LHMP, the hazards evaluated using this methodology are:

- Long Term Coastal Dynamics
- Extreme Heat
- Drought
- Wildfire
- Pandemic/Epidemic

This methodology is particularly appropriate for hazards that lack clearly defined geographic boundaries and therefore cannot be evaluated through GIS-based analysis. It allows for the incorporation of estimated annual losses and impact data; however, the accuracy of the assessment is highly dependent on the availability and quality of the underlying datasets.

4.6 Earthquake

4.6.1 Description (B1-a)

An earthquake is a sudden movement of the Earth's crust generated by seismic waves that propagate outward in all directions from the focus, or point of origin (FEMA, 1997). The focus is the location within the Earth where the displacement of rocks along a fault initiates, while the epicenter refers to the point on the Earth's surface situated directly above the focus (Puerto Rico Seismic Network, 2019). Earthquakes may occur due to changes in pressure within the Earth's crust, including tectonic plate movement, rock rupture, volcanic activity, landslides, or the collapse of underground cavities.

Most earthquakes result from the release of accumulated stress generated by the displacement of rocks along faults within the Earth's outer crust. These faults are generally located along the boundaries of the planet's major tectonic plates. The highest levels of tectonic instability occur at plate margins where slow, opposing movements create substantial pressure due to plates traveling in different directions and at varying speeds. This deformation along plate boundaries causes stress to build in the surrounding rock. When the accumulated stress surpasses the strength of the rock, a rupture occurs, releasing stored energy in the form of seismic waves that propagate outward and produce an earthquake (NMEAD, 2021).

Earthquakes can impact extensive geographic areas, causing tens of billions of dollars in property damage, significant loss of life, numerous injuries, and widespread disruption to the social and economic stability of affected communities. Most structural damage and earthquake-related fatalities result from building collapse triggered by ground shaking (NMEAD, 2021). The severity of impacts depends on the amplitude and duration of seismic shaking, which are influenced by factors such as earthquake magnitude, proximity to the fault rupture, and the local and regional geologic conditions (NMEAD, 2021). Additional hazards associated with earthquakes include landslides where soil and rock masses move downslope and liquefaction, a process in which saturated soils lose their rigidity and behave like a fluid. Liquefaction can cause foundations and structures that rely on soil stability to shift, tilt, or collapse.

Puerto Rico is located near the boundary between the North American and Caribbean tectonic plates, within a subduction zone where one plate gradually descends beneath the other. This tectonic environment is characterized by significant seismic activity and lateral displacement. The relative movement between these two plates is approximately 2 centimeters per year (U.S. Geological Survey, 2025). According to the Puerto Rico Seismic Network, seismic activity in the region is concentrated in eight (8) primary zones:

- The Puerto Rico Trench to the North,
- The North and South Slope Faults of Puerto Rico,
- The "Sombrero Zone", to the Northeast,
- The Mona Passage to the West
- The Mona Canyon to the West,
- The Virgin Islands and Anegada depressions to the East,
- The Muertos Trough to the South,
- In the southwest of Puerto Rico

To describe earthquake size, seismology uses three (3) primary terms: intensity, magnitude, and ground acceleration. Intensity measures the level of shaking experienced by structures and the natural environment at a specific location. It varies based on the distance from the earthquake's focus and the duration of the shaking. Magnitude refers to the amount of energy released during the event, as recorded by seismometers. Ground acceleration expresses the force of the seismic waves acting on the ground and is commonly used to characterize the severity of an earthquake (PRSN, 2019).

Earthquakes can generate a variety of secondary hazards, including liquefaction, landslides, seismic wave amplification, and tsunamis. For the purposes of this analysis, the primary secondary hazard of concern is earthquake-induced liquefaction, as it is a condition for which mitigation strategies can be effectively developed once susceptible areas are identified and mapped. Liquefaction refers to the process in which certain saturated soils temporarily lose their structural strength and behave like a dense fluid, significantly reducing their load-bearing capacity (PRSN, 2019). Liquefaction typically occurs in areas underlain by medium- to fine-grained sandy soils that are saturated with water and of relatively recent geologic origin. These conditions are most found along river margins and within Quaternary (Q) alluvial deposits. Another secondary hazard associated with earthquakes is the amplification of seismic waves. Seismic wave amplification occurs in thick alluvial deposits where seismic waves decelerate, increasing their oscillation and causing the ground to

experience stronger and more prolonged shaking.

4.6.1.1 Affected Area (B1-B)

The following maps measure the spectral acceleration and spectral displacement in HAZUS run scenarios.

Spectral Acceleration is measure used mainly in earthquake engineering to describe how strongly the ground motion from an earthquake would accelerate a structure with a specific natural period. This measure answers the question "If a building (or any structure) vibrates naturally at a certain period, how much acceleration would it experience during an earthquake?" or, How hard the ground is pushing on the building at a specific vibration period? The higher the spectral acceleration, stronger the forces acting on the structure will be, which can cause structural failure if the building isn't designed for it (USGS, 2019).

Spectral Displacement measures how far a structure is expected to move (deform) during an earthquake, based on its natural vibration period and damping, in other words, it answers: "For a building with a given natural period, what is the maximum displacement it would experience during earthquake shaking?" (National Institute of Building Sciences, 2020).

Furthermore, the maps show the HAZUS scenario for .03 seconds and 1.0 seconds. The difference relates to how an earthquake impacts different types of structures based on the natural vibration period the building. The maps showing the 0.3-second scenario can affect buildings that are short, stiff structures like 1 or 2-story buildings. These buildings are rigid, so they vibrate quickly when the ground shakes. While the 1.0-second scenario that is more important for buildings are taller, more flexible structures, like mid- to high-rise buildings. These buildings are taller and less stiff and therefore sway more slowly (over a longer period) during an earthquake (FEMA, Hazus Earthquake Model User Guidance, 2024).

As shown on Map 12, spectral acceleration at a 1.0-second period is higher in the central and northern portions of the municipality than in the southern coastal areas. The highest spectral acceleration values (0.116852 - 0.155500 g) are concentrated in the interior portion of the municipality, extending across central Lapa, southern Quebrada Yeguas, and the area immediately north of Aguirre. This zone generally follows the transition between the mountainous northern wards and the southern coastal plain.

Likewise, portions of the municipality's commercial, public service, and transportation corridors located between Barrio Pueblo and Aguirre fall within a high spectral acceleration zone (0.116852 - 0.155500 g). Residential communities located within this zone include portions of Lapa, Quebrada Yeguas, Aguirre, and the northern sectors adjacent to Barrio Pueblo.

The lowest levels of spectral acceleration (0.084156 - 0.085362 g) are found in the southern coastal areas of Aguirre and the coastal sector south of Barrio Pueblo, where the mapped earthquake scenario projects lower acceleration values than those observed inland.

Map 13 illustrates an additional earthquake scenario based on spectral acceleration at 0.3 seconds. In this scenario, the highest vulnerability again appears in the central half of the municipality. Spectral acceleration values ranging from 0.378430 - 0.468457 g are observed in the central area of Salinas characterized by consolidated development and transportation corridors. Communities and wards within this high-acceleration zone include central Lapa, southern Quebrada Yeguas, northern Aguirre, and interior sectors east of Barrio Pueblo, among others.

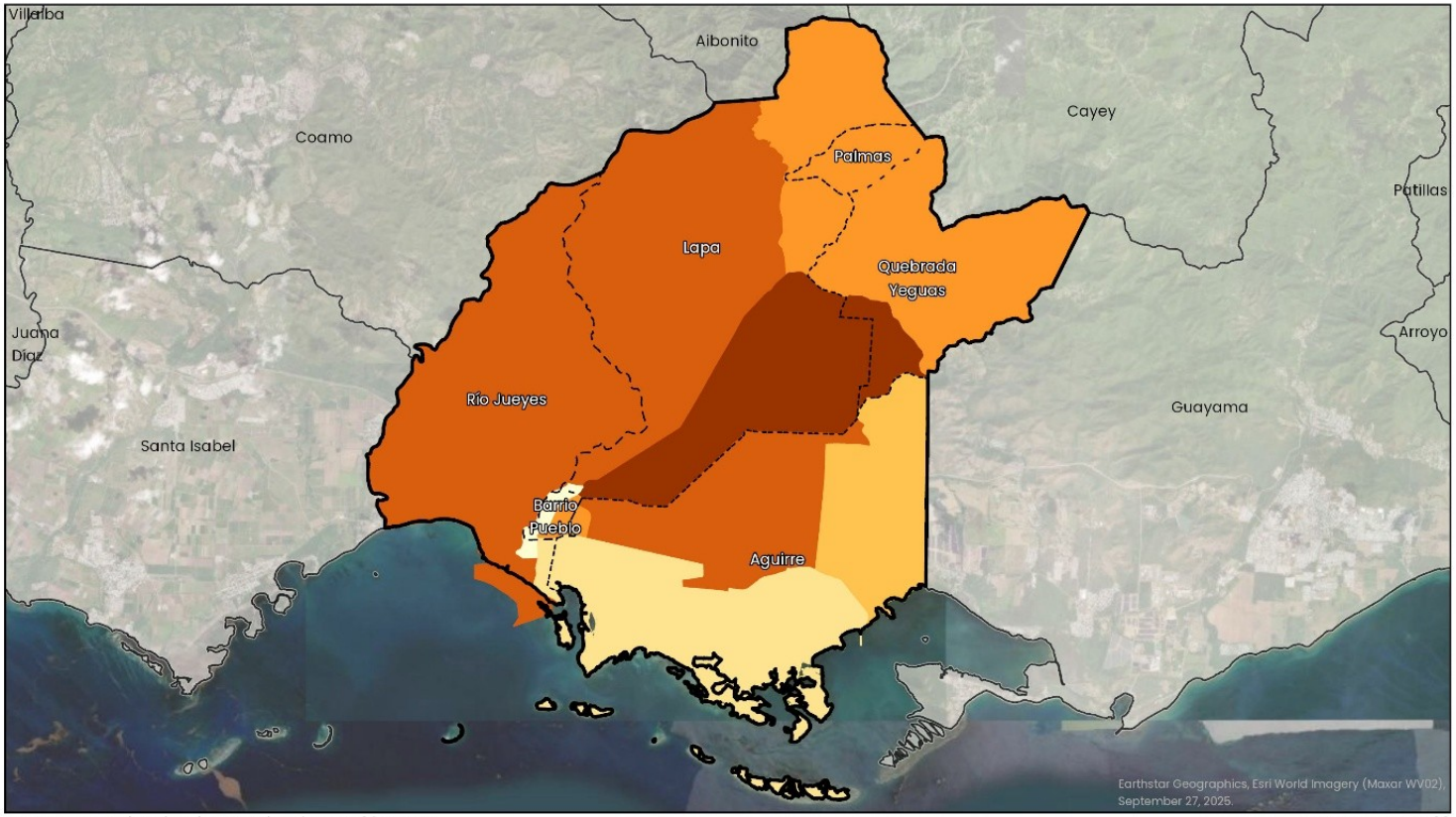
In the second most intense spectral acceleration zone (0.309979 - 0.378429 g), the communities of Río Jueyes, western Lapa, portions of Aguirre, and areas surrounding Barrio Pueblo are included. Additional zones include the 0.298444 - 0.309978 g range, which encompasses areas such as central Aguirre and western Río Jueyes; the 0.291125 - 0.298443 g range, which includes portions of Palmas and eastern Quebrada Yeguas; and the 0.287597 - 0.291124 g range, located primarily in the southern coastal plain and southeastern Aguirre sectors.

Maps 14 and 15 illustrate the spectral displacement expected during an earthquake, which represents the degree of movement or sway that buildings may experience. The spatial distribution of displacement closely mirrors the patterns observed in spectral acceleration, as higher acceleration levels generally correspond to greater structural sway. Under the 1.0-second spectral displacement scenario, the highest displacement values (1.145143 - 1.523897 inches) are projected within the central portion of the municipality, particularly in central Lapa, southern Quebrada Yeguas, and northern Aguirre. Moderate displacement values (0.900746 - 1.145142 inches) extend across much of Río Jueyes, Lapa, and interior Aguirre, while the lowest displacement values (0.824732 - 0.836545 inches) occur along the southern coastal areas of Aguirre and Barrio Pueblo.

Under the 0.3-second spectral displacement scenario, the same central area is expected to experience the greatest degree of structural movement, with displacement values ranging from 0.333775 - 0.413179 inches. The second highest displacement zone (0.273402 - 0.333774 inches) includes portions of Río Jueyes, Lapa, Aguirre, and Barrio Pueblo. Lower displacement values are observed within the 0.263228 - 0.273401 inches, 0.256772 - 0.263227 inches, and 0.253660 - 0.256771 inches ranges, which are distributed primarily across Palmas, Quebrada Yeguas, coastal Aguirre, and the southern portion of the municipality. Overall, both displacement scenarios indicate that the central interior wards of Salinas exhibit the highest projected seismic demand, while the southern coastal sectors exhibit comparatively lower levels of structural displacement.

Map 12: Earthquake: Spectral Acceleration at 1.0 sec

Earthquake: Spectral Acceleration at 1.0 sec (g)



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Spectral Acceleration (g)

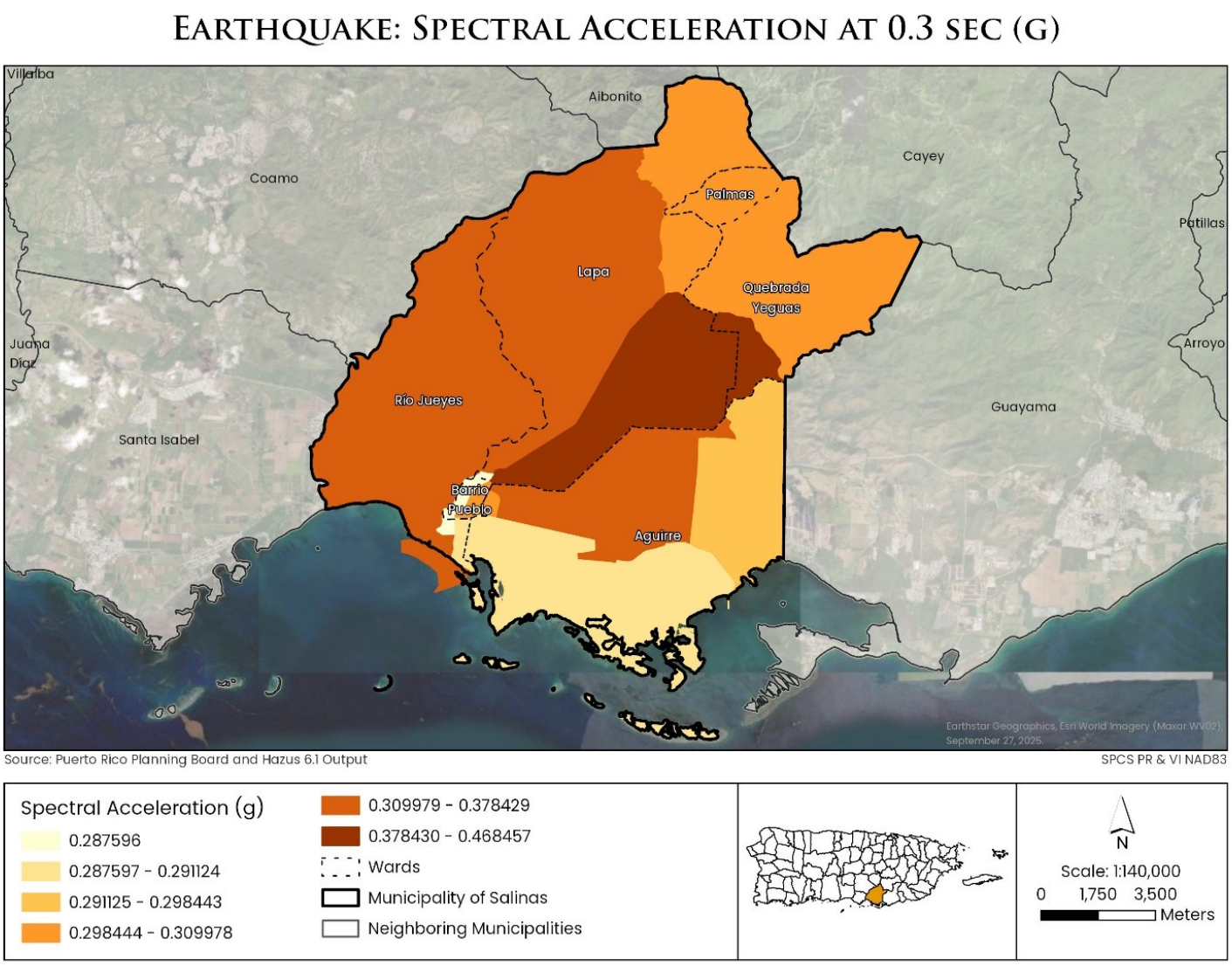
- 0.084156
- 0.084157 - 0.085362
- 0.085363 - 0.087885
- 0.087886 - 0.091913
- 0.091914 - 0.116851
- 0.116852 - 0.155500
- Wards
- Municipality of Salinas
- Neighboring Municipalities

N

Scale: 1:140,000

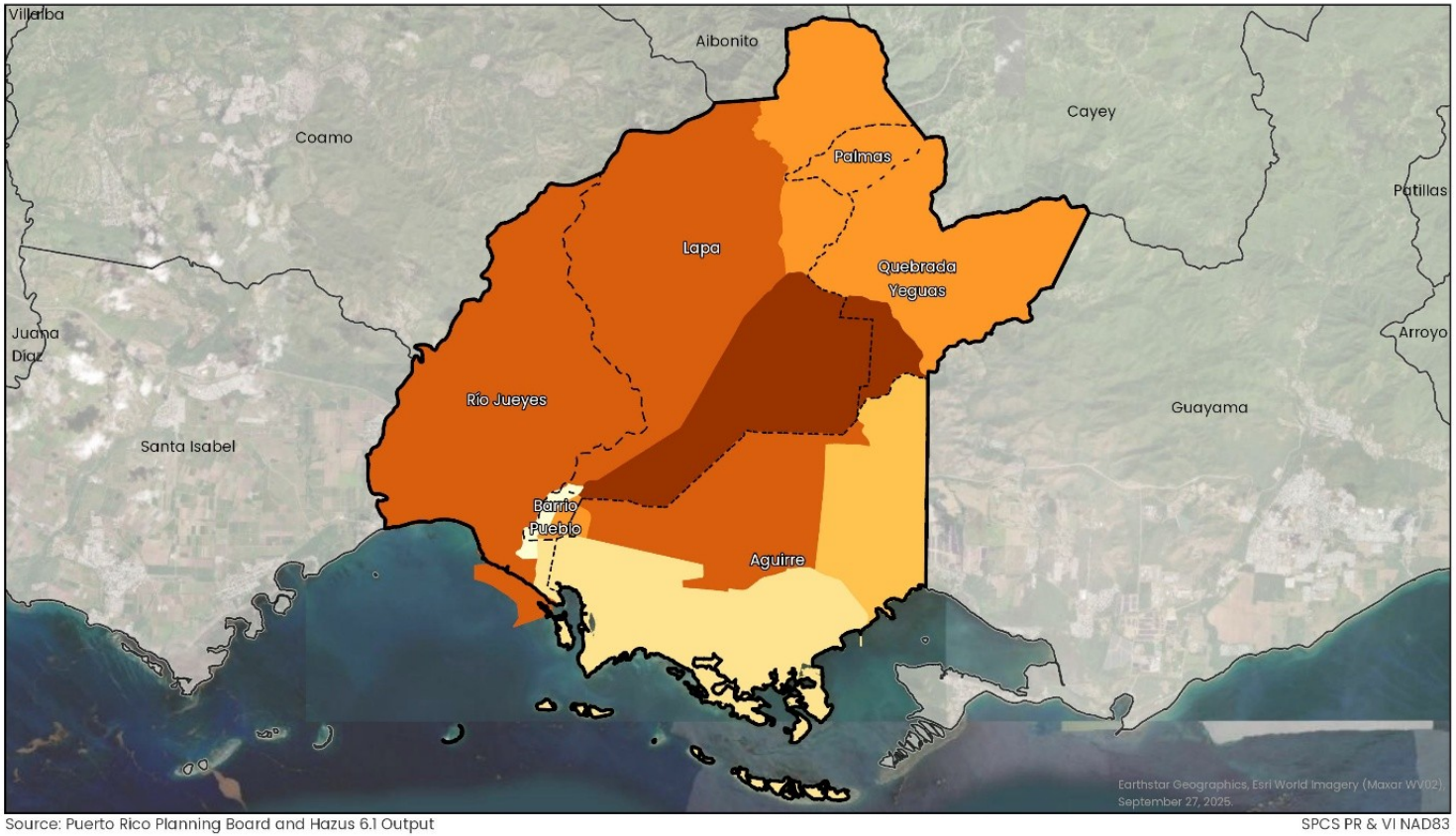
0 1,750 3,500 Meters

Map 13: Earthquake: Spectral Acceleration at 0.3 sec



Map 14: Earthquake Spectral Displacement at 1.0 sec

Earthquake: Spectral Displacement at 1.0 sec (in)



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Spectral Displacement (in)

- 0.824732
- 0.824733 - 0.836545
- 0.836546 - 0.861277
- 0.861278 - 0.900745
- 0.900746 - 1.145142
- 1.145143 - 1.523897
- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

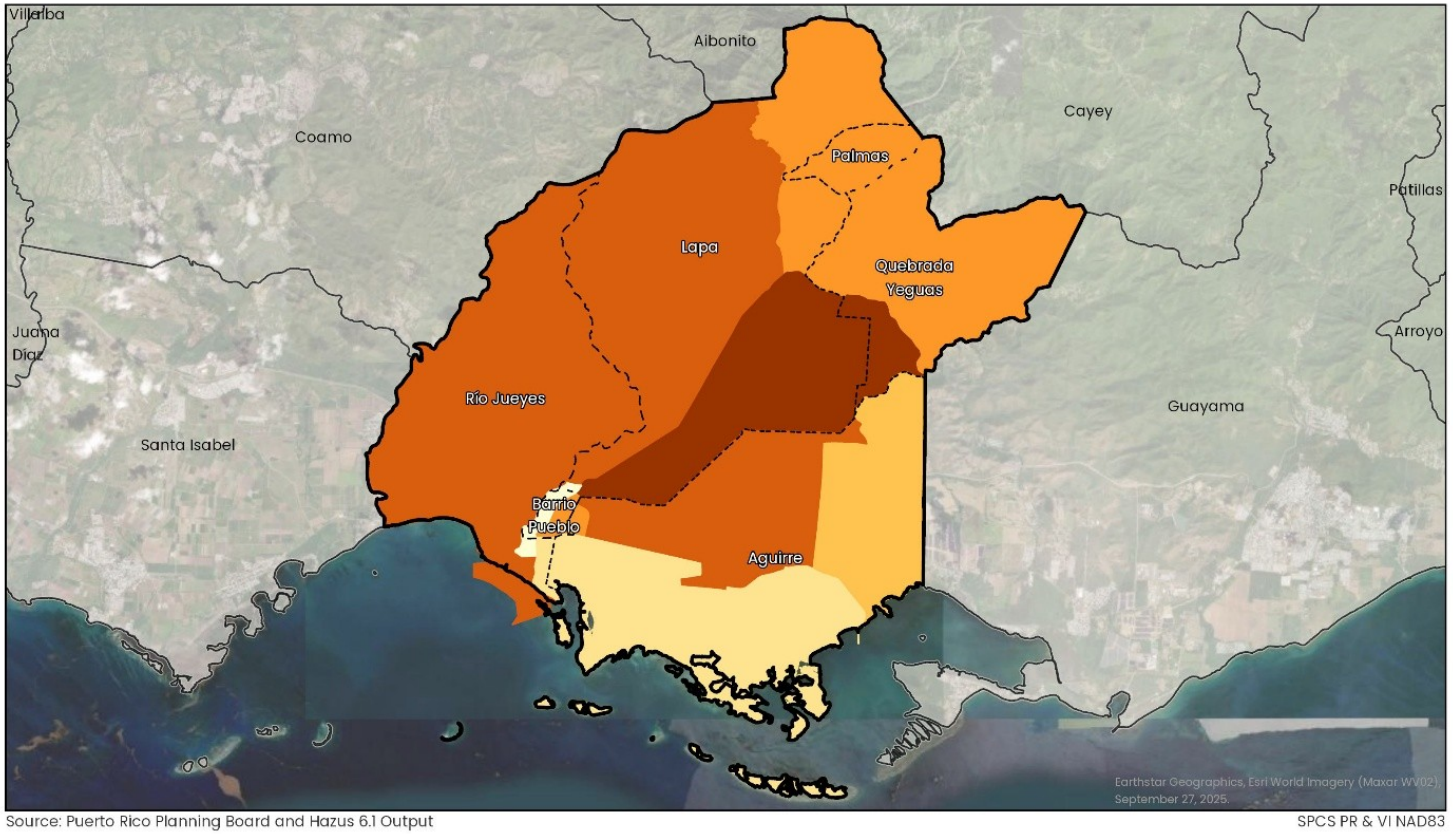
Scale: 1:140,000

0 1,750 3,500

Meters

Map 15: Earthquake: Spectral Displacement at 0.3 sec

Earthquake: Spectral Displacement at 0.3 sec (in)



4.6.1.2 Risk Magnitude (B1-C)

The size of an earthquake, commonly associated with the Richter Scale, is widely recognized but often misunderstood. The concept of a logarithmic magnitude scale was first introduced by Charles Richter in the 1930s to measure earthquakes in Southern California using high-frequency recordings from nearby seismograph stations. This original scale, designated as ML where "L" stands for "local" eventually became known as the Richter magnitude.

As global seismic monitoring networks expanded, it became evident that the Richter method was accurate only within specific frequency and distance ranges. To accommodate a broader range of seismic signals recorded worldwide, additional magnitude scales were developed as extensions of Richter's original concept, including the body-wave magnitude (Mb) and the surface-wave magnitude (Ms). Each of these scales applies to a particular frequency range and type of seismic waves, and within their respective valid ranges, they provide magnitudes equivalent to the Richter scale. (USGS, 2024)

Due to the limitations of the ML, Mb, and Ms scales, a more universally applicable scale moment magnitude (Mw) was developed. For large-magnitude earthquakes, Mw provides the most accurate and reliable estimate of earthquake size.

Moment is a physical quantity proportional to the amount of slip that occurs along a fault multiplied by the area of the fault surface that undergoes rupture. It reflects the total energy released by an earthquake. Moment can be derived from seismogram data and geodetic measurements and subsequently converted into a magnitude value using a standardized formula. The resulting measure, known as moment magnitude, provides a consistent and comparable estimate of earthquake size across the full range of magnitudes a capability that earlier scales do not offer (USGS, 2024).

Table 19 below shows the Moment – Magnitude scale.

Table 19: Moment - Magnitude Scale[6]

Range	Description
Mw < 3.0	Usually not felt by people.
Mw 3.0 – 4.9	Minor earthquakes, often felt but rarely cause damage.
Mw 5.0 – 5.9	Moderate can cause slight damage to poorly built structures.
Mw 6.0 – 6.9	Strong can cause significant damage in populated areas.
Mw 7.0-7.9	Major, serious damage over large areas.
Mw ≥ 8.0	Great earthquakes, catastrophic damage over very large regions.

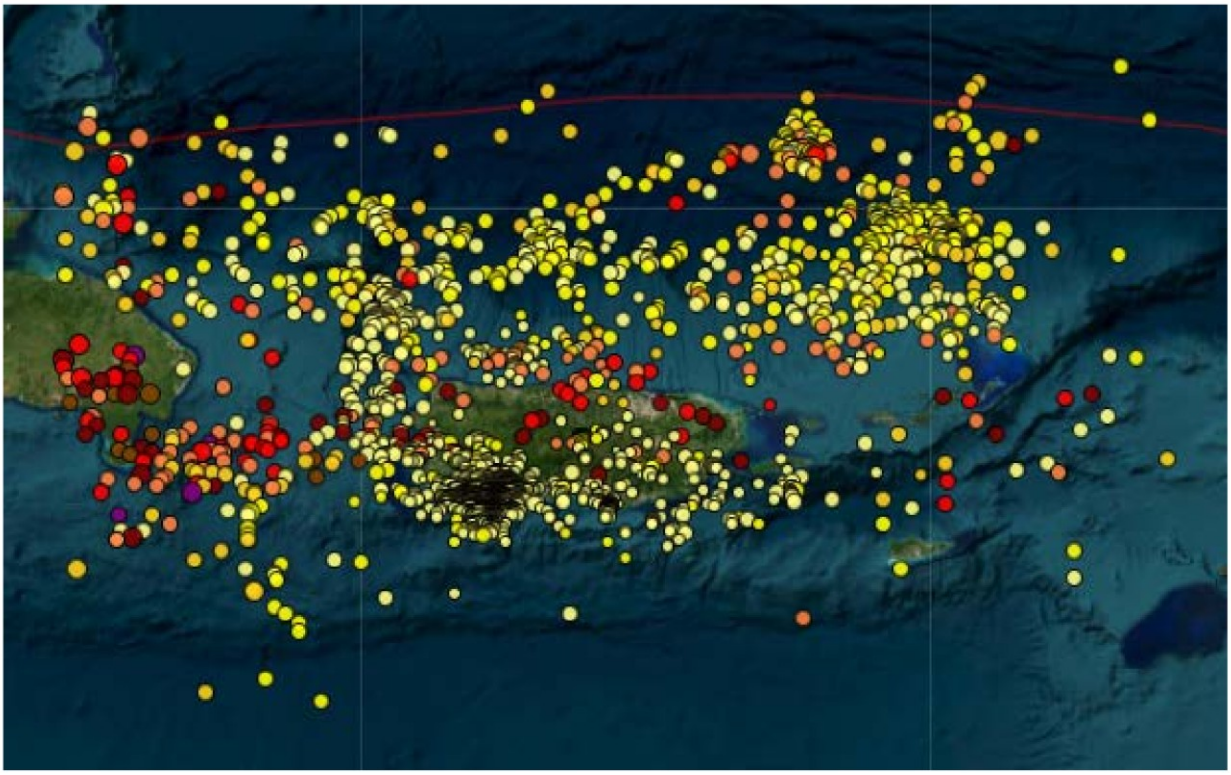
4.6.1.3 Past Events (B1-d)

Earthquakes occur naturally daily, and their impacts increase significantly with greater magnitude. High-magnitude events can be particularly destructive, causing extensive property damage, loss of life, and severe disruption to affected regions. Puerto Rico is located near several active seismic zones including the Puerto Rico Trench, the Mona Canyon, the Anegada Trough, the Muertos Trough, and the southern fault system placing the island at heightened risk for seismic events. Seismicity in the southeastern region of Puerto Rico is primarily associated with faults in the Virgin Islands and Anegada depressions. In the southwestern region, activity is influenced by the Punta Montalva fault (Roig Silva, 2010), an area that has experienced a notable increase in seismic activity in recent years (Weilert & Laó-Dávila, 2023).

Figure 13 is a screengrab sourced from a report published by the Puerto Rico Seismic Network (in Spanish). This report illustrates the epicenters of earthquakes recorded in the Puerto Rico and U.S. Virgin Islands region in 2024 (PRSN, 2025).

[6] Source: USGS, 2025

Figure 13: PRSN - 2024 Earthquakes Epicenter screengrab (PRSN, 2025)



Earthquake Chronology

The table below shows the chronological list of seismic activity in Puerto Rico for the period of 2012 to 2024 as reported by the PRSN (PRSN, n.d.).

Table 20: Puerto Ric Seismic Activity 2013-2024

Year	Description of seismic events
2024	The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Aguadilla (PR). The largest earthquake of 2024 occurred on May 14, 2024, at 8:30:11 p.m. (Puerto Rico local time). The magnitude 5.6 Ml earthquake was located 94.3 km north-northwest of Aguadilla (PR) at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in

Year	Description of seismic events
	Aguadilla (PR). During 2024, aftershocks from the South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Mw. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island. From the start of the South-Southwest Puerto Rico seismic sequence in 2019 through April 2024, 27,497 earthquakes associated with this sequence have been processed (Figure 13). More than 1,688 felt earthquakes and over 492 significant events with magnitudes greater than 3.5 have been recorded. Of these, 42 earthquakes had magnitudes greater than 4.5.
2023	The largest earthquake of 2023 occurred on December 9, 2023, at 10:27:22 a.m. (Puerto Rico local time). The magnitude 5.7 Ml earthquake was located 192.28 km east-northeast of San Juan, PR, at a depth of 7 km. This moderate earthquake was widely felt throughout Puerto Rico and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in St. Thomas (USVI). During 2023, aftershocks from South-Southwest Puerto Rico seismic sequence continued. This sequence began on December 28, 2019, with a magnitude 4.7 Ml earthquake. The main event of this sequence occurred on January 7, 2020, in the southern region of Puerto Rico, 12.7 km south of Guayanilla, with a magnitude of 6.4 Mww. This strong earthquake, at a depth of 7 km, had a maximum intensity of VIII in Guánica, Puerto Rico, and caused major damage across the island.
2022	The seismic sequence in the South-Southwest region of Puerto Rico, which began on December 28, 2019, continues. From its onset until the March 2022 report by the Puerto Rico Seismic Network, a total of 19,436 earthquakes associated with this sequence had been recorded. In that report, 1,502 events were documented for 2022, of which 30 were reported as felt. The regions with the highest seismic activity during March 2022 were in the southern area of Puerto Rico.
2021	The largest earthquake of 2021 occurred on January 24, 2021, at 7:21:41

Year	Description of seismic events
	p.m. (Puerto Rico local time). The magnitude 5.4 Ml earthquake was located 44.82 km southeast of Virgin Gorda, BVI, at a depth of 94 km. This moderate earthquake was widely felt throughout Puerto Rico and the Virgin Islands, with a maximum intensity of V (Modified Mercalli Intensity Scale, MMI) in Tortola, British Virgin Islands.
2020	The year 2020 was marked by significant seismic activity. An earthquake of magnitude 5.8 was recorded on January 6, 2020, followed by another of 6.4 on January 7, 2020, located 8 km from Indios, Puerto Rico. It is important to clarify that, starting from the 4.7 magnitude event recorded on December 28, 2019, up to October 22, 2020, approximately over 1,200 earthquakes of magnitude 2.0+ have been felt on the island. Tectonic activity in Puerto Rico is dominated by the convergence between the North American and Caribbean plates, with the island compressed between the two. To the north of Puerto Rico, the North American plate subducts beneath the Caribbean plate along the Puerto Rico Trench. To the south of the island, and south of the January 7 earthquake, the upper crust of the Caribbean plate subducts beneath Puerto Rico in the Muertos Trough. However, the January 6 earthquake and other recent events are occurring in the offshore deformation zone, connected by the Punta Montalva fault on land and the Guayanilla Canyon offshore. Between December 28, 2019, and January 23, 2020, southern Puerto Rico recorded 90 seismic events of magnitude 4.0 or greater, including the 6.5 magnitude earthquake on January 7, 2020, according to the USGS. These seismic movements led state authorities to request a disaster declaration from the President of the United States. This Disaster Declaration was issued on January 16, 2020, under number DR-4473. The Municipality of Salinas was not included among those designated to receive Individual Assistance funds from FEMA.
2019	During 2019, the Puerto Rico Seismic Network (PRSN) located a total of 6,510 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2018 (3,974 earthquakes), the detected and located seismicity in 2019 increased. The year 2019 ended with 2,536 more earthquakes than the previous year. In 2019, the month with the highest activity was December with 1,291 earthquakes, while

Year	Description of seismic events
	August had the lowest seismicity with 303 earthquakes. The region with the highest recorded seismicity during 2019 was the Mona Canyon with 1,288 seismic events, followed by the southern region of Puerto Rico with 885 earthquakes (Table 3). Earthquake depths ranged from 1 km to 191 km, and magnitudes varied from 0.34 Md to 6.0 Mw. Of the total earthquakes in 2019, 70 were reported as felt. On December 28, 2019, an active period of seismic activity began, with a 4.7 magnitude earthquake, followed several hours later by another of 5.0 magnitude south of the island.
2018	During 2018, the Puerto Rico Seismic Network (PRSN) located a total of 3,974 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2017 (3,129 earthquakes), the detected and located seismicity increased by 845 more earthquakes than the previous year. In 2018, the month with the highest activity was December with 549 earthquakes, while February had the lowest seismicity with 227 earthquakes. The region with the highest recorded seismicity during 2018 was the southern region of Puerto Rico with 412 seismic events, followed by the 19°N Fault Zone with 349 earthquakes. Earthquake depths ranged from 2 km to 185 km, and magnitudes varied from 0.63 Md to 4.67 Md. Of the total earthquakes in 2018, 29 were reported as felt within our area of responsibility.
2017	During 2017, the Puerto Rico Seismic Network (PRSN) located a total of 3,129 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2016 (3,948 earthquakes), the detected and located seismicity decreased by 20%, which means 819 fewer earthquakes than the previous year. In 2017, the month with the highest activity was April with 518 earthquakes, while October had the lowest seismicity with 48 seismic events. The region with the highest recorded seismicity during 2017 was the Sombrero Seismic Zone with 856 seismic events, followed by the Virgin Islands Platform with 327 earthquakes. Earthquake depths ranged from 1 km to 180 km, and magnitudes varied from 0.85 Md to 4.8 Mb. Of the total earthquakes in 2017, 24 were reported as felt within our area of

Year	Description of seismic events
	responsibility.
2016	During 2016, the Puerto Rico Seismic Network (PRSN) located a total of 3,947 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2015 (3,235 earthquakes), the detected and located seismicity increased by 22.0%, or 712 more earthquakes than the previous year. In 2016, the month with the highest activity was September with 566 earthquakes, while March had the lowest seismicity with 169 earthquakes. The region with the highest recorded seismicity during 2016 was the Sombrero Seismic Zone with 973 seismic events, followed by the Virgin Islands Platform with 497 earthquakes. Earthquake depths ranged from 1 km to 177 km, and magnitudes varied from 0.76 Md to 4.6 Ml. Of the total earthquakes in 2016, 28 were reported as felt within our area of responsibility.
2015	During 2015, the Puerto Rico Seismic Network (PRSN) located a total of 3,235 earthquakes in the Puerto Rico and Virgin Islands region (our seismic responsibility area, between latitudes 17°N–20°N and longitudes 63.5°W–69°W). Compared to 2014 (3,420 earthquakes), the detected and located seismicity decreased by 5.4%, or 185 fewer earthquakes than the previous year. In 2015, the month with the highest activity was July with 473 earthquakes, while April had the lowest seismicity with 157 earthquakes. The region with the highest recorded seismicity during 2015 was the Sombrero Seismic Zone with 588 seismic events, followed by the 19°N Fault Zone with 477 earthquakes. Earthquake depths ranged from 1 km to 211 km, and magnitudes varied from 0.80 Md to 4.80 Md (duration magnitude). Of the total earthquakes in 2015, 23 were reported as felt within the area of responsibility.
2014	During 2014, the Puerto Rico Seismic Network (PRSN) located a total of 3,420 earthquakes in the area of responsibility (AOR) known as the Puerto Rico and Virgin Islands Region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2013 (2,293 earthquakes), the detected and located seismicity increased by 49%, which is 1,127 more earthquakes than the previous year. In this year, the month with the highest seismicity was January with 709 earthquakes, and the month with the lowest seismicity was November with 192 earthquakes. Of the total seismicity in 2014, 29 earthquakes (0.85%) were reported as

Year	Description of seismic events
	felt, all located within our AOR. The magnitudes (Md) of the seismic events calculated for this year by PRSN ranged from 1.0 to 6.4, although for felt events they ranged from 2.53 Md to 6.4 Mwp. During 2014, depths varied between 1 km and 182 km, while for felt earthquakes they ranged from 6 km to 134 km. Earthquakes with depths of 0 to 25 km were the most frequent with 1,385 events, while those between 175 km and 200 km were the least frequent this year. The region with the highest recorded seismicity during 2014 was the 19°N Fault Zone with 905 seismic events, followed by the Sombrero Seismic Zone with 483 earthquakes.
2013	During 2013, the Puerto Rico Seismic Network (PRSN) located a total of 2,293 earthquakes in the Puerto Rico and Virgin Islands region (latitude 17.00˚ to 20.00˚N and longitude 63.50˚ to 69.00˚W). Compared to 2012 (2,852 earthquakes), the detected and located seismicity decreased by 20%, which is 559 fewer earthquakes than the previous year. In this year, the month with the highest seismicity was September with 272 earthquakes, and the month with the lowest seismicity was February with 114 earthquakes. Of the total seismicity in 2013, 44 earthquakes (1.92%) were reported as felt, all located within the Puerto Rico and Virgin Islands region. The magnitudes of the seismic events calculated for this year by PRSN ranged from 1.0 to 5.12, although for felt events they ranged from 2.36 to 5.12. During 2013, depths varied between 1 km and 182 km, while for earthquakes they ranged from 4 km to 112 km. The region with the highest recorded seismicity during 2013 was the Sombrero Seismic Zone with 504 seismic events, followed by the Virgin Islands Platform with 246 earthquakes. Through its educational program, PRSN reached 14,099 people in Puerto Rico and the U.S. and British Virgin Islands during 2013.

2020 Seismic Sequence

In early January 2020, Puerto Rico experienced a significant seismic sequence that began with a series of foreshocks and culminated in a major earthquake on January 7. The main shock registered a magnitude of 6.4 Mw and struck along the island's southern coast, severely affecting the municipalities of Guayanilla, Ponce, and Yauco. This event was preceded by a magnitude 5.8 Mw earthquake on January 6, which had already caused widespread concern and notable structural damage (USGS, n.d.). The

seismic activity was associated with the complex interaction between the Caribbean and North American tectonic plates, a region characterized by active subduction zones and fault systems. The resulting shaking was felt across the island, causing power outages, school closures, and the collapse of numerous structures, including residential and public buildings.

The aftermath of the earthquake resulted in extensive damage to homes and critical infrastructure, displacing thousands of residents and prompting a federal emergency declaration. The southern region experienced prolonged aftershocks—some exceeding magnitude 5.0, which continued for weeks, intensifying public concern and creating sustained disruption. This event underscored Puerto Rico's heightened vulnerability to seismic hazards and highlighted the importance of preparedness measures and resilient construction practices. The incident received a Presidential Disaster Declaration under the Stafford Act (DR-4473-PR) (FEMA, n.d.). Although the Municipality of Salinas was not included in the Disaster Declaration, it recognizes that Puerto Rico's location along active tectonic boundaries place all jurisdictions at risk of seismic events capable of causing millions of dollars in damage and significant disruptions to daily life.

According to the Puerto Rico Seismic Network (PRSN), from the onset of the South–Southwest Puerto Rico seismic sequence in 2019 through April 2024, a total of 27,497 earthquakes associated with this sequence were recorded and processed. Of these events, more than 1,688 were reported as felt, and over 492 registered magnitudes greater than 3.5. Additionally, 42 earthquakes reached magnitudes exceeding 4.5.

4.6.1.4 Future Event Probabilities (B1-e)

Unlike atmospheric hazards, earthquakes cannot be predicted with current scientific capabilities. However, advances in seismology allow for the development of probabilistic forecasts. Historical records indicate that Puerto Rico has experienced four major destructive earthquakes since 1670—specifically in 1670, 1787, 1867, and 1918. This sequence suggests a recurrence interval ranging from 51 to 117 years, with an average interval of approximately 83 years for significant events. It is important to note, however, that each of these earthquakes originated on different fault systems; therefore, this record alone cannot be used to establish a precise recurrence rate.

For more comprehensive analyses, geologic maps of specific zones are examined to identify active faults and other relevant structural features. These datasets are then

correlated with historical earthquake intensity distributions, seismic attenuation models, and statistical records. This integrated approach produces maps of seismically active areas that delineate regions with varying potential for strong earthquake activity. Identifying these high-risk zones is essential for informed land-use planning and effective emergency preparedness.

In the case of Puerto Rico, the PRSN cites a probabilistic seismic hazard study conducted in 1987 by Dr. William McCann, which estimated a 33–50% probability of a strong earthquake (Intensity VII or higher on the Modified Mercalli Scale) occurring in various parts of the island within a 50-year period (PRSN, 2025).

Further research conducted by the U.S. Geological Survey in 2003 identified an area west–southwest of Puerto Rico as the region most likely to experience strong earthquakes on the island. This probabilistic analysis does not account for secondary hazards such as tsunamis, liquefaction, or seismic wave amplification, which predominantly affect low-lying coastal areas and high-elevation zones susceptible to landslides.

4.6.2 Risk Analysis (B2-a, B2-b)

4.6.2.1 Estimated Losses

The Federal Emergency Management Agency's HAZUS Earthquake Analysis provides estimates of Annualized Earthquake Losses defined as the long-term average annual economic impact of earthquakes on the general building stock within a given geographic area as well as annualized estimates of population loss.

The Annualized Earthquake Loss is calculated using the Riemann Sums Method, which averages the annual losses associated with multiple return periods and then multiplies each average loss by its corresponding differential probability to produce a single loss estimate for each Census tract. (FEMA, National Risk Index Data - Technical Documentation, 2025)

Table 21 presents the exposure to earthquake hazards. It is important to note that, although assigning an exact monetary value to human life is inherently complex, FEMA guidance converts population loss into an economic estimate using a "population equivalence" methodology based on the Value of Statistical Life (VSL). Under this approach, each fatality—or the equivalent of ten injuries—is assigned an economic loss value of $11.6 million, reflecting FEMA's inflation adjusted VSL estimate. All historical

loss figures are subsequently adjusted to December 2024 dollars to account for inflation.

The HAZUS 6.1 analysis indicates that the municipality's total exposure to an earthquake event is $302,987,587,000. This estimate includes $3,835,187,000in building value exposure and $299,152,400,000 in population exposure, based on the population equivalence methodology.

The analysis further indicates that approximately 25,789 residents are located within the earthquake impact area, which encompasses 71.18 square miles of the municipality.

Table 21: Exposure to Earthquake Hazard

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
71.179328	$ 3,835,187,000	25,789	$ 299,152,400,000	$ 302,987,587,000

Source FEMA NRI

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 22 presents the expected annual earthquake-related losses for both buildings and population.

Table 22: Expected Annual Loss to Earthquake

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss -Total
$ 2,103,493	0.1129	$ 1,309,986	$ 3,413,480

4.6.2.2 Lifelines and Critical Infrastructure

Earthquakes can affect a community's lifelines in the following ways:

- Safety and Security – An earthquake can cause the structural failure of critical facilities such as police stations and fire stations, generate increased demand

for search-and-rescue operations, and result in population displacement requiring emergency sheltering. Such conditions may also create challenges in maintaining public order and ensuring community security.

- Food, Hydration, and Shelter – A seismic event can cause damage to water treatment plants and distribution systems, resulting in contamination or loss of potable water. Disruptions to transportation routes and storage facilities may also interrupt food supply chains. Widespread structural damage can increase the demand for temporary shelters. Additionally, the loss of refrigeration capacity may lead to significant spoilage of perishable goods.

- Health and Medicine - Hospitals and clinics may experience structural damage or a reduction in operational capacity during an earthquake. A surge in injuries requiring emergency medical attention can overwhelm existing healthcare facilities. Disruptions to pharmaceutical supply chains and medical logistics may also occur. Additionally, compromised sanitation conditions in emergency shelters can elevate the risk of disease outbreaks.

- Energy - Damage to power plants, substations, and transmission lines can result in widespread power outages. Ruptures in gas lines may create fire and explosion hazards. Interruptions in the fuel supply chain can also impede the operation of generators and emergency response vehicles.

- Communications - Damage to cell towers, fiber-optic cables, and communication hubs can result in significant loss of connectivity. Emergency call surges may overload telecommunications networks, further degrading service availability. These disruptions can impair coordination among emergency response agencies and hinder the timely dissemination of critical information.

- Transportation - Collapse or severe damage to roads, bridges, and tunnels can significantly restrict mobility. Airports and seaports may become inoperable due to damage to runways or docks. Rail systems, including the Tren Urbano, may also be disrupted because of track deformation or landslides.

- Hazardous Materials – An earthquake may cause spills from industrial facilities, chemical plants, or storage tanks, increasing the risk of environmental contamination affecting air, soil, and water resources. Additionally, damage to sites containing hazardous materials may result in fires or explosions.

- Water Systems - Breakage of water mains and sewer lines can result in localized flooding and contamination. Such damage may also reduce firefighting capacity due to diminished water pressure and lead to long-term disruptions in wastewater collection and sanitation services.

Maps 16 and 17 show the identified critical infrastructure locations in relation to the spectral acceleration zones presented in Section 4.2.1.1.

These maps show that several critical facilities are located within areas of high spectral acceleration. The highest spectral acceleration zone is concentrated in the central portion of the municipality, extending across portions of Lapa, Quebrada Yeguas, northern Aguirre, and areas immediately north of Pueblo ward. Within this zone, there are facilities associated with communications, energy, transportation, water systems, safety and security, educational, health and medical, and community support lifelines. The greatest concentration of critical infrastructure is located within Approach Area 1, encompassing the urban core of Salinas and adjacent sectors along the PR-1 and PR-52 corridors. Additional critical facilities are located within Approach Area 2 in Aguirre, where multiple transportation, educational, water system, and community facilities are present.

The maps also indicate that several schools, health and medical facilities, transportation assets, public safety facilities, and utility infrastructure are situated within the Extreme and Very High Spectral acceleration zones. Consequently, these facilities may experience greater seismic forces during an earthquake event than facilities located within the southern coastal sectors of the municipality. Facilities located in the southern portion of Aguirre generally fall within lower acceleration zones and are expected to experience comparatively lower levels of ground shaking.

The spatial distribution of spectral displacement closely mirrors the patterns observed for spectral acceleration. The highest displacement values are concentrated within the central interior portion of Salinas, particularly in Lapa, Quebrada Yeguas, northern Aguirre, and the areas immediately north of Barrio Pueblo. As a result, many of the same facilities identified as being exposed to high spectral acceleration are also located within the areas expected to experience the greatest structural movement during an earthquake.

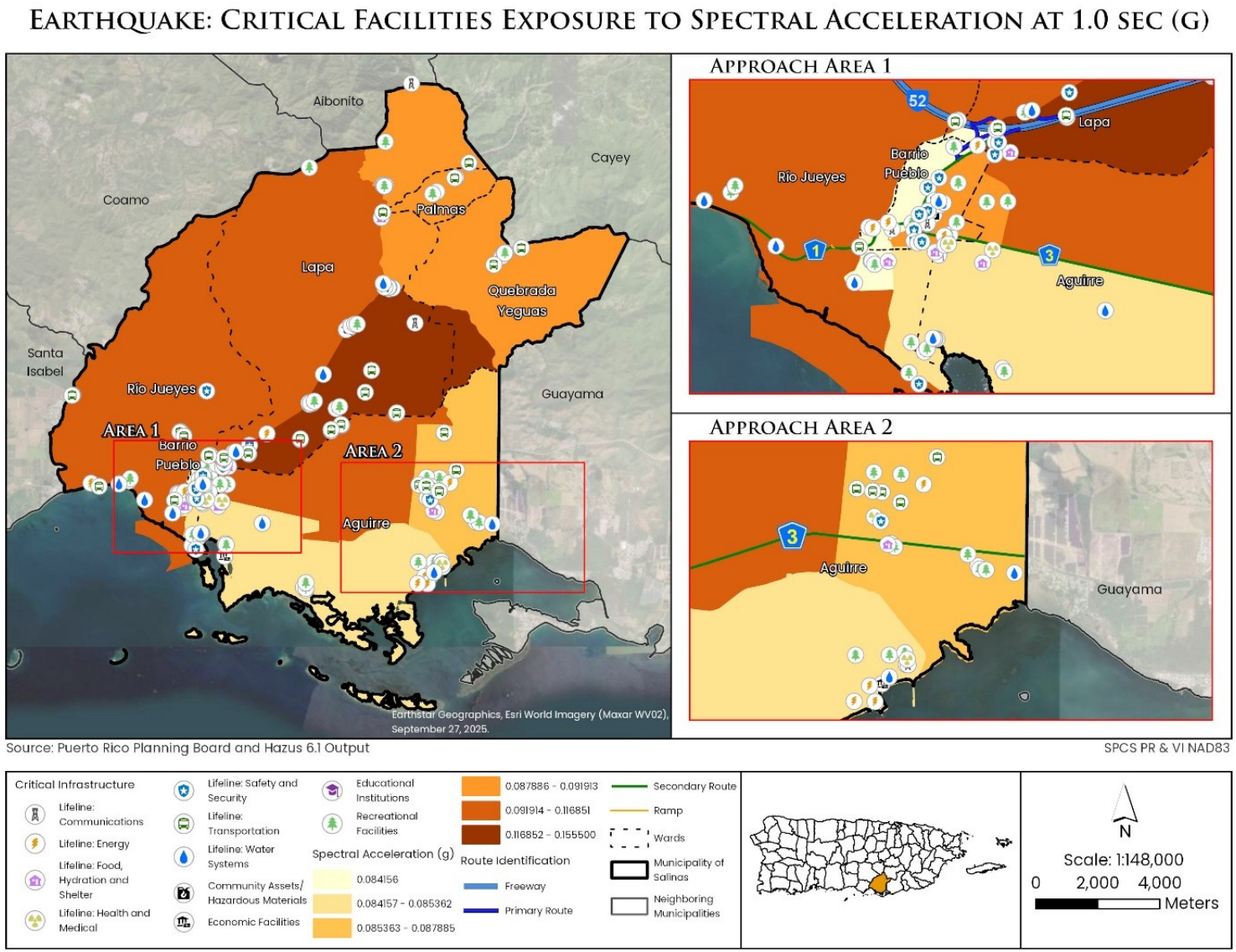
Critical facilities located within the highest spectral displacement zone include

transportation facilities, educational institutions, public safety facilities, communications infrastructure, water system assets, health and medical facilities, and community support facilities concentrated within the municipality's urban center and interior development corridor. These facilities are expected to experience greater building sway and structural demand during a seismic event.

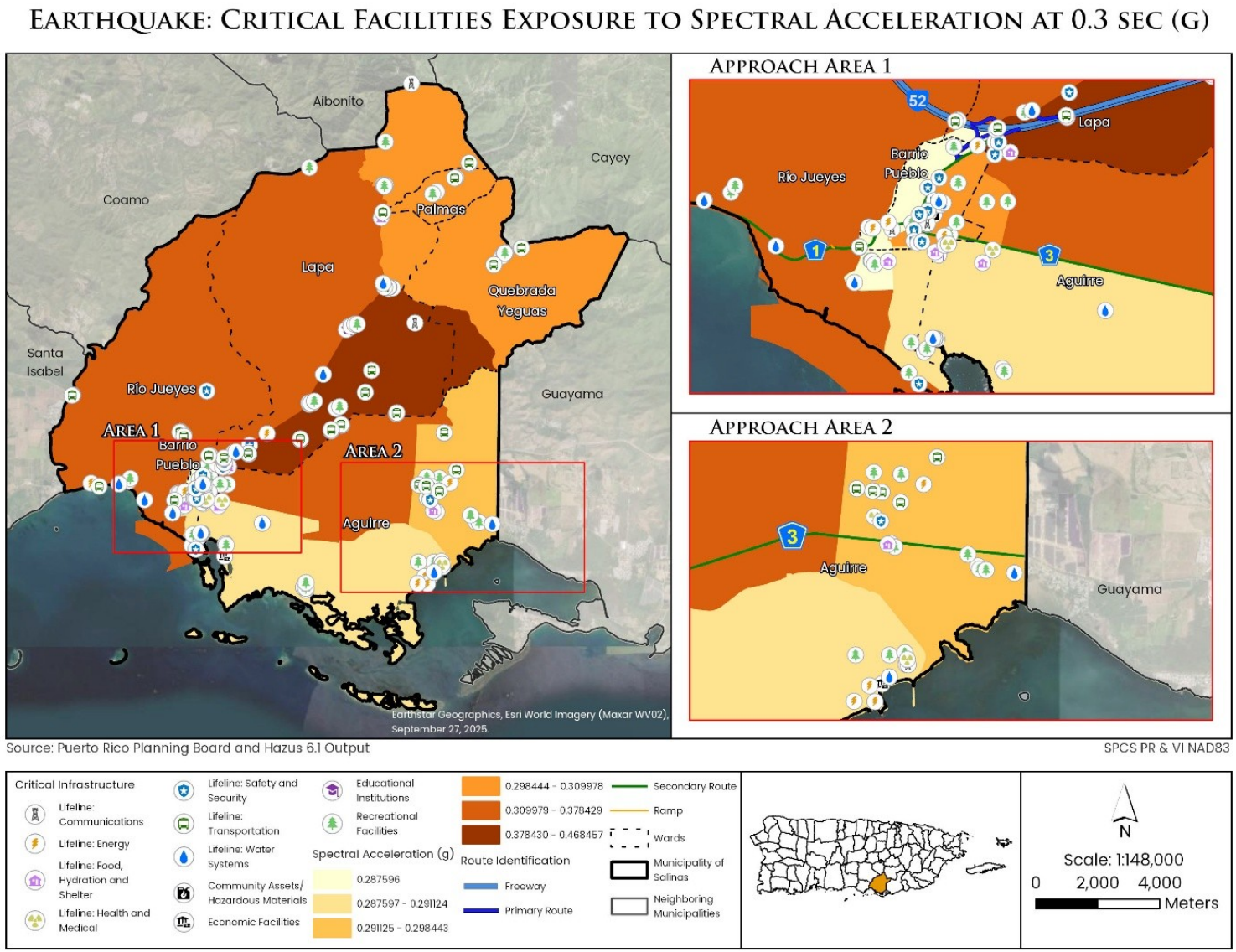
The southern coastal communities of Aguirre and portions of Pueblo ward are predominantly located within the lower spectral displacement zones. Although these facilities remain vulnerable to earthquake impacts, they are projected to experience comparatively lower structural movement than facilities located within the central interior portions of the municipality.

Overall, the analysis indicates that the municipality's most important concentration of critical infrastructure is located within the same corridor where the highest spectral acceleration and displacement values are projected. Therefore, a significant earthquake event could disrupt multiple lifelines simultaneously, particularly within the Pueblo-Lapa-Aguirre development corridor, where public services, transportation, water systems, educational facilities, health services, and emergency response functions are concentrated. Additionally, the population exposure maps indicate that large portions of Aguirre, Lapa, Quebrada Yeguas, and Río Jueyes are located within High, Very High, and Extreme seismic hazard zones, further highlighting the importance of maintaining and improving seismic resilience measures throughout the municipality.

Map 16: Earthquake Critical Facilities Exposure to Spectral Acceleration at 1.0 sec



Map 17: Earthquake - Critical Facilities exposure to spectral acceleration at 0.3 sec



4.6.2.3 Social Vulnerabilities

Social vulnerability to earthquakes in Puerto Rico is shaped by high levels of poverty, aging infrastructure, and limited access to essential resources, all of which disproportionately affect the ability of communities to withstand and recover from seismic events. Many residents face compounding disadvantages—such as disability, low educational attainment, and limited vehicle access—that reduce their capacity to evacuate, access information, or secure aid after a damaging earthquake. Research on disaster governance also shows that systemic governmental neglect and energy insecurity intensify the impacts of disasters, leaving communities with fewer resilience mechanisms in the aftermath of earthquakes.

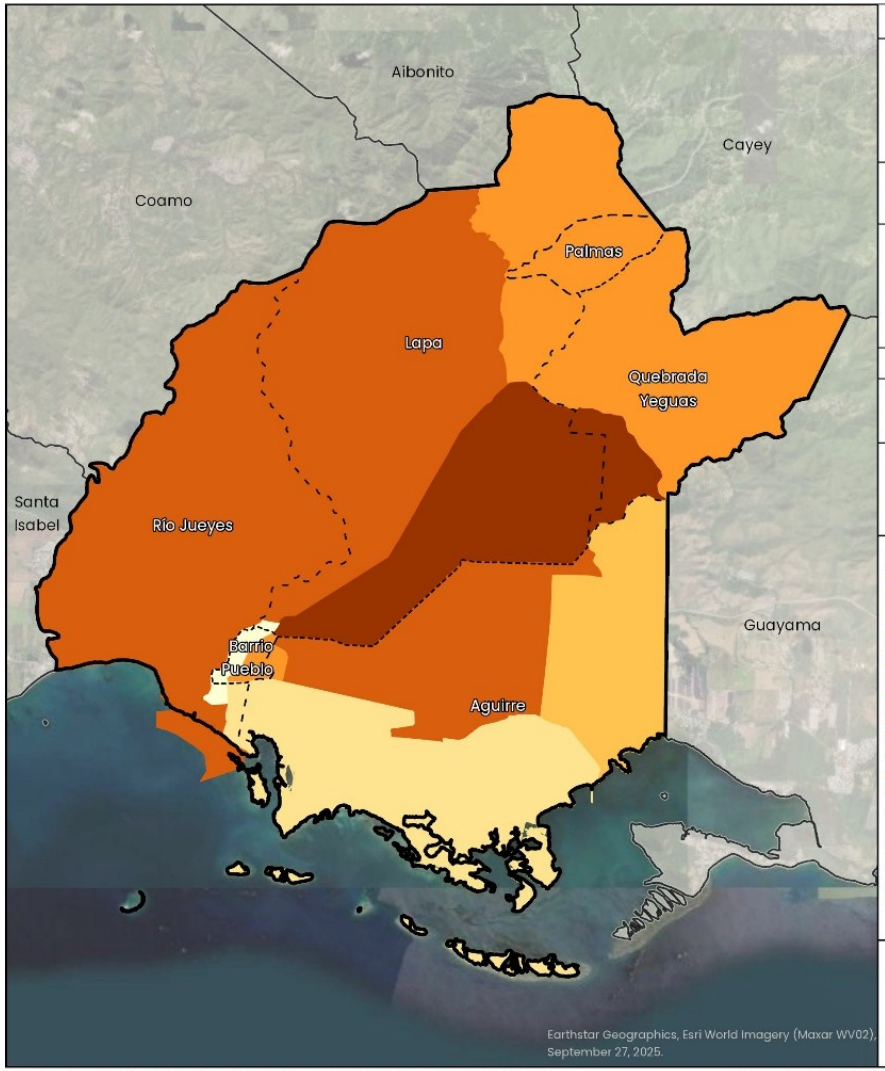
Puerto Rico's disaster research literature identifies long-standing structural inequities that heighten vulnerability, including political and economic marginalization that limit long-term recovery and exacerbate risk accumulation across hazard types. Federal assessments further find that many census tracts exhibit high social vulnerability scores (US Census Bureau, 2024), (US Census Bureau, 2025), meaning that an earthquake's impacts are likely to intersect with broader socio-economic fragility. Overall, these combined factors demonstrate that earthquakes in Puerto Rico pose not only a physical hazard but also a deep social challenge tied to historical, economic, and infrastructural conditions that shape uneven disaster outcomes.

Notwithstanding the classification of the municipal territory into areas of spectral acceleration in section 4.6.1,this version of the LHMP will be more conservative than the previous version and will consider all of the population of Salinas, equally vulnerable to the natural hazard of earthquake.

Maps 18 and 19 show the population by ward by the risk category low, medium, high and very high areas of spectral acceleration at 0.3 and 1.0 g (sec). For the 1.0 g modeling the greatest concentration of population in an extreme category is in Lapa Ward. Same is true for the 0.3 g (sec).

Map 18: Earthquake: Population Exposed to Spectral Acceleration at 1.0 (g) sec

Earthquake: Population Exposure to Spectral Acceleration at 1.0 sec (g)

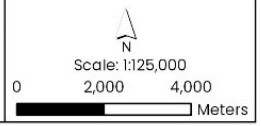


Wards	Risk Category	Population
Aguirre	Low	3,224
	Medium	3,177
	High	687
	Very High	3,671
Barrio Pueblo	Very Low	1,081
	High	1,480
Lapa	Very Low	151
	High	938
	Very High	907
	Extreme	4,786
Palmas	High	261
Quebrada Yeguas	High	1,497
	Extreme	716
Rio Jueyes	Very Low	436
	Low	90
	Very High	988

Spectral Acceleration (g)

- 0.084156 (Very Low)
- 0.084157 - 0.085362 (Low)
- 0.085363 - 0.087885 (Medium)
- 0.087886 - 0.091913 (High)
- 0.091914 - 0.116851 (Very High)
- 0.116852 - 0.155500 (Extreme)
- Wards
- Municipality of Salinas
- Neighboring Municipalities



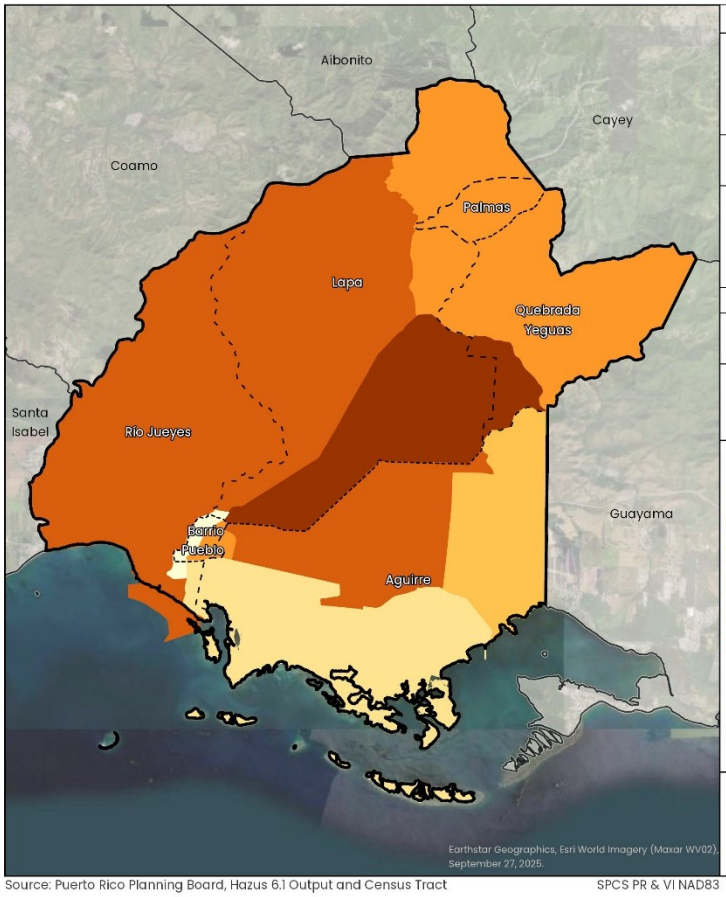


Source: Puerto Rico Planning Board, Hazus 6.1 Output and Census Tract

SPCS PR & VI NAD83

Map 19: Earthquake: Population Exposure to Spectral Acceleration at 0.3 (g) sec

Earthquake: Population Exposure to Spectral Acceleration at 0.3 sec (g)



Wards	Risk Category	Population
Aguirre	Low	3,224
	Medium	3,177
	High	687
	Very High	3,671
Barrio Pueblo	Very Low	1,081
	High	1,480
Lapa	Very Low	151
	High	938
	Very High	907
	Extreme	4,786
Palmas	High	261
Quebrada Yeguas	High	1,497
	Extreme	716
Río Jueyes	Very Low	436
	Low	90
	Very High	988

Spectral Acceleration (g)

- 0.287596 (Very Low)
- 0.287597 - 0.291124 (Low)
- 0.291125 - 0.298443 (Medium)
- 0.298444 - 0.309978 (High)
- 0.309979 - 0.378429 (Very High)
- 0.378430 - 0.468457 (Extreme)
- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

Scale: 1:125,000

0 2,000 4,000 Meters

Source: Puerto Rico Planning Board, Hazus 6.1 Output and Census Tract

SPCS PR & VI NAD83

4.6.2.4 Natural and Cultural Resources

Earthquakes can produce a wide range of impacts on natural and cultural resources:

- Landslides and Soil Instability: Seismic activity can trigger landslides, rockfalls, and soil liquefaction, altering natural landforms and damaging ecological habitats.
- Water Quality and Hydrology: Ground shaking may modify river pathways, impair aquifers, and increase sedimentation in water bodies, which can degrade water quality and disrupt aquatic ecosystems.
- Vegetation and Wildlife: Ground deformation and related secondary hazards such as flooding or fires can lead to habitat loss, fragmentation, and adverse effects on biodiversity.
- Coastal and Marine Environments: Submarine earthquakes may generate tsunamis, resulting in coastal erosion, coral reef degradation, and the deterioration of marine and estuarine ecosystems.

While the following damage can happen to Cultural Resources:

- Seismic forces can cause significant structural damage or the complete collapse of heritage structures, archaeological sites, and monuments.
- Museums and Archives: Earthquakes may lead to the loss, damage, or deterioration of artifacts, archival materials, and collections due to structural failures or insufficient seismic protection.
- Community Identity and Tourism: Damage to culturally important sites can undermine community identity and reduce tourism activity, thereby affecting local economic stability.

4.6.2.5 Future Conditions (E1-a)

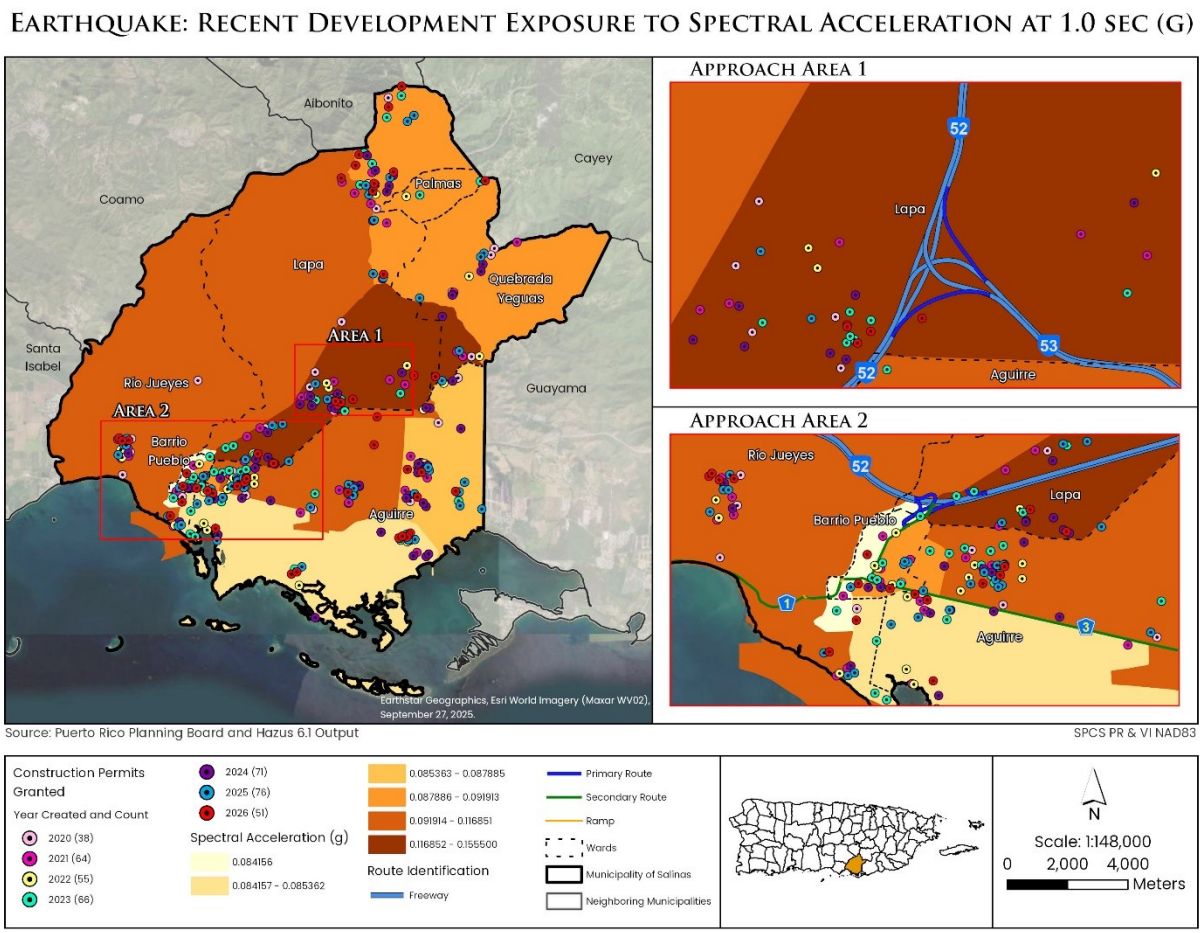
As discussed in Section 3.6, the number of constructions permits issued by the Municipality reflects a sustained level of economic activity. To further support this analysis, Maps 20 and 21 highlight the areas with the highest spectral acceleration values at 0.3 and 1.0 seconds, respectively, alongside the distribution of authorized construction permits. The maps show that many recent development projects are concentrated within Aguirre, Pueblo, Lapa, and Río Jueyes, including areas that correspond to High, Very High, and Extreme spectral acceleration zones. Particularly notable is the concentration of permits within the populated corridor extending from Pueblo toward Aguirre, where seismic acceleration levels are among the highest

identified in the municipality.

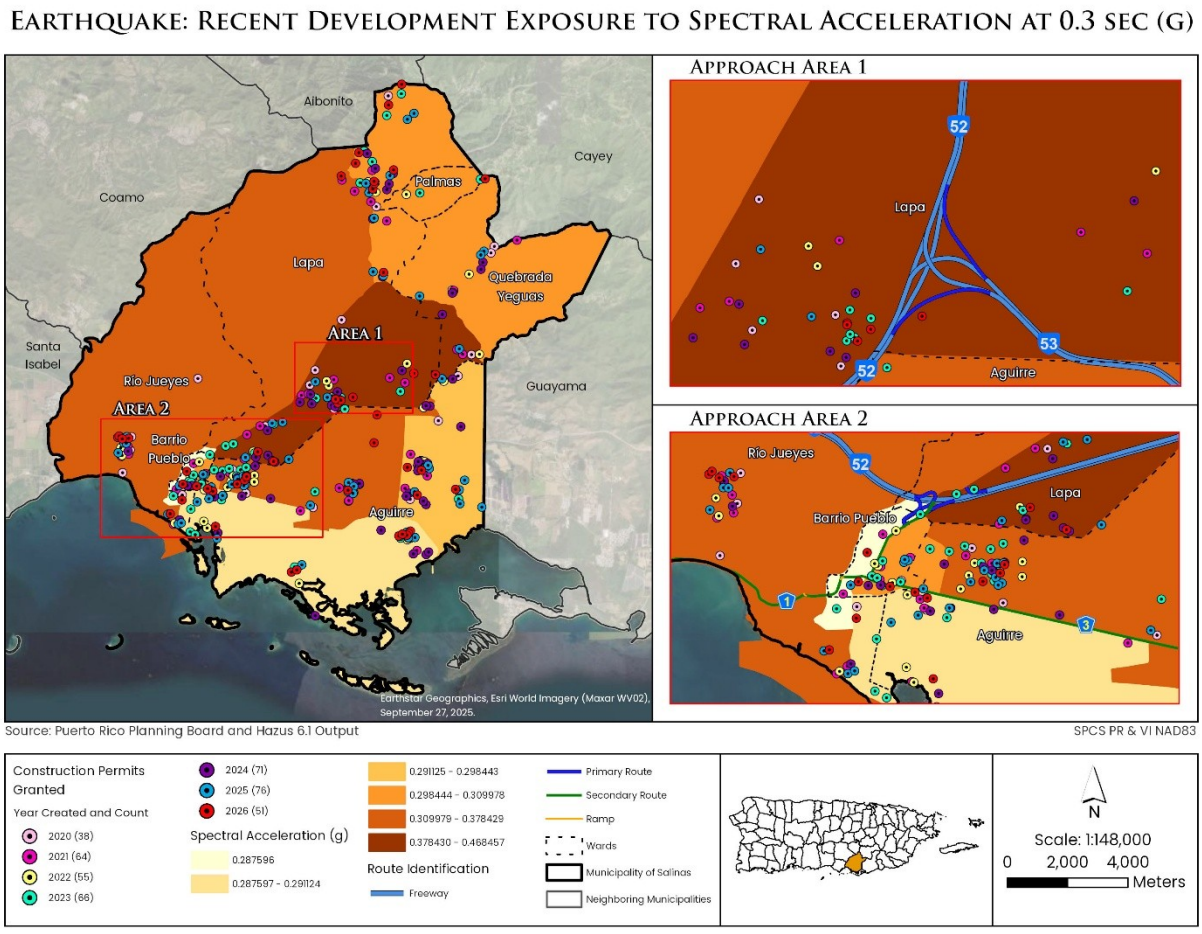
The earthquake exposure analysis indicates that significant portions of Lapa, Quebrada Yeguas, Aguirre, and Río Jueyes are located within zones characterized by elevated seismic demand. The population exposure maps further demonstrate that thousands of residents currently occupy these areas, including approximately 4,786 residents in the Extreme spectral acceleration zone within Lapa, 3,671 residents in the Very High zone within Aguirre, and additional populations located throughout Quebrada Yeguas and Río Jueyes. As new residential, commercial, and community development continues within these sectors, the number of structures and residents exposed to earthquake hazards is expected to increase.

Taking together, these findings indicate that future exposure to earthquake hazards is unlikely to diminish in the near term, as development continues to occur within areas of elevated seismic vulnerability. The concentration of new construction permits within established growth corridors, particularly in Aguirre, Pueblo, Lapa, and Río Jueyes, suggests that both population and building exposure to earthquake-related impacts may continue to increase unless future development incorporates appropriate seismic design standards and mitigation measures. Consequently, integrating hazard mitigation considerations into land-use planning, permitting decisions, and building design will remain essential to reducing future earthquake risk within the Municipality of Salinas.

Map 20: Earthquake: Recent Development Exposure to Spectral Acceleration at 1.0 sec



Map 21: Earthquake: Recent Development Exposure to Spectral Acceleration at 0.3 sec



4.7 Landslides

4.7.1 Description (B1-a)

Landslides are a natural geomorphological process characterized by the downslope movement of soil, rock, or debris due to terrain instability. These events occur when environmental conditions align such that gravitational forces acting on surface materials exceed their natural resistance. The term landslide encompasses multiple types of ground displacement including rockfalls, slope failures, and debris flows, all of which pose significant risks to life and property. Such movements can obstruct transportation routes and carry with them vegetation, homes, bridges, vehicles, and other infrastructure, causing extensive disruption and damage (FEMA, 1997).

Prolonged and intense rainfall associated with meteorological systems such as tropical waves, troughs, and tropical cyclones is one of the primary triggers of landslide events. Additionally, population growth and the expansion of informal construction increase the municipality's exposure to landslide hazards. Potable water supply and wastewater systems including sanitary pipes, septic tanks, and storm sewers whether properly authorized or informally installed, can further exacerbate slope instability. The likelihood of landslides rises significantly when these systems leak or are inadequately sited or constructed (USGS, n.d.).

Multiple factors contribute to the development of landslides, including soil type, terrain slope, degree of soil saturation, erosion processes, the presence of depressions or subsurface voids, human activities, and seismic events. The Building Performance Assessment Report (BPAR) prepared after Hurricane Georges warns that "landslides will become a major problem in the future as more houses are built and more development occurs in areas susceptible to these risks." This observation underscores the increasing vulnerability associated with continued development in high-risk zones (FEMA, 1997).

Many landslides in Puerto Rico fall into a specific subtype known as debris flows. These events typically occur in mountainous areas with steep slopes during periods of intense rainfall. As rainwater infiltrates the ground, the soil becomes saturated and the underlying subsurface layer losses its cohesion. This loss of stability causes the material to detach often at the interface where the subsurface meets the bedrock resulting in a rapid downslope flow of soil, rock, and water.

There are many types of landslides; however, those specifically linked to water-saturated soils include the following (PREMB, 2021):

- Slow Landslide: A gradual and sustained downslope movement of soil or rock. These events are often identifiable by displaced tree trunks, distorted or twisted fences and retaining walls, and leaning posts or structures.
- Debris Flow: A rapid mass movement in which loose soil, rocks, and organic material combine with infiltrated water and air to form a dense, viscous flow that travels swiftly down a hillside.
- Debris Avalanche: An extremely rapid or very fast-moving form of debris flow, characterized by high velocity and significant destructive potential.
- Mudflow: A fast-moving mass composed of water-saturated material containing at least 50 percent sand, silt, and clay particles.

4.7.1.1 Affected Area (B1-b)

The areas most affected by landslides in the Municipality of Salinas are primarily located in its mountainous northern region, which occupies a significant portion of the municipal territory. The municipality is characterized by two distinct physiographic zones: a mountainous interior associated with the foothills of the Cordillera Central and Sierra de Cayey, and a southern coastal plain that extends through Aguirre, Pueblo, and portions of Río Jueyes. Because the mountainous terrain occupies much of the northern half of the municipality, it significantly increases susceptibility to slope instability and landslide events.

The landslide susceptibility map indicates that the highest concentrations of Moderate and High landslide susceptibility occur within the wards of Palmas, Lapa, and Quebrada Yeguas, particularly near the municipal boundaries with Aibonito, Cayey, and Coamo. Numerous areas of elevated susceptibility are also present in the northern portions of Río Jueyes, while the southern coastal wards of Aguirre and Barrio Pueblo are predominantly classified as having Low landslide susceptibility.

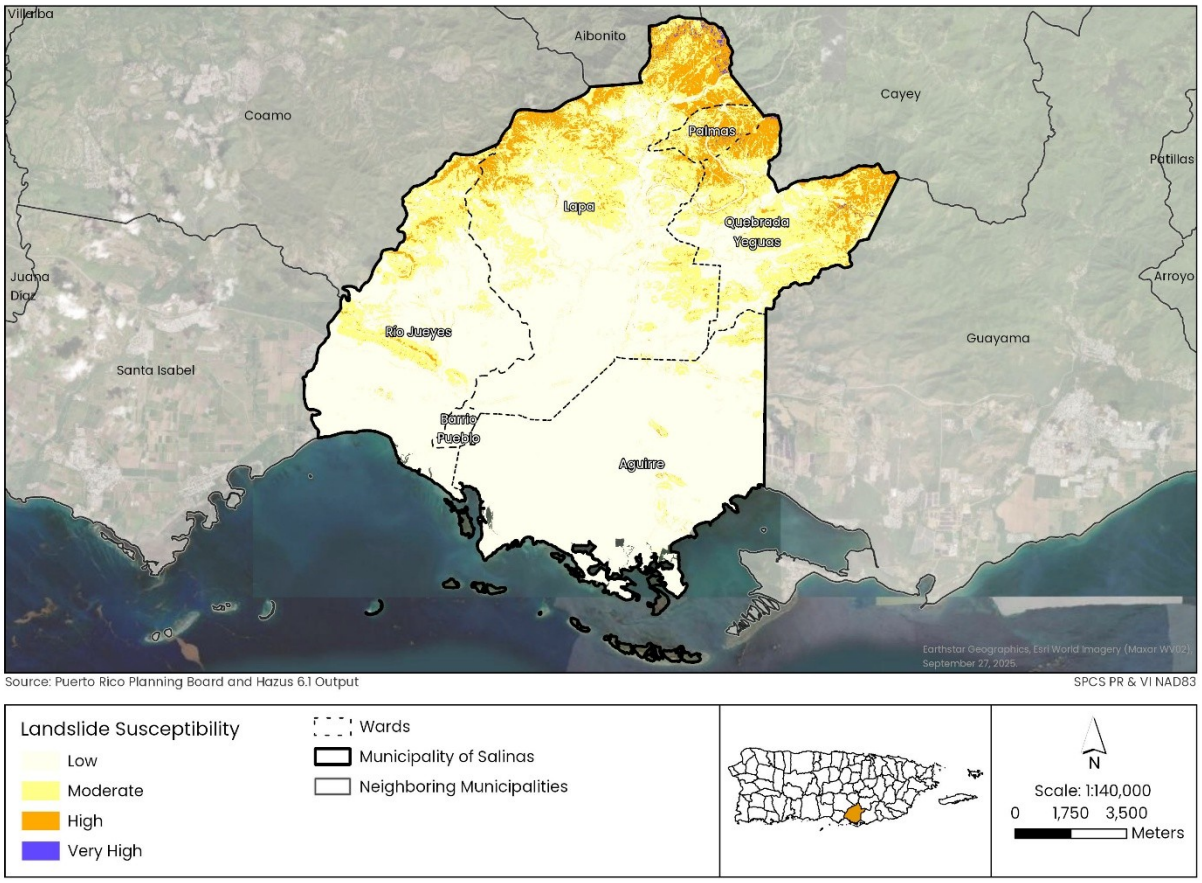
The spatial distribution of susceptibility shown on the map is directly related to the municipality's topography, where steep slopes, highly weathered soils, and drainage patterns increase the likelihood of slope failures. The most vulnerable areas are concentrated along mountainous ridges and dissected hill slopes located within Palmas, Lapa, and Quebrada Yeguas, while the flatter alluvial and coastal areas exhibit substantially lower susceptibility. The pattern observed is consistent with previous studies that identify the northern interior wards as the area's most prone to

landslide activity due to their elevation, slope gradient, and geologic characteristics.

Roadway corridors crossing the mountainous region are particularly vulnerable. As documented in previous studies, there is a strong relationship between transportation infrastructure and landslide occurrence, because roadway cuts and embankments frequently modify natural slopes and drainage conditions. In Salinas, road segments located within Palmas, Lapa, and Quebrada Yeguas, as well as portions of the northern Río Jueyes ward, are potentially susceptible to slope failures during periods of prolonged or intense rainfall.

In summary, landslides in Salinas are most prevalent in the municipality's northern mountainous wards, particularly Palmas, Lapa, and Quebrada Yeguas, with additional susceptible areas in northern Río Jueyes. The steep terrain, combined with soil saturation during extreme rainfall events and the presence of transportation corridors traversing the upland region, contributes to elevated landslide susceptibility throughout these areas. Conversely, the coastal wards of Aguirre and Pueblo generally exhibit low susceptibility due to their relatively flat topography and lower slope gradients.

Map 22: Landslide Susceptibility



4.7.1.2 Risk Magnitude (B1-c)

Landslides typically occur in steep, mountainous areas during periods of intense or prolonged rainfall. As water infiltrates the ground, the soil becomes saturated, weakening natural drainage systems and reducing the structural capacity of the terrain, which can ultimately lead to slope failure. Certain areas are inherently more susceptible to landslides than others, particularly those with greater slope gradients. Vegetation plays a critical role in maintaining soil cohesion and reducing surface erosion; therefore, slopes lacking vegetation are generally more prone to instability.

Slope stability is influenced by several factors, including elevation, steepness, vegetative cover, and underlying geology. In general, increases in slope height and inclination correlate with a greater likelihood of terrain instability. Below are key factors that contribute to the occurrence of landslides:

- The base of inclined slopes
- Areas near small depressions where drainage converges
- The lower portion of slopes is composed of fill - material
- The base or crest of a very steep slope
- Locations with a history of previous landslides
- Hillsides that have been developed and where septic systems are present
- Steep slopes underlain by clay-rich soils
- Hills or slopes with inclinations greater than 12 degrees and elevations exceeding 300 meters

The hazard categories are derived from the USGS classification index, which evaluates slope and soil characteristics as defined by the agency. Table 23 outlines these categories—low, moderate, high, and very high—and describes the corresponding levels of hazard.

Table 23: Landslide Risk Categories

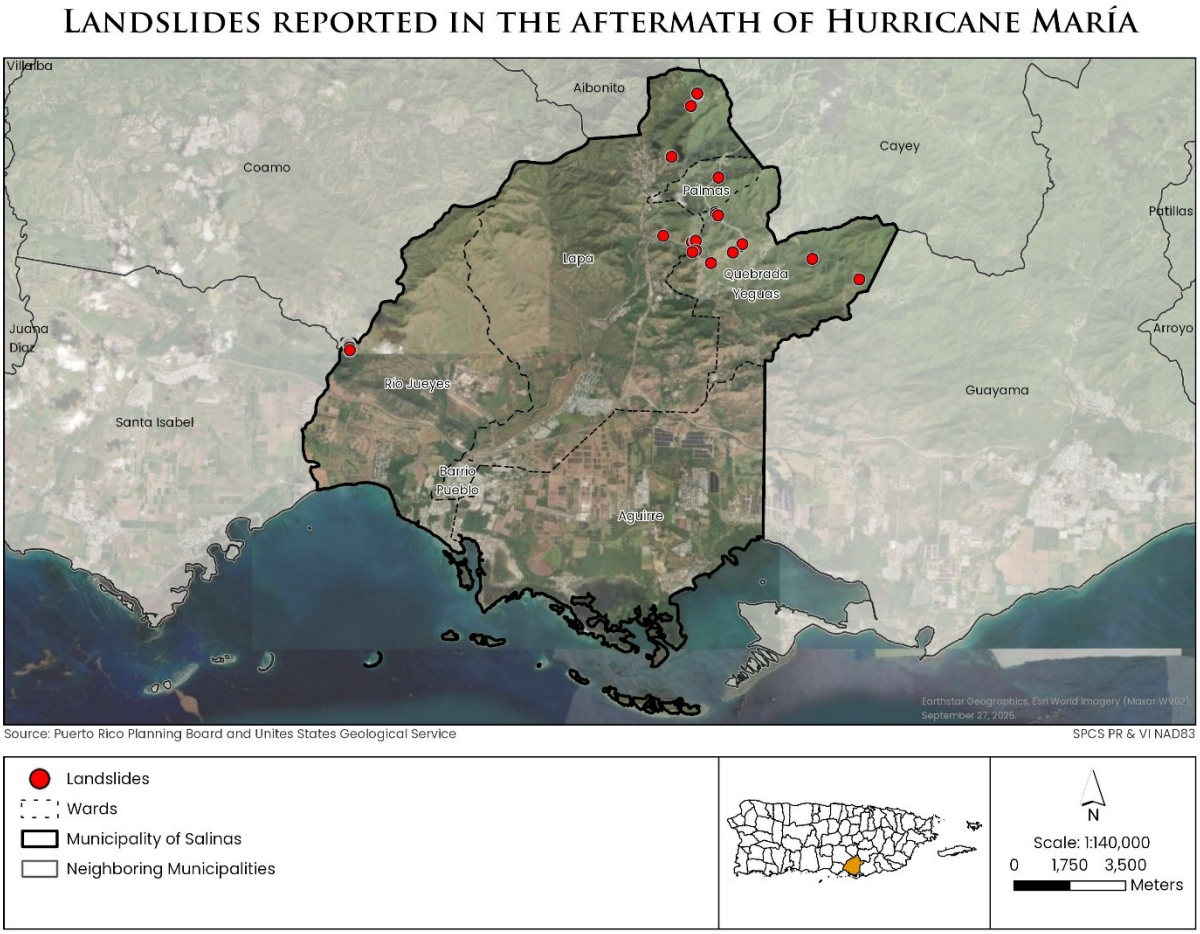
Category	Description
Low	Areas with minimal slopes and stable soil; landslides are unlikely except under extreme conditions.
Moderate	Areas with some susceptibility; landslides may occur during prolonged or intense rainfall.
High	Areas with significant susceptibility; landslides are likely during heavy rain or seismic activity.
Very High	Areas extremely prone to landslides; frequent events during storms or earthquakes.

The municipality incorporates landslide prevention and mitigation measures as an integral component of its earthquake response protocol. (Municipio de Salinas, 2020)

4.7.1.3 Past Events

As noted earlier, landslides are frequently associated with heavy rainfall events. Map 23 illustrates the landslides reported following Hurricane María in 2017, which align with the areas of greatest susceptibility shown in the map. Landslides are often connected to rain events and the prevalence of roadways (Larsen & Park, 1997) (Larsen & Torres-Sanchez, 1998). According to data from the U.S. Geological Survey (USGS), more than 200 individual landslides were identified following Hurricane María (Hughes, Bayouth García, Martínez Milian, Schulz, & Baum, 2019).

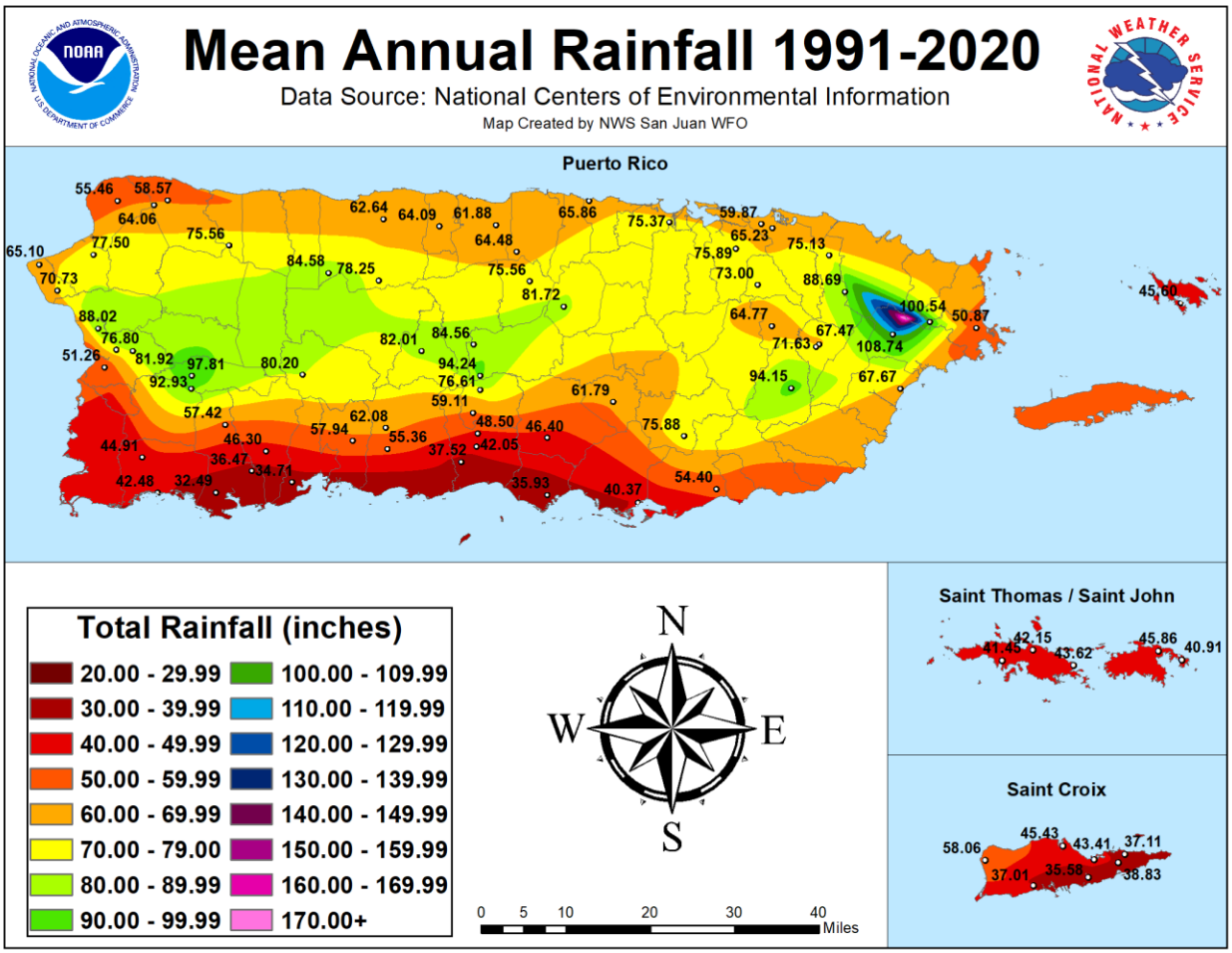
Map 23: Landslides related to Hurricane María



4.7.1.4 Future Event Probabilities

Although landslides can also result from earthquakes or human activities, most landslides in Puerto Rico are triggered by rainfall. As previously discussed, these events can occur during any type of rain event. The Figure below presents the Mean Annual Rainfall for Puerto Rico and the U.S. Virgin Islands from 1991 to 2020. The Municipality of Salinas lies within four (4) different zones that receive between 30 and 69.99 inches of rainfall annually. Given these precipitation levels, landslides are expected to continue occurring in some areas in the municipality.

Figure 14: Mean Annual Rainfall 1991-2020 (PR & USVI)[7]



4.7.2 Risk Analysis

4.7.2.1 Estimated Losses

In the Municipality of Salinas, as in many other parts of Puerto Rico, landslides most often occur during or immediately after major storms that produce intense, prolonged rainfall. Rainfall-induced landslides are closely linked to severe weather systems or consecutive rain events that saturate steep and vulnerable soils.

At present, no standardized models exist to quantify structural or content losses resulting from landslides or other mass-movement events. Consequently, USGS susceptibility indices were applied empirically using the best available data to estimate potential impacts from these hazards in Salinas . These indices classify risk

[7] Obtained from https://www.weather.gov/sju/climo_pr_usvi_normals

into four levels: low, moderate, high, and very high. Due to data limitations, it is not currently possible to calculate monetary losses associated with building damage.

4.7.2.2 Lifelines and Critical Infrastructure

Landslides can impact FEMA Lifelines in the following ways:

- Safety and Security: Landslides can trap and injure or kill individuals through rapidly moving debris, hinder rescue operations, and create life-safety risks when emergency services become isolated or damaged (Center for Disaster Resilient Communities, n.d.).
- Food, Hydration, and Shelter: Landslides can destroy homes and agricultural areas, resulting in displacement and increased food insecurity. They may also disrupt local water and sanitation systems, heightening contamination risks, especially within temporary shelter environments (IFRC, 2023).
- Health and Medicine: Landslides can cause direct injuries such as trauma or suffocation, while longer-term impacts may include outbreaks of waterborne and vector-borne diseases, as well as psychological distress and trauma among survivors (Center for Disaster Resilient Communities, n.d.).
- Energy: Landslides can severely damage power lines, electrical substations, and fuel supply infrastructure, resulting in widespread power outages that hinder both public services and emergency response operations.
- Communications: Damage to communication cables, fallen utility poles, and restricted access to telecommunications infrastructure can disrupt alert and warning systems, hinder coordination among emergency responders, and impair public information networks.
- Transportation: Landslides can render roads, railways, bridges, and tunnels impassable or destroy them entirely as debris obstructs critical routes, severely limiting mobility for the public and restricting access for emergency response services.
- Hazardous Materials: Landslides can rupture containment structures, pipelines, storage tanks, or industrial facilities, leading to the release of hazardous chemicals or pollutants and potentially triggering HAZMAT emergencies (FEMA, 2024).
- Water Systems: Landslides can damage water intakes, treatment plants, distribution lines, and wastewater collection and treatment facilities, leading to contamination, reduced water pressure, and significant service interruptions (IFRC, 2023).

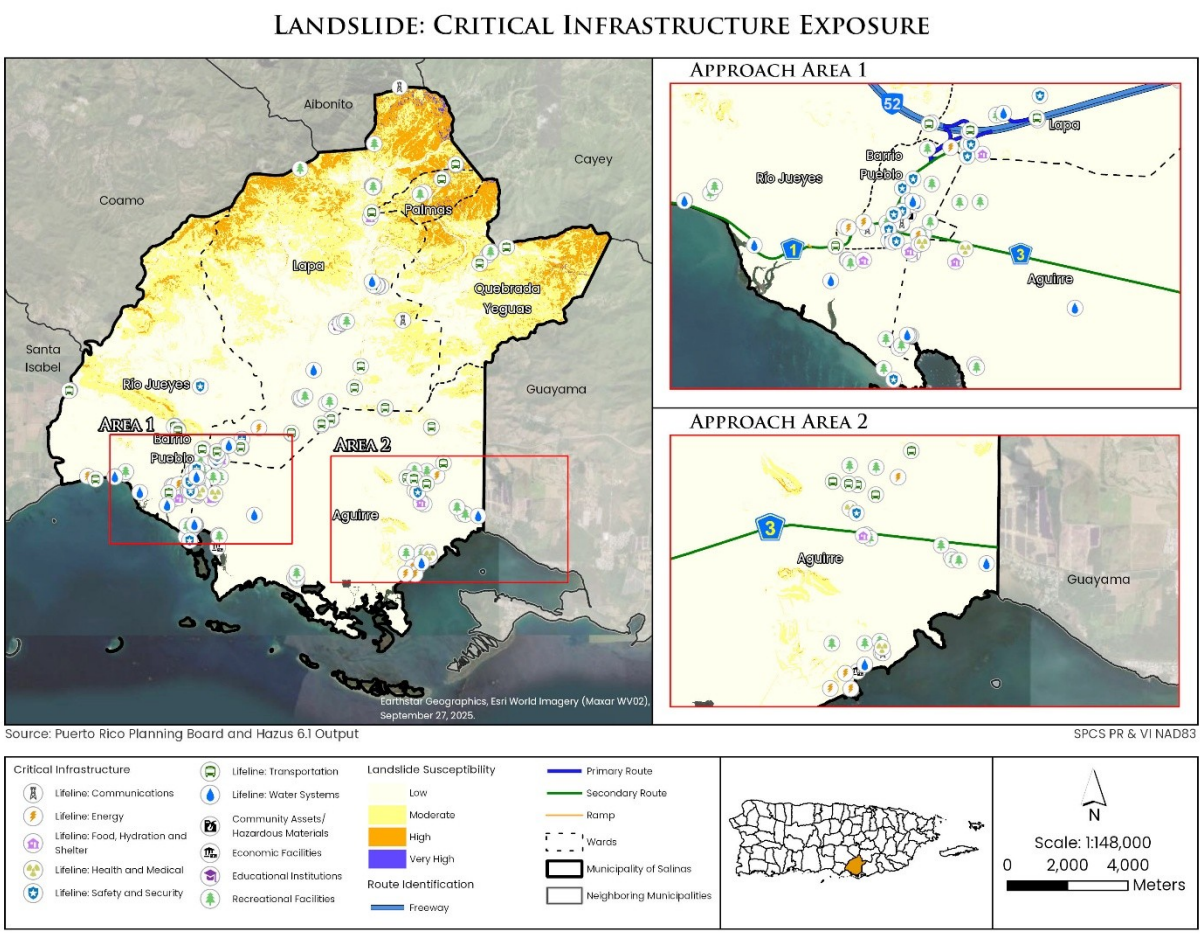
Map 24 shows the identified critical infrastructure that could be affected by landslides. As this map shows, the majority of critical facilities in Salinas are located within the relatively flat southern and coastal portions of the municipality, particularly in Pueblo and Aguirre, where landslide susceptibility is generally classified as low. Consequently, most transportation, public safety, educational, health and medical, communications, water system, and community facilities are not directly exposed to the areas of highest landslide susceptibility.

However, several critical facilities are located near or within areas of moderate to high landslide susceptibility in the northern and northeastern portions of the municipality, particularly within the wards of Palmas, Lapa, and Quebrada Yeguas. These areas correspond to the mountainous region of Salinas, where steep slopes and complex topography increase the probability of slope instability during heavy rainfall events. Facilities associated with transportation, communications, utility, and recreational lifelines are the most likely to be affected in these upland sectors.

The map also highlights the potential vulnerability of transportation corridors traversing the northern portion of the municipality. Because many roads providing access to Palmas, Lapa, and Quebrada Yeguas cross areas with moderate and high landslide susceptibility, slope failures could disrupt access to critical facilities and emergency response routes during or immediately after major storm events. This finding is consistent with previous research indicating a strong relationship between roadway infrastructure and landslide occurrence (Larsen & Park, 1997; Larsen & Torres-Sánchez, 1998).

Although the highest concentrations of critical infrastructure are located within the lower-susceptibility southern wards, facilities situated in or serving the northern mountainous region remain vulnerable to indirect impacts resulting from landslides, including roadway closures, utility interruptions, and restricted emergency access. Therefore, maintaining transportation connectivity and implementing slope stabilization and drainage improvements in the northern wards will be important for reducing future landslide-related impacts to critical infrastructure throughout the Municipality of Salinas.

Map 24: Landslide: Critical Infrastructure Exposure



4.7.2.3 Social Vulnerabilities

Social vulnerability to landslides in Puerto Rico is the product of topography, poverty, aging populations, fragile infrastructure, and geographic isolation, all of which shape the severity of impacts after major storms or seismic events. Academic and federal analyses consistently show that landslides disproportionately burden communities that already struggle with access to transportation, healthcare, income stability, and emergency response. Addressing these vulnerabilities requires hazard mitigation strategies that integrate geospatial risk analysis, social vulnerability indicators, community-based planning, and infrastructure reinforcement tailored to rural and mountainous municipalities (West, Rodríguez Cruz, & Hughes, 2023).

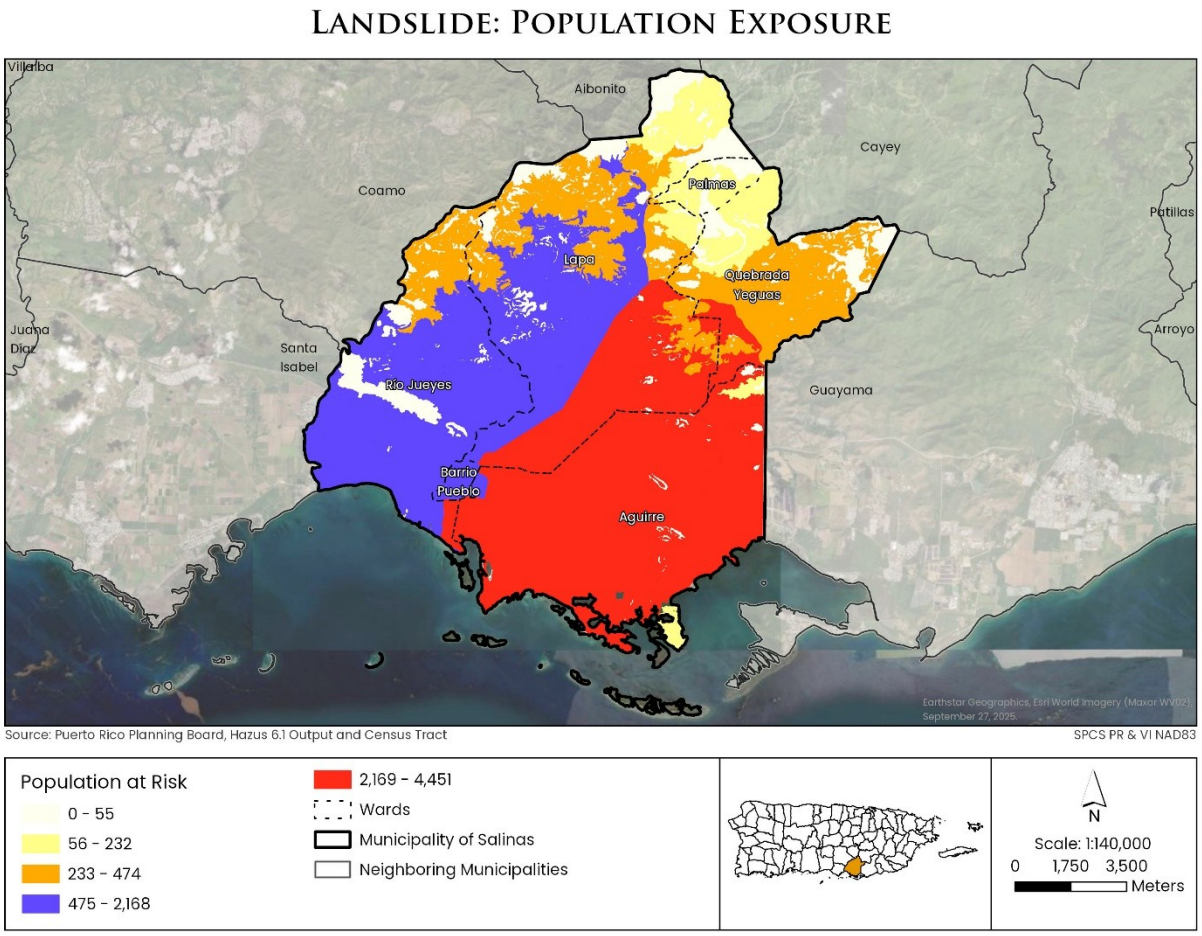
As discussed earlier, a significant portion of Salinas' population is exposed to moderate, high, very high, or extreme landslide susceptibility zones, particularly within the northern wards of Palmas, Lapa, and Quebrada Yeguas. The population exposure maps indicate that the largest concentrations of residents located within the highest susceptibility categories are found in Lapa, where approximately 4,786 residents are located within the Extreme susceptibility zone, and Aguirre, where approximately 3,671 residents are located within the Very High susceptibility zone. Additional populations exposed to elevated landslide susceptibility are present in Quebrada Yeguas, Río Jueyes, and Palmas.

Of particular concern, residents in the municipality's mountainous wards often depend on a limited number of roadway connections to access public services and the urban center. Landslides triggered by intense rainfall can damage or block these transportation routes, temporarily isolating communities and restricting access to emergency services. As shown in the landslide susceptibility and Hurricane María landslide inventory maps, many of the documented slope failures occurred within the northern upland sectors of Palmas, Quebrada Yeguas, and Lapa, where roadway corridors traverse steep terrain and unstable slopes.

This condition is consistent with previous research demonstrating a strong relationship between roadway infrastructure and landslide occurrence (Larsen & Park, 1997; Larsen & Torres-Sánchez, 1998). Disruptions affecting critical transportation routes can restrict access to medical facilities, emergency response services, utilities, food distribution, and other essential services. While the majority of critical infrastructure is located within the lower-susceptibility wards of Pueblo and Aguirre, residents of the northern mountainous communities may experience significant access limitations following major rainfall events.

Consequently, landslide events have the potential to create immediate life-safety concerns for vulnerable populations, including individuals with chronic health conditions, mobility limitations, or emergency medical needs. Although the most severe impacts documented following Hurricane María were concentrated in the municipality's northern wards, future extreme rainfall events could produce similar disruptions. Therefore, maintaining roadway connectivity, implementing slope stabilization measures, and improving emergency access routes remain important priorities for reducing landslide risk in the Municipality of Salinas.

Map 25: Landslide: Population Exposure



4.7.2.4 Natural and Cultural Resources

Landslides are among the most destructive natural hazards, producing impacts that extend far beyond the immediate physical damage they cause (Eliot, Cloyd, & Philbin, 1994). Their effects on natural resources are profound and often irreversible. When a landslide occurs, vast areas of vegetation are uprooted or buried, leading to the loss of critical habitats and a decline in biodiversity. The displacement of soil not only strips away fertile layers essential for agriculture but also introduces large volumes of sediment into rivers and reservoirs. This sedimentation degrades water quality, disrupts aquatic ecosystems, and can compromise drinking water supplies. Furthermore, landslides frequently alter hydrological systems by blocking river channels, creating temporary dams that increase flood risk and modify groundwater recharge patterns.

The cultural dimension of landslide impacts is equally significant. Archaeological sites,

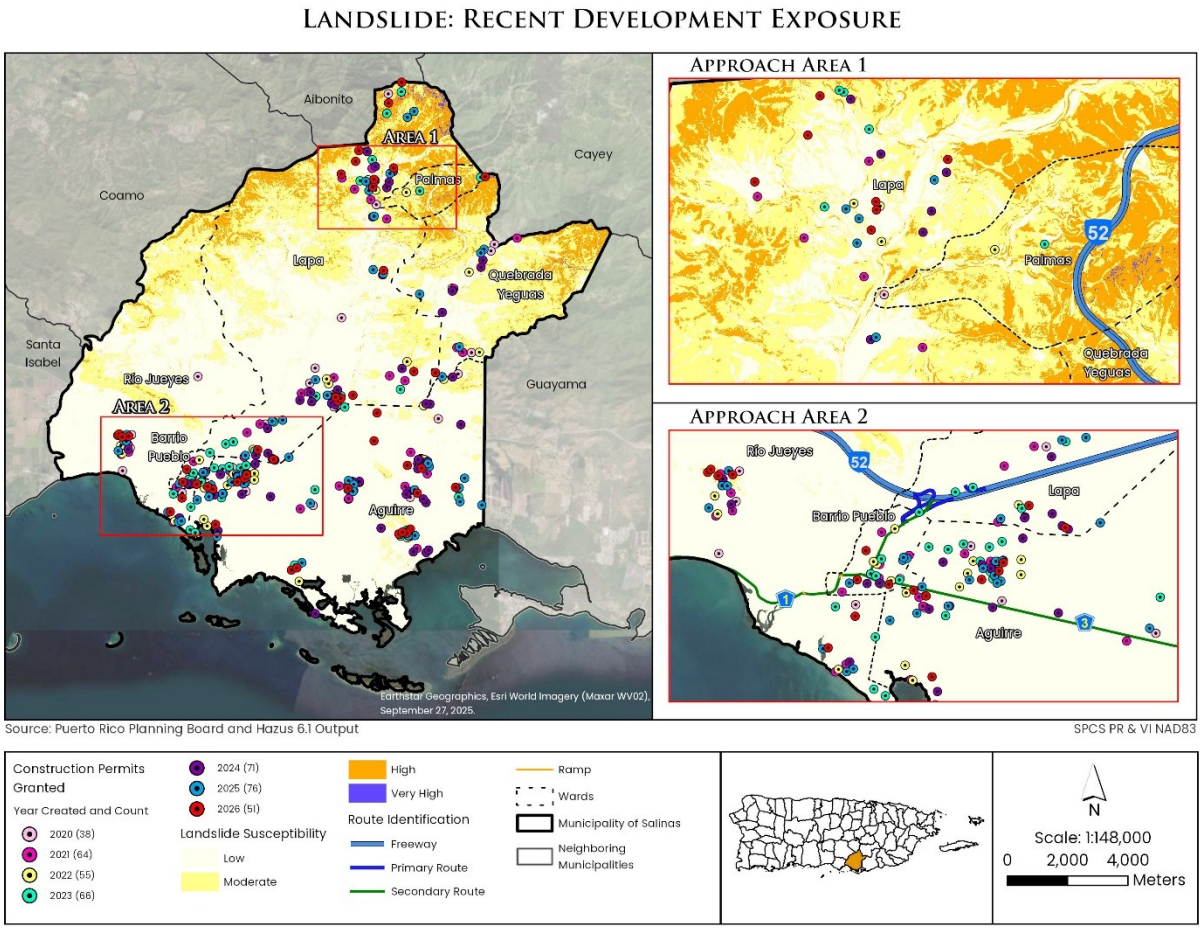
historic monuments, and culturally significant landscapes are highly vulnerable to burial or destruction during such events. These losses are irreplaceable, erasing tangible links to the past and diminishing cultural heritage. In many regions, landslides have damaged centuries-old structures, including churches, colonial buildings, and sacred sites, resulting in costly restoration efforts or permanent loss. Beyond physical damage, the alteration of cultural landscapes such as terraced fields or ceremonial grounds undermines community identity and traditions deeply tied to the land. Economically, these impacts ripple through local economies dependent on cultural tourism, reducing visitor numbers and income for communities that rely on heritage-based activities.

4.7.2.5 Future Conditions

As shown in Map 25, recent development in the municipality has generally not occurred within the areas of highest landslide susceptibility, which are concentrated primarily in the northern mountainous wards of Palmas, Lapa, and Quebrada Yeguas. Most recent construction activity has been concentrated within the more developed and accessible sectors of Pueblo, Aguirre, and Río Jueyes, where landslide susceptibility is generally classified as low to moderate. The areas with the greatest concentration of recent development are located within the southern coastal plain, outside the zones identified as having the highest potential for slope instability.

This means that future exposure to landslide hazards is not expected to increase substantially as a result of recent development trends. The current pattern of growth indicates that new construction is generally occurring in areas with lower landslide susceptibility, thereby limiting the number of new structures and residents being placed in the municipality's highest-risk landslide zones. However, because portions of the transportation network serving Palmas, Lapa, and Quebrada Yeguas continue to traverse areas of moderate and high landslide susceptibility, existing communities and infrastructure within the northern mountainous region remain vulnerable to roadway closures, utility disruptions, and restricted emergency access during periods of intense rainfall. Consequently, although recent development patterns appear favorable from a landslide risk perspective, continued monitoring of development activity in the northern wards and the implementation of slope stabilization measures remain important components of the municipality's hazard mitigation strategy.

Map 26: Landslide: Recent Development Exposure



4.8 TSUNAMI

4.8.1 DESCRIPTION (B1-A)

A tsunami, or tidal wave, is a series of waves typically caused by a vertical displacement of the ocean floor resulting from an underwater earthquake. Tsunamis can also be triggered by submarine landslides or volcanic eruptions in a specific region. The characteristics of a tsunami vary depending on whether the wave is moving through deep water or approaching the shore. In deep waters, these waves can travel at speeds of up to 500 miles per hour and appear as low waves, generally less than one foot above sea level, often unnoticed by vessels at sea. The distance between wave crests is usually very wide. As the waves near coastal areas, their speed decreases significantly while their height increases dramatically because the wave frequency rises as its amplitude diminishes. This phenomenon can produce massive waves, sometimes exceeding 98 feet in height. However, tsunamis are often sudden,

large surges in sea level along the coast, resembling a powerful tide rushing inland. Additional warning signs may precede a tsunami. These include a noticeable retreat of the sea—where water recedes from the shore—or a rapid and excessive rise in coastal sea level. Typically, a loud roar from the ocean can be heard, similar to the sound of a low-flying aircraft. Other noises may occur as powerful waves crash against reefs, rocks, and objects dragged by the current.

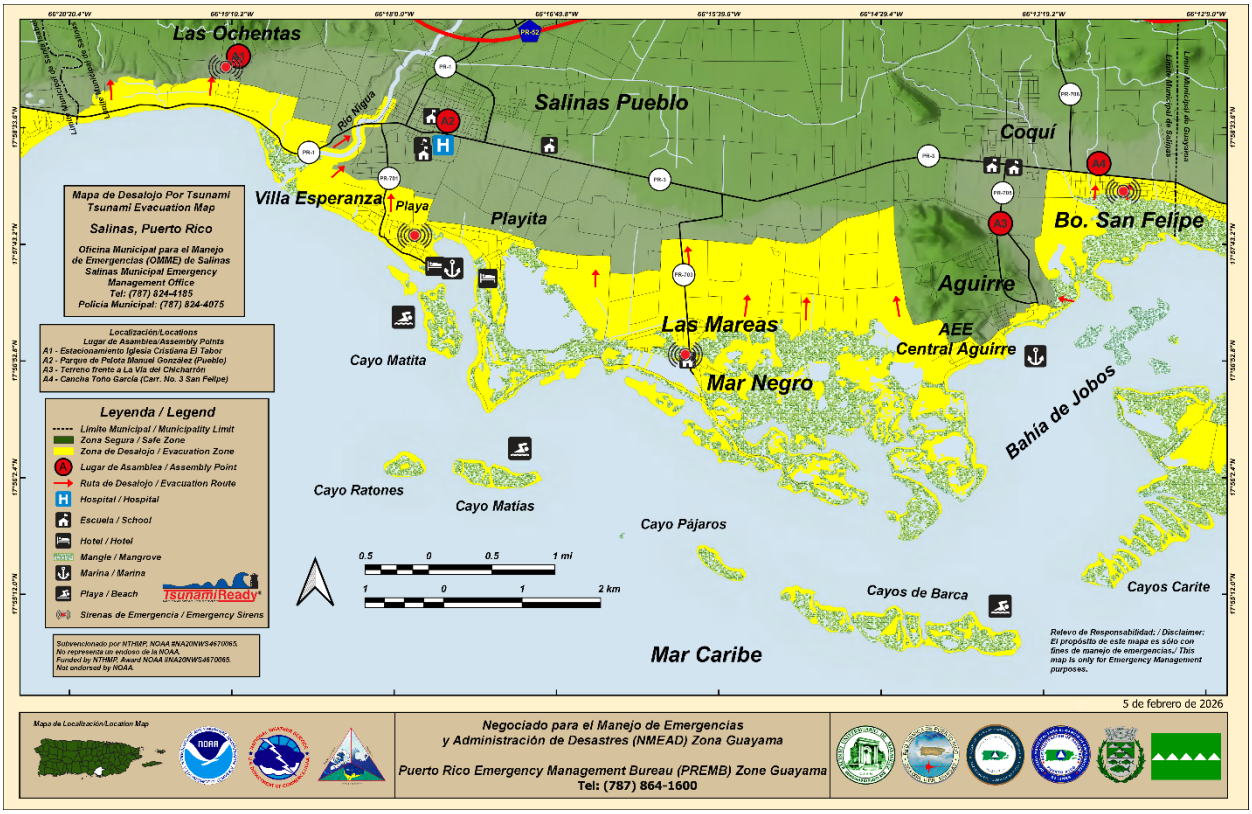
Although tsunami hazards cannot be prevented, municipalities can implement mitigation measures through individual and collective preparedness, maintain alert systems to warn vulnerable communities, and ensure an effective response after such an event. In Puerto Rico, efforts have been coordinated under the National Tsunami Hazard Mitigation Program (NTHMP) at the University of Puerto Rico at Mayagüez (UPRM) and by UNESCO's IOCARIBE for regional areas. This program aims to reduce tsunami impacts through disaster assessment, alert messaging guidance, and mitigation strategies. NTHMP develops tsunami inundation maps, disseminates information through media for community drills, and promotes awareness of past events. Mitigation efforts include improving information dissemination, reducing risks, creating evacuation plans, producing educational materials, and implementing NOAA's Tsunami Ready Program, among other initiatives.

4.8.1.1 Affected Area (B1-B)

Figure 15 below shows the Tsunami Evacuation Map developed by PREMB and other partners[8]. In the event of a Tsunami, the area's most vulnerable include the coastal communities of **Las Ochentas, Villa Esperanza, Playita, Las Mareas, Mar Negro, Aguirre, Coquí, and Barrio San Felipe**, which are located within the designated tsunami evacuation zone along the Caribbean coastline and Bahía de Jobos. The map identifies areas at risk, designated assembly points, emergency sirens, critical facilities, and evacuation routes leading to higher ground and safer inland locations. It also illustrates the official tsunami evacuation routes and assembly areas established to support the timely and orderly evacuation of residents and visitors from exposed coastal sectors.

Figure 15: Tsunami Evacuation Map

[8] NOAA, NWS, PRSN and University of Puerto Rico, Mayagüez



4.8.1.2 Risk Magnitude (B1-C)

Tsunami events rank among the most severe natural disasters. Among the hazards associated with a tsunami event are the following:

- Flooding of low-lying coastal areas: This occurs when tsunami waves penetrate inland, causing property destruction and fatalities due to drowning.
- Damage to coastal properties and buildings: Homes and structures located near the shoreline can suffer severe damage, rendering them uninhabitable. Additionally, these waves cause significant coastal erosion and undermine building foundations by washing away sand and soil, increasing their reach and force.
- Floating debris and large objects: A tsunami can carry debris or even large vessels inland, creating additional hazards and potentially causing major accidents and further tragedies.

Although this natural phenomenon moves slowly across the ocean, the force of a tsunami's waves can cause thousands of deaths and extensive property damage, including homes, critical facilities, and municipal infrastructure. If the disturbance originates near a coastal area, the tsunami can devastate the community within

minutes (NOAA, n.d.). Developing and implementing an early warning system is essential to mitigate or reduce the impacts of such events. Likewise, it is critical that communities vulnerable to tsunamis are prepared to respond promptly and effectively once an alert is issued (NOAA, n.d.).

In 1995, the U.S. Congress designated NOAA to lead the National Tsunami Hazard Mitigation Program (NTHMP). This program represents a federal–state partnership that includes NOAA, FEMA, the U.S. Geological Survey, and 28 states and territories. Its primary goal is to reduce tsunami impacts on U.S. coasts through activities such as public education and awareness, community-level planning, risk assessments for specific areas, and guidance on tsunami alerts (NOAA, n.d.).

The TsunamiReady Program, created by NOAA's National Weather Service, aims to minimize loss of life and property from tsunamis and promote preparedness. In Puerto Rico, the Seismic Network (RSPR) manages funds for both the NTHMP and TsunamiReady Program, in coordination with the NWS Forecast Office in San Juan, FEMA, PREMB, Municipal Emergency Management Offices (OMMEs), and local communities.

Currently, 46 municipalities across the island participate in the TsunamiReady Program, including Salinas. The municipality of Salinas has a tsunami evacuation map and holds TsunamiReady certification.

Map 27 shows the modeled extent of the tsunami impact area in Salinas. The map indicates that tsunami inundation is concentrated along the municipality's southern coastal zone, affecting primarily the wards of Aguirre, Pueblo, and portions of Río Jueyes. The greatest inundation depths are projected along the low-lying coastal areas, particularly within the southeastern portion of Aguirre and the extensive coastal plain that extends westward toward Pueblo.

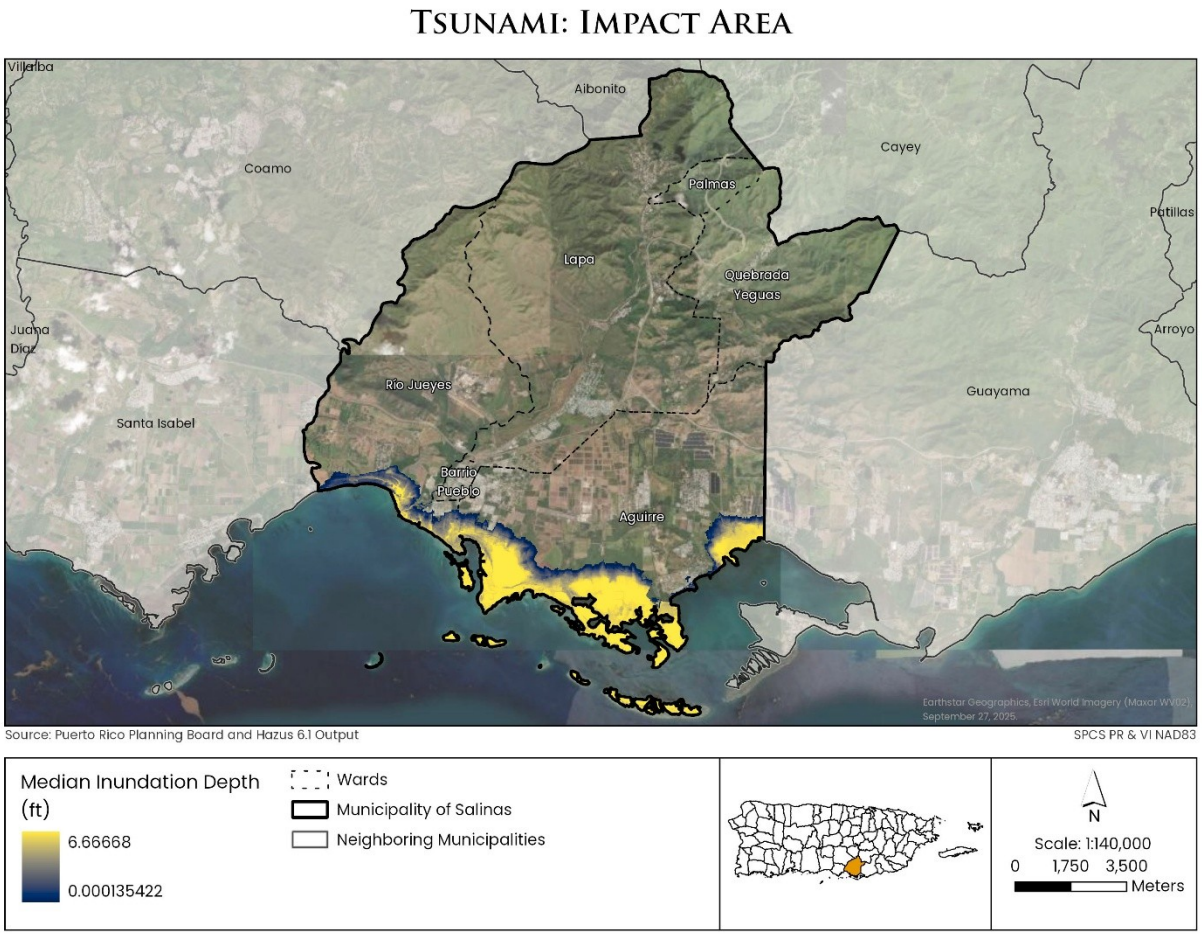
The modeled tsunami impact area follows the municipality's coastline and extends inland across several developed coastal sectors. Communities located near the shoreline, including Las Mareas, Playita, Playa, Las Ochenta, San Felipe, and portions of Aguirre, are among the areas most vulnerable to tsunami inundation. The map also shows that the inundation zone encompasses sections of the coastal transportation network, which could affect evacuation and emergency response operations following a tsunami event.

In contrast, the northern wards of Lapa, Palmas, and Quebrada Yeguas, which are

characterized by higher elevations and mountainous terrain, lie outside the modeled tsunami impact area and are therefore less susceptible to direct tsunami inundation. These upland areas would likely serve as evacuation destinations for residents of the coastal communities.

Overall, Map 27 demonstrates that tsunami impacts in Salinas are closely associated with the municipality's low-elevation coastal plain. The highest vulnerability is concentrated in the coastal sectors of Aguirre, Barrio Pueblo, and Río Jueyes, where residential areas, transportation infrastructure, community facilities, and economic assets are located within the projected inundation zone. As a result, these areas remain a priority for evacuation planning, public education, and tsunami mitigation efforts.

Map 27: Tsunami Impact Area



4.8.1.3 Past Events (B1-D)

The following tables show the most recent recorded Tsunami Events in Puerto Rico.

Table 24: Tsunami events in Puerto Rico

Tsunami Event	Description
1946 Tsunami	In Puerto Rico, the sea receded at Aguadilla (24 m) and Mayagüez (76 m) before returning as destructive waves. The combined earthquake and tsunami resulted in 75 fatalities and left 20,000 people homeless. At San Juan, the tsunami was recorded on a tide gauge 35 minutes after the earthquake, following a second shock (Ms 7.9) nearly as strong as the August 4 quake but located about 100 km to the northwest. The waves were also detected at distant locations, with travel times of 2:02 hours to Bermuda, 4:02 to Daytona Beach, and 4:42 to Atlantic City (Lander, Whiteside, & Lockridge, 2002).
1918 Tsunami	On October 11, 1918, Puerto Rico experienced one of the most powerful earthquakes in its history. Official reports indicate that 116 people lost their lives, and economic losses were estimated at $4 million—twice the island's annual budget at the time. The earthquake generated a tsunami that struck the island's western coast within minutes of the initial shaking. Waves reached heights of up to 20 feet, at the island's northwestern corner, appearing almost immediately after the quake. Approximately 40 of the fatalities were attributed to the tsunami itself (PRSN, 2025). In all areas where the wave was observed, witnesses reported that the sea first receded, exposing reefs and sections of the seabed never seen before, even during the lowest tides. The water then surged back, reaching equally high levels. In some locations, the large wave was followed by one or two smaller ones, and in

Tsunami Event	Description
	enclosed bays, the water remained turbulent for some time. At Punta Borinquen in Aguadilla, the lighthouse keeper noted that the water began to recede during the earthquake and later rose to 15 feet. Near Punta Aguejereada, the wave reached between 18 and 20 feet, arriving 4 to 7 minutes after the quake. In Aguadilla, 32 people drowned, and nearly 300 beachside huts were destroyed. The tsunami reached Mayagüez about 20 minutes after the earthquake, with a height of approximately 5 feet (PRSN, 2025).
1867 Tsunami	On November 18, an earthquake of magnitude 7.3 was felt strongly in the Virgin Islands and the eastern region of Puerto Rico. The epicenter was in the Anegada Passage, between the islands of St. Thomas, St. Croix, and Vieques. The resulting tsunami reached heights of nearly 20 feet in St. Thomas and St. Croix. At San Juan and Arroyo, water levels increased by approximately 0.9 to 1.5 meters, accompanied by significant wave activity near the Vieques Islands. In Fajardo, only a minor wave was documented, whereas in Yabucoa, a pronounced sea withdrawal occurred prior to a return surge that penetrated approximately 137 meters inland (Lander, Whiteside, & Lockridge, 2002). No fatalities were recorded (Castro Rivera, Proyecto 1867, n.d.).

4.8.1.4 Future event probabilities (B1-E)

The occurrence of a tsunami cannot be predicted, nor can its timing be determined with precision. However, because tsunamis are closely associated with seismic events such as earthquakes, their future likelihood depends on the probability of future seismic activity. Vulnerability studies have estimated a 33% to 50% probability of experiencing strong ground shaking (Modified Mercalli Intensity VII or higher) in different parts of the island within a 50-year period (PRSN, n.d.). Consequently, given that the areas of greatest seismic activity around Puerto Rico are located underwater

to the northwest southeast and southwest of the island, it is plausible that the next significant earthquake could generate a tsunami.

Earthquakes and tsunamis are relatively infrequent phenomena, and not all earthquakes generate tsunamis. Nevertheless, when a major earthquake occurs beneath the ocean floor, the likelihood of a tsunami increases substantially. This implies that the probability of a tsunami is directly correlated with the probability of a strong earthquake, particularly in coastal areas. This probability serves as a key parameter for risk classification, based on historical records and contributions from planning committees and existing studies.

4.8.2 Risk Analysis (B2-a, B2-b)

4.8.2.1 Estimated Losses

The table presents the exposure to tsunamis, as registered in FEMA National Risk Index.

Table 25: Tsunami Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
0.939585	$ 617,899,250	3,008	$ 34,889,317,197	$ 35,507,216,447

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 26 presents the expected annual tsunami-related losses for both buildings and population.

Table 26: Expected Annual Loss to Tsunami

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss -Total
$ 1,826	0	$ 375	$ 2,202

4.8.2.2 Critical Infrastructure and Lifelines

A tsunami event poses a severe and cascading threat to community functionality due

to rapid onset, widespread inundation, strong currents, and extensive debris transport. Tsunamis can significantly disrupt all **FEMA Community Lifelines**, both immediately and over prolonged recovery periods. Lifeline impacts are often interdependent, creating compounding effects that hinder response, relief, and long-term recovery efforts (FEMA, 2021).

- The Safety and Security lifeline is critically compromised during tsunami events due to sudden flooding, debris, and limited evacuation time. Law enforcement, fire services, and emergency shelters may be damaged or rendered inaccessible by inundation or coastal erosion. Search and rescue operations are often required on a large scale, placing heavy strain on emergency responders while access routes are obstructed by debris, collapsed structures, or washed-out roadways. Additionally, damaged correctional facilities and disrupted communications can elevate secondary public safety risks (NOAA, n.d.).
- Tsunami impacts frequently contaminate potable water systems through saltwater intrusion, chemical releases, and damage to treatment facilities. Food distribution systems may be interrupted due to flooded warehouses, damaged ports, and loss of refrigeration. Housing stock in coastal and low-lying areas is particularly vulnerable; entire neighborhoods may be destroyed or declared uninhabitable due to structural damage or mold contamination. As a result, large, displaced populations require mass care, sheltering, and long-term housing solutions, significantly stressing local and regional resources (FEMA, 2020).
- Healthcare systems face immediate challenges following a tsunami, including physical damage to hospitals and clinics, loss of power, and limited access for patients and staff. Medical surges are common due to drowning, trauma, and exposure-related injuries. Public health risks increase as standing water and debris contribute to disease transmission, while ongoing disruptions to water and sanitation systems exacerbate health vulnerabilities. Long-term mental health impacts are also common among affected populations and first responders (FEMA, 2017; World Health Organization, 2019).
- Electrical substations, fuel storage facilities, and distribution infrastructure located in coastal or low-elevation areas are at high risk of inundation and corrosion damage during tsunami events. Power outages can persist for extended periods, affecting all other lifelines such as water treatment, healthcare delivery, telecommunications, and emergency operations. Fuel supply disruptions may hinder debris removal, emergency response, and generator operations, further delaying restoration efforts (FEMA, 2017).

- Tsunami waves and associated flooding can damage fiber-optic lines, cellular towers, and switching facilities, resulting in widespread loss of voice and data communications. These disruptions impair emergency notifications, situational awareness, interagency coordination, and public information dissemination. Communication outages during evacuation and response phases can significantly increase risk to life and complicate rescue operations (FEMA, 2020).
- Transportation systems are among the most heavily impacted lifelines during tsunami events. Roads, bridges, ports, rail lines, and airports may be destroyed, undermined, or obstructed by debris and sediment. Port facilities are particularly vulnerable and may experience prolonged closures, affecting regional supply chains and economic recovery. Impaired transportation networks limit evacuation, emergency access, and delivery of critical supplies during response and recovery operations (NOAA, 2023).
- Water and wastewater infrastructure is highly susceptible to tsunami damage due to inundation, pipeline breaks, pump station failures, and contamination from saltwater and hazardous materials. Wastewater system failures can result in environmental contamination and public health hazards. Restoration of water service is often complex and time-consuming, particularly where underground infrastructure has shifted or corroded due to saltwater exposure (FEMA, 2017).

Accordingly, Map 28 shows that several critical infrastructure assets could be affected by a tsunami event in Salinas. The facilities most exposed to tsunami inundation are concentrated within the municipality's southern coastal zone, particularly in Pueblo, Aguirre, and portions of Río Jueyes. These areas coincide with the modeled tsunami impact area and contain a diverse range of critical facilities located near the shoreline.

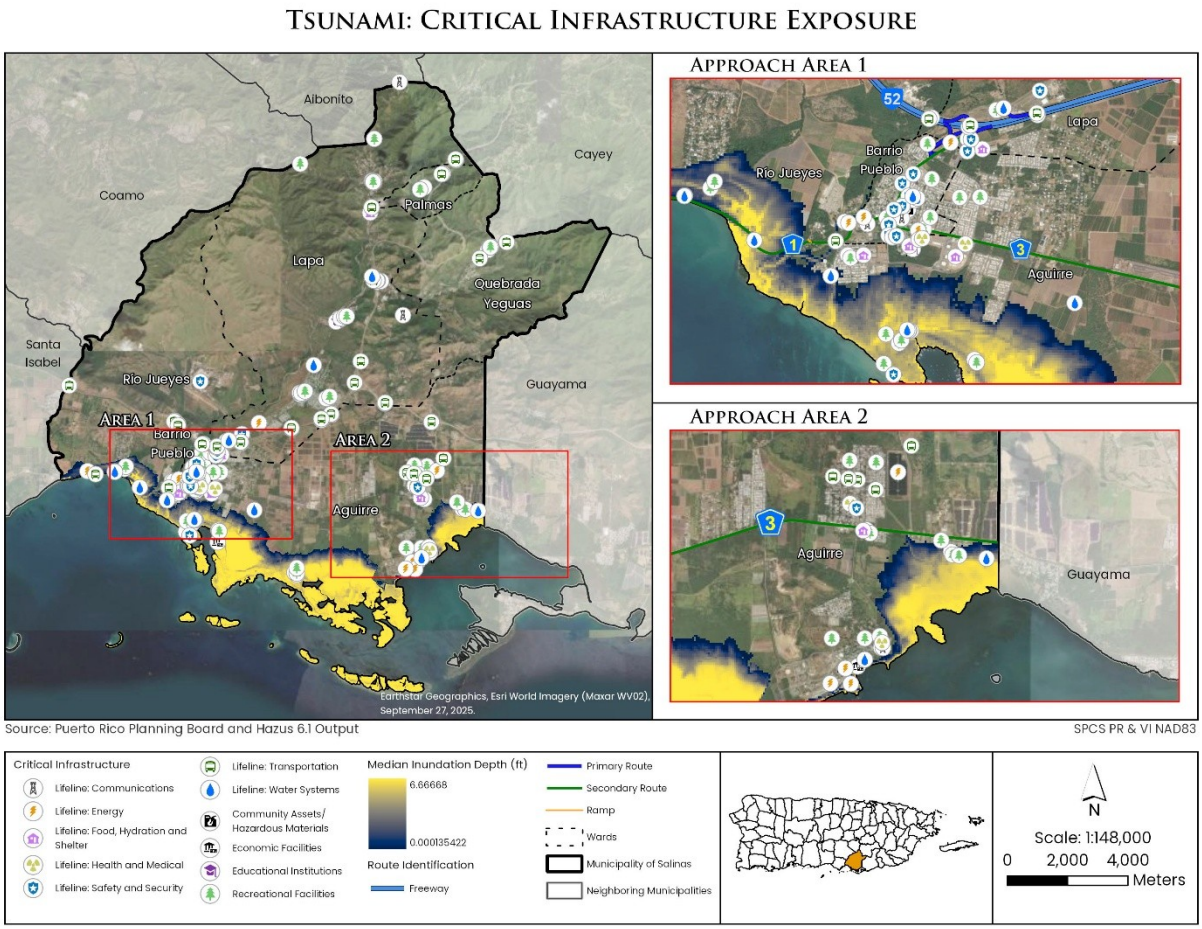
The map indicates that infrastructure associated with multiple community lifelines is exposed to tsunami hazards, including water system facilities, transportation infrastructure, energy facilities, communications assets, public safety facilities, health and medical facilities, educational institutions, shelters, recreational facilities, and community support facilities. The greatest concentration of exposed infrastructure is observed within Approach Area 1, which encompasses the urban center of Salinas and adjacent coastal communities. In this area, several transportations, water systems, public safety, educational, and community facilities are situated within or immediately adjacent to the projected tsunami inundation zone.

Additional exposed facilities are located within Approach Area 2, corresponding to the

coastal portion of Aguirre. This area contains educational facilities, energy infrastructure, transportation assets, water system facilities, community facilities, and recreational facilities positioned near low-elevation coastal lands susceptible to tsunami flooding. The proximity of these facilities to the coastline increases the potential for service disruption during a tsunami event.

Particularly noteworthy is the exposure of infrastructure serving the coastal communities of Las Mareas, Playita, Playa, Las Ochenta, San Felipe, Aguirre, and Barrio Pueblo, where tsunami inundation could affect both facilities and the transportation routes required for evacuation and emergency response. Damage to these assets could result in interruptions to emergency services, utilities, communications, transportation, educational operations, and community support functions.
Overall, Map 28 demonstrates that the municipality's most vulnerable critical infrastructure is concentrated along the southern coastal plain, especially within Barrio Pueblo and Aguirre. While the higher-elevation wards of Lapa, Palmas, and Quebrada Yeguas remain outside the projected tsunami inundation area, many of the facilities that provide essential services to Salinas are located within the coastal impact zone and could experience direct effects from tsunami flooding. Consequently, these facilities should remain a priority for tsunami preparedness, evacuation planning, continuity-of-operations planning, and future mitigation efforts.

Map 28: Tsunami: Critical Infrastructure Exposure



4.8.2.3 Social Vulnerabilities

Social vulnerability during a tsunami event reflects pre-existing social, economic, and health conditions that influence how individuals and communities prepare for, respond to, and recover from rapid-onset coastal hazards. Research by U.S. scholars demonstrates that populations with lower incomes, limited access to transportation, and residence in hazard-prone coastal zones face disproportionately higher risk during tsunami evacuations (Cutter, Boruff, & Shirley, 2003). Older adults and people with disabilities are particularly vulnerable due to reduced mobility, dependence on medical and social support systems, and challenges accessing timely warnings and evacuation assistance ((Peek & Stough, 2010)). Studies of community resilience further show that inadequate risk communication, lack of hazard awareness, and weak institutional planning can significantly amplify disaster impacts, even when physical exposure is similar (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2007). Language barriers and social isolation may delay protective actions, increasing

mortality and injury risk during time-compressed tsunami events. Collectively, these factors produce uneven disaster outcomes and underscore the importance of integrating social vulnerability considerations into tsunami preparedness and emergency planning.

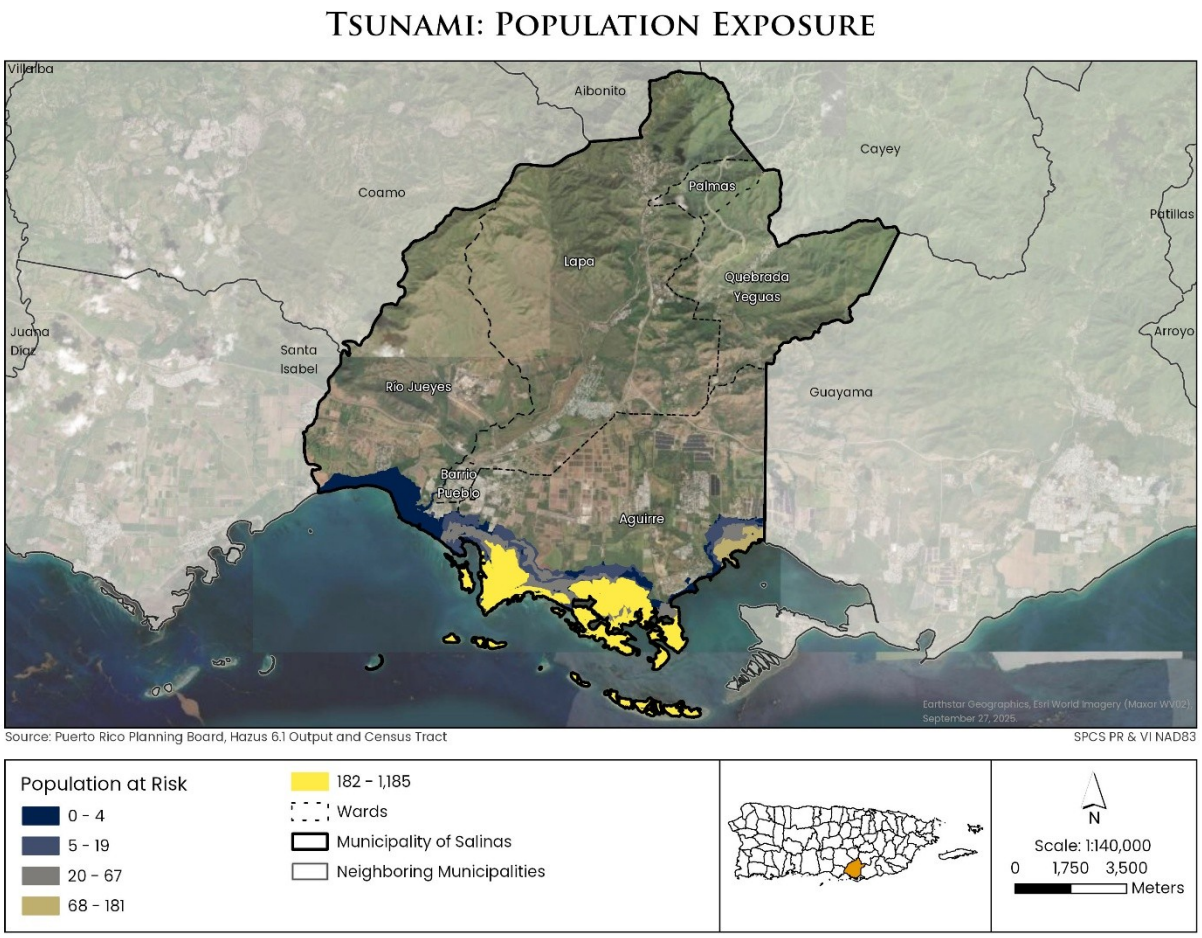
Map 29 shows the population exposure to tsunami hazards in Salinas. The map indicates that the population at risk is concentrated almost entirely within the municipality's southern coastal zone, particularly in the wards of Aguirre, Barrio Pueblo, and portions of Río Jueyes, where the modeled tsunami inundation area extends inland from the coastline.

The highest concentration of exposed population (182 to 1,185 persons) is located within the coastal portions of Aguirre, including the communities of Las Mareas, San Felipe, Playita, Playa, and Las Ochenta. These areas are characterized by low elevations, proximity to the shoreline, and direct exposure to the modeled tsunami inundation zone. Additional concentrations of exposed population are present near the coastal sectors of Barrio Pueblo and western Río Jueyes, where tsunami inundation overlaps with developed residential areas.

Moderate levels of population exposure (68 to 181 persons and 20 to 67 persons) are distributed along the remainder of the coastal corridor extending from western Río Jueyes through Barrio Pueblo and Aguirre. Lower exposure levels (0 to 19 people) are found in smaller coastal segments where development is less concentrated.In contrast, the inland and mountainous wards of Lapa, Palmas, and Quebrada Yeguas lie outside the modeled tsunami impact area and therefore exhibit little to no direct population exposure. These higher-elevation areas would likely serve as evacuation destinations for residents of the coastal communities during a tsunami emergency.

Overall, Map 29 demonstrates that tsunami risk in Salinas is heavily concentrated within the municipality's coastal communities. The greatest potential impact to human life is expected in the densely populated coastal sectors of Aguirre, Barrio Pueblo, and Río Jueyes, where residential development, critical infrastructure, and transportation corridors coincide with the projected tsunami inundation area. Consequently, these communities should remain the primary focus of evacuation planning, public education efforts, warning systems, and tsunami mitigation strategies.

Map 29: Tsunami: Population Exposure



4.8.2.4 Natural and Cultural Resources

A tsunami's waves scour coastal areas, eroding beaches, dunes, and cliffs, and reshaping geomorphology through sediment redistribution. They remove coastal vegetation, including mangroves, saltmarshes, and coastal forests, severely weakening ecological buffers against future events and disrupting habitat for wildlife. Submerged ecosystems, such as coral reefs and seagrass beds, suffer mechanical damage or smothering from debris and sediment, reducing biodiversity and undermining fisheries (Institute for Environmental Research and Education, 2025).

Saltwater intrusion contaminates freshwater ecosystems and aquifers, compromising drinking water and agriculture. Inland, fish and other aquatic organisms are often displaced or perish due to abrupt changes in salinity, wave force, and sedimentation.

Studies on the 2011 Tōhoku tsunami showed changes in seafloor sediment structure that affected benthic invertebrate activity over time, highlighting lasting ecological legacies. Overall, these effects can take years or decades to recover from, especially when compounded by diminished habitat complexity and altered physical conditions (Institute for Environmental Research and Education, 2025).

Cultural heritage in coastal regions—including historic towns, monuments, and archaeological sites—is profoundly impacted. Physical destruction often occurs due to wave forces, flooding, debris impact, and prolonged inundation. Buildings and monuments can collapse or suffer structural failure, while artifacts and intangible cultural practices may be irretrievably lost. (Okamura, et al., 2013).

4.8.2.5 Future Conditions (E1-a)

Map 30 shows the approved construction permits in the municipality for the period of 2020-2026 layered over the modeled tsunami impact area. This map shows that a portion of recent development has occurred within areas susceptible to tsunami inundation, particularly within the coastal sectors of Aguirre, Barrio Pueblo, and Río Jueyes. Several construction permits are located either directly within or immediately adjacent to the mapped tsunami impact zone, especially along the southern coastal plain where tsunami inundation is projected to extend inland.

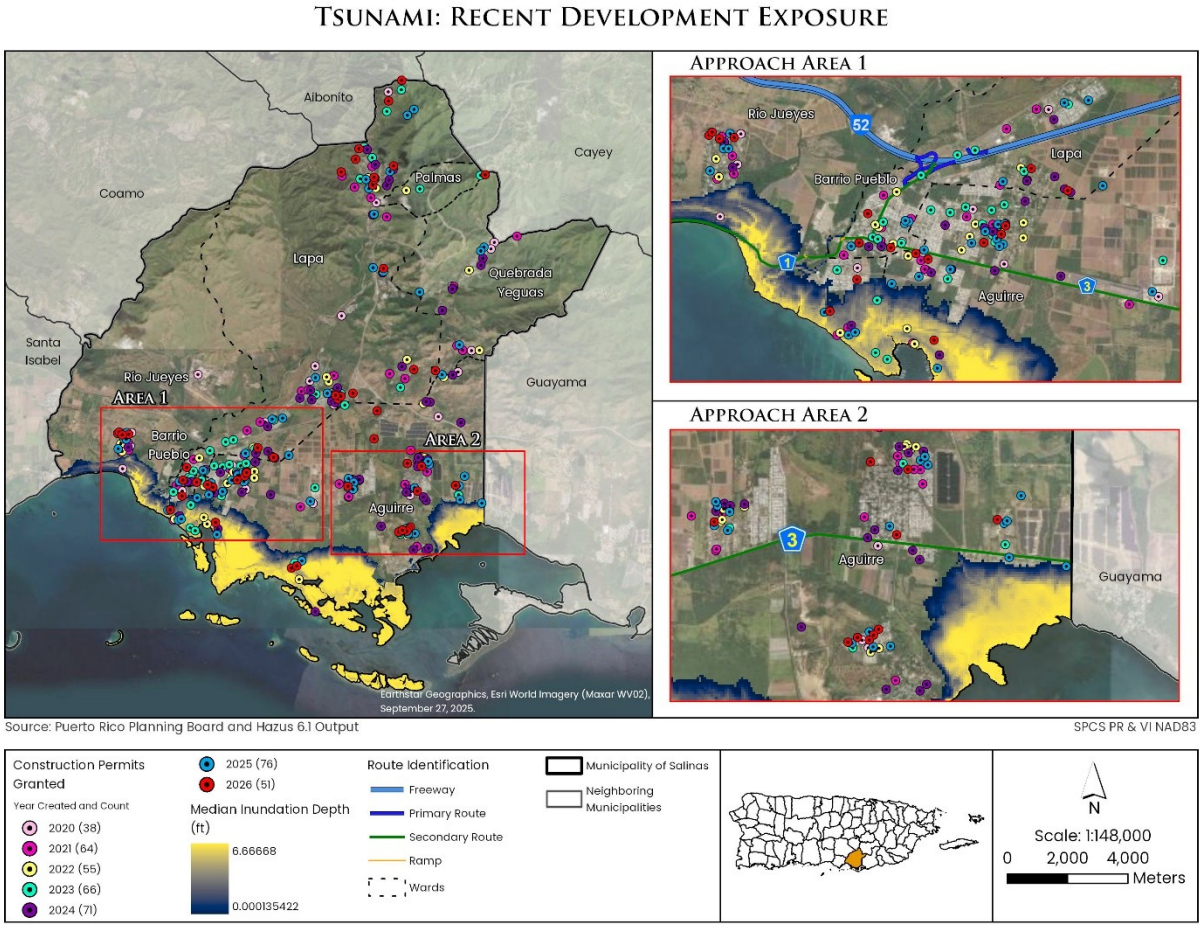
The greatest concentration of permits is observed within the urbanized corridor extending between Barrio Pueblo and Aguirre, where residential, commercial, and mixed-use development has continued throughout the study period. Additional permits are visible within coastal communities such as Las Mareas, Playita, Playa, and San Felipe, all of which are located within or near the projected tsunami inundation area. These development patterns indicate that population and structural exposure to tsunami hazards may continue to increase if future development persists within low-lying coastal sectors.

At the same time, the map also shows that a substantial number of construction permits have been issued outside the tsunami impact area, particularly within Lapa, Palmas, and Quebrada Yeguas, where higher elevations provide natural protection from tsunami inundations. Development in these inland wards contributes less to future tsunami exposure and may provide opportunities for future growth in lower-risk areas.

Overall, Map 30 demonstrates that while new development is occurring throughout

the municipality, a measurable share of recent construction activity has taken place within tsunami-prone coastal areas. Consequently, future exposure to tsunami hazards is unlikely to decrease in the near term. Continued development within Aguirre, Barrio Pueblo, Río Jueyes, and other coastal communities may result in additional residents, structures, and infrastructure being located within areas vulnerable to tsunami inundation. Therefore, integrating tsunami hazard information into permitting decisions, land-use planning, evacuation planning, and future mitigation strategies remains essential to reducing long-term risk in the Municipality of Salinas.

Map 30: Tsunami: Recent Development Exposure



4.9 FLOODING

4.9.1 DESCRIPTION (B1-A)

Floods, generally caused by excessive rainfall (FEMA, 1997), are classified into two main categories: general floods and flash floods.

- General floods are long-duration events that can last several days and include riverine, coastal, and urban floods. Coastal floods are associated with storm surges, waves, and heavy rains generated by hurricanes and tropical storms, while urban floods result from the alteration of natural drainage due to urban development. Riverine floods occur when rivers overflow due to excessive water runoff though rainfall or structural failures, causing water to spill into surrounding land. Flash floods often stem from stationary storms, hurricanes, or dam failures, affecting both mountainous areas and urbanized zones.

- Flash floods happen when prolonged rainfall falls over a watershed (water basin). The latter result from intense precipitation over a short period in specific areas. The magnitude of flash floods events depends on factors such as basin topography and physiography, weather patterns, soil saturation, and surface impermeability. Flash floods mainly originate from slow-moving storms over specific areas or from intense rainfall associated with hurricanes and tropical storms (NMEAD, 2021). However, they can also occur after the collapse of dams or levees within minutes or hours, due to extreme rainfall or the sudden release of water from retention basins or other stormwater control facilities. Although more frequent in mountain streams, these events can occur in urban areas where impermeable surfaces limit infiltration.

The periodic flooding of land adjacent to rivers, streams, and coasts—known as floodplains—is a predictable natural phenomenon based on recurrence intervals. These intervals represent the average time, in years, between events of equal or greater magnitude. The longer the recurrence interval, the greater the magnitude of the event, which implies a significant increase in risk and the extent of the affected area. Floodplains flood periodically according to recurrence intervals, defined as the average time between events of equal magnitude. For example, a 100-year flood has a 1% annual probability, while a 500-year flood corresponds to 0.2%. These frequencies are calculated through statistical analysis of historical flow records and extreme events.

The table below shows the different flood zone classifications for Puerto Rico adopted by the PRPB (PRPB, 2021).

Table 27: Puerto Rico Flood Zones

Flood Zone	Description
Zone A	Special Flood Hazard Area with a recurring period of one hundred (100) years determined by using approximate methodologies with no base flood elevation or Floodway determined.
Zone AE	Special Flood Hazard Areas with a recurring period of one hundred (100) years determined by detailed methodologies with base flood elevations indicated. According to the scope of the study, may include the Floodway determination.
Zone AO/AH	Shallow Special Flood Hazard Areas with a recurring period of one hundred (100) years with a base flood depth fluctuating between 0.30 meters (one (1) foot) and 0.91 meters (three (3) feet). The average flood depths are obtained from detailed hydraulic analysis.
Zone A99	areas prone to flooding from a flooding event with a one percent (1%) annual chance of occurring. These special areas are within a flood protection or control system where enough progress has been made in its construction, even though it has not been completed, but specific statutory progress has been reached to complete it. This zone does not detail base flood elevations or flooding depths, so it is recommended to use, if required, the previous flood elevation for Zone 99. Mandatory flood insurance purchase requirements apply.
Zone D	Flooding area that is not determined but is possible.
Zone VE	Coastal high flood hazard area with a recurring period of one hundred (100) years with velocity and energy (storm surge) and a determined base flood elevation.
Zone X Shaded	flooding area with 0.2% chance of occurring each year or the one hundred (100) year flood with a water depth of less than 0.3 meters, with drainage areas of less than 2.6 square kilometers or areas protected by levees against the one hundred (100) year flood.
Zone X (unshaded)	Area determined to be outside the five hundred (500) year storm flood.

4.9.1.1 Affected Area

Flood Hazard Insurance Map

Map 31 shows the affected areas by flood in Salinas. The light blue areas represent the 1% annual chance flood hazard (100-year floodplain), while the orange areas represent the 0.2% annual chance flood hazard (500-year floodplain).

The extent of flood hazard in Salinas is strongly influenced by the municipality's physiography, hydrology, and coastal setting. The largest flood-prone areas are concentrated within the southern coastal plain, particularly in Aguirre, Pueblo, and portions of Río Jueyes, where low elevations and proximity to both the coastline and major drainage systems contribute to increased flood risk. In addition, extensive flood hazard areas are mapped along the municipality's principal drainage corridors, including the floodplain associated with the Río Nigua and its tributaries, which extend from the northern interior toward the southern coast.

The map illustrates that the 1% annual chance flood hazard covers a substantial portion of the municipality's low-lying lands, including coastal communities, agricultural areas, transportation corridors, and developed sectors surrounding Pueblo and Aguirre. The regulatory floodway follows the main river corridor through the central portion of the municipality and represents the area where floodwaters are expected to flow with the greatest velocity and depth during major storm events.

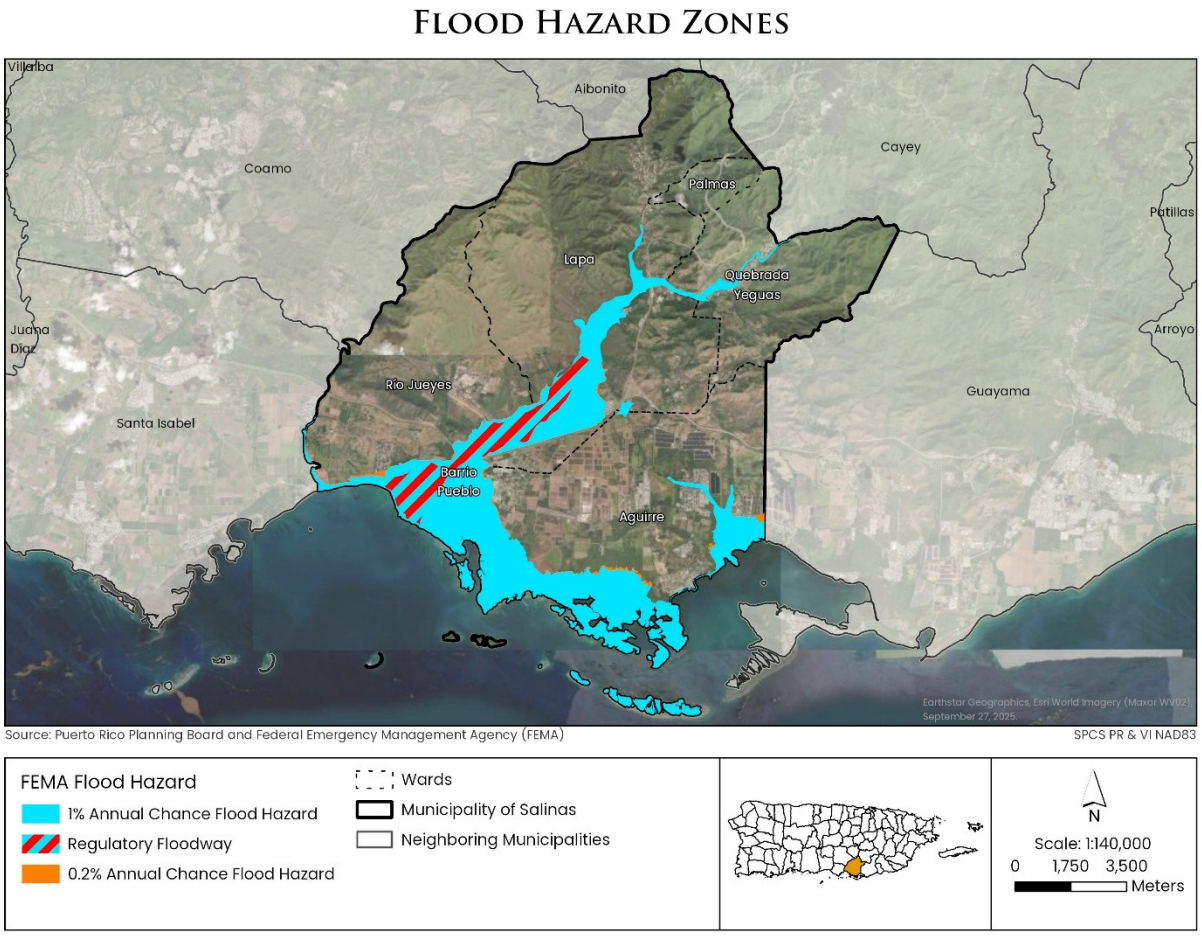
Unlike the northern wards of Palmas, Lapa, and Quebrada Yeguas, which are characterized by steep mountainous terrain and relatively limited floodplain development, the southern wards contain broad alluvial and coastal deposits that facilitate the accumulation and storage of floodwaters. Runoff originating in the upland watersheds is rapidly conveyed toward these lower-elevation areas through the municipality's drainage network. During periods of intense rainfall, particularly those associated with tropical storms and hurricanes, large volumes of water flow from the mountainous interior toward the coastal plain, increasing the frequency and extent of flooding.

Frequent heavy rainfall events can quickly saturate soils throughout the watershed, reducing infiltration capacity and increasing surface runoff. Once saturation occurs, excess rainfall is transported toward the municipality's rivers, streams, drainage channels, and coastal lowlands, resulting in higher flood stages and expanded

inundation areas. This process is especially significant in the areas surrounding Barrio Pueblo, where riverine flooding and coastal flooding may occur simultaneously during severe storm events.

Together, the combination of coastal lowlands, extensive alluvial deposits, river floodplains, and runoff generated from the northern mountainous region creates a highly vulnerable flood environment in Salinas. These factors explain why both the 100-year, and 500-year flood scenarios encompass large portions of the municipality's southern developed area and underscore the importance of flood mitigation projects, drainage improvements, land-use planning, and continued participation in floodplain management programs.

Map 31: Flood Hazard Zones



Figures 16 to 20 shows various FIRMette that shows specific areas of flooding in the Municipality.

- Figure 16 shows that the area is predominantly located within VE and AE Flood Zones, indicating exposure to coastal flooding associated with the 1-percent annual chance flood event and wave action. Base flood elevations in the mapped area range from approximately 2.4 to 4.4 meters, reflecting the potential depth and extent of flooding during severe coastal storm events. The figure also highlights the presence of protected coastal lands, wetlands, and undeveloped areas that are vulnerable to storm surge and coastal inundation. Given its location adjacent to the coastline, this area may experience flooding from hurricane-induced storm surge, extreme tidal conditions, and wave action. This map was selected because it demonstrates the extent of FEMA-designated coastal flood hazards in the southern portion of the Municipality of Salinas and the potential exposure of natural resources and coastal infrastructure to flood-related impacts.
- Figure 17 was selected because it illustrates a developed residential area within the Municipality of Salinas that is largely located within a FEMA-designated AE Flood Zone. The FIRMette shows extensive flood exposure affecting numerous residential neighborhoods and local streets, indicating vulnerability to the 1-percent annual chance flood event. The map also identifies a nearby regulatory floodway to the northwest, suggesting that flooding in the area is influenced by the overflow of adjacent drainage channels and floodplain systems. Base flood elevations shown on the map range approximately 34.5 to 42.3 meters, indicating the expected water surface elevations during a base flood event. This figure was selected because it demonstrates the extent to which existing residential development is located within a mapped flood hazard area and highlights the potential impacts to homes, transportation infrastructure, and community services during significant rainfall and flooding events.
- Figure 18 was selected because it illustrates a flood-prone area within the Municipality of Salinas where residential development is located adjacent to a mapped AE Flood Zone and a regulatory floodway. The FIRMette shows that a substantial portion of the area is subject to the 1-percent annual chance flood event, with base flood elevations ranging from approximately 42.3 to 49.5 meters. The presence of the floodway along the western portion of the map indicates an area of concentrated flood flows where water depths and velocities may be significantly higher during major storm events. The figure also shows the transition between the flood hazard area and an Area of Minimal

Flood Hazard (Zone X) located to the east. This map was selected because it demonstrates the potential exposure of residential properties and local infrastructure to flooding associated with nearby drainage channels and floodplain systems, highlighting the importance of flood mitigation measures and land-use planning in reducing future flood risks.

- Figure 19 shows that several residential neighborhoods and developed areas located west of the mapped flood boundary are situated within the AE Flood Zone, indicating exposure to the 1-percent annual chance flood event. The map also depicts multiple base flood elevation contours ranging from approximately 4.5 to 10.7 meters, demonstrating variations in potential floodwater elevations across the area. In contrast, properties located east of the flood boundary are classified as an Area of Minimal Flood Hazard (Zone X). The figure highlights the proximity of residential developments to the floodplain and underscores the potential risk to homes, local infrastructure, and community services during significant rainfall events and flood conditions. This area was selected because it demonstrates the interface between developed urban areas and FEMA-designated flood hazard zones, providing an example of flood exposure within the Municipality of Salinas.
- Figure 20 was selected because it illustrates a coastal flood hazard area within the Municipality of Salinas characterized by extensive AE and VE Flood Zones associated with storm surge, wave action, and coastal inundation. The FIRMette shows that much of the mapped area is located within FEMA-designated high-risk coastal flood zones, with base flood elevations ranging from approximately 2.1 to 3.7 meters. The map also identifies environmentally sensitive coastal areas and protected lands that are susceptible to flooding during hurricane events and other severe coastal storms. The presence of both AE and VE zones indicates a combination of coastal flooding hazards, including inundation and wave impacts that may affect natural resources, wetlands, and any existing infrastructure within the area. This figure was selected because it demonstrates the extent of coastal flood exposure in the southern portion of Salinas and highlights the vulnerability of low-lying coastal environments to storm surge and flood-related hazards.

Figure 16: National Flood Hazard Layer FIRMette

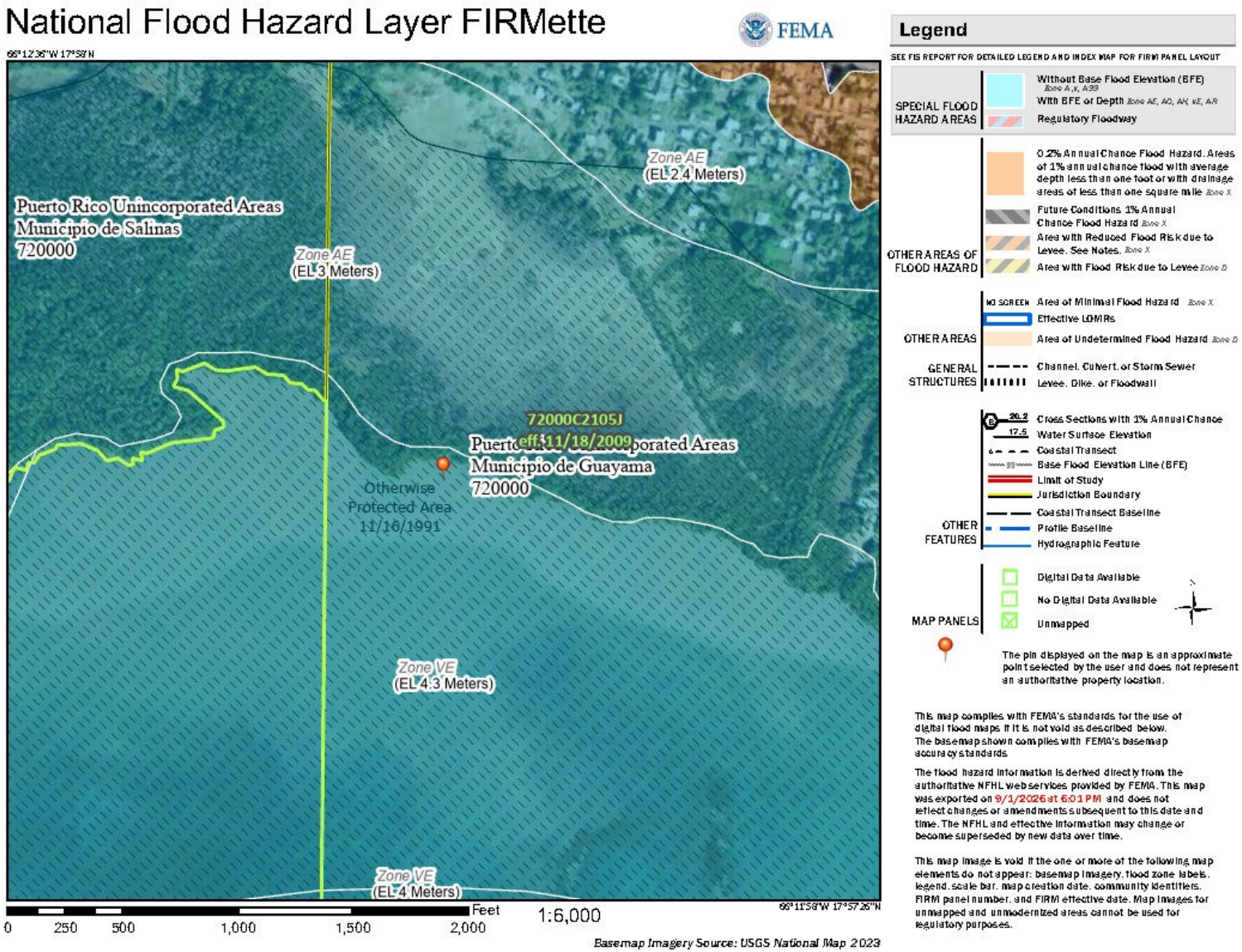


Figure 17: National Flood Hazard Layer

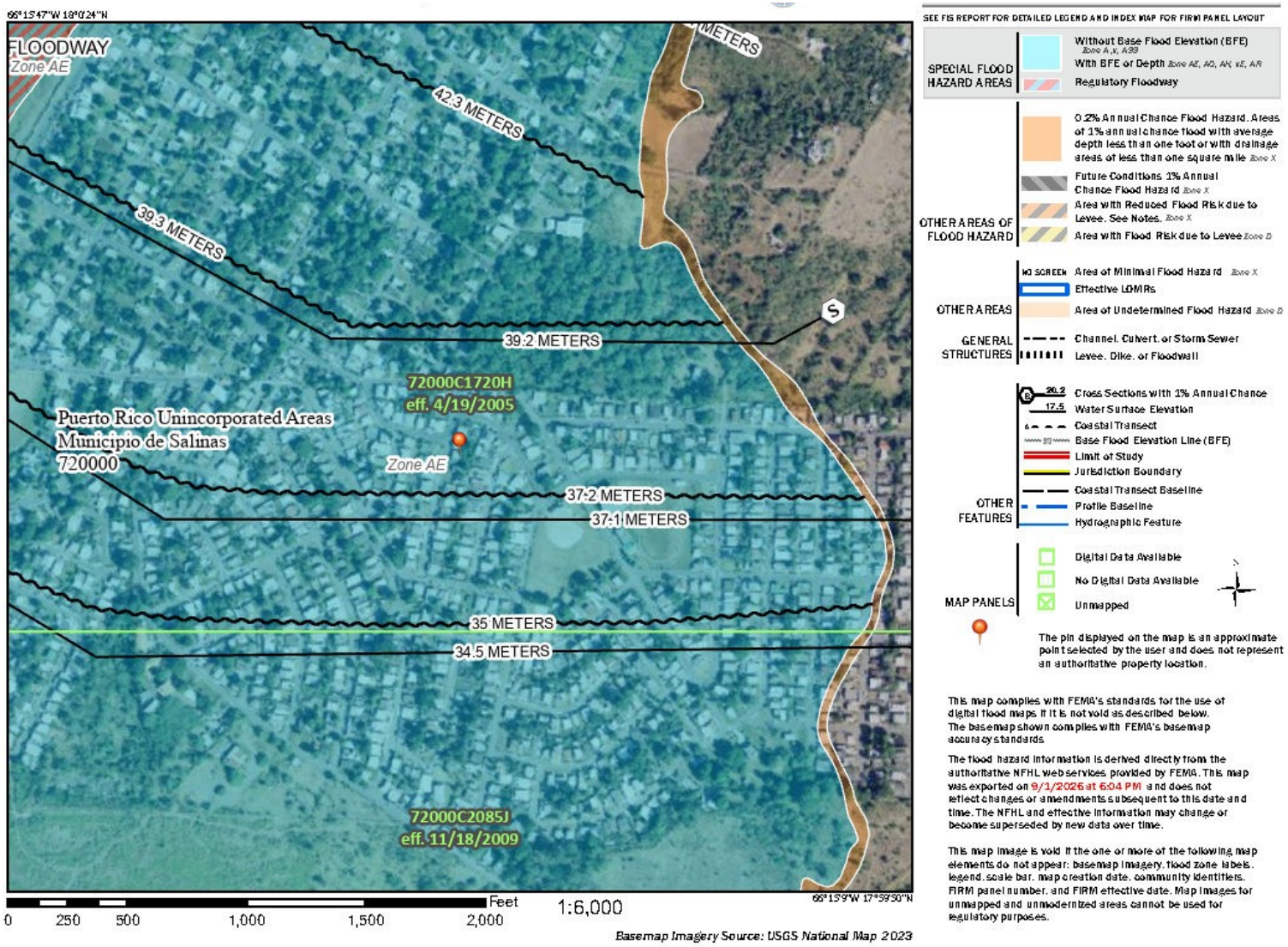


Figure 18: National Flood Hazard Layer FIRMette

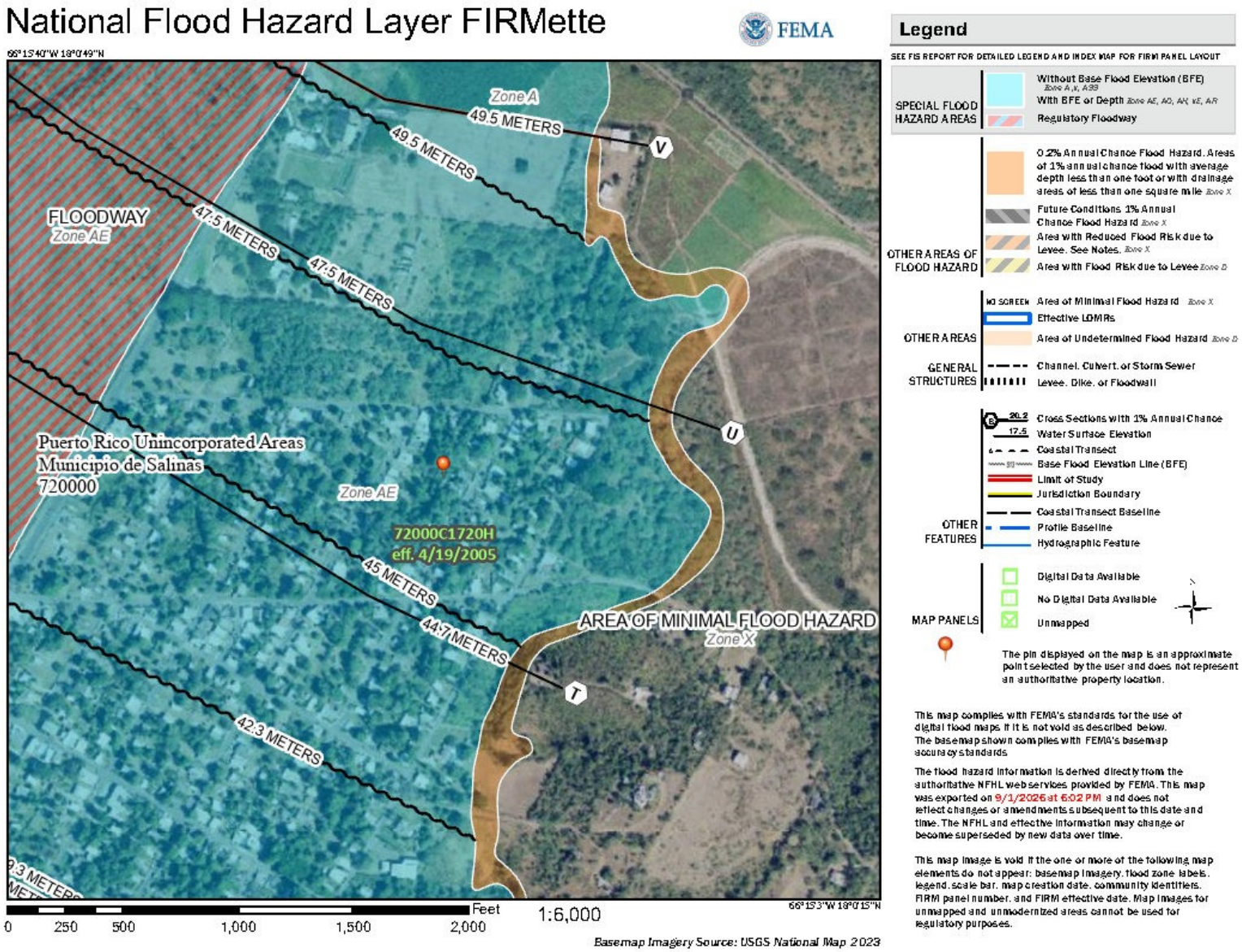


Figure 19: National Flood hazard Layer

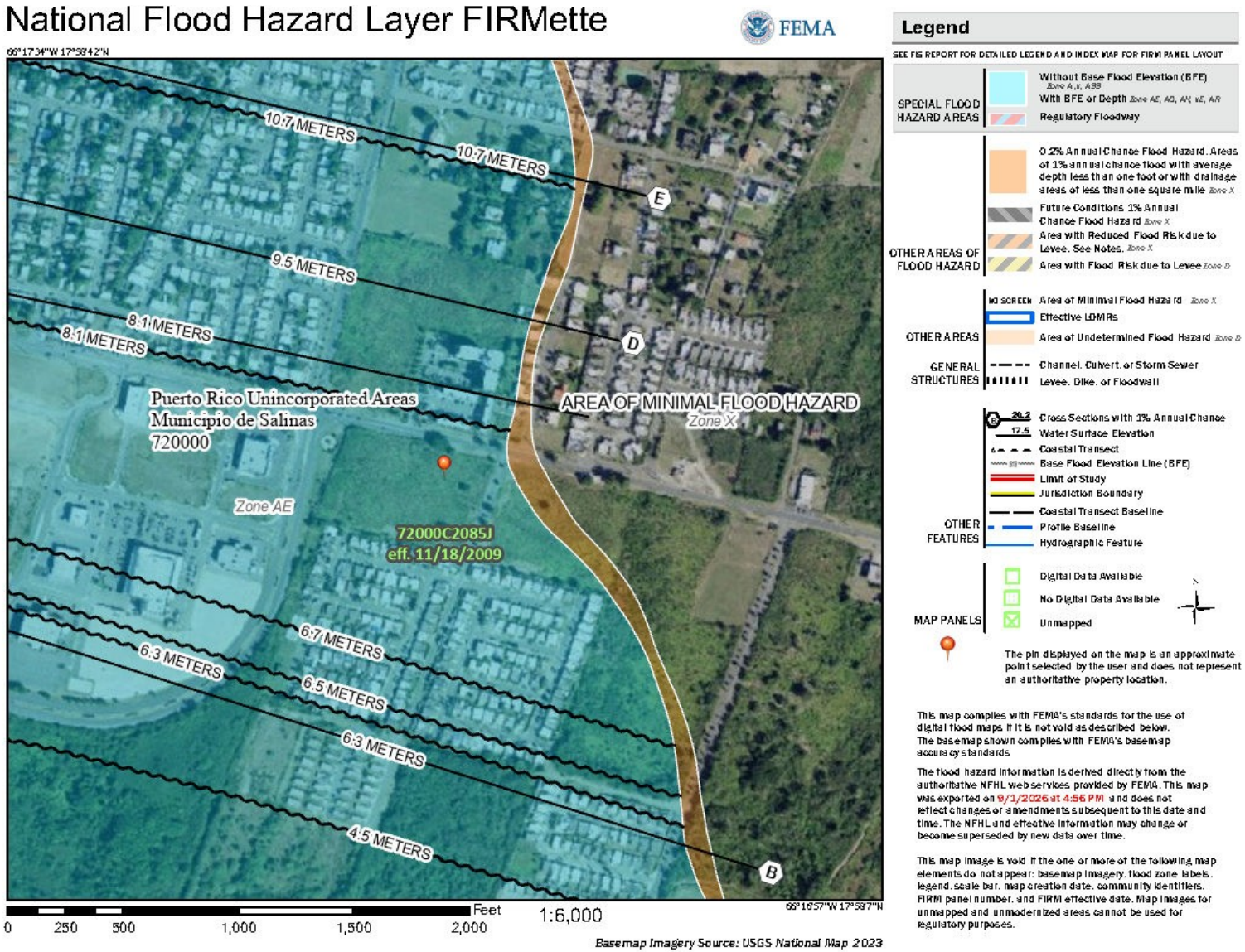
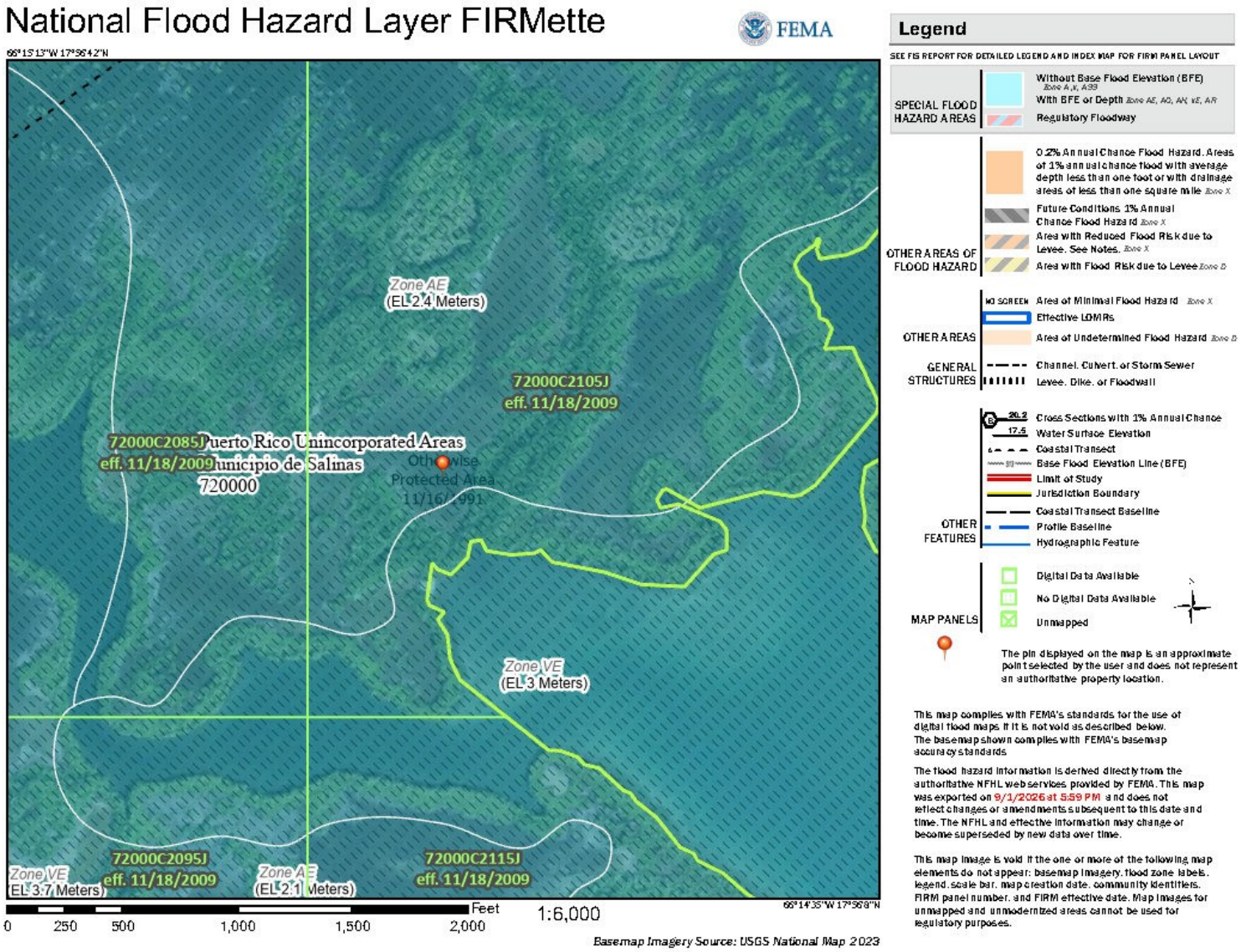


Figure 20: National Flood Hazard Layer FIRMette



Advisory Base Flood Elevation (ABFE)

Likewise, FEMA uses another type of map for the purpose of developing regulations and construction permits known as the Advisory Base Flood Elevation Maps (ABFE). ABFEs are developed after the occurrence of a high-impact atmospheric event, and several factors related to the latest engineering analysis are taken into consideration to determine whether an analysis is necessary. Some of the factors considered in the analysis include the age of the analysis, the territory covered by the analysis, and the engineering models/data used in the analysis. ABFEs have been produced for states such as Mississippi (Hurricane Katrina), New York, and New Jersey (Hurricane Sandy). Following Hurricane María's passage through Puerto Rico in 2017, and due to the availability of better data, FEMA developed ABFEs for Puerto Rico. It should be noted that the Puerto Rico Planning Board adopted the ABFEs on an emergency basis in March 2018. At present, Puerto Rico has two (2) types of flood maps: the FIRMs (2009), which are used solely for flood insurance rates, and the ABFEs (2018), which are used to regulate construction on the Island.

For comparison purposes, this subsection includes the difference in the extent of land affected by flooding based on the FIRMs prior to Hurricane María in September 2017 and the ABFEs developed by FEMA for Puerto Rico. After Hurricane María in 2017, the areas designated as flood-prone throughout the Island increased by 20%. Thus, this reflected an increase of 41%.

Figure 21 shows the difference between the extent of the FEMA Flood Insurance Rate Maps (FIRM) prior to Hurricane María, and the Advisory Base Flood Elevation (ABFE) maps developed after the storm for the 1% annual chance (100-year) flood event. The comparison indicates a substantial increase in the mapped flood hazard area within the Municipality of Salinas.

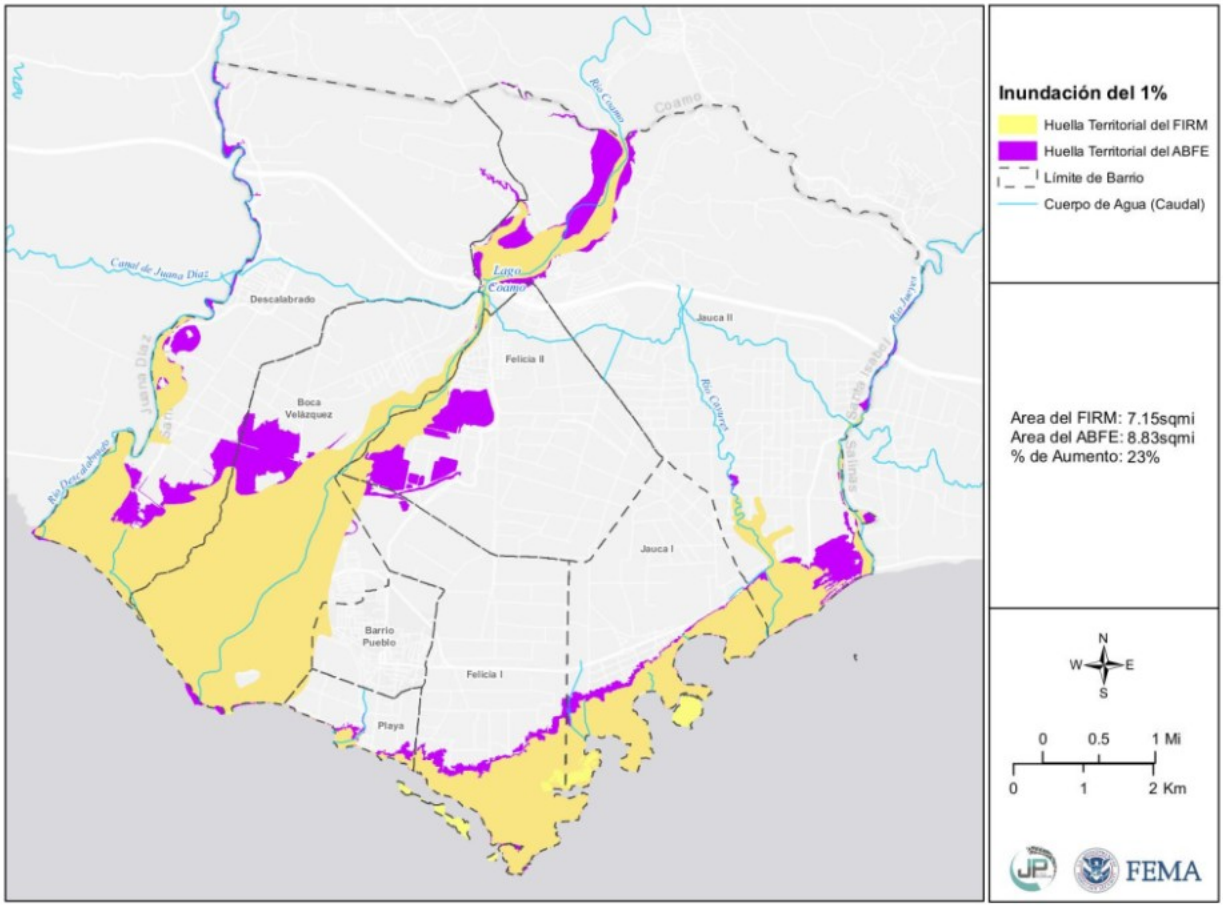
As shown on the map, the FIRM floodplain covered approximately 7.15 square miles, while the ABFE floodplain expanded to approximately 8.83 square miles, representing an increase of approximately 23% in the extent of the 100-year flood hazard area. This increase suggests that flood-prone areas in Salinas are more extensive than previously identified and that the municipality faces a greater degree of flood exposure than was recognized in earlier planning efforts.

The newly identified flood-prone areas include both the expansion of previously mapped floodplains and the addition of new flood hazard areas along important drainage corridors and low-lying coastal sectors. The most significant increases are

observed along the Río Nigua floodplain, portions of the inland drainage network extending through Lapa and Quebrada Yeguas, and the coastal lowlands of Pueblo, Aguirre, and Río Jueyes. Additional expansions are evident along smaller streams and drainage channels that convey runoff from the northern mountainous areas toward the southern coastal plain.

The results demonstrate the substantial influence that Hurricane María had on flood hazard mapping throughout the municipality. The enlarged ABFE footprint highlights areas that may be subject to greater flood depths and more extensive inundation during extreme rainfall events than previously projected. Consequently, future land-use decisions, infrastructure investments, and hazard mitigation strategies should consider the expanded flood hazard areas identified by the ABFE analysis to reduce long-term vulnerability to flooding in the Municipality of Salinas.

Figure 21 ABFE vs FIRM 1% (100 years)



As instructed by PRPB the hazard analysis was made using the ABFE maps.

HAZUS Modeling

Flooding source identification and hazard loss estimation were performed using Federal Emergency Management Agency's (FEMA) HAZUS platform, a nationally standardized tool for multi-hazard risk assessment. The HAZUS flood module was used to delineate streams in areas where no engineering studies have been developed and also used to estimate potential monetary losses associated with structural damage.

Input data included depth grids produced by a Base Level Engineering (BLE) study in 2018 post hurricanes Irma and Mariia. This BLE study did not review all potential riverine flooding sources so additional modeling was developed with HAZUS hydrology and hydraulics to review other potential losses associated with streams with drainage areas of one square mile or more.

Topographic data used by HAZUS s for depth calculations and damage estimation was sourced from the USGS 3D Elevation Program (3DEP) seamless 1/3 arc-second Digital Elevation Model (DEM), at an approximate resolution of 10 feet. This dataset provides current coverage of Puerto Rico and its surrounding islands.

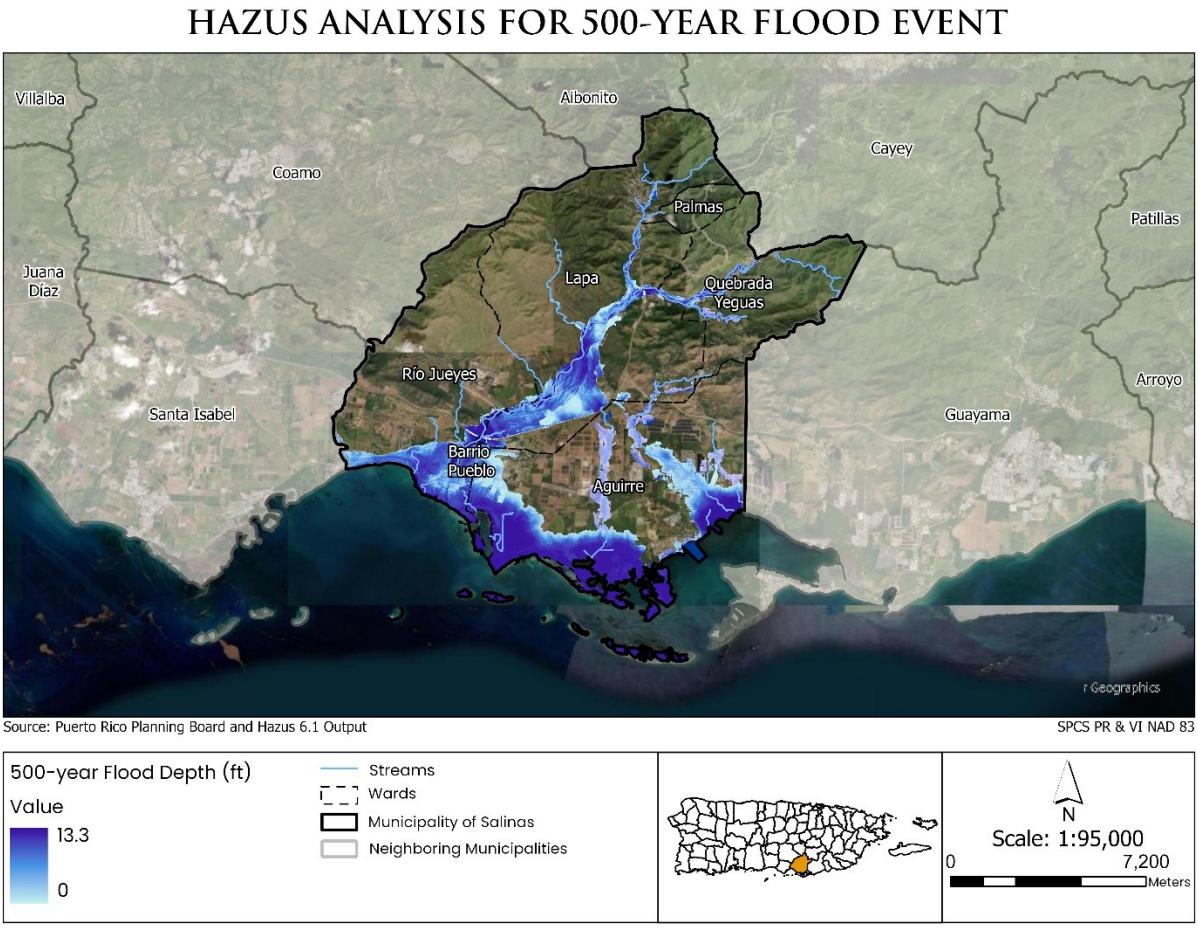
The 3DEP seamless DEM for Puerto Rico is derived from two lidar collection efforts: a 2016–2017 USGS lidar survey and a 2018 USGS post-Hurricane Maria lidar survey. The 2018 collection, conducted following the significant coastal geomorphic changes caused by Hurricane Maria, represents the most current available terrain data for the island and forms the primary basis of the 3DEP elevation layer used in this analysis.

The areas documented in the maps included within the LHMP may have streamlines represented but with no depth grids associated with them. Due to the inconsistency of available regression equations and other data necessary for computation of flood risk and losses with Hazus's hydrology and hydraulics models, some streams that were delineated were unable to be completed during modeling runs. These stream areas may need to be reviewed for future flood studies and potential flood risk identification but, due to the lack of data, they were unable to be included in the HAZUS studies.

The following map shows the results of the most recent HAZUS run for the 500-year flood event in Salinas. The analysis indicates that flooding may extend beyond previously identified flood-prone areas, particularly throughout the municipality's southern coastal plain and along major drainage corridors. The most extensive

inundation is observed in the coastal areas surrounding Barrio Pueblo and Aguirre, including low-lying lands adjacent to the Salinas Bay coastline. Floodwaters are also projected to extend inland through the Quebrada Yeguas watershed and tributaries that drain the northern mountainous sectors of Palmas and Lapa, converging toward the central and southern portions of the municipality. The HAZUS results highlight the potential for widespread flooding in both coastal and riverine environments, affecting agricultural lands, developed areas, and critical transportation corridors in the southern part of Salinas.

Map 32 HAZUS Analysis for 500 – Year Flood Event



4.9.1.2 Risk Magnitude (B1-C)

Flood events can represent one of the most severe atmospheric threats, as there is no other event worldwide that causes greater loss of life (FEMA, 1997). This is due to the

high frequency of such events and the population's lack of awareness regarding the magnitude of the damage they can cause, whether physical harm or property damage. It should be noted that most disaster declarations in the U.S. are related to flood events. The majority of flood-related incidents involve people being swept away by fast-moving water, along with their vehicles (FEMA, 1997). Each year, the devastation caused by floods results in billions of dollars in asset losses. Highly urbanized areas with dense populations are particularly vulnerable to flash floods, as the construction of buildings, roads, and parking lots create impermeable surfaces, reducing the land's natural ability to absorb water (NSWL, n.d.).

Floods are the most common natural disaster, occurring when water overflows and submerges land that is typically dry. They are often triggered by heavy rainfall, rapid snowmelt, or storm surges from tropical cyclones or tsunamis in coastal regions.
Floods can cause extensive destruction, including loss of life and severe damage to homes, property, and critical public health infrastructure. Between 1998 and 2017, floods impacted more than 2 billion people worldwide. Those living in floodplains, in poorly constructed buildings, or without access to warning systems and hazard awareness are the most vulnerable (WHO, 2025).

Three common types of floods include:

- Flash floods: Result from sudden, intense rainfall that rapidly raises water levels, overwhelming rivers, streams, channels, or roads.
- River floods: Occur when prolonged rainfall or snowmelt causes rivers to exceed their capacity.
- Coastal floods: Caused by storm surges linked to tropical cyclones or tsunamis.

Regarding the impact on life, property, and operations, floods cause loss of life and property damage, including residences, buildings, infrastructure, agriculture, and sanitation and drainage systems. After a flooding event, the aftermath can increase the occurrence of various diseases, such as leptospirosis, and lead to rises in contaminated water (Malilay, 2000).

According to a Congressional Budget Office (CBO) report, "Over the past 10 years, damage from flooding in the United States has averaged $46 billion per year (in 2023 dollars)" (CBO, 2024). This estimate includes costs such as:

- The replacement of residential and commercial property;
- Repairs for or rebuilding of public infrastructure;

- Emergency response measures;
- Costs associated with the continued loss of property use (for example, the provision of temporary housing);
- Commercial losses resulting from business interruptions; and
- Damage to crops, livestock, and timbers (CBO, 2024).

Although the effectiveness of adaptation projects varies, estimates by the U.S. Army Corps of Engineers indicate that approximately two-thirds of its projects—excluding those in the highest and lowest sixth of benefit–cost ratios—are expected to reduce flood damages by $2 to $6 for every dollar invested over a 50-year project lifespan (CBO, 2024).

4.9.1.3 Past Events (B1-d)

For the most part, flooding events in Puerto Rico are related to tropical systems (tropical waves, tropical depressions, tropical storms and hurricanes). Consequently, flooding hazards occur most frequently during Atlantic hurricane season, which extends from June 1 through November 30.

However, flooding events can occur outside this window as shown in the case of the April- May 2024 Floods, the February 2022 floods and the Three Kings' Flooding of 1992. The following table summarizes the major flooding events in the period of 2010 – 2025.

Table 28: Major flooding events in Puerto Rico 2010-2025

Event	Date	Disaster Declaration Number	Salinas Included?	Description
Tropical Storm Ernesto	8/14/2025 – 8/16/2025	DR-4850- PR	Public Assistance – NO Individual Assistance NO	The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas. The municipality of Barranquitas measured 11.20 inches over a 48-hour period, while Villalba reported 10.20 inches. Eastern municipalities, including Vieques and Culebra, observed 8–10 inches of rain. Multiple rivers exceeded their banks, including the La Plata River, resulting in significant inundation of adjacent communities. Flash flooding occurred in

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				urban and rural areas, rendering primary and secondary roads impassable. Floodwaters caused structural failures in bridges and washed-out critical road segments, isolating several communities. Stormwater drainage systems in metropolitan areas, notably San Juan, were overwhelmed, leading to localized urban flooding. Emergency Response and Disruptions Evacuations were conducted in flood-prone areas such as Toa Baja to mitigate loss of life.
Puerto Rico Severe Storms, Flooding, Landslides, and Mudslides	4/29/2024 – 5/10/2024	DR-4805-PR	Public Assistance – No Individual Assistance - No	In April 2024, Puerto Rico was struck by a series of severe storms that delivered prolonged heavy rainfall—some areas received more than 10 inches—leading to widespread flooding and landslides. Central and western

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				municipalities saw rivers overflow, with the Manatí and Cibuco rivers breaching their banks and inundating highways like PR-2. Urban areas, especially in the southwest (Cabo Rojo, Mayagüez, Ponce), faced flash flood warnings as heavy afternoon downpours overwhelmed drainage systems. Floodwater turned streets into torrents, trapping residents on rooftops and prompting emergency evacuations in over 20 municipalities.
Hurricane Fiona	9/17/2025 - 9/21/2022	DR-4671-PR	Public Assistance – Yes Individual Assistance - Yes	Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains—up to 31.22 inches of rainfall over 72 hours in Ponce, nearly matching the accumulation from Hurricane Maria. This deluge led to

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				catastrophic flooding, with 7 to 20 inches common across most of the island and localized spots exceeding 30 inches.
Puerto Rico Severe Storm, Flooding and Landslide	2/4/2022 – 2/6/2022	DR-4649-PR	Public Assistance: No Individual Assistance: No	In February 2022, Puerto Rico experienced a severe storm that brought prolonged heavy rainfall, causing widespread flooding across the island. Rainfall totals ranged from 3 to 10 inches in many areas, with localized peaks reaching up to 16 inches in Toa Alta. The intense precipitation overwhelmed drainage systems, leading to urban flooding in San Juan, Guaynabo, and coastal towns such as Dorado and Vega Baja. Rivers swelled beyond their banks, inundating roads and isolating communities, while landslides compounded the

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				damage in mountainous regions. Emergency responders issued flash flood warnings and conducted evacuations as homes and businesses were submerged.
Puerto Rico Severe Storm and Flooding	9/13/2020	DR-4571-PR	Public Assistance: No Individual Assistance: No	Puerto Rico was battered by a severe storm and flooding on September 13, 2020, resulting in widespread flood damage and infrastructure disruption. Torrential rains overwhelmed drainage systems and caused rivers to overtop in areas like Arecibo, where one home was destroyed, over 100 suffered major damage, and more than 20 experienced minor flooding. Roads and bridges were submerged or damaged, isolating communities and impeding emergency response efforts.

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				Floodwaters inundated homes and public facilities, prompting evacuation orders and flash flood warnings across several municipalities.
Tropical Storm Isaías	7/29/2020 - 7/31/2020	DR-4560-PR	Public Assistance: No Individual Assistance; No	Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island.
Hurricane María	9/17/2017 – 11/15/2017	DR-4339-PR	Public Assistance – Yes Individual Assistance - Yes	Widespread flooding severely affected the whole Island. For example, in San Juan, water levels reached up to 6 feet in some areas and numerous structures losing their roofs. The coastal neighborhood of La Perla was largely destroyed, while Cataño suffered extensive damage,

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				with the Juana Matos community estimated to be 80% destroyed. Strong winds, heavy rains, and flash floods near the La Plata Lake dam in Toa Baja impacted thousands of residents. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas experienced depths of up to 15 feet (4.6 m).
Hurricane Irma	9/5/2017 – 9/7/2017	DR-4336-PR	Public Assistance – Yes Individual Assistance - No	On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage. Two people died due to torrential rains before the hurricane: a man died in Orocovis after falling from his ladder while repairing his roof;

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				another man on the coast in Capitanejo died after being struck by lightning. Wave heights in Puerto Rico reached 9 meters, and sustained winds of 111 mph were recorded in Culebra.
Tropical Storm María[9]	9/8/2011 – 9/14/2011	DR-4040-PR	Public Assistance: No Individual Assistance: No	Tropical Storm (later Hurricane) Maria formed in early September 2011 and passed near Puerto Rico, bringing significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters near Patillas destroyed several homes and bridges, and approximately 150 houses in Yabucoa were

[9] Tropical Storm María was a tropical system that pass to the northeast of Puerto Rico in 2011 and that caused flooding in the Island. Not to be confused with the 2017 Hurricane María. The name "María" was retired from the official Atlantic hurricane season list of names after 2017.

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				flooded and damaged.
Hurricane Irene	8/21/2011 – 8/24/2011	DR-4017-PR	Public Assistance: Yes Individual Assistance: No	Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily. The Río Grande de Manatí in Manatí recorded its third-highest level in history, surpassed only during Hurricane Hortense (1996) and Hurricane Georges (1998). The Puerto Nuevo River near Hato Rey reached its fourth-highest level on record. Flooding was severe enough to cause infrastructure stress and dangerous conditions across multiple municipalities. Tragically, there was one direct fatality attributed to Irene, due to drowning.

Event	Date	Disaster Declaration Number	Salinas Included?	Description
Puerto Rico Severe Storms, Flooding. Mudslides and Landslides	5/20/2011 – 6/8/2011	DR-4004-PR	Public Assistance: No Individual Assistance: No	In May 2011, Puerto Rico experienced a series of intense rainfall events that caused flash flooding, river overflows, mudslides, and landslides, particularly in mountainous and interior regions. Although May is normally one of the wettest months of the year, several storm systems produced short-duration but high-intensity rainfall, overwhelming local drainage systems and destabilizing steep terrain.

In summary, between 2010 and 2025 there were a total of 11 major disaster declarations caused by flooding or events that had flood related damage. Of those, the municipality of Salinas was declared eligible for either Public Assistance or Individual Assistance in four instances.

4.9.1.4 Special Consideration: Floods by Stormwater Management Deficiencies

Urban drainage systems — whether natural or constructed — are designed to convey surface water runoff to receive water bodies. When storm drains, channels, or swales become obstructed, insufficient or overwhelmed by heavy rainfall and expanding urbanization, they can overflow and flood surrounding areas. As a result, floodwaters

may spread beyond FEMA's mapped floodplains, even entering zones typically considered low or moderate risk (e.g., Zones B, C, or X) (FEMA, Reducing Damage from Localized Flooding, 2025).

Puerto Rico's stormwater runoff is conditioned by the island's climate, topography and land cover. Annual rainfall varies from less than 1,000 millimeters (mm) to over 4,000 mm (40 to 157 inches). The island's watersheds are largely mountainous, with steep slopes, and stream valleys are typically narrow and well-incised. Intense but short-duration storms are common, leading to rapid flooding with peak discharges that can be several orders of magnitude higher than base flows. All of Puerto Rico's watersheds have experienced significant alterations. It is estimated that more than 11% of the island is covered by developed surfaces, within areas reaching up to 40% in regions such as the San Juan Metropolitan Area. These changes have significantly modified stormwater drainage patterns and downstream floodwater levels (FEMA, 2024).

Paved surfaces severely limit the infiltration of rainwater, increasing both the volume and velocity of surface runoff. As a result, storm drains can easily become overwhelmed. In addition, runoff from paved surfaces reaches streams and rivers much faster, exceeding their capacity to convey water and causing higher and more frequent flood levels in adjacent areas. Moreover, contaminants from both point and non-point pollution sources are more likely to reach surface water bodies when transported by runoff over paved surfaces instead of being partially or totally degraded by vegetated soils. Higher flows also have a greater capacity to remove and transport soil and other loose materials from streambanks and riverbeds, facilitating erosion and scouring (FEMA, 2024).

Paradoxically, river flow between rain events tend to decrease after urbanization. Paved surfaces act as a barrier that isolates the soil, preventing the infiltration of rainwater that otherwise would have gradually discharged from the ground and into streams days later, a process that is critical for maintaining base flows for riparian fish and wildlife species, but also to sustain public water supply. In response, various hard infrastructure measures (hard infrastructure measures such as flood-control pump stations, concrete trapezoidal channels, and curved side gutters have been widely implemented across Puerto Rico. While effective at quickly conveying runoff, these structures often neglect ecological, social, cultural, and aesthetic considerations. These practices often involve significant operation and maintenance costs and, in many instances, can exacerbate downstream erosion, scouring and water quality problems.

A more sustainable approach would be to take advantage of the ecological services that green areas and other nature-based solutions to manage runoff flows and improve water quality. Such strategies are increasingly critical to protect communities from the growing water-related impacts of climate change in Puerto Rico (FEMA, 2024).

4.9.1.5 Future Event Probabilities (B1-e)

A sustained increase in the frequency of extreme rainfall events has been identified in recent decades. As stated above, the Island of Puerto Rico has had 13 flood – related flood major disaster declaration in the last fifteen years. This means that the average frequency of a flooding event is approximately every 14 months.

Any mitigation action adopted to reduce the effects of flooding in the Municipality of Salinas must consider, for example, that 100-year return events or those with a 1% annual probability could become 50-year return events or have a 2% annual probability in the future. This means that flood events of a certain magnitude and impact on the municipality may increase, particularly in high-risk areas. Though there are many floods control projects in Salinas, the probability of future events is considered high.

4.9.2 Risk Analysis (B2-a, B2-b)

4.9.2.1 Estimated Losses

Maps 33 and 34 show the estimated building losses resulting from 100-year (1% annual chance) and 500-year (0.2% annual chance) flood events in Salinas, distributed by census tract. It is important to note that these maps do not represent the geographic extent of flooding, but rather the estimated economic losses to structures resulting from flood exposure.

For the 500-year flood scenario, the highest estimated building losses are concentrated in the southern coastal portion of the municipality, particularly within the census tracts located in Aguirre, Pueblo, and the coastal sectors of Río Jueyes. The areas exhibiting the greatest losses correspond to the municipality's most developed coastal and urbanized sectors, where residential, commercial, and community assets are concentrated. Some of the highest estimated losses occur in the census tracts encompassing the Aguirre community, the urban center of Pueblo, and coastal residential sectors such as Playita, Playa, Las Mareas, and Las Ochenta. These areas

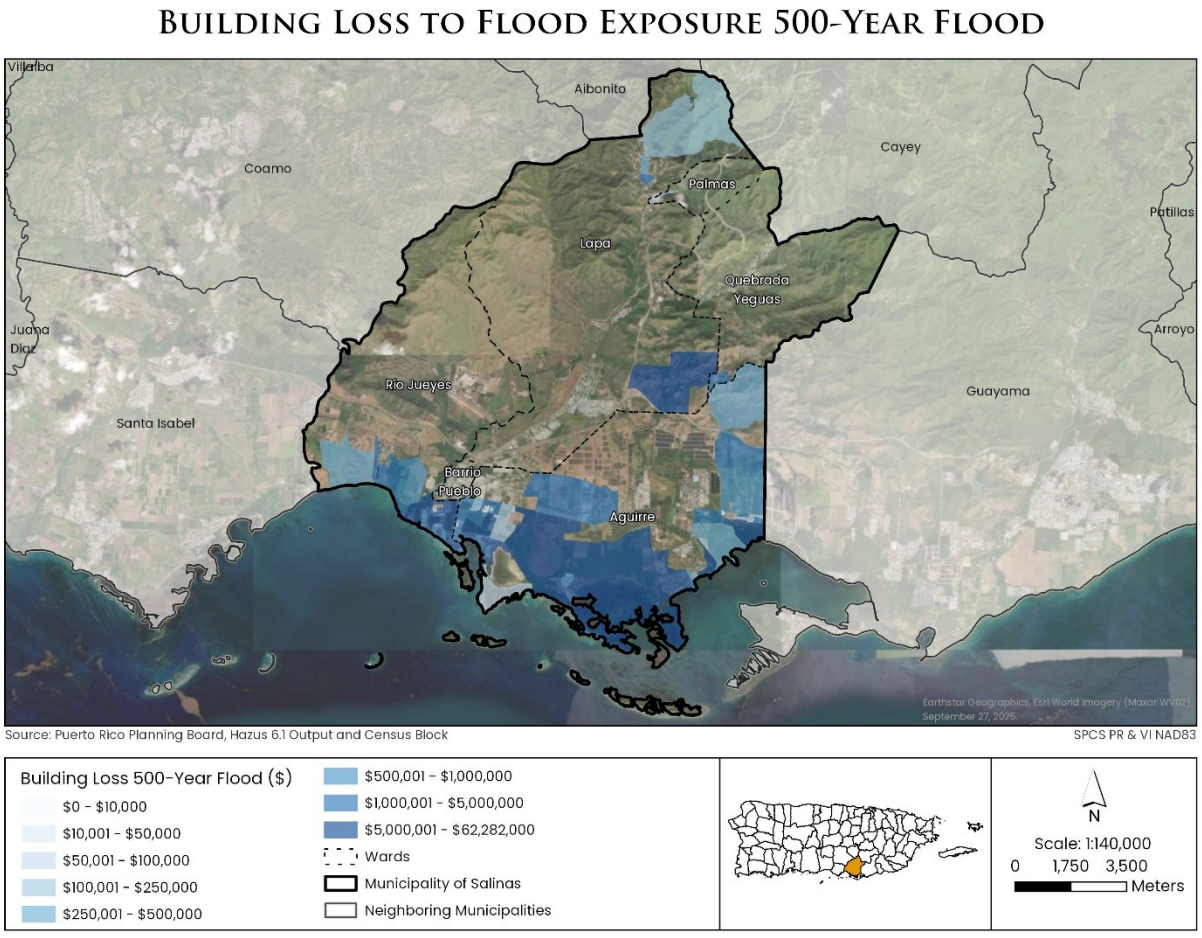
contain a large number of structures located on low-lying terrain that are highly susceptible to both riverine and coastal flooding.

The 500-year flood loss map also identifies elevated losses in portions of the central municipality along the major drainage corridors associated with the Río Nigua watershed and other stream systems that convey runoff from the northern mountainous region toward the coast. Although the northern wards contain fewer structures overall, localized losses are observed in areas where development has occurred along drainage channels and valley floors.

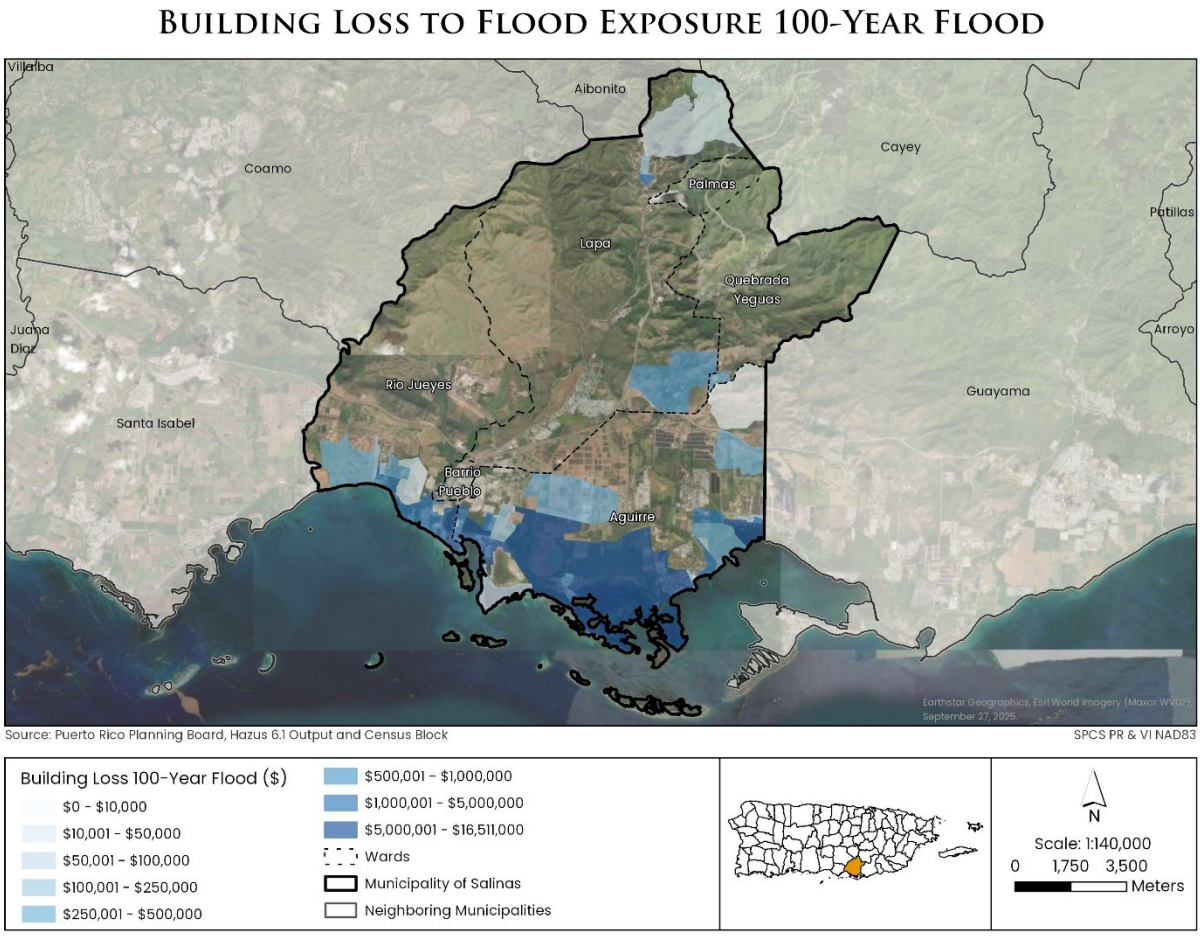
Map 34, which illustrates estimated building loss for the 100-year flood event, shows a similar spatial pattern but generally lower loss values than the 500-year scenario. The highest losses remain concentrated within Aguirre, Pueblo, Río Jueyes, and adjacent coastal sectors, demonstrating that these areas represent the municipality's most economically vulnerable locations during flood events. The difference between the two scenarios is primarily the magnitude of potential losses, with the 500-year event affecting a larger number of structures and generating substantially higher economic impacts.

As a reminder, these maps do not measure flood extent; instead, they estimate the potential monetary losses to buildings resulting from flood exposure. The concentration of losses in the southern portion of the municipality is largely due to the presence of developed residential, commercial, institutional, and industrial areas within low-elevation flood-prone zones. At the same time, runoff originating in the northern mountainous wards of Palmas, Lapa, and Quebrada Yeguas contributes to flooding downstream through channels and river systems, particularly the Río Nigua and its tributaries. During extreme rainfall events, these waterways can overtop channels, affect nearby structures, and contribute to substantial economic damage in the coastal and urbanized portions of Salinas.

Map 33: Building Loss to Flood Exposure 500 – year flood



Map 34: Building Loss to Flood Exposure 100 – year flood



The following table shows the municipality exposure to flood.

Table 29: Flood Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
2.42	$ 1,668,379,609	12720	$ 147,551,380,018	$ 149,219,759,628

While the next table presents the expected annual flood related losses for both buildings and population.

Table 30: Expected Annual Loss to Flood

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss -Total
$ 57,749	0.0009	$ 10,764	$ 68,514

After running the HAZUS 6.1 model, the following flood-related losses and exposure levels were estimated for Salinas:

- The modeled 500-year flood event affects approximately 2.42 square miles of the municipality
- The analysis estimates a total exposure of approximately $149,219,759,628, including both structural and population-equivalent exposure. Building value exposure accounts for approximately $1,668,379,609, while population exposure represents approximately 12,720 residents, equivalent to $147,551,380,018 using FEMA's population-equivalence methodology.
- The expected annual flood loss is estimated at approximately $68,514, consisting of $57,749 in building losses and $10,764 in population-equivalent losses. Population losses are estimated to be minimal in annualized terms (0.0009) due to the probabilistic nature of the analysis.
- As shown in the HAZUS flood-depth model, the areas experiencing the greatest flood depths and therefore the highest potential losses are concentrated in the southern portions of Aguirre, Barrio Pueblo, and Río Jueyes, as well as along the Río Nigua floodplain extending northward through the central municipality. Additional areas of significant exposure occur along the drainage corridors that descend from Lapa, Palmas, and Quebrada Yeguas toward the coastal plain.
- The concentration of exposure within Aguirre, Pueblo, and the southern coastal plain reflects the presence of residential, commercial, industrial, and community assets situated in low-lying areas susceptible to both riverine and coastal flooding. Consequently, these sectors represent the municipality's highest potential economic loss areas during major flood events.

Overall, the HAZUS analysis confirms that flood risk in Salinas is driven primarily by the interaction of the Río Nigua watershed, the municipality's extensive coastal plain, and the concentration of development within low-elevation areas. The highest expected

losses occur where flood-prone lands overlap with the municipality's most developed residential, commercial, and infrastructure corridors.

Table 31: Total Structures at Risk

Structures	
Non-Residential	55
Residential	15,633
Total	15,688

Table 32: Aggregated Loss of dollars for 1% (100-year) and 0.2% (500 - year) events

Occupancy Type	Losses in Dollars. 1% Event	Losses in Dollars. 0.2% Event
Non-Residential	$14,849,000	$16,544,000
Residential	$66,306,000	$71,543,000
Total	$81,155,000	$88,087,000

Table 33: Detailed Loss for Non-Residential Buildings

Occupancy	Losses in Dollars, 1% Event	Losses in Dollars, 0.2% Event
Commercial	$4,739,000	$5,290,000
Education	$717,000	$739,000
Government	$9,393,000	$10,515,000
Religious	$0	$0
Agriculture	$0	$0
Industrial	$0	$0
Total	$14,849,000	$16,544,000

Table 34: Detailed Loss for Residential Buildings

Residential, Detailed Losses	Losses in Dollars, 1% Event	Losses in Dollars, 0.2% Event
Structure	$23,587,000	$26,171,000
Contents	$13,801,000	$15,092,000
Relocation	$18,044,000	$18,913,000
Rental Income	$10,874,000	$11,367,000
Total	$66,306,000	$71,543,000

4.9.2.2 Lifelines and Critical Infrastructure

Flooding is among the most disruptive natural hazards, affecting all eight FEMA Community Lifelines. These lifelines represent essential services that support public health, safety, and economic stability. Below is an analysis of some of the impacts that flooding can have on lifelines:

- **Safety and Security** - Flooding can damage emergency services infrastructure such as police stations, fire departments, and emergency operations centers. Blocked evacuation routes and submerged roads hinder rescue efforts, while prolonged outages increase vulnerability to crime and civil unrest.

- **Food, Water, Shelter** - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Food supply chains may be severely disrupted when warehouses and grocery stores are flooded. Damage to residential structures can result in displacement, creating urgent demand for temporary shelters.

- **Health and Medical** - Hospitals and clinics may become inaccessible or experience power outages during flood events. Flood conditions can contribute to increased incidence of waterborne diseases and mold-related illnesses increase significantly. Disruptions to medical supply chains may delay both emergency care and routine treatments.

- **Energy (Power and Fuel)** - Flooding can submerge electrical substations and transformers, causing widespread outages. Fuel distribution networks may be disrupted due to impassable roads and damaged transportation routes. Prolonged power loss can significantly affect critical facilities such as hospitals and water treatment plants.

- **Communications** – Flooding can damage cell towers, fiber-optic cables, and emergency communication systems, reducing the capacity to coordinate rescue and recovery operations. This disruption can delay the dissemination of critical information.

- **Transportation**- Flooding can wash out or undermine roads, bridges, and rail lines, rendering them impassable. Airports and seaports may be forced to suspend operations, delay evacuation and the delivery of emergency supplies.

Also, transportation disruptions amplify the overall impact of the disaster.

- **Hazardous Materials** - Floodwaters can mobilize and disperse hazardous substances from industrial sites, sewage systems, and fuel storage tanks, increasing the risk of environmental contamination. Cleanup efforts can become complex, costly and time-consuming, potentially resulting in long-term public and environmental impacts.

- **Water Systems** - Floodwaters can contaminate drinking water supplies and damage water treatment facilities. Excessive inflow from floodwaters may overwhelm sewer systems, causing untreated sewage to backflow into streets and homes. Flood conditions can exceed the design capacity of storm drains and retention basins, resulting in urban flooding and infrastructure damage. The accumulation of sediment and debris clog drainage systems, reducing effectiveness and increasing flood risk during subsequent storms events.

Map 35 and 36 shows the location of critical facilities in relation to the flood-prone areas identified within Salinas. The map indicates that a substantial number of critical facilities are located within or adjacent to the municipality's principal flood hazard areas, particularly in Pueblo, Aguirre, and portions of Río Jueyes, where the highest concentration of development overlaps with areas of elevated flood risk.

The vulnerability of the road system and bridges is primarily associated with flooding, soil erosion, scour, roadway overtopping, and obstruction caused by debris, sediment, vegetation, utility poles, and other materials transported during significant storm events. The municipality's transportation network is especially vulnerable where major roadways intersect the floodplains associated with the Río Nigua and other drainage corridors that convey runoff from the northern mountainous wards toward the southern coastal plain.

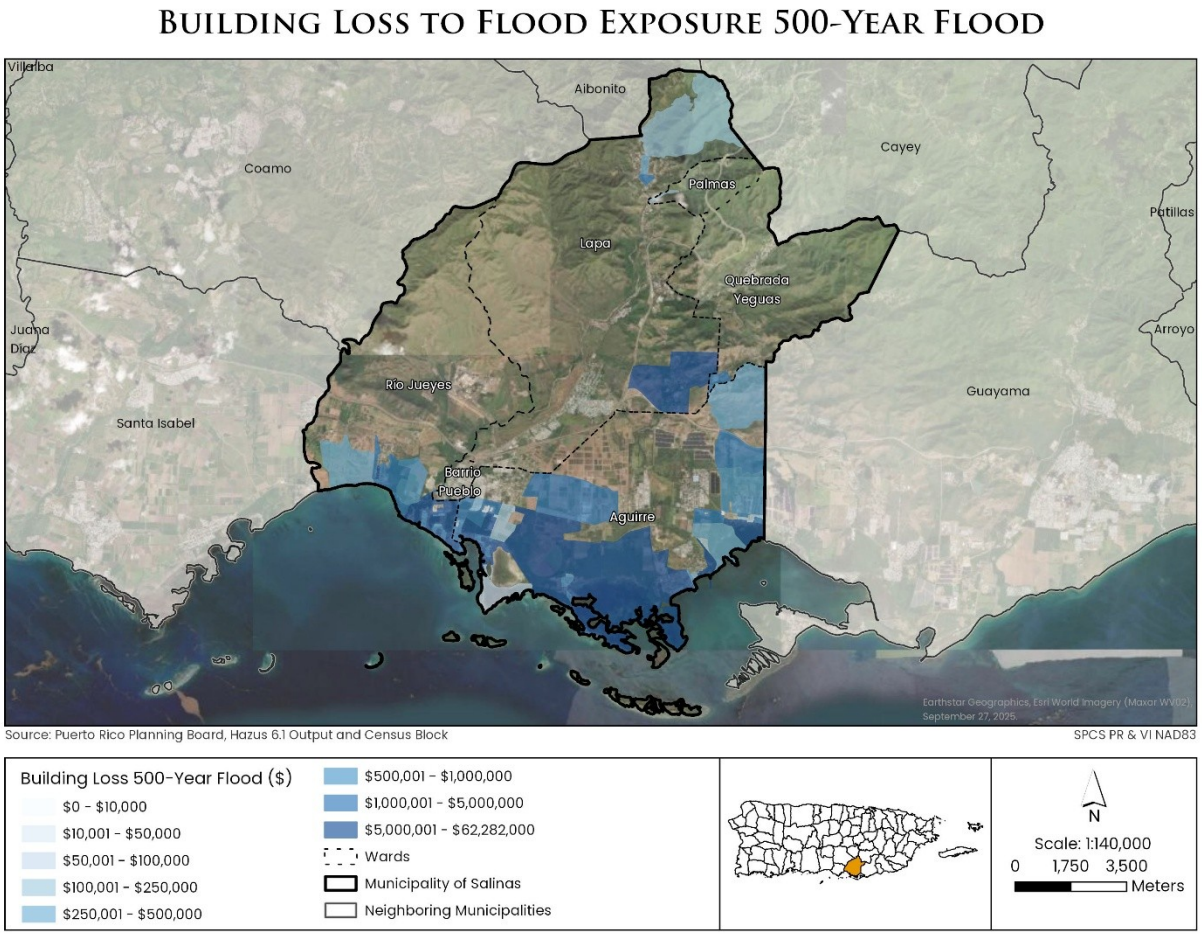
As reflected in the flood hazard and building loss analyses, many of the municipality's critical facilities and transportation corridors are concentrated within the low-lying southern portion of Salinas, including Aguirre, Pueblo, Playita, Playa, Las Mareas, Las Ochenta, and Río Jueyes. These areas contain transportation infrastructure, water system facilities, educational institutions, public safety facilities, community assets, and other critical infrastructure that may experience direct impacts during both the 100-year and 500-year flood events.

The northern wards of Palmas, Lapa, and Quebrada Yeguas present a different type of

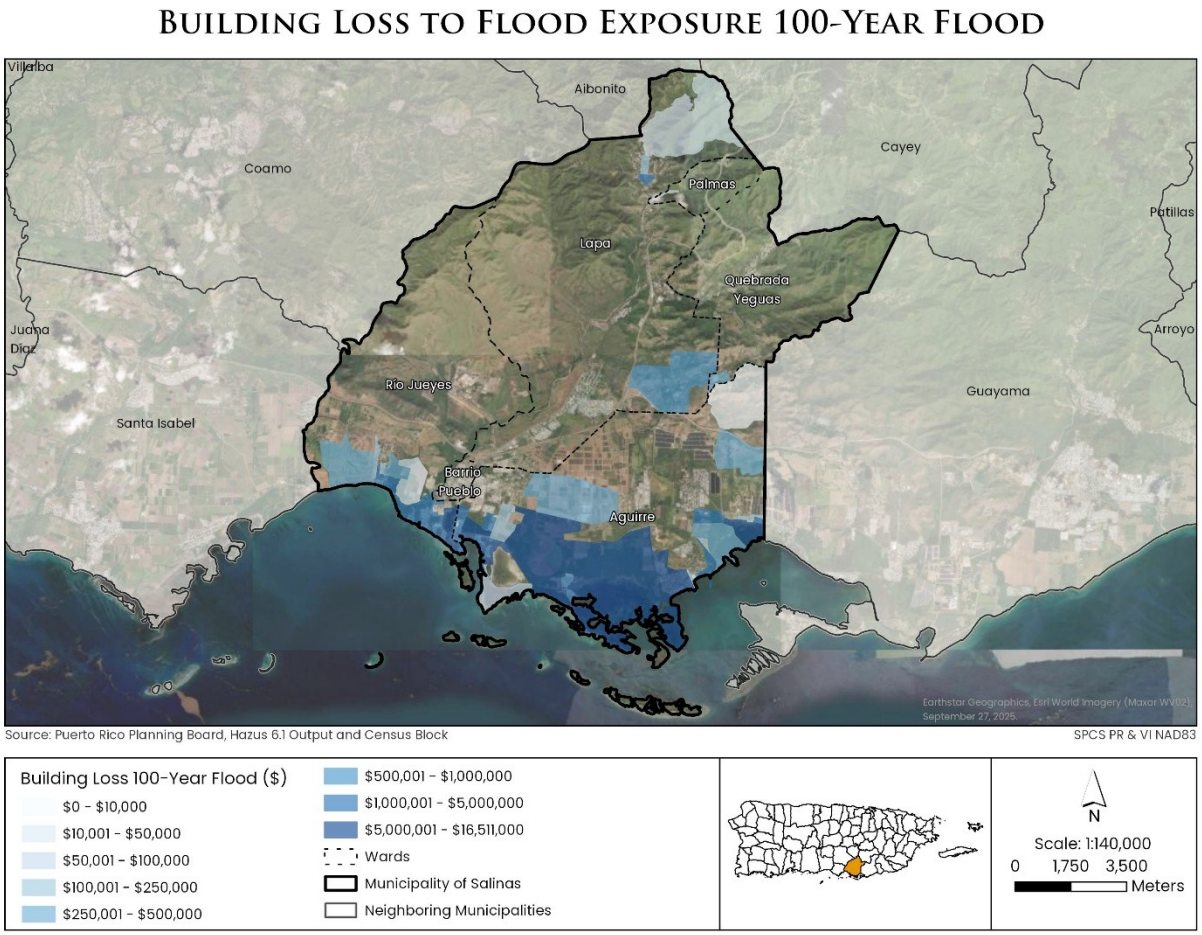
vulnerability. While many facilities in these wards are located outside the primary floodplain, the numerous streams and drainage channels originating in the mountainous terrain can affect roadway crossings and local access routes during intense rainfall events. Flooding, erosion, and debris accumulation along these corridors may restrict access to communities and critical facilities even when the facilities themselves are not located directly within mapped flood zones.

Overall, the analysis demonstrates that flood hazards in Salinas affect both critical facilities and the transportation network that supports them. The concentration of development and infrastructure within Pueblo, Aguirre, and Río Jueyes, combined with the municipality's extensive floodplain system and coastal exposure, underscores the importance of continued flood mitigation efforts, drainage improvements, bridge maintenance, and transportation resilience planning throughout the Municipality of Salinas.

Map 35: Flood Critical Facilities Exposure 500 yrs flood



Map 36: Flood: Critical Facilities Exposure to 100 yrs flood



4.9.2.3 Social Vulnerabilities

Map 37 shows the population at risk of displacement during a 500-year (0.2% annual chance) flood event by census tract. The highest population exposure is concentrated within the municipality's southern coastal plain, particularly in the census tracts encompassing Aguirre, Pueblo, and portions of Río Jueyes, where the largest concentrations of residential development overlap with flood-prone areas. The communities of Las Mareas, Playita, Playa, Las Ochenta, and San Felipe are among the areas where large numbers of residents could be affected by major flood events.

Other census tracts with significant populations at risk are located along the Río Nigua floodplain, which extends from the northern interior toward the southern coast and serves as one of the municipality's principal drainage systems. Additional populations at risk are found along the drainage corridors that descend from Lapa, Palmas, and

Quebrada Yeguas, where runoff generated in the mountainous uplands is conveyed toward the lower-elevation coastal sectors.

As discussed earlier, a significant portion of Salinas' population is exposed to flood hazards, particularly within the developed southern portion of the municipality. Of particular concern, residents living in coastal and flood-prone communities often depend on a limited number of transportation routes for access to employment centers, emergency services, schools, and commercial areas. During major rainfall events, these routes may become impassable due to flooding, erosion, debris accumulation, or damage to drainage infrastructure.

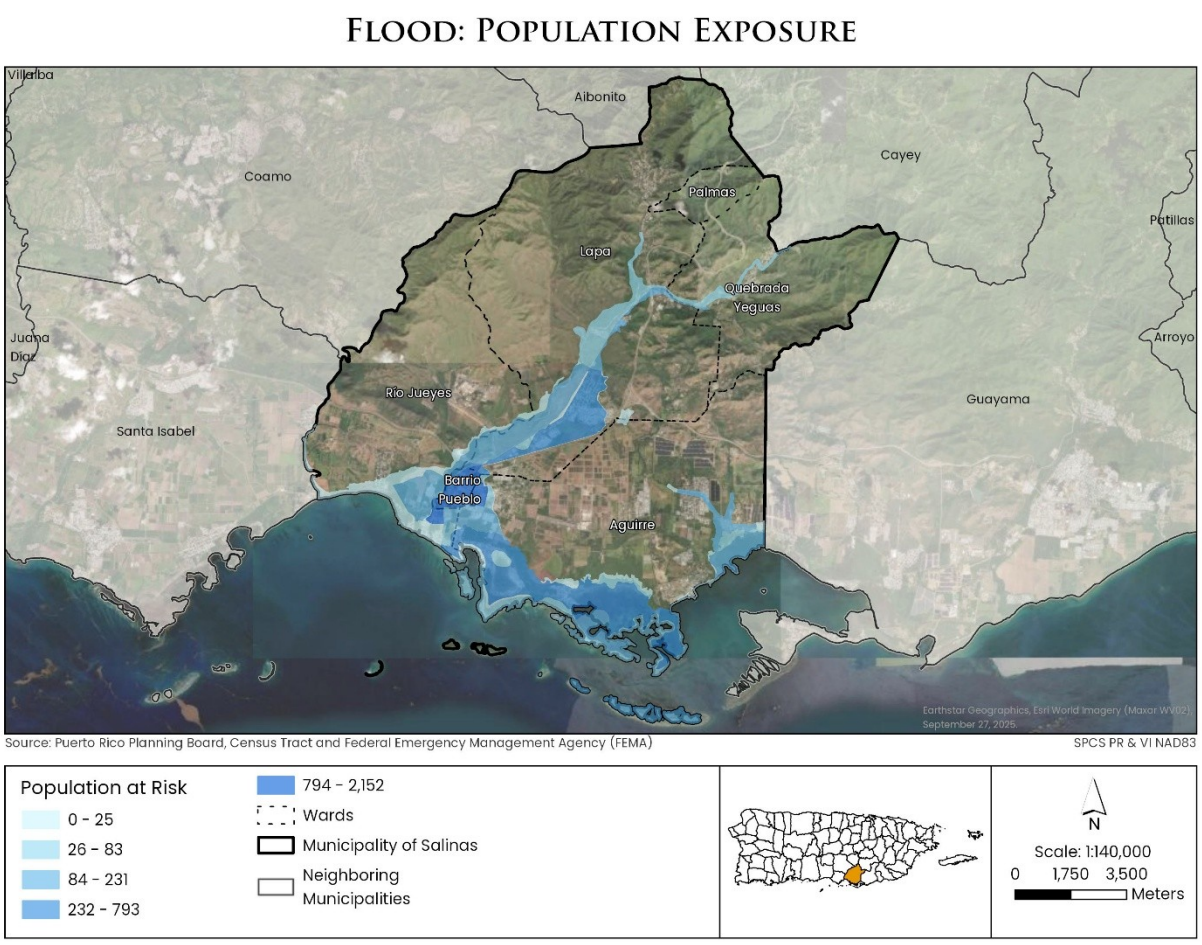
One particularly important transportation corridor is PR-3, which traverses several of the municipality's most flood-prone coastal communities, including portions of Aguirre, Pueblo, and Río Jueyes. Flooding affecting this corridor could restrict mobility, delay emergency response, and temporarily isolate residents from critical services. Similarly, local roads serving communities such as Las Mareas, Playita, Playa, and Las Ochenta are vulnerable to flood-related disruptions due to their proximity to low-elevation coastal and alluvial areas.

Overall, the population exposure analysis demonstrates that the greatest risk of displacement is concentrated in the municipality's southern developed corridor, where extensive residential development coincides with areas susceptible to both riverine and coastal flooding. Consequently, maintaining transportation connectivity, improving drainage infrastructure, and coordinating evacuation planning remain critical components of flood risk reduction in the Municipality of Salinas.

Research in flood-prone Puerto Rican communities shows that access to economic, material, and social resources strongly influences adaptive capacity, with low-income residents facing significant barriers to elevating homes, purchasing insurance, or relocating away from high-risk zones. These same communities frequently experience “false security” due to structural flood-control measures that reduce perceived risk but do not eliminate underlying exposure, which can worsen long-term vulnerability when residents underestimate future flood potential. Flood impacts also disproportionately affect individuals with limited mobility—including older adults, disabled residents, and those with chronic medical conditions—who may be unable to evacuate rapidly or access emergency shelters during rising waters. The Census Bureau’s Community Resilience Estimates indicate that vehicle access, caregiver support, health insurance gaps, and disability prevalence are among the most widespread vulnerability components in the commonwealth, factors that directly

shape whether individuals can flee or recover from flooding (US Census Bureau, 2024), (López Marrero, 2010) .

Map 37: Flood Population Exposure



4.9.2.4 Natural and Cultural Resources

In most flood events, water resources are exposed to high levels of contaminants associated with rising water, sewage accumulation, and other hazardous or toxic substances left behind by flooding (Malilay, 2000). This contamination can facilitate the spread of diseases in municipal water bodies and adversely affect local flora and fauna, including humans. For example, prolonged stagnant water after a flood can promote diseases such as dengue and leptospirosis. Following Hurricane María, stagnant water contributed to leptospirosis outbreaks and mosquito proliferation. Leptospirosis is a bacterial disease that affects both humans and animals and can spread through urine from infected animals. These contaminated residues often remain in stagnant water after flooding events.

Floods also lead to the accumulation of debris, including structural remnants, soil, sediments, organic waste, and personal belongings. If not properly managed, this debris can contaminate land and water when burned, abandoned, buried, or dumped into water bodies.

4.9.2.5 Special Consideration: Repetitive Losses and Severe Repetitive Losses

In Salinas there are properties insured under the National Flood Insurance Program (NFIP). These properties participate in the NFIP covered by the PRPB. Section 6.5 provides further details on how the municipality can use the NFIP as a mechanism for mitigation planning.

The Municipality has included properties that have experienced repetitive losses and/or severe repetitive losses located in identified flood hazard areas. These properties currently lack descriptions of the type of structures (residential, commercial, institutional, among others). Including this information helps to understand the vulnerability of properties affected by flooding within the jurisdiction and increases the likelihood of qualifying for flood control or prevention grants through programs such as Flood Mitigation Assistance (FMA), Hazard Mitigation Grant Program (HMGP), Housing and Urban Development (HUD), CDBG-DR, and others.

As of May 29, 2026, the information regarding NFIP coverage for Repetitive Losses (RL) and Severe Repetitive Losses (SRL) for the Municipality of Salinas are as follows:

Table 35: NFIP Policies in force and coverage

Amount of NFIP Policies	Total Disbursement for both RL and SRL Losses
133	$ 1,134,218

Accordingly, the registered RL are as follows:

Table 36: NFIP Repetitive Losses

Structures with Repetitive Losses (RL)	Insured structures (RL)	Total Repetitive Losses (RL)
73	2	175

While the data provided show the following information regarding SRL

Table 37: NFIP Severe Repetitive Losses

Structures with Severe Repetitive Losses (SRL)	Insured structures S(RL)	Total Repetitive Losses (SRL)
9	0	26

4.9.2.6 Future Conditions (E1-A)

The following map shows the locations of recent construction permits in Salinas in relation to known flood hazard areas. This map shows that a significant portion of recent development has occurred within or immediately adjacent to the FEMA 1% annual chance flood hazard area, particularly within the southern and coastal portions of the municipality. The highest concentration of permits is located inPueblo, Aguirre, and portions of Río Jueyes, where residential, commercial, and mixed-use development overlaps with both the mapped floodplain and the regulatory floodway.

The two detailed approach areas highlight this trend. Approach Area 1 shows multiple permits located near the flood-prone corridor extending between Lapa and Aguirre, where development has occurred adjacent to flood hazard zones associated with the municipality's principal drainage network. Similarly, Approach Area 2 illustrates a substantial concentration of permits within Pueblo and Aguirre, including several permits located within the 1% annual chance flood hazard area and near the regulatory floodway.

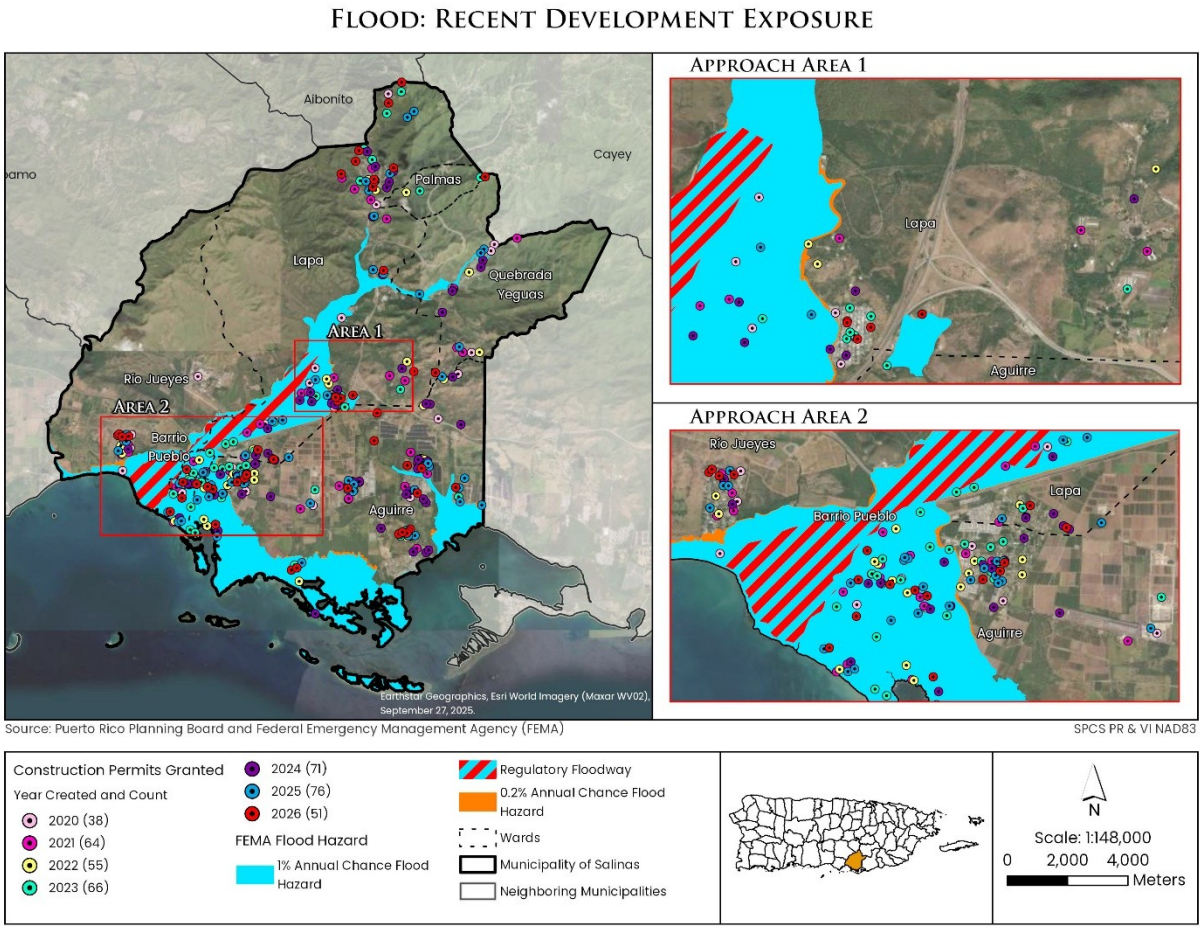
The map further demonstrates that development pressure continues within some of the municipality's historically flood-prone areas. Numerous permits issued between

2020 and 2026 are clustered in low-elevation coastal sectors, including areas near Playita, Playa, Las Mareas, Las Ochenta, Aguirre, and the urban center of Pueblo. These areas have previously been identified as vulnerable to both riverine and coastal flooding due to their proximity to the Río Nigua floodplain, coastal drainage systems, and low-lying terrain.

At the same time, the map shows that recent development has also occurred outside the mapped flood hazard area, particularly in portions of Palmas, Lapa, and Quebrada Yeguas, where higher elevations generally provide greater protection from flood inundation. However, development within these areas may still be indirectly affected by flooding through disruptions to transportation routes, drainage systems, and utility infrastructure.

Overall, the map indicates that future flood exposure in Salinas is unlikely to decrease in the near term, as development continues within portions of the municipality already identified as vulnerable to flooding. The presence of recently approved construction permits within flood-prone areas suggests that additional residents, structures, and economic assets may be exposed to future flood events. Consequently, the continued integration of flood hazard information into land-use planning, permitting decisions, drainage improvements, and mitigation strategies will remain critical to reducing long-term flood risk in the Municipality of Salinas.

Map 38: Recent Development and Flood Risks



4.10 Tropical Cyclones and other Extreme Wind Events

4.10.1 Description (B1-a)

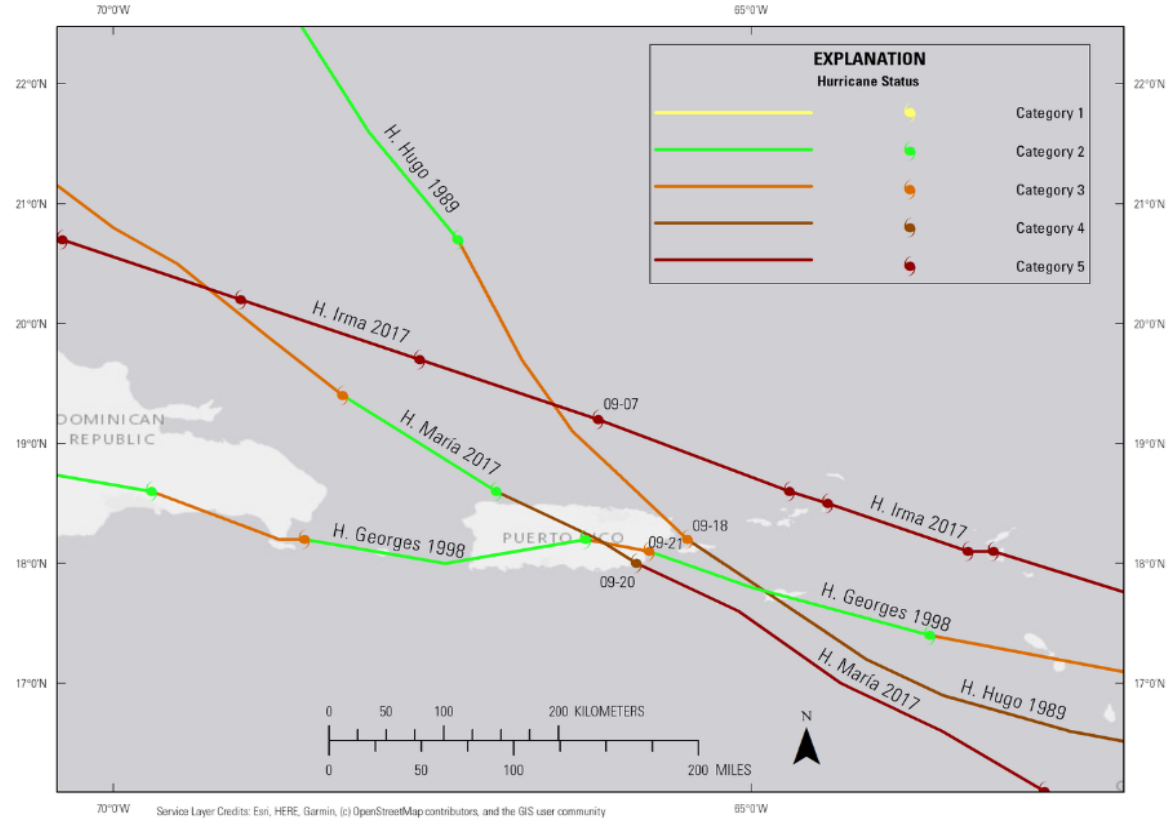
Winds consist of air currents generated in the atmosphere due to variations in pressure. Although these currents are constantly present, when their intensity increases, they can become a high-level hazard. For the purposes of this Plan, we will focus on events severe wind events associated with tropical cyclones and their extreme force (Castro Rivera & López Marrero, Cartilla de los Ciclones, 2018).

This sub-chapter is titled Tropical Cyclones in order to include phenomena such as tropical storms and tropical depressions. However, hurricanes pose the greatest threat due to their high destructive potential, wide geographic impact, rapid development, and sometimes unpredictable paths. In addition, hurricanes are often

accompanied by high tides, storm surges, and heavy rainfall, which may result in landslides and riverine flooding. Since these accompanying hazards are addressed in separate sections, this section will focus specifically on the impact of wind within the municipality.

Figure 22 shows the path of category 2 – 5 hurricanes that have affected Puerto Rico since 1989.[10]

Figure 22: Hurricane Tracks 1989-2017 (only Cat 2-5) [11]



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Figure 1. *Hurricane tracks for Hugo (1898), Georges (1998), Irma (2017) and Maria (2017). Data provided by NOAA. Base image is intellectual property of Esri and is used herein under license. Copyright Esri and its creator.*

Figura 1: *Trayectorias de los huracanes Hugo (1989), Georges (1998), Irma (2017) y María (2017). Datos provistos por la NOAA. La imagen de base es propiedad intelectual de Esri y se usa aquí bajo licencia. Los derechos de autor y reproducción son propiedad de Esri y sus licenciatarios.*

4.10.1.1 AFFECTED AREA (B1-B)

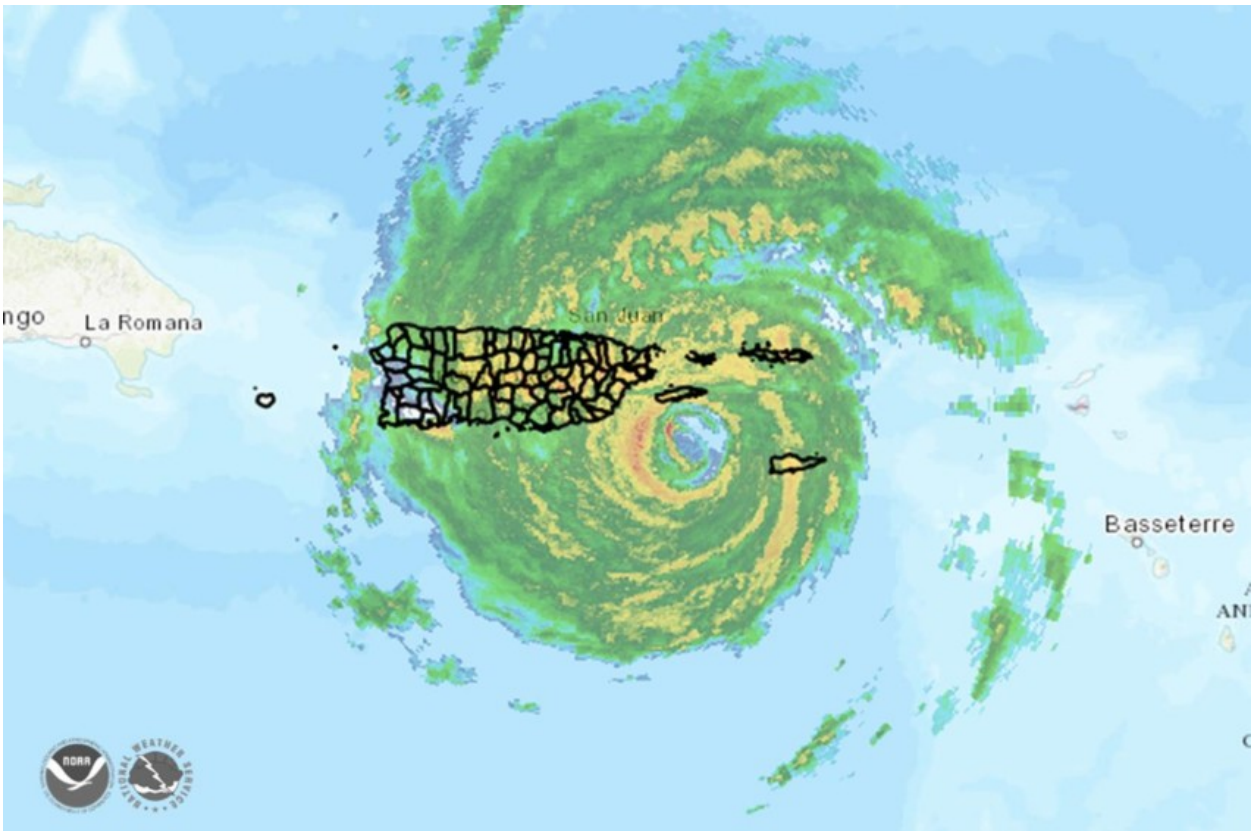
Tropical Cyclones are atmospheric systems that can affect the whole island. For

[10] Hortense (1996) and Fiona (2022) are not shown since they were category 1 hurricanes when they hit Puerto Rico.

[11] htt.s://www.usgs/gov/mission-areas/natural-hazards/science/Puerto-rico-natural-hazards-hurricanes-peligros-naturales-de

example, Figure 23 shows the size of hurricane María (2017) as it approached Puerto Rico.

Figure 23: Hurricane María (2017) as it approaches Puerto Rico[12]



4.10.1.2 Risk Magnitude (B1-C)

Tropical cyclones are the most frequent natural hazard in Puerto Rico, with hurricanes being the most dangerous. Hurricanes are tropical atmospheric systems characterized by sustained wind speeds exceeding seventy-four (74) miles per hour. They develop over warm ocean waters and result from instability caused by the interaction of warm and cool air masses. Tropical cyclones are classified according to sustained wind intensity as follows:

- Tropical Depression: An organized system of clouds with a defined circulation and maximum sustained winds below 39 mph. This represents the formative stage of a tropical cyclone.

[12] Obtained from https://www.researchgate.net/figure/Hurricane-Maria-approaching-Puerto-Rico-NWS-2017_fig1_371340603.

- Tropical Storm: An organized system of clouds with a defined circulation and maximum sustained winds ranging from 39 to 73 mph.
- Hurricane: The most intense form of a tropical cyclone, with sustained winds of 74 mph or greater. Hurricanes have a well-defined center with very low barometric pressure. They are categorized from one (I) to five (V), and the strongest can reach wind speeds exceeding 155 mph (Castro Rivera & López Marrero, 2018).

Table 38 shows the Saffir - Simpson Scale of hurricanes and gives historical examples of those passing through or near Puerto Rico.

Table 38: Saffir-Simpson Hurricane Scale

Category	Wind Speed	Description	Historical Example
Tropical Storm	39 – 73 mph	Strong enough to cause tree damage, power outages, and localized flooding, but generally less destructive than a hurricane.	Eloise (1975) Claudette (1979) Frederic (1979) Jeanne (2004) Irene (2011) Isaias (2020) Ernesto (2024)
1	74–95 mph	Winds can cause minor damage to roofs, siding, and trees, with potential for power outages.	Santa Clara[13] (1956) Hortense (1996) Fiona (2022)
2	96–110 mph	Strong winds can cause extensive damage to roofs and trees, leading to widespread power loss.	Marilyn (1995)
3	111–129 mph	Devastating winds can destroy roofs and walls of homes, uproot trees, and cause prolonged outages.	Hugo (1989) Georges (1998)
4	130–156 mph	Catastrophic winds can cause severe structural damage,	San Ciriaco (1899) San Ciprian (1932)

[13] Officially known as Hurricane Betsy

Category	Wind Speed	Description	Historical Example
		most trees snapped or uprooted, and power outages lasting weeks.	Donna (1960) David (1979) María (2025)
5	157 mph or higher	Catastrophic winds can result in total roof failure and building collapse, rendering areas uninhabitable for weeks or months.	San Felipe II (1928) Irma (2017)

To assess the vulnerability posed by hurricanes, this LHMP utilizes the 100 – year wind event and 500-year wind event as benchmark design standards. A 100-year wind event refers to a wind speed that has a 1% chance of being equaled or exceeded in any given year. Similarly, a 500-year wind event has a 0.2% annual probability of being equaled or exceeded. These terms describe statistical return periods and do not imply that such events occur only once every 100 or 500 years. Rather, they express the likelihood of occurrence in any single year. Wind returns period values are derived through statistical analysis of historical wind speed records using extreme value probability models. These analyses estimate wind intensities associated with specific recurrence intervals and are widely applied in engineering, insurance modeling, and hazard mitigation planning.

These values are critical for structural design standards like the American Society of Civil Engineers Standard 7 (ASCE 7), which specify wind loads for different risk categories, and for insurance companies assessing potential storm damage. For example, typical 3-second gust wind speeds at 33 ft above ground (Exposure Category C) are about 100 mph for a 100-year event and approximately 110–115 mph for a 500-year event. These design speeds ensure safety for buildings, bridges, and critical infrastructure, and help guide emergency planning and financial risk management.

4.10.1.3 Past Events (B1-d)

The following table shows the extreme wind events that received a declaration of disaster in since 2000. One column identifies whether the Municipality of Salinas was designated for Public Assistance (PA), Individual Assistance (IA), or both under each declaration. Table 39 provides a list of tropical cyclones that have affected Puerto Rico

during the first quarter of the twenty-first (21st) century, throughout the twentieth (20th) century, and selected notable storms from earlier centuries that had significant historical impact.

Table 39: Tropical Cyclone Disaster Declarations since 2025

Event	Date	Disaster Declaration Number	Salinas Included?	Description
Tropical Storm Ernesto	8/14/2024 – 8/16/2024	DR-4850- PR	Public Assistance – No Individual Assistance No	The storm's slow movement and moisture-rich environment contributed to prolonged precipitation, particularly in central and eastern municipalities. Parts of Central Puerto Rico recorded 12–14 inches of rainfall in localized areas. The municipality of Barranquitas measured 11.20 inches over a 48-hour period, while Villalba reported 10.20 inches. Eastern municipalities, including Vieques and Culebra, observed 8–10 inches of rain. Multiple rivers exceeded their banks, including the La Plata River, resulting in significant inundation of adjacent communities. Flash flooding occurred in urban and rural areas, rendering primary and

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				secondary roads impassable. Floodwater caused structural failures in bridges and washed-out critical road segments, isolating several communities. Stormwater drainage systems in metropolitan areas, notably San Juan, were overwhelmed, leading to localized urban flooding. Emergency Response and Disruptions Evacuations were conducted in flood-prone areas such as Toa Baja to mitigate loss of life.
Hurricane Fiona	9/17/2022 - 9/21/2022	DR-4671-PR	Public Assistance – Yes Individual Assistance - Yes	Hurricane Fiona struck Puerto Rico in September 2022, unleashing torrential rains—up to 31.22 inches of rainfall over 72 hours in Ponce, nearly matching the accumulation from Hurricane Maria. This deluge led to catastrophic flooding, with 7 to 20 inches common across

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				most of the island and localized spots exceeding 30 inches.
Tropical Storm Isaías	07/29/2020 – 07/31/2020	DR-4560-PR	Public Assistance: No Individual Assistance; No	Although the center of Tropical Storm Isaías did not make landfall on the island, the system left a large amount of rain in its path, causing flooding throughout Puerto Rico. Rainfall accumulation of up to 10 inches was recorded around the island.
Hurricane María	9/17/2017 – 11/15/2017	DR-4339-PR	Public Assistance – Yes Individual Assistance - Yes	Widespread flooding severely affected the whole Island. For example, in San Juan, water levels reached up to 6 feet in some areas and numerous structures losing their roofs. The coastal neighborhood of La Perla was largely destroyed, while Cataño suffered extensive damage, with the Juana Matos community estimated to be 80% destroyed. Strong winds, heavy rains, and flash floods near the La Plata Lake dam in Toa Baja

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				impacted thousands of residents. Survivors reported that floodwater rose 6 feet in just 30 minutes, and some areas experienced depths of up to 15 feet (4.6 m).
Hurricane Irma	9/5/2017 – 9/7/2017	DR-4336-PR	Public Assistance – Yes Individual Assistance - No	On September 5, 2017, Hurricane Irma impacted Puerto Rico; an Emergency Declaration was issued for the Island. On September 6, 2017, a Major Disaster Declaration was issued following Hurricane Irma's passage. Two people died due to torrential rains before the hurricane: a man died in Orocovis after falling from his ladder while repairing his roof; another man on the coast in Capitanejo died after being struck by lightning. Wave heights in Puerto Rico reached 9 meters, and sustained winds of 111 mph were recorded in Culebra.

Event	Date	Disaster Declaration Number	Salinas Included?	Description
Tropical Storm María[14]	9/8/2011 – 9/14/2011	DR-4040-PR	Public Assistance: No Individual Assistance: No	Tropical Storm (later Hurricane) Maria formed in early September 2011 and passed near Puerto Rico, bringing significant heavy rainfall and tropical storm conditions to the island. The storm caused widespread flooding that inundated numerous roadways and homes; floodwaters near Patillas destroyed several homes and bridges, and approximately 150 houses in Yabucoa were flooded and damaged
Hurricane Irene	8/22/2011	DR-4017-PR	Public Assistance: Yes Individual Assistance: No	Total rainfall reached 22 inches over three days, with the eastern region being the most affected—the same area that had already received over 6 inches earlier in August during the close passage of Tropical Storm Emily. The Río

[14] Tropical Storm María was a tropical system that pass to the northeast of Puerto Rico in 2011 and that caused flooding in the Island. Not to be confused with the 2017 Hurricane María. The name "María" was retired from the official Atlantic hurricane season list of names after 2017.

Event	Date	Disaster Declaration Number	Salinas Included?	Description
				Grande de Manatí in Manatí recorded its third-highest level in history, surpassed only during Hurricane Hortense (1996) and Hurricane Georges (1998). The Puerto Nuevo River near Hato Rey reached its fourth-highest level on record. Flooding was severe enough to cause infrastructure stress and dangerous conditions across multiple municipalities. Tragically, there was one direct fatality attributed to Irene, due to drowning.

4.10.1.4 Future event probabilities (B1-E)

According to the Colorado State University Tropical Cyclones, Rada, Atmospheric Modeling and Software Team, the following average annual probabilities apply for storms coming ashore or passing within 50 miles of Puerto Rico: (Colorado State University, 2026)

- Average probability of a named storm coming ashore or within 50 miles of Puerto Rico: **40%**
- Average probability of a hurricane coming ashore or within 50 miles of Puerto Rico: **24%**
- Average probability of a major hurricane coming ashore or within 50 miles of Puerto Rico: **9%**

4.10.2 Risk Analysis (B2-A, B2-B)

4.10.2.1 Estimated Losses

Table 40 presents the exposure to tropical cyclones as registered in FEMA National Risk Index.

Table 40: Tropical Cyclone Exposure

Exposure - Impacted Area (sq mi)	Exposure - Building Value	Exposure - Population	Exposure - Population Equivalence	Exposure - Total
71.179328	$ 3,834,473,310	25,734	$ 298,508,639,239	$ 302,343,112,550

The expected annual loss for each Census tract or jurisdiction represents the average yearly economic impact, expressed in dollars, anticipated from natural hazard events. Table 41 presents the expected annual tsunami-related losses for both buildings and population.

Table 41: Expected Annual Loss to Tropical Cyclones

Expected Annual Loss - Building Value	Expected Annual Loss - Population	Expected Annual Loss - Population Equivalence	Expected Annual Loss -Total
$ 18,346,488	0.0493	$ 572,192	$ 18,918,680

The following maps show the expected losses resulting from the impact of a tropical

cyclone. Map 39 presents the projected total number of damaged buildings associated with a 100-year wind event, while Map 40 presents the results for a 500-year wind event.

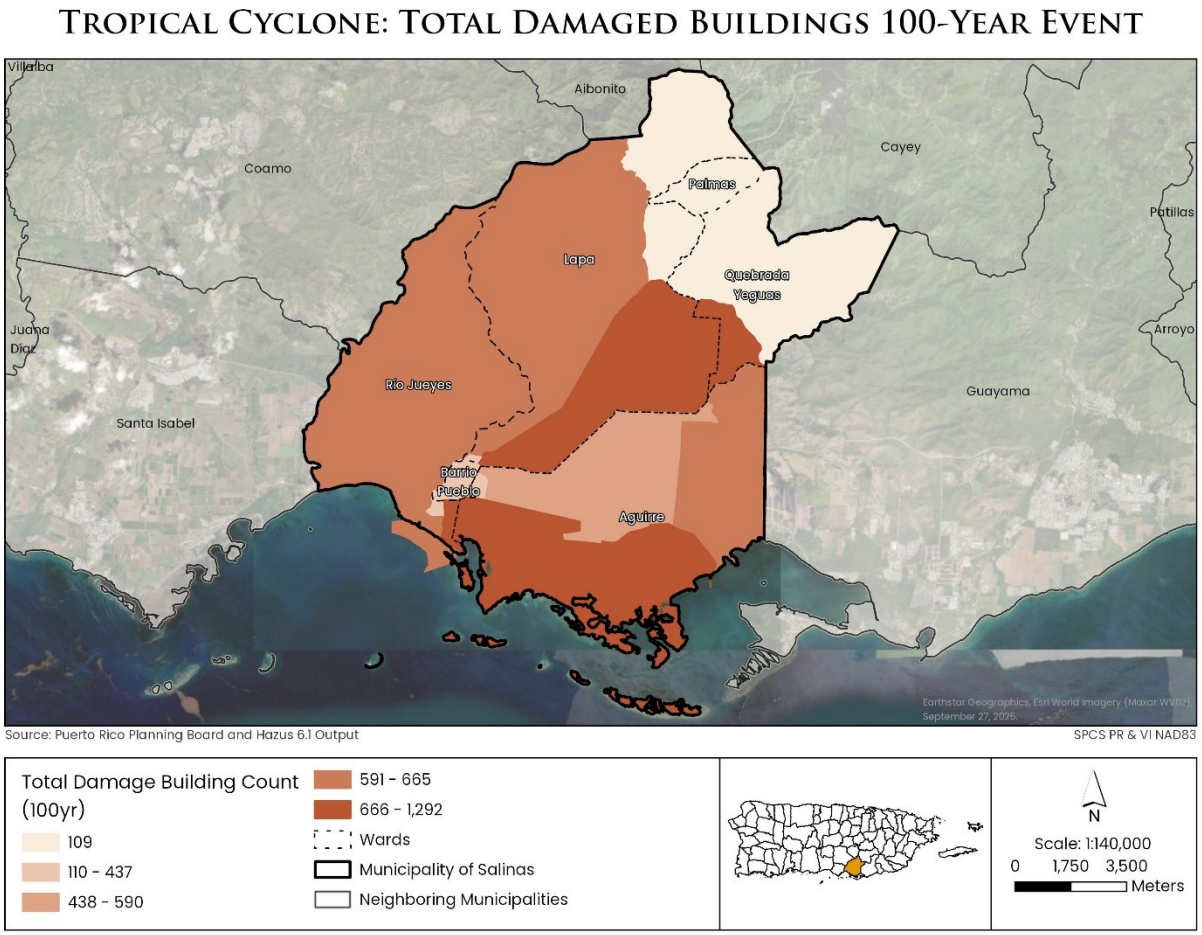
The 100-year event map shows that the greatest concentration of damaged buildings is expected within the central and southern wards of Aguirre, Río Jueyes, and Lapa, as well as portions of the municipality located between Pueblo and Quebrada Yeguas. The highest damage category (666 to 1,292 damaged buildings) is concentrated in the central interior sector of the municipality, extending across portions of Aguirre and the area immediately east of Pueblo. Elevated levels of expected damage are also identified in Río Jueyes, Lapa, and southern Quebrada Yeguas, where projected losses range from 438 to 665 damaged buildings.

The 500-year event shows a very similar spatial distribution to the 100-year event map, though with greater overall damage levels resulting from the stronger design wind speeds associated with this scenario. The area exhibiting the highest building damage (685 to 802 damaged buildings) remains concentrated within the central and southern portion of the municipality, particularly within Aguirre and adjacent census tracts east of Pueblo. Additional areas of elevated losses continue to be observed throughout Río Jueyes, Lapa, and portions of Quebrada Yeguas.

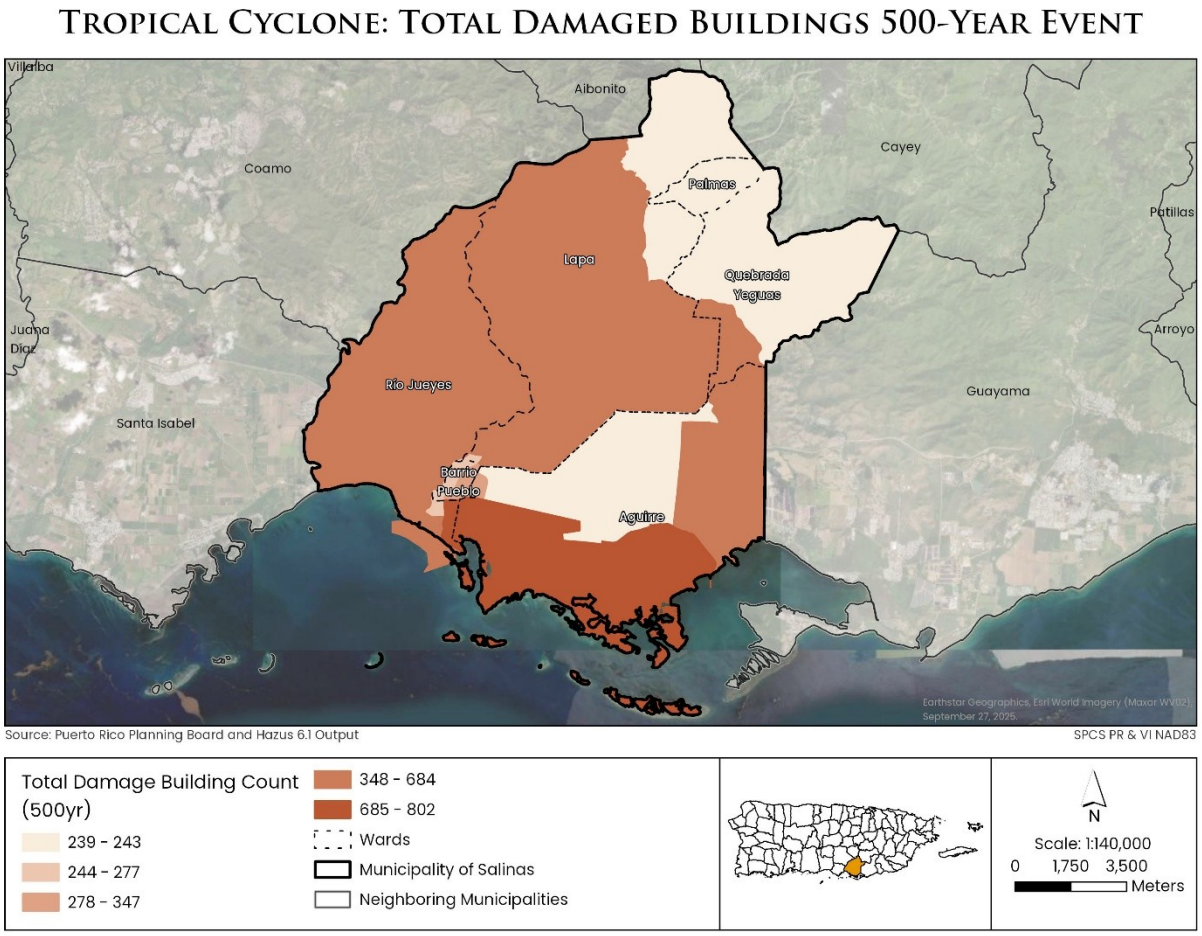
Unlike municipalities where wind exposure is primarily controlled by mountainous terrain, the damage pattern observed in Salinas appears to be strongly influenced by the distribution of development, structure density, and building inventory. The highest concentrations of projected building damage occur where residential, commercial, institutional, and industrial development is most extensive, particularly in the municipality's southern developed corridor extending through Aguirre, Pueblo, and Río Jueyes. Although the northern wards of Palmas, Lapa, and Quebrada Yeguas contain higher elevations, their lower development density generally results in fewer total damaged buildings compared to the more heavily developed southern sectors.

Overall, the maps indicate that the areas expected to experience the greatest building losses during future tropical cyclone events correspond largely to the municipality's most urbanized and densely developed areas. Consequently, future mitigation efforts focused on strengthening structures, improving building resilience, protecting critical facilities, and reducing vulnerability in Aguirre, Pueblo, Río Jueyes, and adjacent developed sectors would provide the greatest reduction in potential wind-related losses.

Map 39: Total Damaged Buildings 100 – Year Event



Map 40: Total Damaged Building 500 - Year Event



Map 41 shows the total dollar exposure associated with hurricane impacts under the 100-year wind event scenario, while Map 42 presents the total economic losses associated with the 500-year wind event scenario.

Map 41 shows the total dollar exposure to buildings and contents resulting from a 100-year hurricane event. The highest concentration of economic exposure is located in the southern and central portions of Salinas, particularly within Aguirre, portions of Pueblo, and the census tracts located immediately north of the urban center. The area exhibiting the highest loss category ($242,756.81 to $337,655.99 thousand) is concentrated in the central sector of the municipality between Aguirre, Pueblo, and Quebrada Yeguas, reflecting the concentration of residential, commercial, industrial, and public infrastructure assets located in these areas. Elevated economic losses are

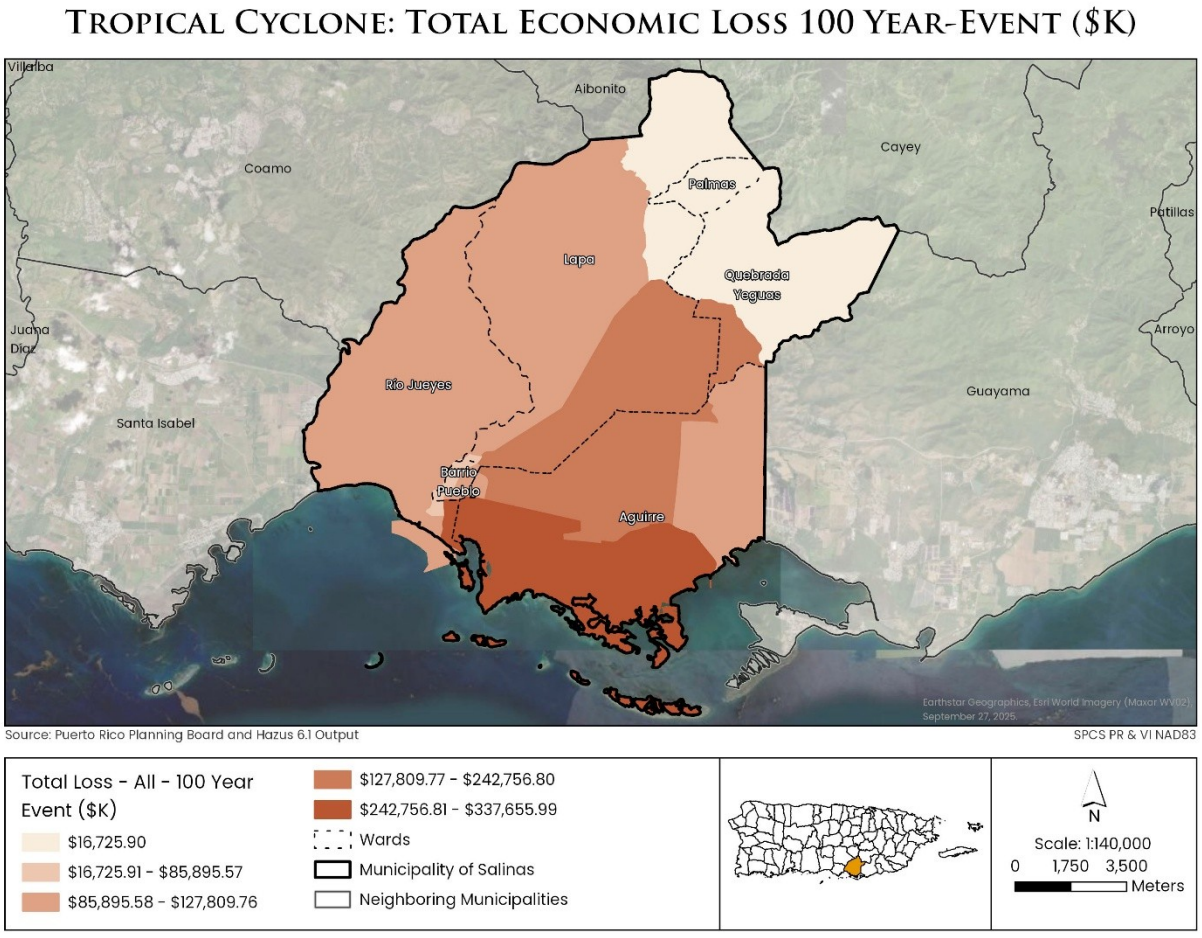
also projected throughout Río Jueyes, Lapa, and southern Quebrada Yeguas, where substantial development and building inventories are present.

Map 42 shows the total dollar exposure for the 500-year hurricane event. The spatial distribution of losses is similar to the 100-year scenario; however, the magnitude of economic losses increases considerably. The highest concentration of losses ($408,883.33 to $586,164.34 thousand) remains concentrated within the central portion of the municipality, particularly in the developed corridor extending between Aguirre, Barrio Pueblo, and the southern portions of Quebrada Yeguas. Additional areas with elevated losses continue to be observed throughout Río Jueyes, Lapa, and portions of Aguirre, where the combination of building density and increased wind intensity contributes to greater projected damage.

The pattern shown in both maps indicates that economic losses are driven primarily by the distribution and value of developed assets rather than solely by topographic influences. In Salinas, the highest losses occur where residential neighborhoods, commercial establishments, public facilities, industrial properties, and critical infrastructure are concentrated. Consequently, Aguirre, Barrio Pueblo, Río Jueyes, and the central development corridor of the municipality represent the areas with the greatest potential economic impact resulting from future hurricane events.

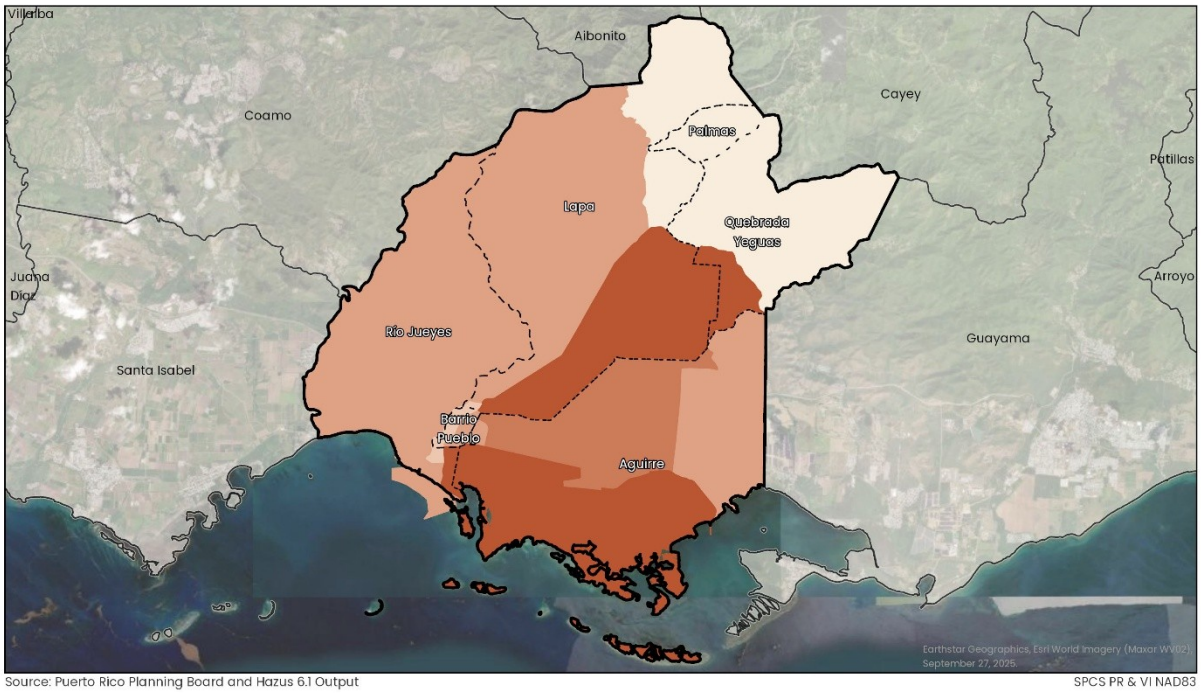
Overall, the maps demonstrate that the greatest hurricane-related economic exposure in Salinas is concentrated within the municipality's most developed sectors, where a high density of buildings and infrastructure coincides with areas susceptible to strong winds and associated storm impacts. As a result, mitigation measures aimed at improving structural resilience, protecting critical infrastructure, and strengthening the building stock within Aguirre, Barrio Pueblo, Río Jueyes, and adjacent developed sectors would provide the greatest reduction in future hurricane-related economic losses.

Map 41: Total Economic Loss 100 Year



Map 42: Total Economic Loss 500 Year

Tropical Cyclone: Total Economic Loss 500 Year-Event ($K)



Source: Puerto Rico Planning Board and Hazus 6.1 Output

SPCS PR & VI NAD83

Total Loss - All - 500 Year Event ($K)

- $94,287.21
- $94,287.22 - $145,032.06
- $145,032.07 - $284,334.11
- $284,334.12 - $408,883.32
- $408,883.33 - $586,164.34
- Wards
- Municipality of Salinas
- Neighboring Municipalities



N

Scale: 1:140,000

0 1,750 3,500 Meters

4.10.2.2 Lifelines and Critical Infrastructure

Hurricane winds have profound effects on all eight FEMA Community Lifelines, disrupting essential services and infrastructure.

- Safety and Security systems are compromised when high winds damage police stations, fire departments, and emergency operations centers, while debris and fallen power lines obstruct emergency routes, delaying rescue efforts.
- Food, Hydration, and Shelter lifelines suffer as winds destroy agricultural fields, damage food storage facilities, and tear roofs off homes and shelters, leaving communities vulnerable and displacing thousands.
- In the Health and Medicine sector, hospitals and clinics experience roof failures and structural damage, forcing evacuations and interrupting critical care, while pharmacies and supply chains face severe disruptions.
- The Energy lifeline is particularly vulnerable, as hurricane winds topple transmission towers, snap utility poles, and damage substations, causing widespread power outages that cascade into other lifelines.
- Communications systems fail when telecommunication towers and antennas are blown down, severing cellular and internet connectivity and hindering emergency coordination.
- Transportation networks are crippled by blocked roads, damaged bridges, and wind-related destruction at airports and seaports, delaying relief efforts and supply deliveries.
- Facilities handling Hazardous Materials face increased risks when wind-driven debris ruptures tanks or pipelines, creating environmental hazards and complicating cleanup operations.
- Finally, Water Systems are disrupted as treatment plants and pumping stations sustain roof and equipment damage, while elevated storage tanks and distribution infrastructure collapse, interrupting access to clean water for drinking and sanitation. These cascading failures underscore the critical need for wind-resistant design standards and proactive planning to protect lifelines and maintain community resilience during hurricane events.

For planning purposes this LHMP shall assume that all critical infrastructure is equally exposed to this hazard.

4.10.2.3 Social Vulnerabilities

As discussed before in Section 4.10.1.1 a tropical cyclone can impact the whole island. For this LHMP we are going to assume that all the population of Salinas is vulnerable to this hazard.

4.10.2.4 Natural and Cultural Resources

Hurricane winds caused extensive damage to both natural and cultural resources by exerting extreme mechanical forces on landscapes and built environments. In natural settings, strong winds uproot trees, strip foliage, and break branches, leading to deforestation and habitat loss. This disruption affects biodiversity and can alter ecosystem functions for years. Coastal vegetation such as mangroves is particularly vulnerable, as wind-driven forces weaken root systems and reduce their ability to protect shorelines. Agricultural areas also suffer severe losses, with crops flattened or destroyed, impacting food supply and local economies.

Cultural resources, including historic buildings, monuments, and archaeological sites, are equally at risk from hurricane winds. High wind speeds can dislodge roofing materials, collapse walls, and damage structural integrity, especially in older or unreinforced constructions. Museums, archives, and heritage sites may experience irreparable harm if protective measures are inadequate. The loss of these cultural assets not only affects community identity but also has economic implications for tourism and preservation efforts. Understanding wind speed thresholds and incorporating them into design standards and conservation planning is essential to mitigate these risks and safeguard both natural and cultural heritage.

4.10.2.5 Future Conditions (E1-a)

The risk of tropical cyclones is a municipal – wide risk. Every part of the recent development approved by the municipality is equally in risk of being affected by a tropical cyclone.

4.11 Storm Surge

4.11.1 Description

A storm surge is the inland movement of seawater that occurs when a hurricane makes a direct impact on the coast. These storm surges occur due to an atypical

increase in the water levels of water bodies. Primarily, storm surges are produced by an excessive rise in water along coastlines as a consequence of a massive low-pressure system, rainfall, and strong winds, characteristic of a hurricane or tropical storm (Castro Rivera & López Marrero, 2018).

These factors, inherent to a storm surge, create dangerous conditions at sea and cause extensive devastation after passing through coastal areas. Consequently, this type of natural hazard results in loss of life and severe damage to infrastructure and structures located in the affected areas. They are particularly dangerous when they occur during high tide, combined with the effects of swells and wave action. These factors make it difficult to predict this type of event because they depend on the diversity of tropical systems, the geological formations of the impacted area, and meteorological forecasts (FEMA, 1997).

The maximum potential storm surge for a particular location depends on a series of different factors. Storm surge is a very complex phenomenon because it is sensitive to even slight changes in storm intensity, forward speed, size (radius of maximum winds—RMW), angle of approach to the coast, central pressure (which contributes minimally compared to wind), and the shape of coastal features such as bays and estuaries.

Coastal areas are usually prone to storm surge impacts when an imminent hurricane threat is present. The behavior, magnitude, and impact of storm surge over land vary depending on the hurricane's trajectory. Likewise, the topography and coastal bathymetry of the municipality play an important role in relation to the impact of the surge on affected areas (FEMA, 1997).

4.11.1.1 Affected Area

Maps 43 and 44 show the areas affected by storm surge in the Municipality of Salinas under Category 1 and Category 5 hurricane scenarios, respectively. The communities and sectors directly impacted by storm surge are concentrated along the municipality's southern coastline, particularly in Aguirre, Las Mareas, Playita, Playa, Las Ochenta, San Felipe, and portions of Pueblo. Under the Category 1 storm surge scenario, the affected area is generally limited to the immediate coastal fringe and low-lying wetlands of Aguirre and the Jobos Bay coastal system, where water levels are projected to exceed three feet above ground in many locations.

Under the Category 5 storm surge scenario, the extent and severity of inundation

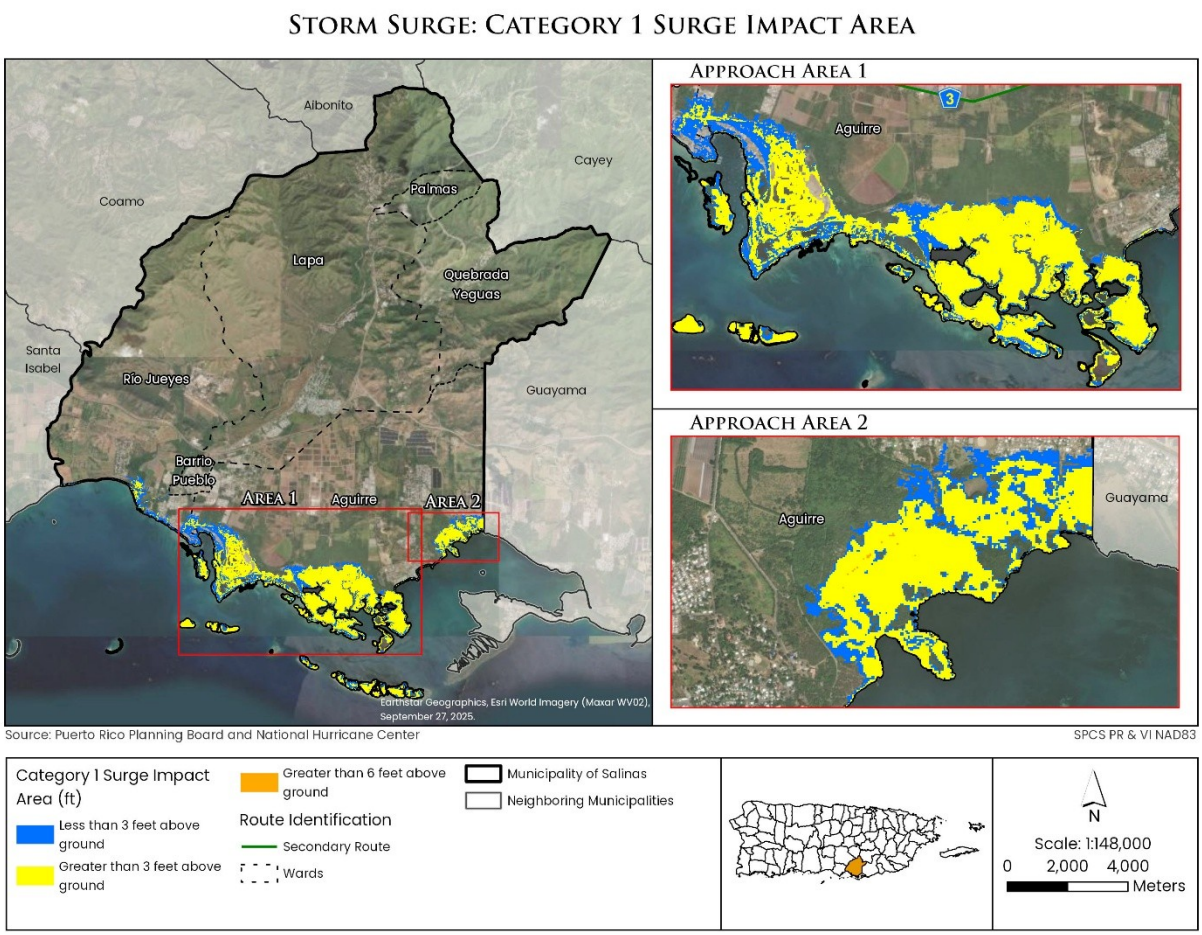
increase substantially. Large portions of Aguirre, including coastal residential areas, environmentally sensitive wetlands, transportation corridors, and agricultural lands, are projected to experience inundation depths exceeding six feet, while portions of the lowest-lying coastal sectors may experience surge depths exceeding nine feet above ground. The Category 5 scenario also expands farther inland around the coastal plain east and southeast of Pueblo, affecting a significantly larger area than the Category 1 event.

Although the highest surge levels are concentrated in areas with relatively low population density compared to the municipality's urban center, this hazard presents a direct threat to coastal transportation infrastructure, utility systems, public facilities, residential communities, agricultural operations, and environmentally sensitive coastal resources. In particular, the extensive agricultural lands and infrastructure located within the coastal plain of Aguirre are vulnerable to prolonged inundation, saltwater intrusion, erosion, and storm-related damage.

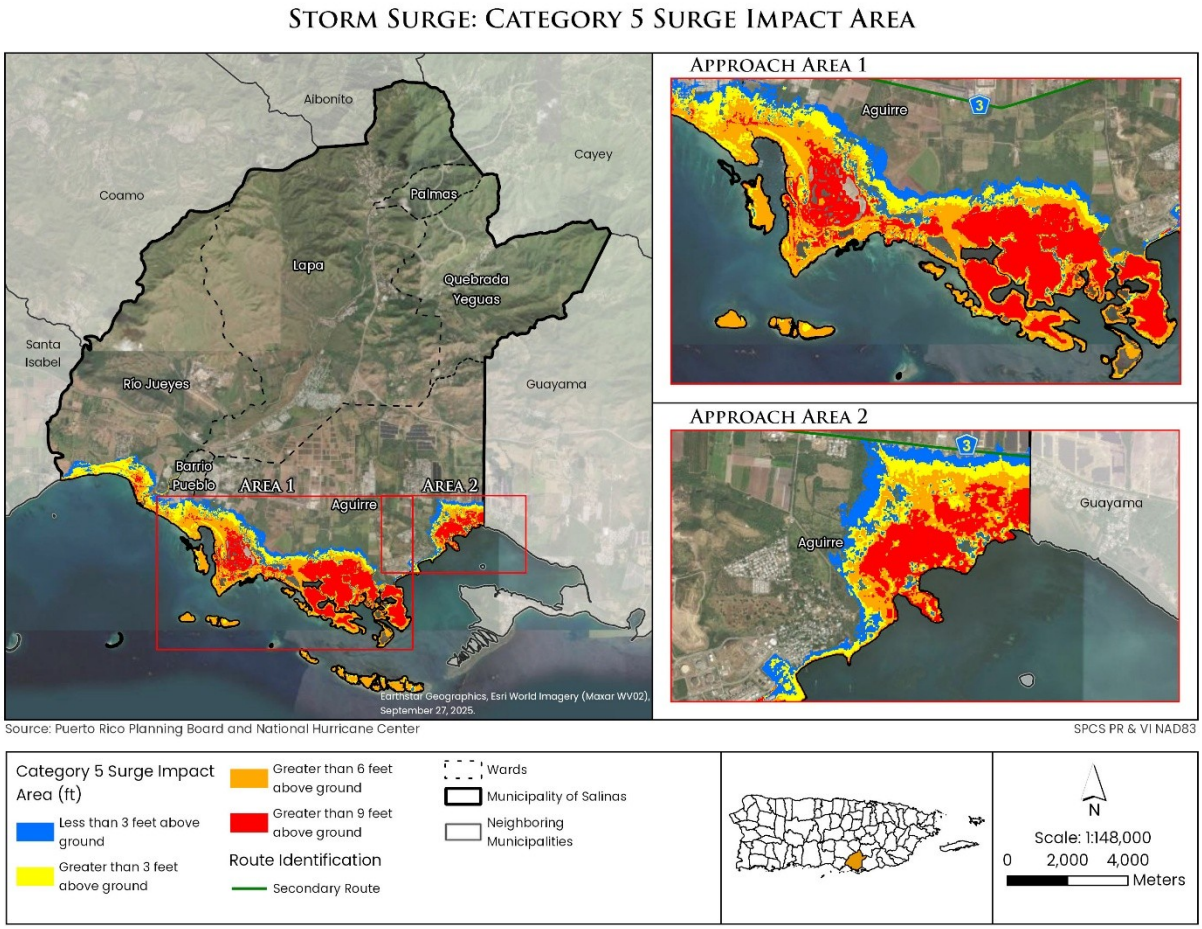
The storm surge hazard also poses a significant risk to roadway connectivity serving coastal communities such as Las Mareas, Playita, Playa, Las Ochenta, and San Felipe. Access routes connecting these communities to the urban center and emergency services may become impassable during major hurricane events, potentially limiting evacuation and post-disaster response operations.

Overall, Maps 43 and 44 demonstrate that storm surge is primarily a coastal hazard in Salinas, with the greatest impacts concentrated within Aguirre and the municipality's southern coastal communities. While Category 1 events produce localized flooding along the shoreline, Category 5 hurricanes have the potential to inundate extensive portions of the coastal plain, threatening critical infrastructure, economic assets, transportation systems, agricultural lands, and coastal communities throughout southern Salinas.

Map 43: Category 1 Storm Surge Area



Map 44: Category 5 Storm Surge Impact Area



4.11.1.2 Risk Magnitude

Each of the storm surge maps shows the depth of flooding that would be expected at a given location based on the category of the storm. Flood depth represents the severity/magnitude of the storm surge risk; therefore, when describing this severity/magnitude, it could be expressed in a manner such as, "the greatest flood depth that community XX could experience as a result of storm surge is XX feet." The building table can be used to determine a rough estimate of the maximum potential flood depth.

The maps included in the storm surge section of the risk assessment, with reference to the geographic areas affected by this natural hazard, show the impact of this event based on flood depth and according to the occurrence of Category 1 and Category 5 hurricane events. In summary, flood depth represents the severity or magnitude of the

storm surge risk, and likewise, there is a correlation between the magnitude of the storm event and the depth of flooding and the extent of land area that will be affected. That is, in most instances, as a storm escalates to higher-magnitude categories, a greater number of neighborhoods and sectors may be impacted by flooding events of greater depth.

Similar to other coastal hazards, storm surges have the potential to expose the population and infrastructure supporting lifelines. Likewise, areas within the municipality that are already prone to flooding may be more severely affected by flooding resulting from storm surge events.

4.11.1.3 Past Events

Hurricane Maria (2017) generated measurable storm surge and storm tide impacts along Puerto Rico's southeastern and eastern coasts. Post-storm field investigations conducted by the U.S. Geological Survey (USGS) documented storm-tide inundation heights generally ranging from approximately 6 to 9 feet above ground level in coastal municipalities including Humacao, Naguabo, and Ceiba (Byrne, 2019). Lower storm surge levels, typically between 1 and 4 feet, were observed along portions of the northern and western coasts. Although the most catastrophic impacts of Hurricane Maria were driven by extreme rainfall and inland flooding, storm surge contributed to coastal flooding, shoreline erosion, and damage to marinas and port facilities, particularly along exposed eastern shorelines (Byrne, 2019) (Pasch, Penny, & Berg, Hurricane Maria, 2023).

Hurricane Georges (1998) generated storm surge impacts along the southern and eastern coasts, exacerbating coastal inundation and contributing to damage in low-lying coastal communities (Guiney, 1999). More recently, Hurricane Fiona (2022) caused storm surge and wave-driven coastal flooding along Puerto Rico's southern coast, particularly in municipalities facing the Caribbean Sea, despite making landfall as a hurricane of relatively lower wind intensity (Pasch, Reinhart, & Alaka, Hurricane Fiona, 2023).

4.11.1.4 Future Events Probability

The NOAA defines the term storm surge as the rise in ocean level resulting from the effects of wind and the drop in atmospheric pressure associated with hurricanes and other storms. In other words, storm surge is caused primarily by the strong winds of a hurricane or tropical storm; therefore, the probability of occurrence of a storm surge

event in the municipality is directly associated with—and increases following—events of strong winds such as hurricanes and will increase or may intensify as such events occur.

To this end, the Sea, Lake, and Overland Surges from Hurricanes model (known as SLOSH, by its English acronym) is a computerized model used by NOAA for the assessment of coastal flooding risk and the operational prediction of storm surge.

According to FEMA, coastal flood risk areas are determined through a statistical analysis of records of riverine flow or currents, storm tides, and rainfall; information obtained through consultations with the community; and a hydrologic and hydraulic analysis. Coastal flood risk areas are delineated or defined in the Flood Insurance Rate Maps (FIRM). These maps also communicate two regulatory flood mapping elements: the extent of land at risk of base flooding (1% annual probability) and the related flood levels in these areas, known as Base Flood Elevations (BFE).

4.11.2 Risk Analysis

4.11.2.1 Estimated Losses

For the FEMA National Risk Index (NRI), storm surge losses are generally represented under the Coastal Flooding hazard category. FEMA does not report a separate "storm surge" Expected Annual Loss (EAL) value for Salinas (FEMA, 2026). To prevent duplication of the data presented in the flood risk analysis, this LHMP will not consider it, as it cannot separate damages created by storm surge or other types of coastal floods.

4.11.2.2 Critical Infrastructure and Lifelines

Storm surges pose a significant threat to FEMA-defined community lifelines by inundating critical infrastructure located in coastal and low-lying areas. Transportation lifelines are frequently disrupted when roads, bridges, ports, and evacuation routes are flooded or damaged, restricting evacuation, emergency response, and supply chain movement. Energy lifelines, including power plants, substations, and fuel distribution systems, are highly vulnerable to saltwater intrusion and flooding, which can result in equipment failure and prolonged power outages. Communications lifelines may also be compromised when cell towers, fiber-optic networks, 911 systems, and backup power supplies are damaged or inaccessible due to storm surge flooding. These cascading failures reduce situational awareness and hinder coordination among emergency responders and government agencies.

Collectively, impacts on these lifelines significantly reduce a community's ability to protect lives and property during storm surge events. (NOAA, n.d)

Map 45 shows the critical infrastructure that would be affected by a storm surge associated with a Category 1 hurricane, while Map 46 shows the same analysis for a Category 5 hurricane storm surge event.

Under the Category 1 scenario, the infrastructure exposed to storm surge is concentrated primarily within the coastal portions of Aguirre, Pueblo, and Río Jueyes. The most vulnerable facilities are located in proximity to the shoreline and include assets associated with the water systems, transportation, communications, energy, health and medical, safety and security, educational, and community support lifelines. The largest concentration of exposed facilities is observed within Approach Area 1, where portions of the urban center and coastal sectors overlap with the projected surge area. Additional exposed facilities are identified in Approach Area 2 along the southeastern coast of Aguirre.

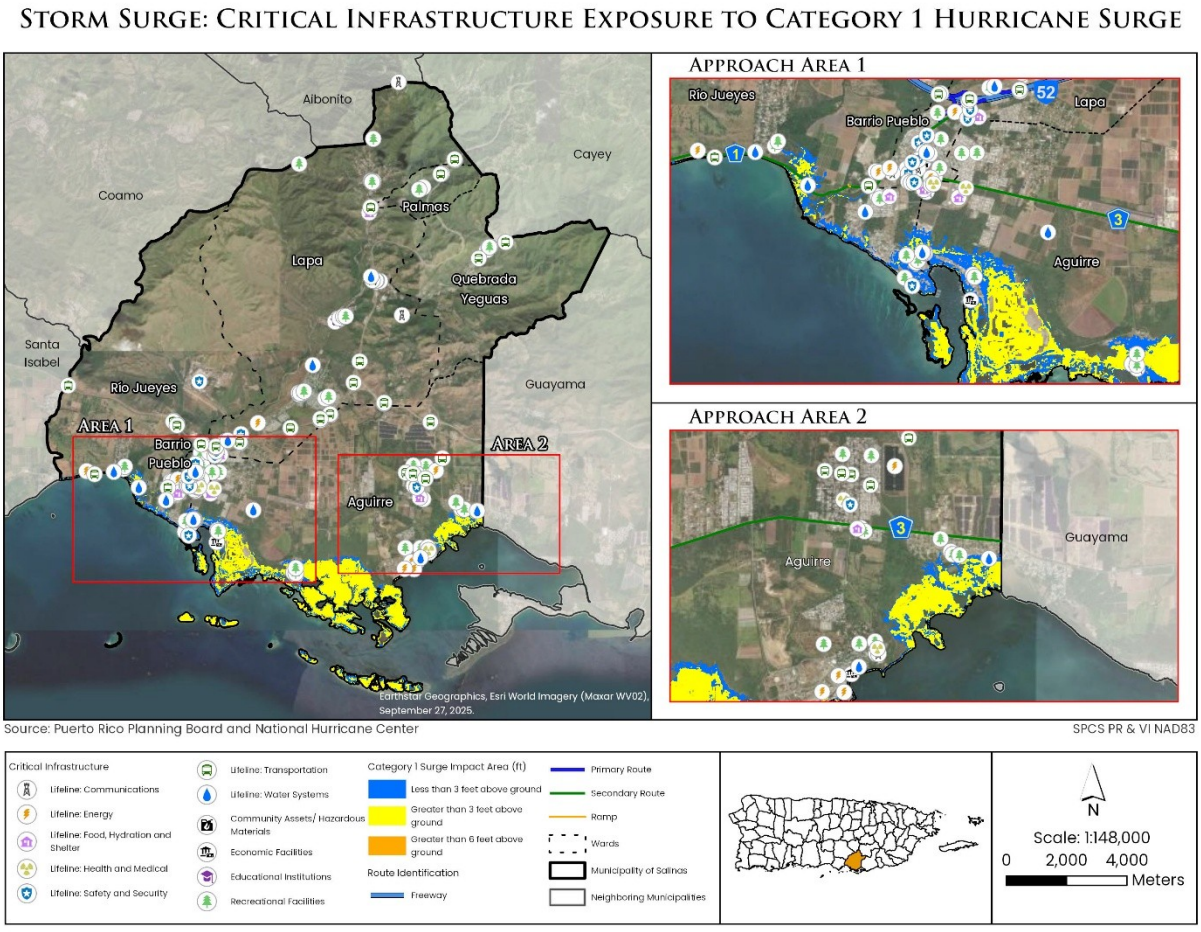
Under the Category 5 hurricane scenario, both the extent and depth of storm surge increase substantially. Many facilities that are only partially exposed during the Category 1 event become fully surrounded by surge waters exceeding 6 feet and, in some locations, 9 feet above ground level. The areas of greatest exposure remain concentrated in Aguirre, particularly near Las Mareas, San Felipe, and adjacent coastal sectors, as well as the shoreline immediately south of Pueblo. Several transportation facilities, water system assets, community facilities, educational institutions, and utility infrastructure are located within these high-impact areas.

The maps also demonstrate the potential vulnerability of the roadway network serving the municipality's coastal communities. Segments of corridors connecting Las Mareas, Playita, Playa, Las Ochenta, Aguirre, and Pueblo are located within projected storm surge zones and may become inaccessible during major hurricane events. Such disruptions could affect evacuation operations, emergency response access, and continuity of essential services.

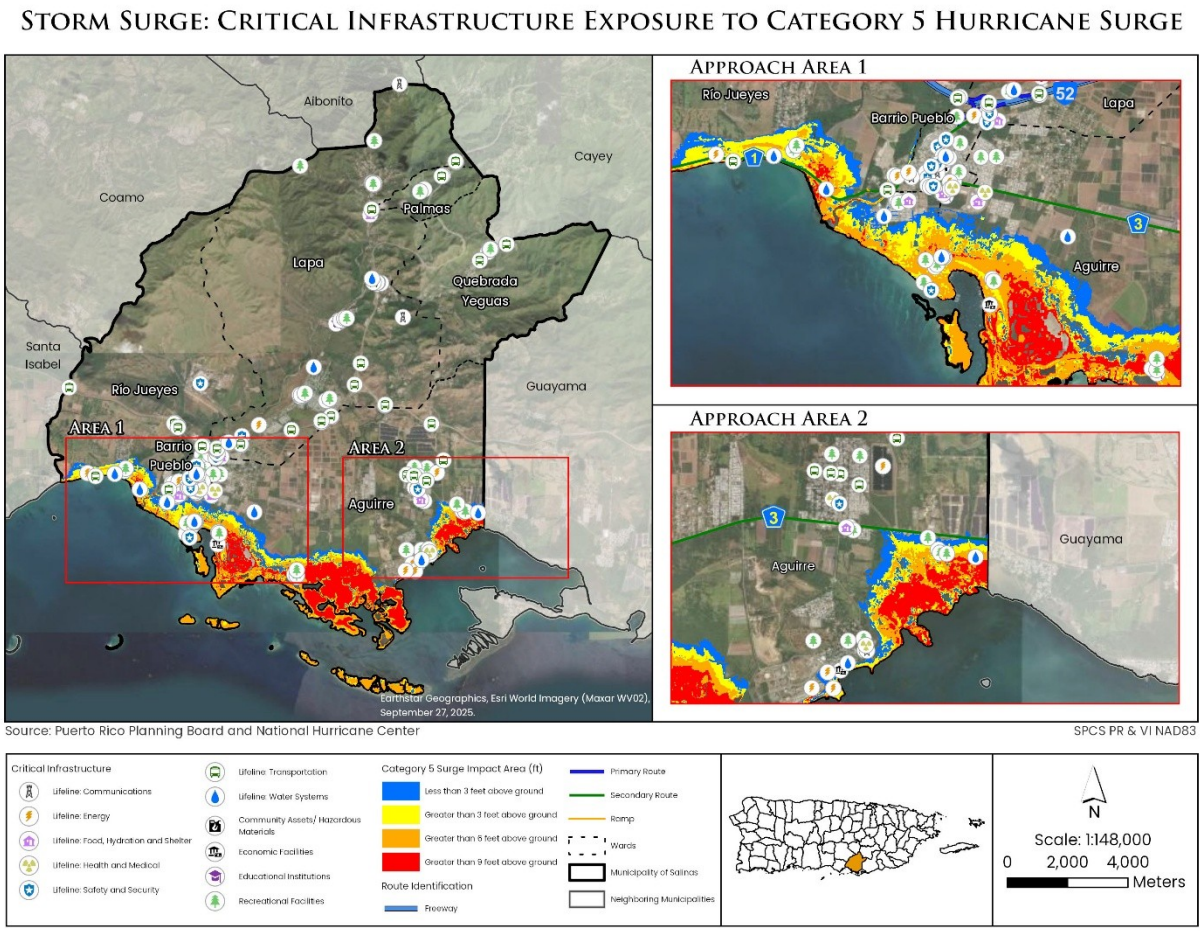
Overall, Maps 45 and 46 indicate that the critical infrastructure most vulnerable to storm surge is concentrated within the municipality's southern coastal plain, particularly in Aguirre, Barrio Pueblo, and Río Jueyes. While the higher-elevation wards of Lapa, Palmas, and Quebrada Yeguas remain outside the projected surge impact areas, many facilities that support municipal operations and community functions are located in low-lying coastal sectors and could experience direct impacts during

severe hurricane events. Consequently, these facilities should remain a priority for resilience planning, floodproofing measures, continuity-of-operations planning, and future storm surge mitigation efforts.

Map 45: Critical Infrastructure affected by a Cat 1 Storm Surge



Map 46: Affected Critical Infrastructure Cat 5 Hurricane



4.11.2.3 Social Vulnerabilities

Storm surge events represent a significant social hazard for Puerto Rico due to the Island's extensive coastline, high population density in coastal municipalities, and legacy socioeconomic vulnerabilities. Storm surge–related flooding frequently results in displacement, housing damage, and prolonged interruption of essential services, particularly in low-lying coastal communities and estuarine areas. Studies of hurricanes impacting Puerto Rico, including Hurricane Maria, have shown that flood exposure and displacement are disproportionately concentrated among low-income households, older adults, and communities with limited access to transportation, healthcare, and economic resources, which delays recovery and increases long-term vulnerability. FEMA and NOAA analyses further indicate that socially vulnerable populations are more likely to reside in surge-prone areas and experience compounded impacts when storm surge coincides with power outages, roadway flooding, and disruptions to water and medical services. (Chowdhury, et al., 2025)

Storm surge flooding also poses serious public health, economic, and equity challenges for Puerto Rico. Flooding of homes, healthcare facilities, and water and wastewater systems increases risks of injury, water contamination, and adverse mental health outcomes, particularly in communities that experience extended power outages and limited access to medical care. Economic impacts are often prolonged, as small businesses, informal workers, and coastal livelihoods face income losses and slower recovery due to limited insurance coverage and financial capacity. Research and federal reviews of disaster recovery programs highlight that inequities in disaster assistance and rebuilding resources can exacerbate social and wealth disparities on the Island, reinforcing the need for mitigation actions that integrate social vulnerability, equitable recovery, and community resilience into storm surge planning. (Chowdhury, et al., 2025)

Storm surge impacts in Salinas would disproportionately affect vulnerable populations, which make up approximately 43.14% of the municipality. Residents living in low-lying, flood-prone areas where housing and resources are limited, increasing their exposure to displacement, service disruptions, and health risks. Damage to energy, transportation, and food systems would further restrict access to essential services, prolong recovery, and intensify existing social and economic challenges.

Maps 47 and 48 show the population exposure to storm surge associated with Category 1 and Category 5 hurricane events, respectively. The maps indicate that population exposure is concentrated primarily within the municipality's southern coastal communities, particularly in Aguirre, Las Mareas, Playita, Playa, Las Ochenta, San Felipe, and portions of Pueblo.

Under the Category 1 storm surge scenario, the population exposed to inundation is relatively limited and concentrated within the lowest-lying coastal sectors. The highest population exposure category (107-251 persons) is observed within portions of Aguirre and adjacent coastal communities, while many other impacted areas contain smaller populations ranging from 0 to 106 persons. This reflects the fact that much of the Category 1 surge area consists of wetlands, coastal habitats, agricultural lands, and low-density development.

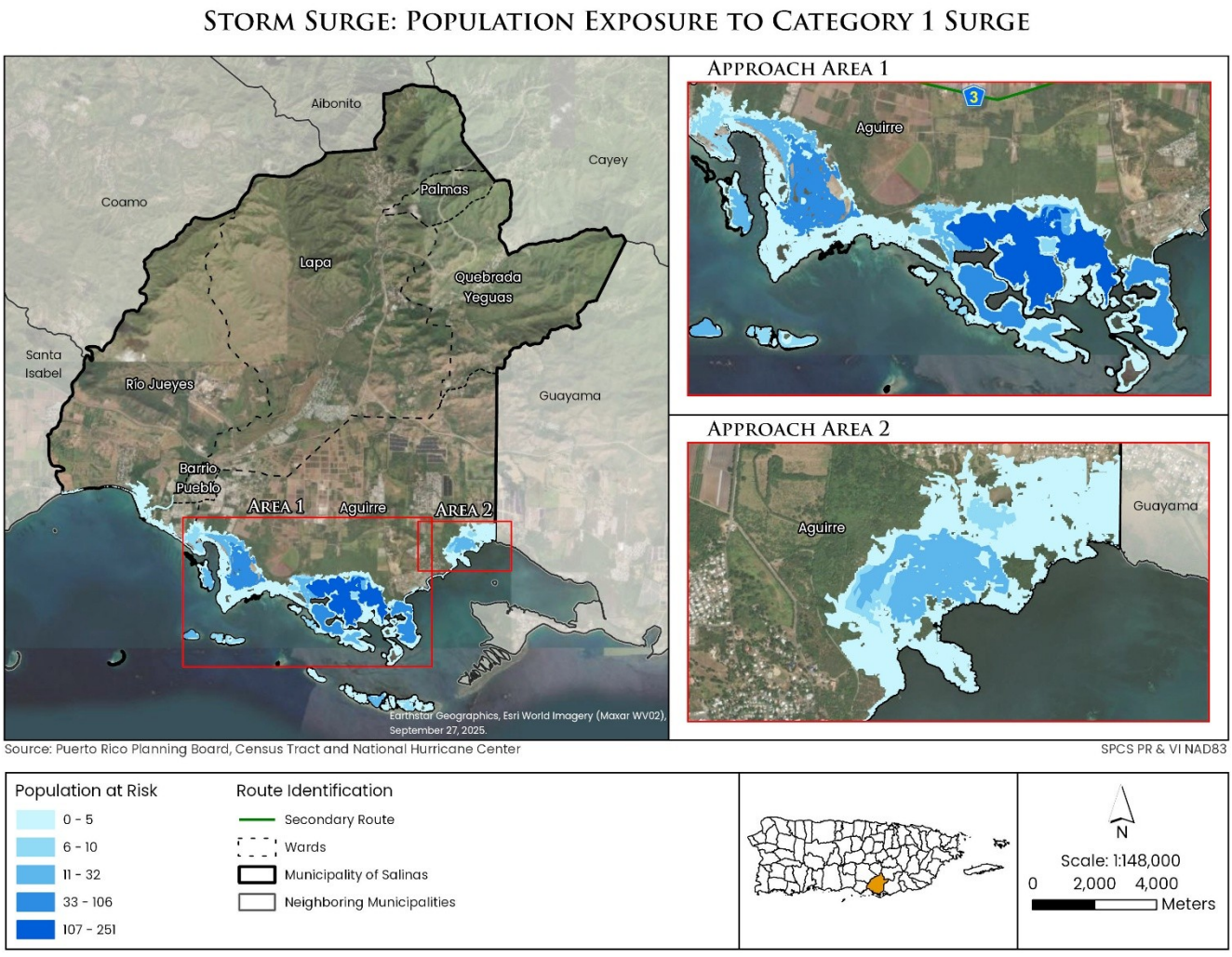
The Category 5 storm surge scenario results in a substantial increase in both the extent of inundation and the number of people exposed. Population exposure expands farther inland, affecting larger portions of Aguirre, coastal Pueblo, and adjacent shoreline communities. The highest population exposure category (109-236 persons)

remains concentrated in the developed coastal sectors of Aguirre, while moderate exposure categories extend throughout much of the southern coastal plain.

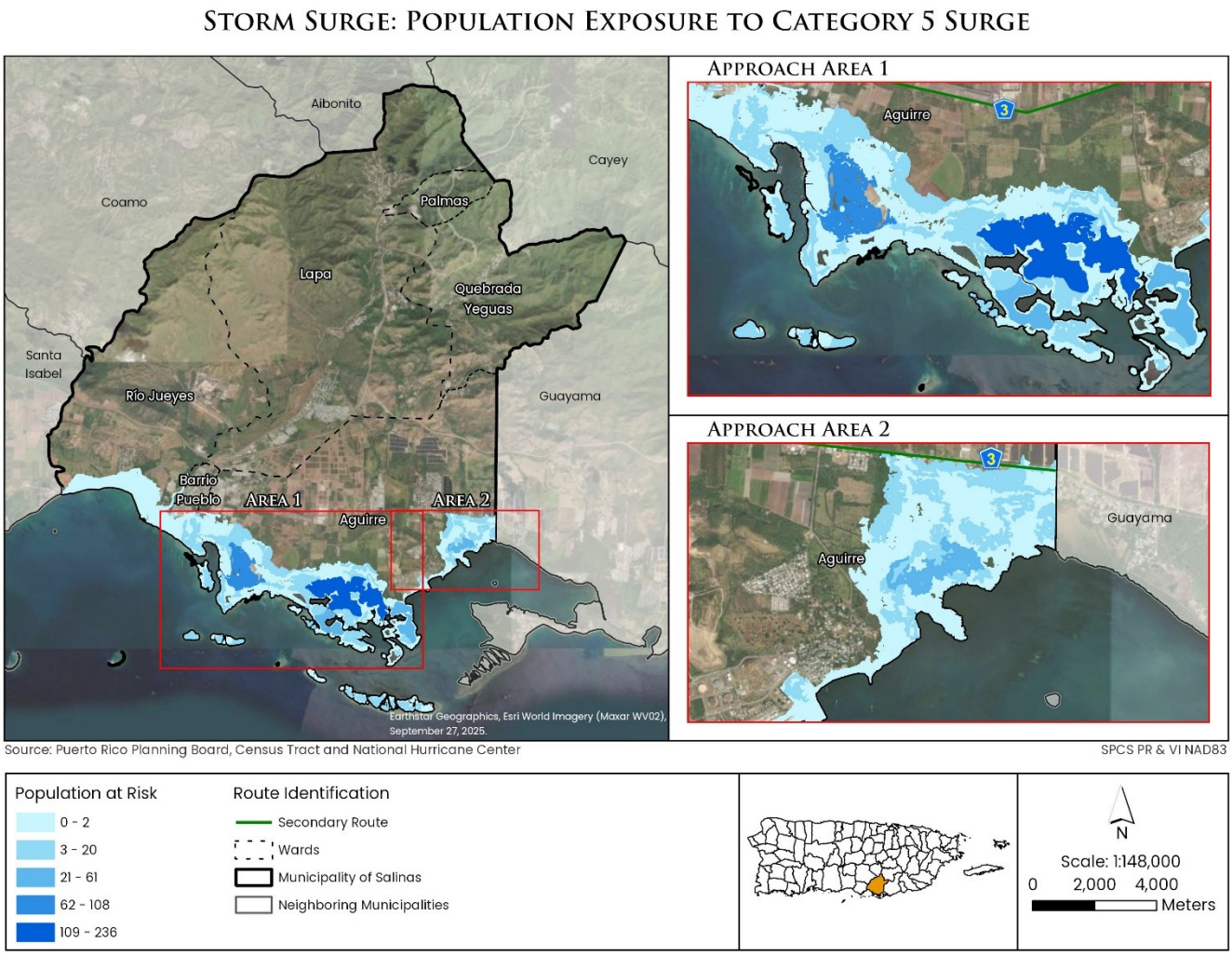
Unlike tsunami exposure, where impacts are concentrated in narrow coastal corridors, the Category 5 storm surge scenario demonstrates the potential to affect a broader area and a larger resident population due to the extensive inland penetration of surge waters. Nevertheless, the municipality's highest population densities remain located outside the most severe surge zones, particularly in the interior portions of Barrio Pueblo, Lapa, Palmas, and Quebrada Yeguas.

Overall, Maps 47 and 48 show that while storm surge exposure in Salinas is primarily limited to the coastal zone, the communities of Aguirre, Las Mareas, Playita, Playa, Las Ochenta, San Felipe, and coastal Barrio Pueblo remain highly vulnerable. As storm surge intensity increases from a Category 1 to a Category 5 event, the number of residents exposed to flooding grows substantially, underscoring the importance of evacuation planning, public warning systems, transportation accessibility, and coastal resilience measures for the municipality's coastal population.

Map 47: Storm Surge Population Exposure to Category 1 Surge



Map 48: Strom Surge Population Exposure to Category 5 Surge



4.11.2.4 Natural and Cultural Resources

Storm surge poses a significant natural hazard to Puerto Rico's coastal and near-coastal environments due to the Island's extensive shoreline, low-lying coastal plains, and concentration of sensitive ecosystems. Surge-driven flooding and wave action can cause severe erosion, saltwater intrusion, and habitat degradation in mangroves, coastal wetlands, estuaries, seagrass beds, and coral reef systems that are critical to biodiversity, fisheries, and natural coastal protection. These ecosystems can experience vegetation die-off, sediment redistribution, and long-term loss of ecological functions such as flood attenuation and water filtration following storm surge events. Repeated storm surge exposure can permanently alter coastal geomorphology and reduce the buffering capacity of natural systems, increasing

vulnerability of inland areas and amplifying future flood risk across Puerto Rico's coastal municipalities (Ganz, Duan, & Ji, 2023).

Storm surge also presents substantial risks to Puerto Rico's cultural and historic resources, many of which are concentrated in coastal zones and historic town centers. Flooding and erosion associated with storm surge events can damage or destroy historic buildings, archaeological sites, cemeteries, and cultural landscapes, including Spanish-era structures and Indigenous archaeological resources located near the coast. In addition to physical damage, storm surge–related displacement can disrupt traditional cultural practices and undermine community identity tied to historic places and coastal livelihoods. FEMA and its federal partners recognize the vulnerability of cultural resources to coastal flooding and support mitigation, documentation, and recovery efforts through programs such as the Heritage Emergency National Task Force, emphasizing the importance of incorporating cultural resource protection into hazard mitigation planning for Puerto Rico.

4.11.2.5 Future Conditions

Maps 49 and 50 show the construction permits approved during the 2020-2026 period in relation to the storm surge impact areas associated with Category 1 and Category 5 hurricanes, respectively.

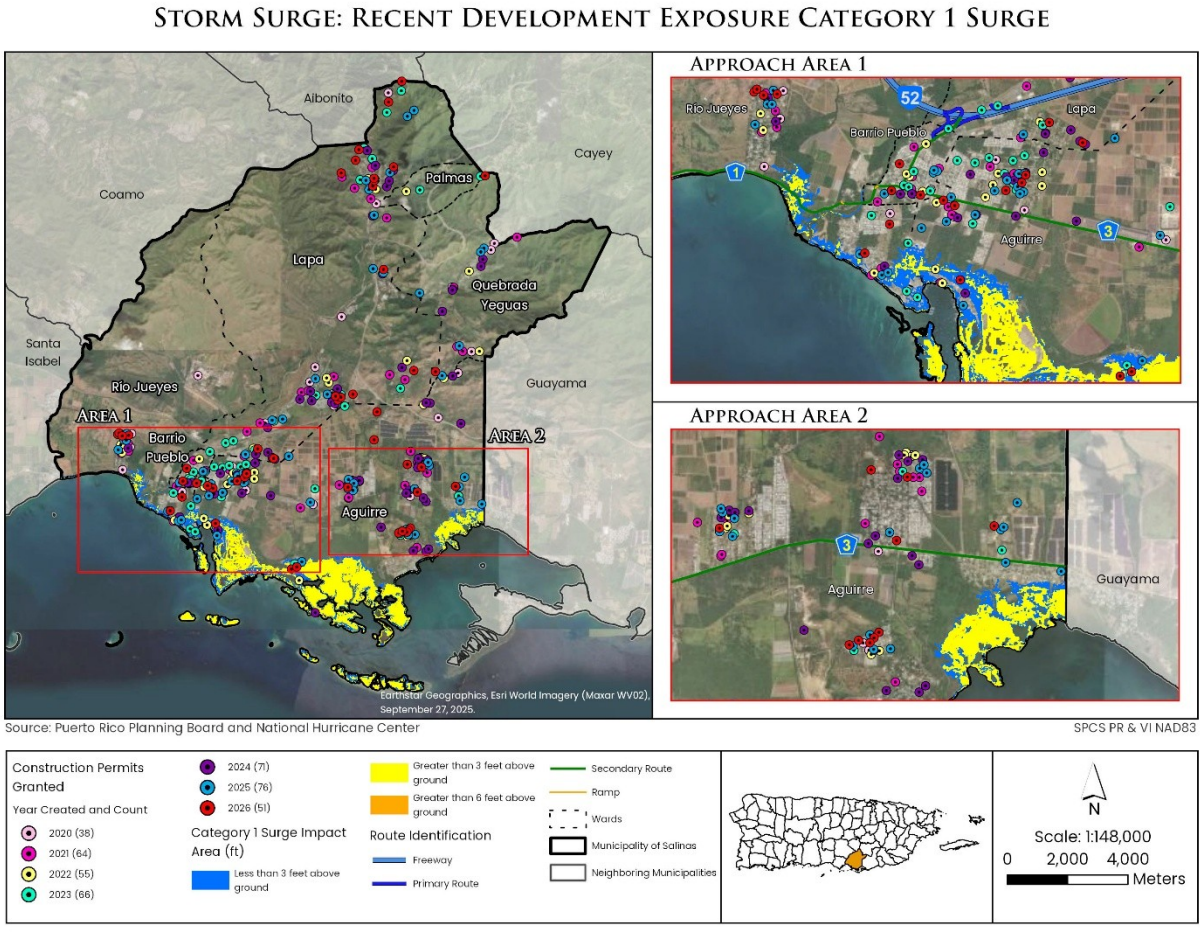
Map 49 indicates that relatively few recent development projects are located within the storm surge area associated with a Category 1 hurricane. Most approved permits are concentrated in the urbanized sectors of Pueblo, Aguirre, Lapa, and Quebrada Yeguas, outside the areas projected to experience direct storm surge inundation. Only a limited number of permits are located within or immediately adjacent to the Category 1 surge zone, primarily in the coastal communities of Aguirre, Playita, Playa, Las Mareas, and Las Ochenta. This suggests that recent development has generally occurred outside the area's most susceptible to storm surge impacts from lower-intensity hurricane events.

Map 50 presents a substantially different pattern for the Category 5 hurricane scenario. Under this event, the storm surge extent expands significantly inland, affecting a much larger portion of the coastal plain. As a result, a considerably larger number of construction permits are located within areas projected to experience storm surge inundation. This is particularly evident within Aguirre and portions of Pueblo, where numerous permits approved between 2020 and 2026 overlap with the

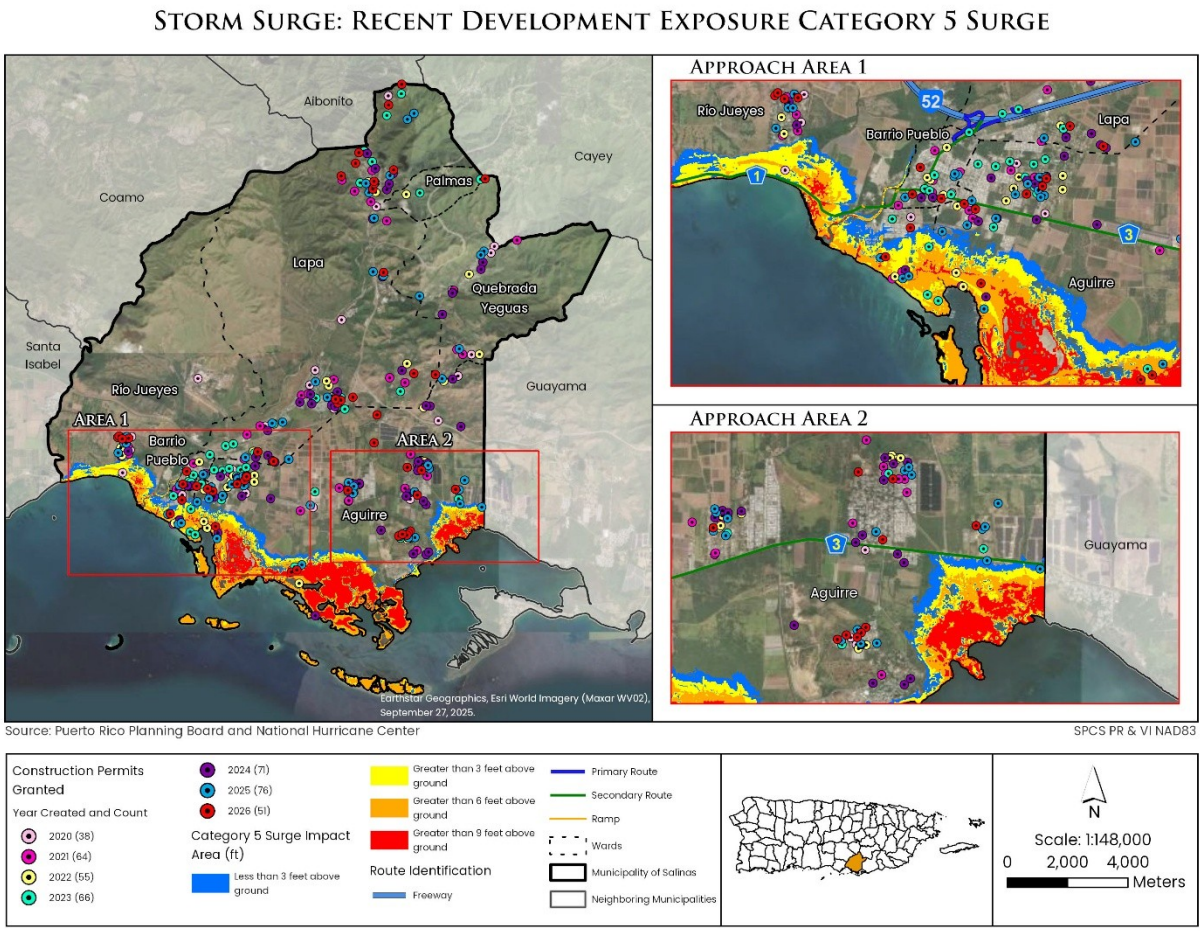
projected Category 5 surge impact area. Additional development located near the coastline and low-elevation sectors become exposed under this more severe scenario.

Together, these maps indicate that future exposure to storm surge hazards in Salinas remains relatively limited under Category 1 hurricane conditions but increases considerably under Category 5 hurricane conditions. While most recent development has occurred outside the Category 1 surge zone, a notable portion of the municipality's newer development, particularly within Aguirre and coastal portions of Pueblo, would be exposed to inundation during an extreme hurricane event. Therefore, continued consideration of storm surge hazards in land-use planning, permitting decisions, building design, and emergency evacuation planning remain important for reducing long-term coastal risk in the Municipality of Salinas.

Map 49: Storm Surge Recent Development Exposure Category 1



Map 50: Storm Surge Recent Development Exposure Category 5



4.12 Extreme Heat

4.12.1 Description (B1-a)

There is no universally accepted definition for extreme heat or heat waves. For the purposes of this Plan, the definition adopted by the Department of Homeland Security (DHS) is used. It is defined as a prolonged period of 48 to 72 hours of intense heat and humidity, with temperatures above 90 °F. Under these conditions, evaporation is reduced and the body is forced to make a significant effort to maintain its normal temperature, which has caused the death of many people in attempts to stabilize physically. In general, extreme heat represents the highest rate of deaths among weather-related hazards.

A study titled Heat Risk Perception and Vulnerability in Puerto Rico: Insights for Climate

Adaptation in the Caribbean, published in the academic journal International Journal of Environmental Research and Public Health, analyzes how Puerto Rico residents perceive health risks associated with extreme heat and how these perceptions relate to vulnerability and protective behaviors during extreme heat events that occurred in the summer of 2020 (Guzmán-Colon, Guido, Amaya-Ardilla, Cabrera-Rivera, & Méndez-Lázaro, 2025). The research was conducted through a cross-sectional telephone survey of 500 adults in metropolitan and non-metropolitan areas. This study defined the metropolitan area as the municipalities of Carolina, Cataño, Toa Baja, and Trujillo Alto. The non-metropolitan zone consists of the remaining municipalities of Puerto Rico.

The questionnaire included sociodemographic variables, health status, prior heat exposure, risk perception, and mitigation strategies. Statistical analysis employed chi-square tests and multinomial and logistic regression models.

The results reveal that, although most participants expressed concern about climate change and high temperatures, less than half perceived heat as a high health risk, and only one-fourth considered it likely to suffer a heat-related illness in the next five years. Risk perception was significantly higher among men, people aged 50 to 64, the unemployed, individuals with fair health, multiple chronic conditions, and those who had experienced heat-related symptoms. In contrast, older adults (65+) reported low levels of risk perception despite their high vulnerability.

Forty-four percent (44%) of respondents indicated having suffered heat-related symptoms during the summer, and 68% reported nighttime thermal discomfort, a factor closely linked to health problems. The most common strategies to mitigate heat were the use of fans (84%) and air conditioning (64%), although economic limitations and instability of the electrical system reduced their effectiveness. Regional differences were also notable: residents in non-metropolitan areas showed greater risk perception than those in metropolitan zones.

The study concludes that there is a significant gap between actual vulnerability and risk perception, especially among older adults. It recommends strengthening risk communication targeted at vulnerable groups, addressing nighttime heat exposure, and improving electrical infrastructure to ensure equitable access to cooling systems. Proposed solutions include decentralized energy systems, cooling centers with backup power, and passive designs that reduce electrical dependence, thus contributing to community resilience in the face of increasing extreme heat events.

4.12.1.1 Affected Area (B1-B)

Extreme heat events can impact the entire municipality, particularly in urbanized areas where the heat island effect may occur. Based on previously presented information, adverse climate effects have been observed, including severe droughts, increased frequency of strong wind events and flooding, higher heat index levels, among others. Due to the municipality's geography and location, the entire region is highly susceptible to extreme heat conditions.

Urban heat islands refer to urbanized areas where structures such as buildings, roads, and other infrastructure absorb and emit the sun's heat more than natural landscapes such as forests and water bodies. Daytime temperatures in urban areas are about 1–7 °F higher than temperatures in outlying areas; nighttime temperatures are about 2–5 °F higher (EPA, 2025).

Heat islands develop due to a combination of factors:

- Loss of Natural Landscapes – Urban areas often replace trees, vegetation, and water bodies—natural elements that cool the air through shade, transpiration, and evaporation—with hard, dry surfaces like roads, rooftops, and parking lots. These surfaces provide little shade or moisture, leading to higher temperatures.
- Properties of Urban Materials – Common construction materials such as asphalt and concrete absorb and retain more heat than natural surfaces. They reflect less solar energy and release heat slowly, causing temperatures to remain elevated, especially after sunset.
- Urban Design and Geometry – The layout of buildings affects airflow and heat retention. Dense developments with narrow streets and tall structures create "urban canyons" that trap heat and block cooling winds, turning buildings into thermal masses that release heat gradually.
- Human-Generated Heat – Activities such as transportation, industrial operations, and air conditioning add waste heat to the environment, intensifying the heat island effect.
- Weather and Geographic Conditions – Clear, calm weather amplifies heat islands by maximizing solar energy absorption and limiting heat dispersion. Conversely, wind and cloud cover help reduce the effect. Geographic features like mountains can also influence wind patterns, either blocking cooling breezes or channeling heat through urban areas (EPA, 2025).

According to the Salinas Land Use Plan and Hazard Mitigation Plan, a large portion of

the municipality consists of rural, agricultural, environmentally protected, and coastal lands, while urbanized development is concentrated primarily within Pueblo, Aguirre, Río Jueyes, and portions of Lapa.

4.12.1.2 Risk Magnitude (B1-C)

Local NWS offices often work with community agencies to decide when heat alerts should be issued. Because the United States is so geographically and culturally diverse, heat tolerance varies by region. For example, residents of Puerto Rico are generally more accustomed to temperatures above 90°F than those living in Alaska.

Nevertheless, the NWS uses the following standard alerts (NWS, n.d.):

- Excessive Heat Warning – Issued 12 hours before dangerous heat conditions are expected. This occurs when the heat index is forecast to reach 105°F or higher for more than three hours over two consecutive days, or 115°F or higher for any period of time.
- Excessive Heat Watch – Issued when an extreme heat event is possible within the next 24 to 72 hours.
- Heat Advisory – Issued 12 hours before conditions where the heat index is at least 105°F but less than 115°F for three consecutive days.
- Extreme Heat Outlook – Issued when there is potential for extreme heat within the next three to seven days, providing advance notice for those who need extra time to prepare.

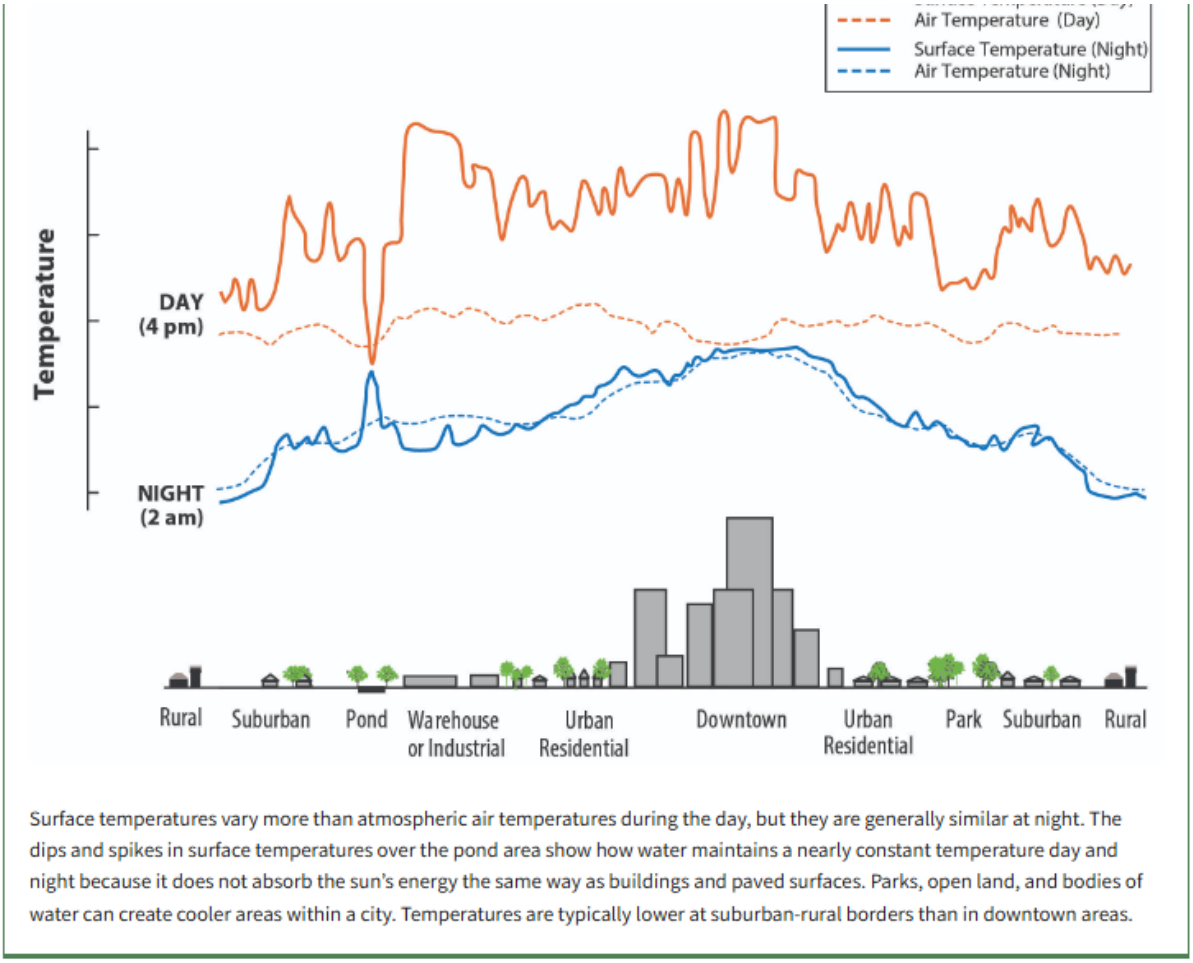
It must be emphasized that Urban Heat islands (UHI) phenomena can occur regardless of whether there is an extreme heat warning event. UHI is a relative temperature difference between urban and surrounding rural areas caused by factors like heat-absorbing surfaces, lack of vegetation, and human activities. It exists year-round, even during mild or cool weather, because cities consistently retain more heat than natural landscapes. Extreme heat events can amplify UHI, making UHI effects more dangerous, but UHI does not require extreme heat to form—it simply means urban areas are warmer than their surroundings under similar conditions.

UHIs are typically assessed by comparing temperatures in urban areas to those in surrounding regions. Even within a city, temperatures can vary significantly. Some neighborhoods are hotter due to dense concentrations of heat-absorbing surfaces like buildings and pavements, while areas with trees and greenery remain cooler.

These variations create what are known as intra-urban heat islands. In diagrams illustrating this effect, urban parks, ponds, and residential zones generally appear cooler than central downtown districts.

The following diagram, taken from an EPA website, shows a diagram of how a heat island effect behaves in temperature.

Figure 24: Heat Island Effect Diagram (EPA, 2025)



Surface temperatures vary more than atmospheric air temperatures during the day, but they are generally similar at night. The dips and spikes in surface temperatures over the pond area show how water maintains a nearly constant temperature day and night because it does not absorb the sun's energy the same way as buildings and paved surfaces. Parks, open land, and bodies of water can create cooler areas within a city. Temperatures are typically lower at suburban-rural borders than in downtown areas.

4.12.1.3 Past Events (B1-D)

Méndez Lázaro et al. (2015) identified several years in which extreme heat temperatures were recorded in the San Juan metropolitan area. According to their findings, periods of extreme heat occurred in 1983, 1995, 2012, and 2013. Notably, the summer of 2012 was the hottest in a century, with 42 days of extreme temperature values. During June, July, and August, the maximum heat index reached 98.06° F,

98.96° F, and 102.02° F, respectively (Méndez Lázaro et al., 2015).

4.12.1.4 Future event probabilities (B1-e)

Official NOAA assessments in the 2018 Puerto Rico and U.S. Virgin Islands State Climate Summary report an increase in both average temperature (≈1.5°F since 1950) and the frequency of extreme heat events (NOAA, 2022). Additionally, climate projections from CMIP6 (via the World Bank's Climate Change Knowledge Portal) show steady rises in summer and annual maximum temperatures for Puerto Rico, further indicating elevated future risk for heat waves (World Bank, n.d.).

4.12.2 Risk Analysis (B2-a, B2-b)

4.12.2.1 Estimated Losses

Extreme Heat primarily causes material and system stress rather than immediate structural failure. For example:

- Roads and Pavements: Asphalt can soften and deform under prolonged high temperatures, leading to rutting and surface damage (Highways Industry, n.d.) (EPA, 2012).
- Rail Systems: Steel tracks expand in extreme heat, which can cause buckling and derailment risks (USDOT - FRA, 2013).
- Power Infrastructure: Electrical grids experience higher loads from air conditioning demand, and transformers or cables can overheat, reducing efficiency or causing outages.
- Building Materials: Expansion and contraction of concrete, steel, and glass can lead to cracks or joint failures over time. Roofing materials may degrade faster under intense heat.
- Cooling Systems: HVAC systems work harder, increasing energy consumption and risk of failure, which can compromise indoor comfort and safety.

While heat waves rarely cause buildings to collapse, they accelerate wear and tear, increase maintenance costs, and can lead to system failures that disrupt essential services. As of now the municipality does not have a method to calculate losses from extreme heat events.

4.12.2.2 Lifelines and Critical Infrastructure

Extreme heat poses systemic risks across energy, transportation, and communications systems, creating compound failures precisely when demand for services peaks. In Energy Lifeline, high temperatures drive sharp increases in electricity demand for cooling while simultaneously decreasing generation and delivery efficiency. Thermoelectric plants may be forced to curtail output when cooling water is too warm, solar panels produce less electricity at elevated module temperatures, and transmission lines lose carrying capacity as conductors heat and sag—conditions that heighten the likelihood of voltage drops and blackouts during heat waves (Jessen, 2025). The combination of record cooling loads and diminished supply underscores a growing "peak risk" problem for grids that were not designed for today's heat extremes (Jessen, 2025) (American Society of Civil Engineers, 2024).

Similarly, the Transportation Lifeline is similarly vulnerable. Prolonged high surface temperatures soften asphalt, accelerating rutting and deformation; steel rails thermally expand and can buckle, prompting heat-related slow orders that disrupt service; and catenary or other overhead lines can sag in the heat, further constraining operations. Airports face dual constraints: runway pavements can deform under extreme heat, and reduced air density on hot days impairs aircraft performance, affecting takeoff weight and scheduling. These effects are now commonly observed across U.S. systems during sustained heat events, requiring operational restrictions and emergency maintenance that ripple through supply chains and passenger mobility (American Society of Civil Engineers, 2024)

Communication Lifeline also faces mounting heat stress. Data centers, switching facilities, and network nodes rely on continuous cooling; overheating elevates outage risks and can degrade equipment lifespans. Heat-related disruptions to power supply and localized microclimate conditions compound these risks, with cascading impacts across other lifeline sectors that depend on connectivity for operations and emergency response. Federal assessments underscore that extreme weather—including extreme heat—can interrupt fiber networks, degrade wireless performance, and limit access to data centers, affecting each of the other critical infrastructure sectors and complicating disaster response coordination (Public-Private Analytic Exchange Program, 2025).

Overall, extreme heat acts as a stress multiplier: it pushes materials beyond design thresholds, reduces equipment efficiency, and narrows operational safety margins, all while increasing demand for services. The evidence from engineering organizations

and energy market observers indicates that without targeted adaptation—such as heat-resilient design standards, strategic grid reinforcement, enhanced thermal management for digital infrastructure, and heat-aware operations—systems will face more frequent service disruptions and higher lifecycle costs as heat events intensify (American Society of Civil Engineers, 2024).

4.12.2.3 Social Vulnerabilities

A recent academic study examines the relationship between heat stress and mortality in Puerto Rico (Méndez - Lázaro, et al., 2025). Researchers analyzed hourly 2-meter air temperature data from ERA5 reanalysis for 2015–2020 and derived daily minimum, maximum, and mean values to calculate two heat stress indices: the Heat Index (HI) and the Universal Thermal Climate Index (UTCI). Findings show that extreme heat conditions are common for eight months of the year, with August and September being the hottest months, and that urban heat island effects exacerbate exposure in metropolitan areas. (Méndez - Lázaro, et al., 2025) Mortality risk increased significantly on days with high heat stress: deaths were 23% higher in the highest HI tertile and 47% higher in the highest UTCI tertile compared to the lowest. Cardiovascular and cerebrovascular diseases, heart failure, and respiratory conditions were among the leading causes of death associated with heat stress. The study highlights Puerto Rico's socio-economic vulnerabilities, aging population, and limited infrastructure amplifying health risks during extreme heat events (Méndez - Lázaro, et al., 2025).

Further information about social vulnerabilities can be found in section 3.4.4.

4.12.2.4 Natural and Cultural Resources

Extreme heat, specifically Urban Heat Islands can pose the following impacts on the natural resources:

- Increased Energy Consumption – Heat islands increase electricity demand for air conditioning and peak energy demand. Increased electricity demand for air conditioning ranges from 1–9% for each 2°F increase in temperature, with the highest increase in countries where most buildings have air conditioning, such as the United States.[3] This increased demand contributes to higher electricity expenses. Peak demand generally occurs on exceptionally hot afternoons, when offices and homes are running air-conditioning systems, lights, and appliances. This increased demand can overload systems and require a utility

to institute controlled brownouts or blackouts to avoid power outages.

- Elevated Emissions of Air Pollutants – To meet electricity needs, utility companies typically rely on fossil fuel power plants as a power source. Increased use of fossil fuels increases emissions of air-borne pollutants, such as carbon dioxide, which can have health concerns, especially in people living with respiratory diseases.
- Compromised Human Health and Comfort – Hot weather events contribute to heat-related deaths and heat-related illnesses. Areas experiencing heat islands further contribute to higher daytime temperatures and reduced nighttime cooling. Heat is of greatest concern for groups such as older adults, young children, populations with low-income, people who work outdoors, and people with chronic health conditions, disabilities, mobility constraints, or taking certain medications. From 2004 to 2018 the Centers for Disease Control and Prevention recorded an average of 702 heat deaths per year.

- Impaired Water Quality – High temperatures of pavement and rooftop surfaces can heat stormwater runoff, which drains into storm sewers. This runoff raises water temperatures as it is released into streams, rivers, ponds, and lakes. Water temperature affects the metabolism and reproduction of many aquatic species.

Rapid temperature changes can also be stressful, and even fatal, to aquatic life. One study found that urban streams have more frequent temperature surges than streams in forested areas. Temperature surges in urban streams were as much as 18°F higher due to heated runoff from urban areas, higher discharge volumes due to impervious surfaces, and warmer baseline stream temperatures (EPA, 2025).

4.12.2.5 Future Conditions

The approved construction permits map (Map 30) shows that many of the recent developments in Salinas are in the already built-up area of the city. This means that the urban heat island effect will continue to be present in the municipality in the near future.

Most of Salinas settlements, being a predominantly rural municipality, are spread throughout existing, or past, agrarian communities. While the potential for UHI is relatively low when compared to larger, denser, urban developments, design decisions regarding the materials, design, placement and orientation of buildings can create or exacerbate extreme heat conditions in individual buildings.

4.13 Drought

4.13.1 Description (B1-a)

Drought is described as a temporary irregularity in rainfall or natural water flow, where a prolonged lack of precipitation leads to a significant hydrological imbalance. This condition may or may not result in interruptions to regular drinking water service, crop failures, and adverse effects on wildlife and vegetation. The severity of a drought is determined by the level of moisture deficiency, its duration, and the geographic extent of the affected area (Colón, 2009).

Drought represents one of the most complex climatological risks and one of the most severe events (DRNA, 2016). Drought is the result of a natural reduction in the expected amount of precipitation over a prolonged period, usually a season or longer. High temperatures, strong winds, and low humidity levels can exacerbate the effects of drought in areas where they are already prevalent. Likewise, drought can lead to severe wildfires (FEMA, 1997). Human actions and the demands they place on water resources can accelerate drought-related impacts. Droughts occur in different forms across the island, meaning that some regions may experience greater impact while others remain normal.

According to FEMA there are four types of droughts (FEMA, 1997):

Table 42: Types of Droughts

Meteorological Drought	A period characterized by a significant deficiency in precipitation compared to normal conditions over a specific timeframe (e.g., monthly, seasonal, yearly)
Agricultural Drought	Occurs when soil moisture becomes insufficient to support crops or livestock needs, typically following meteorological drought.
Hydrological Drought	Defined by reduced water levels in streams, rivers, reservoirs, and groundwater systems, often lagging behind meteorological drought
Socioeconomic Drought	Reflects the impact on human systems and the economy, arising when water supply shortages—due to any form of drought—fail to meet societal demand for water and other resources

In 1999, the Federal Drought Monitor program was implemented. This program is a tool that publishes data and maps on drought conditions in the United States, including Puerto Rico and Hawaii. This system integrates information from various agencies, such as NOAA, the United States Department of Agriculture (USDA), and the National Drought Mitigation Center at the University of Nebraska-Lincoln. In addition, the monitor has developed standardized indicators that allow drought categories to be classified at the national level, providing a uniform reference for risk assessment and management.

The short-term drought indicator focuses on precipitation over 1–3 months. The long-term drought indicator focuses on a period of 6–60 months. Additional indices used, especially during the growing season, include the "USDA/NASS Topsoil Moisture," the Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite vegetation health indices. Other indicators include groundwater levels, reservoir capacity, and pasture conditions.

In Puerto Rico, the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Electric Power Authority (PREPA), and the Department of Natural and Environmental Resources (DNER) are responsible for constantly monitoring the dams and reservoirs used for potable water supply. Once critical levels are reached, the first strategy adopted at the supply system level is reducing water pressure. If adequate levels are not restored, water rationing begins. This is implemented in phases lasting 12 hours and, in extreme cases, up to 48 hours. The affected area is divided into sectors, and the different rationing phases of a given duration are initially implemented locally, usually in municipalities with the highest consumption. In extreme circumstances, several municipalities and entire regions may be affected.

4.13.1.1 Affected Area

Droughts are not limited by geographical boundaries. For example, a period of drought up-river in the Municipality of Salinas could affect the potable water supply since it is from the Cidra Reservoir where many residents of Salinas get their water from. For this analysis it will be assumed that the whole municipality can be affected by the drought hazard with the caveat that the municipality can be affected by a drought regardless of whether there is a diminution of rainfall within the municipality.

4.13.1.2 Risk Magnitude (B1-C)

Drought is a slow-onset hazard, but over time, it can have highly detrimental effects on crops, municipal water supplies, recreational uses, and wildlife. If drought conditions persist for several years, the direct and indirect economic impact can be significant. Drought can also potentially provide favorable conditions for another hazard to occur, wildfire.

The National Drought Monitoring Center uses the following categories to describe the magnitude of drought conditions (US Drought Monitor, 2025).

Table 43: US Drought Monitor Categories

Category	Description	Typical Impacts
None	Normal/Wet Conditions	No drought impacts
D0 - Abnormally Dry	Early signs of dryness may slow planting, affect surface water	Short-term dryness; minor stress
D1 - Moderate Drought	Noticeable soil moisture depletion; low water; voluntary restrictions	Crop stress; reduced streamflow
D2 - Severe Drought	Common water shortages; likely crop/pasture losses	Mandatory restrictions possible
D3 - Extreme Drought	Major crop/pasture losses; widespread restrictions	Fire bans; severe water stress
D4 - Exceptional Drought	Exceptional and widespread losses; water emergencies	Emergency measures; critical impacts

4.13.1.3 Past Events (B1-D)

Puerto Rico has a humid tropical climate characterized by two well-defined seasons: a rainy season, which extends from May to November, and a dry season, which runs from December to April. The eastern and western interior regions record the highest annual rainfall, while the northern zone receives significantly more rain than the south.

USGS identified that major drought conditions have occur in 1967 – 1969, 1974, 1994, 1994, 1997, 2001-2002 and 2013 -2016 (USGS, 2014), (DNER, 2016). According to historical records the federal government has activated its resources to deal with drought conditions;

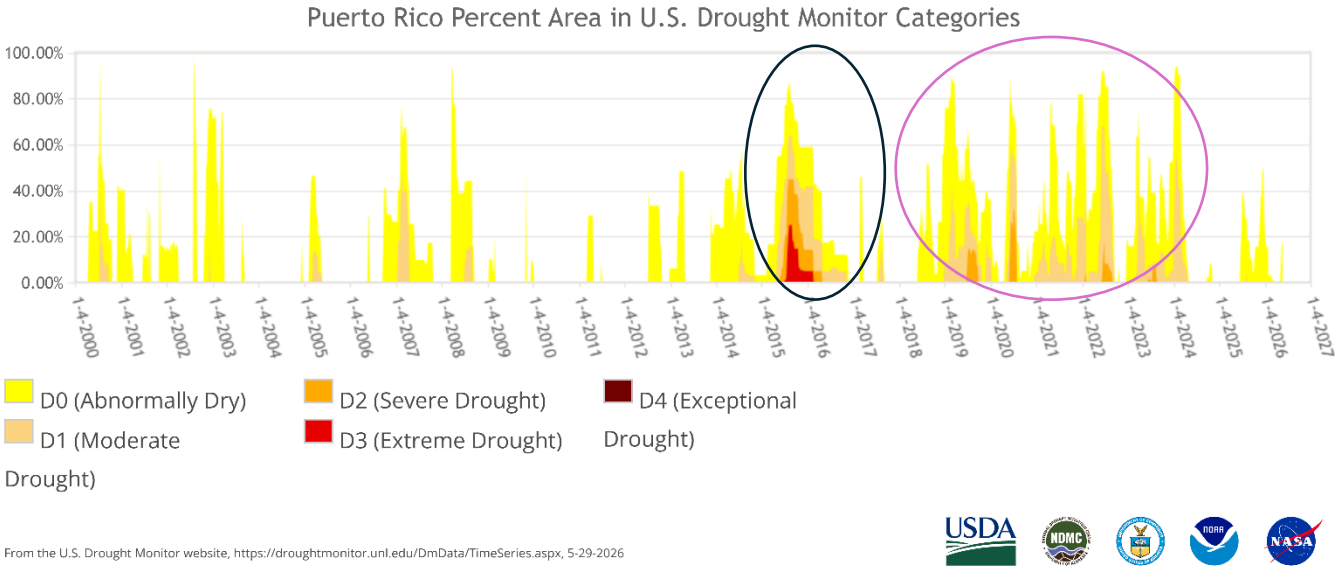
- Puerto Rico Extreme Drought Conditions (DR-170-PR) – Date of Declaration May 26, 1964
- Puerto Rico Impact of Drought (EM-3002-PR) - Date of Declaration August 29, 1974

During the rainy season, precipitation mainly comes from local convection processes, orographic effects, tropical waves, and cyclones. In contrast, rainfall during the dry season is mostly associated with the influence of cold fronts and troughs (CEACC, 2024).

Figure 25 shows the data captured by US Drought Monitor Categories for the period of January 2020 to January 2026 (US Drought Monitor, 2025) for Puerto Rico's entire territory. The graph measures the occurrence, duration, territorial extent and intensity of droughts in Puerto Rico. Intensity is measured with a color gradient ranging between yellow (D0 (abnormally Dry in the legend) as being the lowest intensity and the dark red (D4 Exceptional Drought) representing the highest level of drought. Duration is measured through the width of the data, expressed along the lower axis of the graph. Territorial extent is represented on the horizontal axis of the graph, the higher an event reaches the more Puerto Rico's territory it covers. Occurrence is measured by combining all of the other variables and locating them within the graph.

It also shows that the occurrences of D1 – Moderate Drought has become more recent in Salinas since 2019 (see purple oval in figure)

Figure 25: Municipality's Percent Area in U.S. Drought Monitor Categories[15]



From the graph we may appreciate a sustained trend of increased occurrence, duration and intensity of droughts in Puerto Rico that began as early as 2010 and solidified by 2014. Between 2015-2017, Puerto Rico experienced the most intense period of drought in recent years, with more than 80% of the Island's territory experiencing at least Abnormally Dry levels while at least 20% of the territory experienced Extreme Drought. The 2017 Hurricane season brough historic volume of precipitation, which explains the brief reduction in drought between 2017-2019. From 2017-2024, Puerto Rico experienced an extended period of drought in the vast majority of its territory.

4.13.1.4 Future Event Probabilities (B1-E)

USGS reports that in Puerto Rico, drought has an occurrence of 15 of 18 years (USGS, 2016), (USGS, 2014). Recent scientific data shows that the Caribbean region faces increased vulnerability to drought hazards. (USGCRP, 2018). The probability of drought occurrence is difficult to forecast or foresee in a long-term perspective. Though as figure 15 shows, moderate droughts periods have become more prevalent since 2018.

[15] Source US Drought Monitor

4.13.2 Risk Analysis (B2-a, B2-b)

If drought results in potable water rationing, the municipality could experience economic losses to the extent that services are immediately affected by the partial or total closure of schools, businesses, industrial areas, and public and private offices.

The potential economic impact of a prolonged drought would arise from the need to mobilize the municipality to meet the basic needs of its population during the emergency period. This cost is associated with mobilizing resources such as personnel and equipment for the distribution of water to communities and municipal facilities. However, the municipality has not been able to quantify the economic impact of this expense, nor the impact on agriculture, due to a lack of information. Since drought is a hazard that does not directly affect structures, no dollar estimate of structural losses is generated.

Among other effects, it results in increased food prices, loss of agricultural production, impacts on the industrial, commercial, and service sectors, losses in hydroelectric energy, and losses in the tourism industry, whether domestic tourism or foreign visitors.

4.13.2.1 Estimated Losses

Documenting the fiscal impact of a drought is a complex process due to the wide range of ways this climate event affects society (DNER, 2015). For example, during the 2015 drought (see Figure 29) a potable water rationing plan was implemented for the San Juan Metropolitan Area (SJMA) of which Salinas is not part of.

Another way to document the losses caused by drought period is by looking at the impact on the agricultural sector. The Puerto Rico Department of Agriculture reported that the 2015 drought had a net cost of $14,000,000.00 impact on the agricultural sectors.

4.13.2.2 Critical Infrastructure and Lifelines

Drought can place significant strain on critical infrastructure by reducing water availability for municipal systems, often leading to rationing measures and service interruptions. Extended water shortages can disrupt essential operations in schools, hospitals, and businesses, resulting in economic losses and reduced access to public services. Energy infrastructure may also be affected, particularly where hydroelectric

generation declines due to low reservoir levels, increasing reliance on more expensive or less sustainable energy sources. Transportation systems can experience indirect impacts, such as road damage caused by soil shrinkage and heightened wildfire risk along highways. Emergency response and communication services may face additional challenges when limited water supplies constrain cooling systems and firefighting capabilities. Collectively, drought conditions can trigger cascading impacts across interconnected infrastructure systems, increasing vulnerabilities and underscoring the need for coordinated mitigation and response strategies.

As noted above, drought events that require potable water rationing can lead to economic losses for the municipality by disrupting normal government operations. Partial or complete closures of schools, businesses, industrial zones, and public or private offices may occur when water availability is reduced. These impacts primarily affect the day-to-day functioning of municipal assets, as the services they provide are directly limited by water shortages or service interruptions. As droughts become more frequent or prolonged, their cumulative effects on operations are likely to intensify. However, while drought significantly affects service delivery and operational capacity, it does not directly damage the municipality's critical facilities and physical assets.

4.13.2.3 Social Vulnerabilities

As mentioned in Section 3.3.1 the estimated vulnerable population of Salinas is of 42.04%. If the pattern that began in 2019 continues, the vulnerable population of Salinas will continue to face major challenges regarding access to potable water. Communities will experience a decrease in water availability, which is essential for industrial and agricultural production, as well as for personal use by residents. It can also affect public health. This results in a reduction in quality of life, mental and physical stress, and social discomfort, with potential risks of malnutrition, dehydration, and disease. Since the effects of a drought period can have effects on the whole population (even drought periods that do not directly affect the municipality's territory, it is recommendable for the municipal administration to consider the whole population of Salinas as exposed to this hazard.

4.13.2.4 Natural and Cultural Resources

When a region experiences prolonged and cumulative periods of little or no rainfall, a drought begins. This natural hazard has adverse effects on biodiversity and water supplies. For instance, a precipitation deficit lowers water levels in bodies of water,

including mangroves, impacting the region's flora and fauna. Damage to vegetation directly affects animal habitats, creating an imbalance in food availability for wildlife.

Agriculture in the area is also severely affected due to the lack of water. When rainfall is significantly below normal levels, it causes severe hydrological imbalances that negatively affect land productivity systems. Similarly, crop growth and harvests decline, along with the availability and quality of drinking water. Drought can also lead to ecosystem degradation, loss of biodiversity and species, wind erosion, and increased wildfire risk.

4.13.2.5 Future Conditions

Over the long term, drought-related challenges are expected to intensify as rainfall patterns continue to vary. These variations may result in droughts that are more severe, longer in duration, and wider in geographic extent than those experienced historically, thereby increasing vulnerability among affected populations.

Overall population trends in the Municipality of Salinas indicate a general decline at the neighborhood level. However, the population aged 65 and older has increased (see Section 3.3.1), representing a particularly vulnerable segment of the community. The growing proportion of older adults requires special consideration in drought planning due to heightened sensitivity to water shortages, health impacts, and service disruptions.

Future land development also plays a critical role in drought vulnerability. Approving projects near sinkholes or developments that rely on septic systems increases the risk of groundwater contamination, which becomes especially problematic during drought conditions when alternative water sources are limited. Additionally, soil surface impermeabilization and the obstruction or filling of sinkholes reduce natural aquifer recharge by increasing surface runoff. These factors further diminish groundwater availability, limiting its viability as a supplemental water source during drought events.

4.14 Wildfire (E1-a)

4.14.1 Description (B1-a)

Wildfires are uncontrolled fires that spread through vegetation, posing serious threats

to structures, human health, and natural ecosystems. These events often begin unnoticed and can spread rapidly, producing dense smoke that affects nearby communities. While wildfires may occur at any time of year, they are most common during periods of low rainfall, when grasses, leaves, and other fine fuels become dry and highly combustible.

In 2021, the Puerto Rico Department of Natural and Environmental Resources published its Forest Action Plan (DNER, 2021). The Plan discusses overall trends, issues and objectives for the management of forest resources. Wildfires are among the challenges discussed in the document. The Plan argues that wildfire management is a pressing issue at both local and global levels due to the complex interactions among human activity, fire dynamics, and natural landscapes. While research has established that fire influences ecosystem structure and function, its effects on ecosystem services remain uncertain because of interrelated factors such as land cover changes, invasive species, and climate change (Gould, 2008).

A clear understanding of the ecological and social impacts of wildfire in Puerto Rico's natural ecosystems is essential for guiding effective conservation and management strategies. Prevention efforts must extend to private forest owners and the general public, as most fires on the island are human caused (Gould, 2008). Historically, fire monitoring and research in the region have received limited attention. Currently, fires occur predominantly in dry forest zones, where the risk is highest. However, climate change, prolonged droughts, and human-induced landscape fragmentation could expand fire-prone conditions into moist and wet tropical forests, as well as into areas traditionally unaffected by fire (Gould, 2008).

Increasing temperatures, more frequent droughts, and the spread of invasive species are making forests more susceptible to wildfires. This shift is already evident in Puerto Rico, where fires are becoming more frequent and occurring in areas with no prior history of such events (Robbins, Eckelmann, & Quiñones, 2009).

4.14.1.1 Risk Magnitude

The United States Forest Service main classification for fire types (USFS, n.d.) are;

- Ground Fire - Fire that burns within the organic material below the litter layer, mostly by smoldering combustion. It typically occurs in duff, peat, dead moss and lichens, and punky wood are typically ground fire. Ground fires mainly growing vegetation such as grasslands, shrubs, and tree bases. Depending on

environmental factors (vegetation composition and density, slope orientation and steepness, wind speed, among others), these fires can vary in intensity but generally release less thermal energy than fires that spread through tree canopies.

- Crown Fires – A fire that burnt in the crowns of trees and shrubs usually ignited by a surface fire. Crown fires are common in coniferous forests and chaparral-type shrublands. In these types of fires, flames climb through lower branches until reaching the tree canopy. However, in some cases, its spread remains primarily surface-based, often because trees are sparse and their canopies are too far apart.
- Surface Fire – A fire that burnt through leaf litter and other live or dead fuels located at or just above the ground, mostly by flaming combustion.

While FEMA follows a four-classification typology (FEMA, 1997):

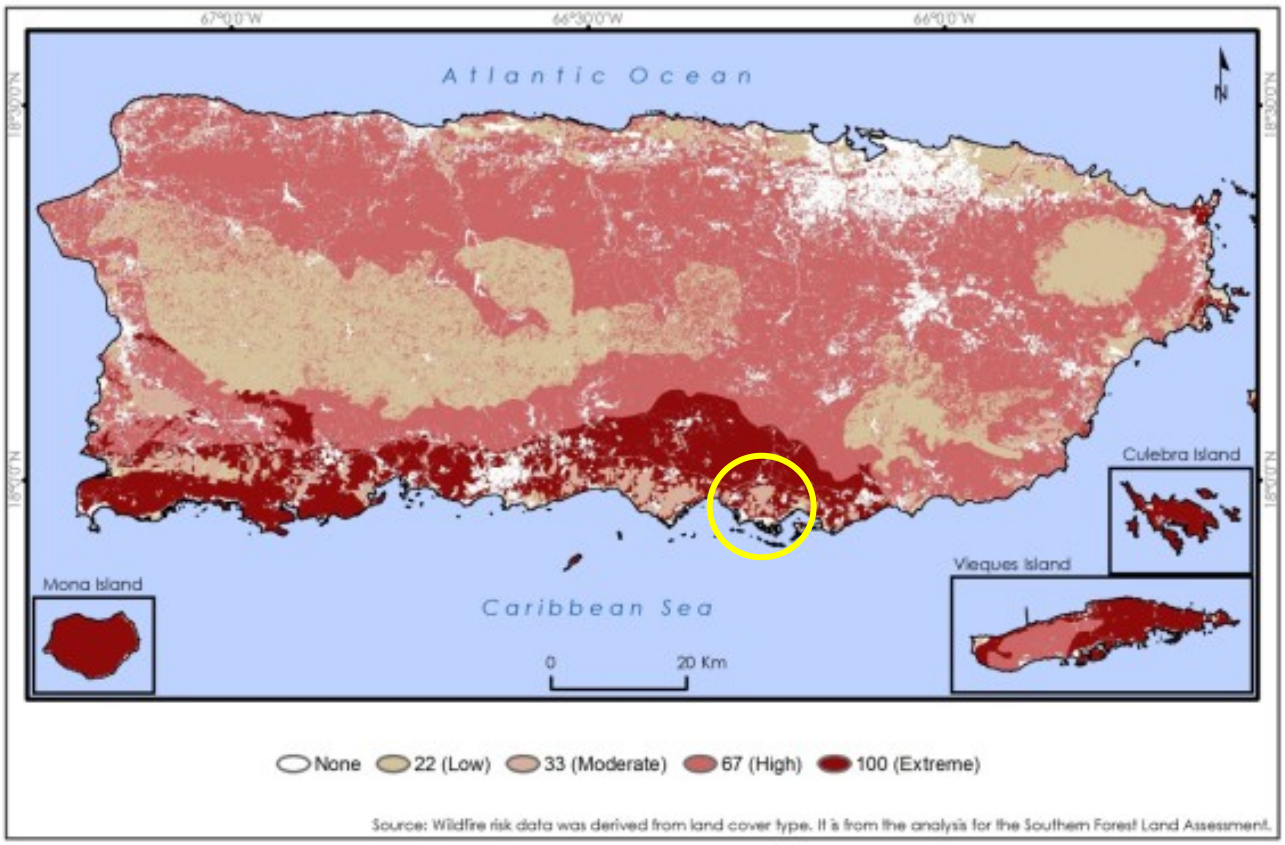
- Wildfires – Fueled almost exclusively by natural vegetation. They typically occur in forests and national parks, where federal agencies are responsible for fire management and suppression.
- Interface or Intermixed Fires – Fires that occur in urban and/or wildland areas where vegetation and integrated surroundings provide the fuel.
- Firestorms – Events of such extreme intensity that effective suppression is virtually impossible. Firestorms occur under severe weather conditions and generally burn until conditions change, or available fuel is exhausted.
- Intentional and Prescribed Burns – Fires caused by human intervention and natural fires intentionally allowed to burn vegetation for management purposes.

Another typology is the distinction between wildfires and wildland-urban interface (WUI) fires. Wildfires occur in areas with minimal development, except for infrastructure such as roads or power lines. WUI fires, on the other hand, involve situations when fire spreads into areas with structures or other human developments. In WUI fires, flames feed on both vegetation and structural elements of urban areas. The US Fire Administration defines WUI as the zone or area where human structures and developments meet or intermingle with wildland vegetation and fuels (US Fire Administation, 2025).

4.14.1.2 Affected Area (B1-B)

Figure 26 (DNER, 2021) provides an overview of areas in Puerto Rico, Vieques, and Culebra under varying levels of wildfire incidence, as defined by Southern Federal Land Assessment (SFLA). This information provides the state of knowledge of what is known as fire-prone landscapes. The combination of human presence, dry fuels, and climatic conditions accounts for the high number of fires in the southern coastal plain. Salinas's territory (yellow circle) is characterized by High risk in the mountainous area and a moderate risk in the valleys to wildfires.

Figure 26: Overview of areas of Puerto Rico, Vieques and Culebra under different levels of wildlife incidence accounting to SFLA



4.14.1.3 Risk Magnitude (B1-C)

Wildfires tend to be associated with template climate areas, like California or Canada. However, the recent experience in the State of Hawai'i showed that rapid and deadly wildfire can occur even in tropical humid locations. The catastrophic Lahaina Fire of

August 2023 sent swift, devastating flames through densely built neighborhoods, revealing severe vulnerabilities in early warning systems, evacuation planning, and community preparedness. Fueled by dry vegetation, strong winds, and record-setting drought conditions, the blaze rapidly ignited structures and overwhelmed emergency response efforts. Independent investigation by the Fire Safety Research Institute highlights that inadequate infrastructure resilience, insufficient communication networks, and a lack of coordinated interagency planning significantly amplified the disaster's impact.

As Puerto Rico faces similar wildfire threats, especially in southern coastal plains, this tragedy underscores the need to strengthen detection systems, bolster community evacuation routes, and elevate public education about fire safety. Building codes that emphasize fire-resistant materials and defensible space strategies around homes and critical facilities can reduce structural losses under extreme wildfire conditions.

The importance of integrated land management also emerges, encouraging Puerto Rico to limit development in WUI zones and maintain vegetation buffers. The Lahaina lessons highlight that rapid, well-coordinated suppression and resilient communications systems are vital to curbing wildfire escalation. Investing in cross-agency collaboration and emergency training at the local level will help Puerto Rican municipalities respond more effectively. Ultimately, Lahaina serves as a stark wake-up call, emphasizing that proactive planning, robust infrastructure, and community resilience are essential to preventing a similar wildfire catastrophe in Puerto Rico.

4.14.1.4 Past Events (B1-D)

Citing data from the Puerto Rico Firefighters Bureau (PRFB), The Puerto Rico Forest Action Plan states that a total of 7,099 wildland fires were reported across Puerto Rico between 2018 and 2020. The highest number of incidents occurred in 2020, with 5,077 recorded fires. The regions most affected were Ponce, Guayama, and Mayagüez (DNER, 2021).

Within the Department of Natural and Environmental Resources (DNER) Protected Natural Areas, fire incidence increased in 2019 compared to 2018. Notable affected sites included Guánica State Forest, Boquerón Wildlife Refuge, Punta Cuchara Natural Reserve, Caño Tiburones Natural Reserve, and Tortuguero Lagoon Natural Reserve. Most of these fires were linked to human activities, such as unattended campfires, discarded cigarettes, intentional burning, improper waste burning, and poorly managed prescribed burns in pasturelands (DNER, 2021).

The high frequency of wildfires in Puerto Rico highlights the urgent need for targeted education and public outreach efforts to raise awareness. When combined with active land management and a landscape-scale conservation approach, these initiatives can help reduce the occurrence of fires and mitigate additional pressures on forest ecosystems.

During 2024 a total of 44 wildfires were reported by the Puerto Rico Fire Bureau. The following table shows the details of the wildfires reported in that year.

Table 44: Registered Wildfires

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR090724-514	2024-09-07 13:16:12.498000	2024-09-07 19:28:30.278000	-66.29605, 17.9645
BPR010524-729	2024-01-05 15:35:40.661000	2024-01-05 17:26:21.223000	-66.2229, 17.9701
BPR072724-578	2024-07-27 14:27:32.879000	2024-07-27 21:45:06.524000	-66.2653, 17.9938
BPR080524-794	2024-08-05 17:05:56.327000	2024-08-05 20:49:38.627000	-66.2653, 17.9938
PR091124-656	2024-09-11 13:50:19.361000	2024-09-11 14:56:45.669000	-66.2512, 17.9716
PR091724-752	2024-09-17 15:21:45.347000	2024-09-17 18:18:53.580000	-66.27842, 17.9827
PR010124-1097	2024-01-01 20:26:58.709000	2024-01-01 23:38:21.496000	-66.216, 18.0293
PR010224-721	2024-01-02 14:23:51.834000	2024-01-02 14:43:23.404000	-66.24901, 17.9785
BPR010224-780	2024-01-02 15:06:09.736000	2024-01-02 16:01:09.454000	-66.2653, 17.9938
PR010524-465	2024-01-05 11:53:00.887000	2024-01-05 15:19:40.705000	-66.27526, 17.9896
PR010824-907	2024-01-08 16:39:52.881000	2024-01-08 18:04:58.896000	-66.24896, 17.9785
PR011124-989	2024-01-11 18:31:10.435000	2024-01-11 19:11:40.298000	-66.26357, 17.9926
PR011224-893	2024-01-12 17:28:20.940000	2024-01-12 18:12:50.306000	-66.2348, 18.0478

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR011424-350	2024-01-14 10:17:50.149000	2024-01-14 11:05:35.804000	-66.24287, 18.0752
BPR011424-987	2024-01-14 20:03:09.270000	2024-01-14 20:36:03.594000	-67.0423, 18.0178
BPR011724-683	2024-01-17 14:12:54.870000	2024-01-17 14:52:05.912000	-66.2653, 17.9938
BPR011724-762	2024-01-17 15:32:40.568000	2024-01-17 16:57:51.298000	-66.2653, 17.9938
BPR011724-905	2024-01-17 17:34:11.598000	2024-01-17 18:44:08.530000	-66.2653, 17.9938
PR011924-951	2024-01-19 17:52:41.322000	2024-01-19 19:21:25.233000	-66.21747, 18.0321
PR012024-837	2024-01-20 16:16:31.688000	2024-01-20 17:19:15.693000	-66.24177, 18.0796
PR012224-1062	2024-01-22 18:23:16.608000	2024-01-22 19:29:14.432000	-66.23982, 18.0813
BPR012324-749	2024-01-23 14:10:53.429000	2024-01-23 14:53:01.848000	-66.2653, 17.9938
PR012424-678	2024-01-24 13:39:20.413000	2024-01-24 15:41:55.286000	-66.21295, 18.0546
BPR012424-708	2024-01-24 14:02:04.844000	2024-01-24 14:40:02.659000	-66.2653, 17.9938
PR012724-977	2024-01-27 19:22:24.130000	2024-01-27 21:04:24.027000	-66.21523, 18.0336
BPR012824-498	2024-01-28 12:44:56.792000	2024-01-28 16:36:43.160000	-66.2653, 17.9938
PR012824-720	2024-01-28 15:55:05.710000	2024-01-28 21:17:32.816000	-66.23995, 17.9782
PR012824-721	2024-01-28 15:55:26.810000	2024-01-28 21:01:32.183000	-66.25636, 17.9968
PR012824-940	2024-01-28 19:20:48.870000	2024-01-28 19:31:21.196000	-66.23761, 17.9523
PR012924-855	2024-01-29 16:21:11.499000	2024-01-29 17:38:50.365000	-66.25409, 18.0224
PR012924-1024	2024-01-29 18:36:02.857000	2024-01-29 19:24:08.251000	-66.23962, 18.0377

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
PR012924-1086	2024-01-29 19:45:58.763000	2024-01-29 20:23:23.402000	-66.25647, 18.0155
BPR012924-1113	2024-01-29 20:13:16.111000	2024-01-29 20:26:25.233000	-66.2653, 17.9938
BPR013024-566	2024-01-30 12:16:26.292000	2024-01-30 13:12:28.005000	-121.6069, 36.6343
PR022024-647	2024-02-20 13:39:06.963000	2024-02-20 14:31:28.377000	-66.2243, 17.9816
BPR031124-474	2024-03-11 10:49:39.311000	2024-03-11 12:39:09.616000	-121.657, 36.673
BPR040124-591	2024-04-01 12:55:00.179000	2024-04-01 13:38:52.669000	-66.2229, 17.9701
PR040224-960	2024-04-02 19:25:22.310000	2024-04-02 20:28:06.010000	-66.34159, 17.9974
BPR040824-590	2024-04-08 12:42:41.838000	2024-04-08 17:25:49.026000	-66.2653, 17.9938
PR042924-634	2024-04-29 13:17:45.018000	2024-04-29 13:46:45.085000	-66.2462, 18.0025
PR043024-870	2024-04-30 17:33:34.130000	2024-04-30 19:21:49.843000	-66.22351, 17.9764
BPR051624-580	2024-05-16 12:34:52.418000	2024-05-16 13:50:11.545000	-66.2653, 17.9938
BPR070824-355	2024-07-08 10:08:44.316000	2024-07-08 11:11:08.008000	-121.624, 36.6386
BPR080224-414	2024-08-02 11:00:43.810000	2024-08-02 14:31:59.473000	-66.2653, 17.9938
BPR080824-931	2024-08-08 20:26:41.532000	2024-08-08 21:42:42.249000	-66.2653, 17.9938
BPR082124-837	2024-08-21 17:23:15.184000	2024-08-21 18:41:51.100000	-66.2653, 17.9938
BPR090624-513	2024-09-06 12:19:19.972000	2024-09-06 13:37:14.003000	-66.2229, 17.9701
PR090824-669	2024-09-08 16:40:13.257000	2024-09-08 17:02:54.776000	-66.25376, 17.9959
BPR092424-535	2024-09-24 13:05:11.894000	2024-09-24 13:50:15.700000	-66.2653, 17.9938

Case Number	Discovery Date	Containment Date	Incident Coordinates[17]
BPR092624-397	2024-09-26 10:42:25.097000	2024-09-26 10:43:24.072000	-66.2653, 17.9938
BPR120924-1143	2024-12-09 21:12:04.386000	2024-12-09 22:20:35.552000	-66.2653, 17.9938
BPR012724-962	2024-01-27 19:02:35.229000	2024-01-27 19:31:14.375000	-66.2653, 17.9938

Source: Puerto Rico Fire Bureau

4.14.1.5 Future Event Probability (B1-e)

Long-term trends in rain patterns, such as those caused by fluctuations in the El Niño–Southern Oscillation (ENSO), may lead to extended dry periods (CCOF, 2026), reduced soil moisture, and increased vegetation stress. When combined with rising temperatures, these conditions accelerate evapotranspiration and further dry out fuels, significantly increasing the likelihood of ignition and fire spread. As a result, areas that have not historically been prone to wildfires may become increasingly susceptible under these changing climate conditions.

4.14.2 Risk Analysis (B2-a, B2-b)

4.14.2.1 Estimated Losses

Wildfires can result from both natural conditions, such as the presence of flammable vegetation, and human activities, including the intentional use of fire. These factors strongly influence the potential scale and intensity of wildfire events. The level of potential loss increases with higher population concentrations, greater numbers of structures, and sensitive ecosystems located within the affected area. Climatic conditions, combined with patterns of human activity, largely determine the extent and severity of wildfire impacts.

At present, there is insufficient information to quantify monetary losses related to building damage from this hazard. Additionally, at the time of this Plan update, no official damage estimates were available for the municipality. To address this gap, the municipality will take a proactive approach by incorporating updated damage information in future Plan revisions as data become available.

4.14.2.2 Critical Infrastructure

Wildfires pose a significant threat to critical infrastructure, creating cascading impacts across power systems, communications, water supply, transportation, and the built environment. The electric grid is particularly vulnerable. Research from Sandia National Laboratories (Sandia National Laboratories, n.d.) and other institutions shows that wildfire can both damage grid components and be ignited by them, as seen in the 2018 Camp Fire, which caused $9.3 billion in damages. To address this, the U.S. Department of Energy has invested $3.46 billion through its Grid Resilience and Innovation Partnerships program (DOE, 2023), funding projects that include undergrounding power lines, installing fire-resistant poles, and deploying advanced sensors.

Communications infrastructure faces similar risks. A study by the University of Wisconsin – Madison faculty found that while cell towers often survive fires physically, power outages lead to widespread service disruptions (Anderson, Barford, & Barford, 2020). Water systems and watersheds are also heavily impacted. Post-fire conditions—such as vegetation loss and soil hydrophobicity—can trigger flooding and debris flows, introducing sediment, nutrients, and metals into water supplies.

Transportation networks suffer both direct and indirect damage. Roads, bridges, and drainage systems are often compromised by post-fire floods and debris flows buildings and other structures in the wildland–urban interface is increasingly at risk due to climate change and urban expansion.

In summary, wildfire creates complex, interconnected risks for critical infrastructure, requiring a combination of engineering solutions, advanced modeling, policy reforms, and community engagement. Official and academic sources consistently call for proactive measures—such as infrastructure hardening, improved land management, and resilience planning—to reduce exposure and enhance recovery.

Wildfire occurs regularly during periods of drought, primarily in the southern region of Puerto Rico. These events have significant social and economic impacts, mainly due to structural and property damage or loss caused by the fires. If the affected area served as an employment or industrial hub, many individuals could face unemployment. Additionally, insurance premiums tend to rise because of increased demand for coverage to mitigate economic losses associated with wildfire hazards. Collectively, these factors negatively affect the region's economy, wildlife, vegetation, and contribute to broader social decline.

4.14.2.3 Social Vulnerability

Social vulnerability plays a critical role in shaping how communities experience and recover from wildfire events. Research consistently shows that populations with higher levels of poverty, older adults, individuals with disabilities, limited English proficiency, and households without reliable transportation face greater challenges preparing for, evacuating from, and recovering after wildfires. The CDC/ATSDR Social Vulnerability Index (SVI) identifies these demographic and socioeconomic conditions as key factors that increase susceptibility to disaster impacts, including wildfires, by constraining a community's adaptive and coping capacity before, during, and after an event. National-scale studies further demonstrate that U.S. communities experiencing wildfire occurrence or exposure tend to have systematically higher levels of social vulnerability, including higher unemployment, lower educational attainment, and greater concentrations of medically or socially dependent populations (Schumann, III, et al., 2024).

Wildfires also exacerbate existing inequalities through indirect impacts such as prolonged displacement, loss of livelihoods, and health effects from smoke exposure. Peer-reviewed studies show that socially vulnerable populations experience disproportionate health burdens from wildfire smoke, including higher rates of respiratory and cardiovascular illness and increased mortality risk, due to pre-existing health conditions and limited access to medical care. FEMA and the U.S. Fire Administration emphasize that older adults, low-income households, people living in mobile homes, and individuals without access to private vehicles face heightened risk of injury or death during wildfire evacuations, underscoring the importance of incorporating social vulnerability into wildfire mitigation, evacuation planning, and recovery strategies (Dennin, Nock, Muller, Akindele, & Adams, 2025).

4.14.2.4 Natural and Cultural Resources

The severity, scale, and consequences of wildfire can be grouped into the following categories:

- Impact on Landscape - The most visible effect after a wildfire is the loss of scenic quality caused by the destruction of vegetation cover and its regression to earlier ecological stages.
- Impact on Wildlife - Wildfires have both immediate and long-term effects on fauna. In the short term, fires can cause direct mortality, particularly among

invertebrates, small vertebrates, and young animals with limited mobility, as well as larger herbivores and carnivores that may be trapped by flames or barriers such as fencing. In the longer term, habitat loss, reduction of forage, and ecosystem disruption can force wildlife migration and threaten vulnerable or endangered species.

- Impact on Soil - Wildfires significantly alter soil structure and increase its susceptibility to erosion. The combustion of organic matter destabilizes soil aggregates, causing progressive disintegration. As a result, solid particles are then removed by rain or wind erosion. Fire often creates hydrophobic (water-repellent) layers to the deposition of organic compounds and changes in mineral composition, which reduce water infiltration and further accelerate surface runoff and erosion. Significant losses of soil and organic matter reduce nutrient levels, lowering fertility. In addition, heat also kills many organisms, reducing biological activity and disrupting biogeochemical cycles. However, not all effects are negative. Naturally occurring fires (now increasingly rare) can benefit forest health by mobilizing nutrients and controlling pests. Low-intensity fires help retain carbon in the soil, preventing its release as carbon dioxide.
- Alteration of the Water Cycle - Wildfire-induced soil degradation can significantly disrupt the hydrological cycle. Reduced infiltration lowers groundwater reserves that feed aquifers essential for agriculture and urban use. At the same time, increased surface runoff accelerates soil erosion, transports sediment into water bodies, and heightens the risk of flash flooding following intense rainfall events.
- Increase in Carbon Emissions – The combustion of biomass during wildfires releases substantial quantities of carbon dioxide (CO_2), methane (CH_4), and suspended particles. These emissions cause significant environmental damage and negatively affect people with respiratory illness (Asthma, COPD, etc.).

Wildfires can lead to numerous environmental consequences, including the destruction of vegetation cover, the death or displacement of wildlife, the loss of fertile soil, and an increase in erosion events. They can also cause significant loss of life and property, resulting in substantial economic costs associated with firefighting and recovery efforts.

As for cultural resources, wildfires pose a serious threat to cultural resources, including historic buildings, and archaeological sites. Intense heat and flames can destroy irreplaceable structures, artifacts, and archives, erasing centuries of heritage in a matter of hours. In addition, smoke, soot, and water used during firefighting operations

can further damage delicate materials. Post-fire effects such as erosion and flooding after fires may expose or wash away archaeological remains.

Beyond physical damage, the loss of cultural landmarks disrupts can community identity and traditions, while also affecting tourism and local economies. Protecting these resources requires proactive planning, fire-resistant measures, and collaboration between emergency agencies and cultural preservation experts.

4.14.2.5 Future Conditions (E1-a)

Puerto Rico already experiences a high annual probability of wildfire-supporting conditions. According to the World Bank–supported ThinkHazard! platform, Puerto Rico's wildfire hazard is classified as High, meaning there is a greater than 50% probability in any given year of weather conditions capable of supporting a significant wildfire that could cause impacts to life or property. This assessment incorporates historical fire occurrence, climate variables, vegetation type, and drought conditions and is widely used in infrastructure and hazard mitigation planning worldwide (World Bank, n.d.).

Taken together, the best available scientific evidence indicates that Puerto Rico currently faces a probability exceeding 50% annually of wildfire-supportive weather conditions, with future probability and severity expected to increase due to rising temperatures, expanded drylands, and longer seasonal droughts. While precise ignition probability percentages cannot be reliably projected at the municipal scale, confidence is high that wildfire occurrence, fire weather days, and burned area will increase by mid-century, particularly in southern, western, and interior regions of the island (World Bank, n.d.).

4.15 Long term Coastal Dynamics

4.15.1 Description

Long-term coastal dynamics refer to the gradual, persistent processes that shape coastlines over extended periods of time, including shoreline movement, sediment transport, erosion, accretion, and changes in coastal water levels, which together influence coastal form, stability, and hazard exposure (USGS, 2018) (Mentaschi, Vousdoukas, Pekel, Voukouvalas, & Feyen, 2018). These dynamics differ from short-term storm impacts in that they reflect persistent, incremental change rather than episodic disturbance. For Local Hazard Mitigation Plans, understanding

long-term coastal dynamics is critical because such changes influence shoreline position, coastal stability, and long-term exposure to coastal hazards (USGS, 2018).

Long-term coastal dynamics are primarily driven by the interaction of coastal erosion, coastal accretion, and changes in the mean (base) sea level, all of which influence sediment distribution, natural protective features, and flood exposure along coastal areas (Bird, 2008; Davidson-Arnott, 2010).

Coastal Erosion

Coastal erosion is the long-term landward movement of the shoreline resulting from a net loss of sediment from beaches, dunes, bluffs, or nearshore environments. While erosion may occur rapidly during storm events, long-term erosion reflects sustained sediment imbalance operating over decades (Komar, 1998).

From a hazard mitigation perspective, chronic coastal erosion is important because it gradually reduces beach width and elevation, weakens dune systems, and exposes inland areas to increased wave action and flooding. Long-term erosion is commonly measured as average annual shoreline retreat, integrating multiple historical shoreline positions and providing an indicator of sustained vulnerability rather than isolated event-driven damage (Allan et al., 2003; USGS, 2018).

Coastal Accretion

Coastal accretion refers to the long-term accumulation of sediment that results in shoreline advancement or increases in beach width and elevation. Accretion can enhance coastal resilience by reinforcing natural protective features; however, it is often spatially variable and dependent on sediment availability and transport pathways (Davidson-Arnott, 2010).

In many coastal systems, accretion in one location corresponds to erosion elsewhere, reflecting sediment redistribution rather than net sediment gain. As a result, accretion may be temporary and insufficient to offset long-term erosional trends at a regional scale (Bird, 2008; Mentaschi et al., 2018).

Variations in Mean (Base) Sea Level

Mean sea level, often referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), serves as a controlling baseline for coastal

processes. Long-term changes in mean sea level influence the elevation at which waves interact with the shoreline, the frequency of tidal inundation, and the position of the coastal profile (USGS, 2018).

Gradual changes in mean sea level contribute to long-term coastal dynamics by promoting landward adjustment of beaches and dunes, increasing inundation during routine tides, and enhancing erosion during moderate storm conditions. These impacts occur incrementally and contribute to persistent shoreline retreat over time (Bird, 2008; Mentaschi et al., 2018).

Long-term coastal dynamics emerge from the interaction of erosion, accretion, and mean sea-level position rather than from any single process acting independently. Coastal systems tend to adjust toward equilibrium conditions, which may involve shoreline migration, redistribution of sediment, and progressive loss of natural buffering capacity (Davidson-Arnott, 2010).

As a result, localized accretion may slow erosion but may not reverse long-term shoreline retreat where underlying sediment deficits or water-level changes persist. These interactions explain why many coastlines experience sustained landward movement despite episodic periods of beach recovery (Komar, 1998; Allan et al., 2003).

For Local Hazard Mitigation Plans, long-term coastal dynamics are a key consideration because they contribute to the gradual expansion of coastal hazard exposure beyond areas affected by single storm events. Persistent erosion, shifting shorelines, and changing base water levels can increase the vulnerability of infrastructure, reduce the effectiveness of fixed shoreline protection measures, and influence long-term land-use suitability (USGS, 2018).

Incorporating long-term coastal dynamics into hazard mitigation planning supports proactive decision-making related to land use, infrastructure siting, and mitigation strategy development by addressing the underlying physical processes shaping coastal risk.

Long-term coastal dynamics, including ongoing erosion, accretion, and changes in mean sea level, contribute to gradual shoreline adjustment and increased exposure to coastal hazards over time. These processes represent a persistent source of coastal risk that should be considered in land-use planning, infrastructure investment, and hazard mitigation strategies (Bird, 2008; USGS, 2018).

4.15.1.1 Affected Area

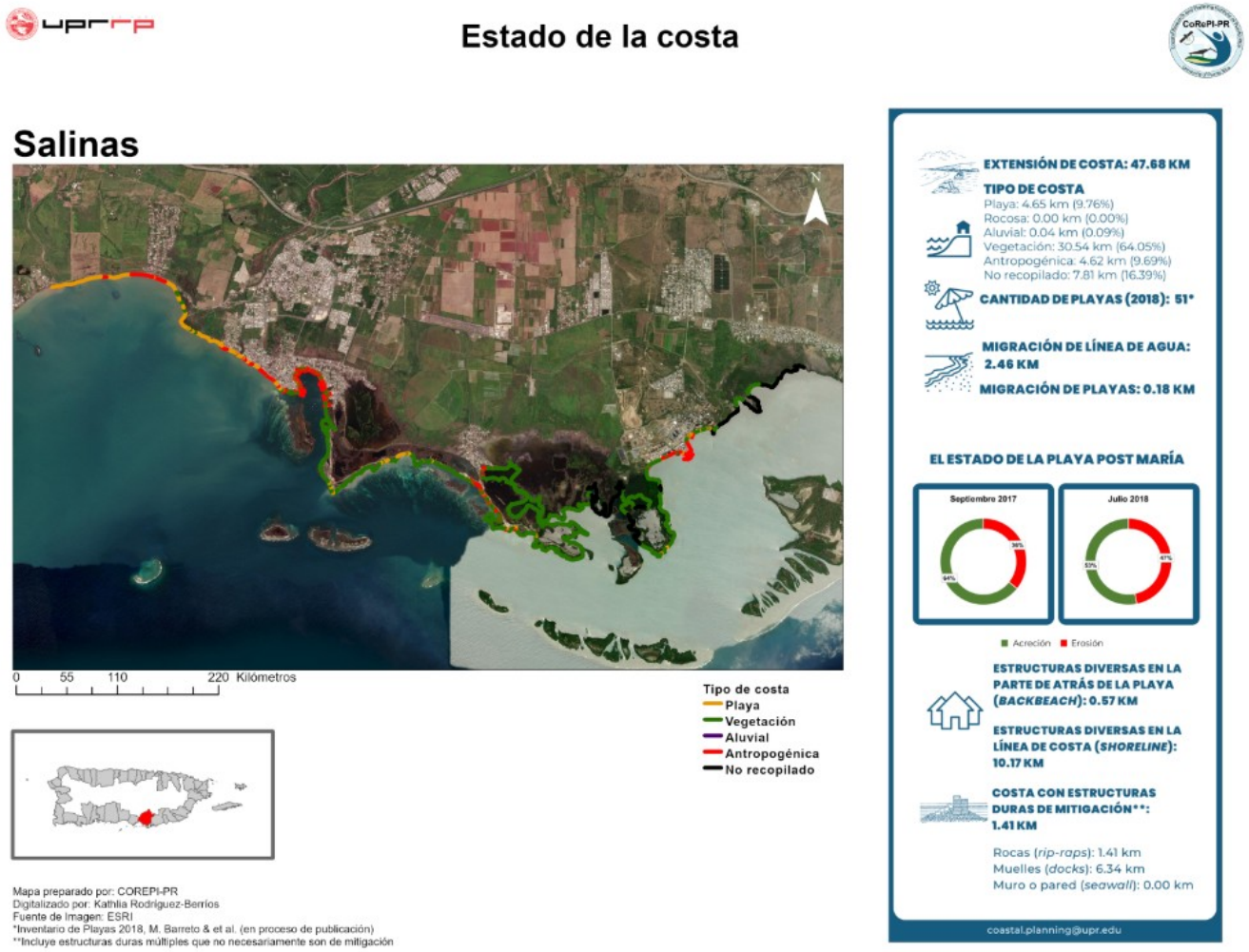
Under HMGP FEMA-4339-DR-PR Subgrantee Number 4339-0007P, a comprehensive post-event coastal assessment was conducted to evaluate the geomorphic condition of Puerto Rico's beaches following Hurricane María (September 2017) and their subsequent recovery. This study was conducted by the University of Puerto Rico, Río Piedras' Coastal Research and Planning Institute of Puerto Rico (COREPI-PR).

The assessment analyzed beach conditions immediately after the hurricane and approximately ten months later (July 2018), covering a representative group of coastal municipalities across the north, west, east, and south coasts including Aguada, Aguadilla, Añasco, Arecibo, Arroyo, Barceloneta, Humacao, Loíza, Rincón, and San Juan (COREPI-PR, 2020). Later other municipalitiesm including Salinas were included.

The Salinas coastline exhibits a dynamic pattern of coastal morphological change influenced by coastal processes, extreme weather events, sea level rise, and human activity. Areas along the municipality's coastal plain, particularly within Aguirre, Las Mareas, Playita, Playa, and Las Ochenta, are vulnerable to shoreline change and erosion processes. These coastal sectors contain low-lying lands, coastal wetlands, beaches, and developed areas that may be affected by long-term shoreline migration and storm-related erosion.

CoRePI-PR's post-María assessment highlights the importance of monitoring shoreline conditions and coastal migration patterns to support planning and mitigation efforts. The information generated by this project assists in identifying areas where erosion may affect natural resources, infrastructure, and coastal communities and supports the development of future coastal resilience and hazard mitigation strategies.

Figure 27 State of the Beach Study



The Salinas coastline is 53 km long. Most of the coast is composed of mangrove-type vegetation (57%). The remaining part of the coastline has 8.74% of beaches and 19% of the coastline is reinforced with some type of hard structure.

By September 2017, 64% of its beaches presented accretion and 36% erosion. An increase in erosion was identified for July 2018 on the municipality's beaches. Changes in the extent of mangrove areas in the area are not included in this coastal assessment (COREPI-PR, 2020).

Approximately 0.31 km of the coast was identified with inland waterline migration for July 2018. The sections that exhibited migration were a small part of Punta Salinas and

section near the Nigua River. In addition, 0.16 km of beach migration was identified for 2018 in section near the Nigua River. (COREPI-PR, 2020).

Figure 27 (available only in Spanish) shows the beach segments along the coastline of Salinas that experienced erosion, accretion, or relatively stable conditions during the period between September 2017 and July 2018, following the passage of Hurricane María. The figure compares shoreline conditions immediately after the hurricane with those observed approximately ten months later and highlights the dynamic nature of the municipality's coastal system.

The figure indicates that shoreline change was not uniform throughout the municipality. Several coastal segments experienced erosion, particularly along portions of the coastline extending from Barrio Pueblo toward Río Jueyes, as well as in isolated sections of Aguirre. These areas exhibited measurable shoreline retreat and beach narrowing during the study period. At the same time, other shoreline segments experienced accretion, indicating localized sediment deposition and beach recovery following the storm.

The distribution of erosional and accretional segments demonstrates that sediment movement along the Salinas coastline is highly variable and influenced by local coastal processes, wave energy, sediment availability, and storm impacts. While some shoreline segments exhibited significant recovery through sediment accumulation, adjacent areas continued to experience erosion, highlighting the complex response of the coastline following Hurricane María.

Overall, Figure 28 shows that the coast of Salinas experienced a combination of erosion and accretion during the period from September 2017 to July 2018, reflecting the ongoing adjustment of the shoreline after a major hurricane event. The observed changes underscore the importance of continued monitoring of coastal conditions, particularly in areas such as Playa Salinas, Las Ochenta, Aguirre, Las Mareas, Playita, Playa, and Río Jueyes, where future shoreline change may affect natural resources, infrastructure, recreational areas, and coastal development.

Figure 28: State of the Beach (Erosion vs. Accretion)

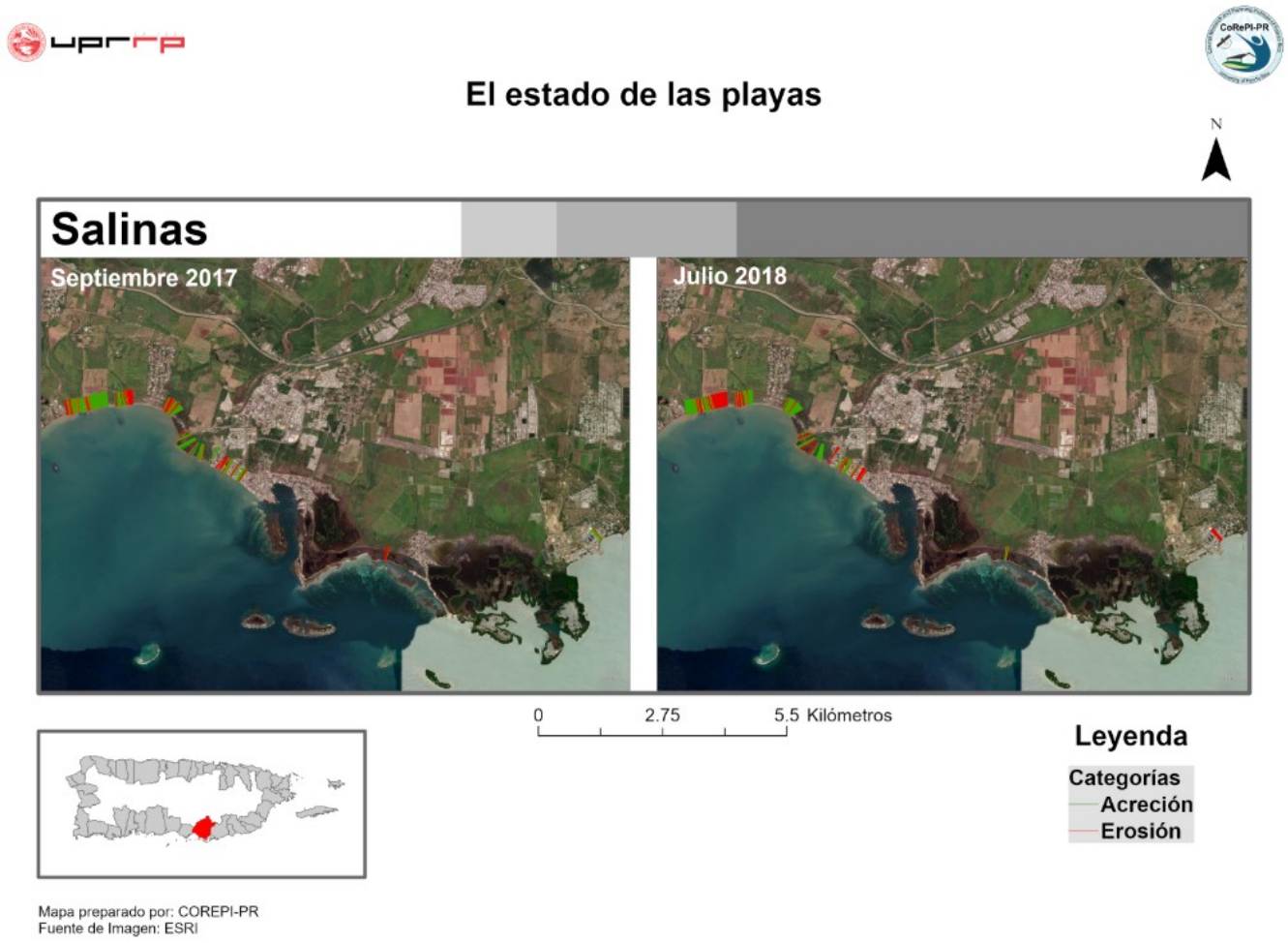


Figure 29 shows the specific changes in beach width observed along the coastline of Salinas between September 2017 and July 2018. The figure illustrates considerable spatial variability in shoreline response following Hurricane María, with both beach erosion and accretion occurring along different sections of the coast

The most significant positive changes in beach width were recorded near the Río Nigua coastal area (transects 1570-1587), where localized accretion reached approximately 40.31 meters and 24.69 meters at specific locations. These results suggest substantial sediment deposition and beach recovery in portions of the coastline during the post-María period.

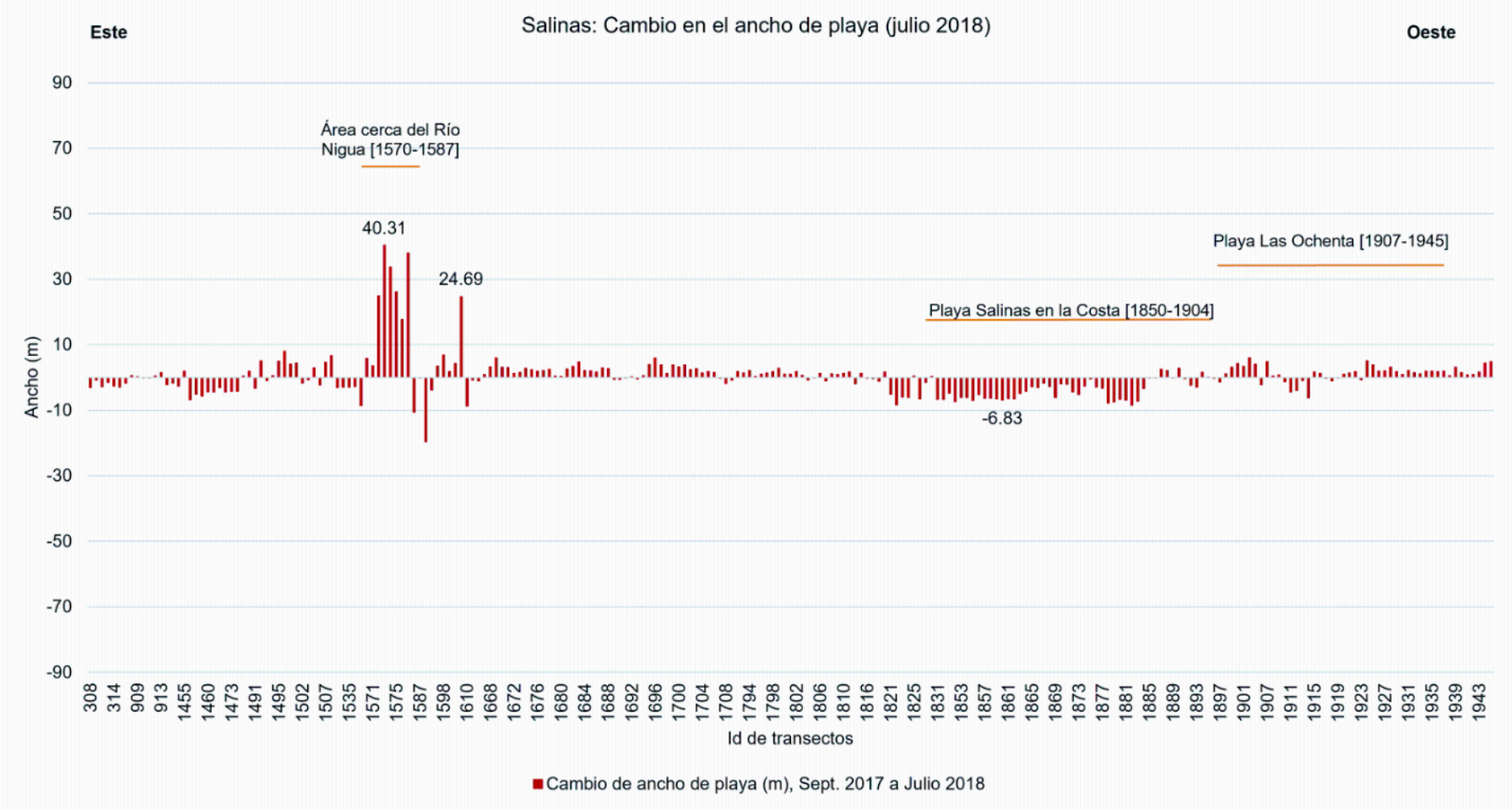
Conversely, several shoreline segments exhibited erosion, particularly along the Playa Salinas coastal sector (transects 1850-1904), where beach width losses reached

approximately -6.83 meters. Additional localized erosional trends were observed throughout the municipality's shoreline, indicating that sediment redistribution following Hurricane María was uneven and highly site-specific.

The figure also shows that shoreline behavior differed among coastal sectors, including the areas surrounding Río Nigua, Playa Salinas, and Playa Las Ochenta (transects 1907-1945). While some segments experienced substantial beach widening, others underwent measurable shoreline retreat. This pattern reflects the dynamic interaction of storm impacts, wave energy, sediment transport, riverine sediment supply, and local coastal morphology.

Overall, Figure 27 demonstrates that the Salinas coastline experienced both erosion and accretion during the period immediately following Hurricane María. The magnitude and direction of shoreline change varied considerably along the coast, highlighting the importance of continued monitoring and management of coastal resources, particularly in communities such as Playa Salinas, Las Ochenta, Aguirre, Las Mareas, Playita, and Playa, where future shoreline change may affect infrastructure, natural resources, and coastal development.

Figure 29: Change in Width of Beach (July 2018)



4.15.1.2 Risk Magnitude

Coastal Erosion

Erosion is the process by which major storms, flooding, strong wave action, rising sea levels, and human activities wear away beaches and cliffs along coastlines (FEMA, 1997). Beaches are affected by storms and other natural events that cause coastal erosion; however, the extent and severity of the problem are not uniform, as they vary by location. Consequently, there is no single solution for mitigating erosion. Erosion processes and their impacts may be episodic or long-term. These two (2) descriptors assign an important temporal component to erosion processes and their consequences.

Episodic erosion, also known as storm-induced erosion, primarily consists of the cross-shore movement of sand and sediments resulting from high-intensity weather events and ocean storms. This type of response leads to coastal adjustment and occurs during a single storm or a sequence of storm events within a season. Changes in beach and shoreline profiles during intense storms may result in dramatic erosion of beaches and dunes, including the reduction or removal of coastal dunes, as well as the retreat and collapse of coastal cliff formations. The consequences of this type of erosion may include increased inland wave penetration and ocean flooding in areas that were previously not exposed to water inundation.

Long-term or chronic erosion, on the other hand, is associated with slower processes such as gradual shoreline change linked to:

- Increases in sea level,
- Land subsidence,
- Changes in sediment supply due to watershed modifications,
- Impacts on coral reefs resulting from rising water temperatures and ocean acidification,
- Coastal structures and development, and
- Decadal adjustments in rainfall, wind, and climate associated with global warming.

Erosion may also be caused by anthropogenic forces (Romeu-Cotchett, 2012), including:

- Removal of coastal sediments, resulting in area erosion and the loss of dunes and beaches;

- Construction of developments, roadways, or agricultural activities, which increase sediment deposition and contamination in coastal waters, causing adverse effects on coral reefs. It should be noted that reefs function as natural barriers that protect beaches from wave impacts and, consequently, from erosion;
- Dam systems constructed to reduce the normal flow of sand delivered to the ocean by rivers; and
- Construction close to beaches, which allows the sea to advance further inland, thereby increasing erosion processes.

Coastal Accretion

Coastal accretion is a fundamental component of long-term coastal dynamics and represents the process by which sediment is deposited along the shoreline, resulting in the widening, elevation, or seaward movement of beaches, dunes, and other coastal landforms. Accretion occurs when sediment inputs exceed sediment losses over time and plays a critical role in shaping shoreline configuration and influencing coastal hazard exposure (USGS, 2018).

For Mitigation planning coastal accretion is significant because it affects the capacity of beaches and dunes to function as natural protective features that reduce wave energy, coastal flooding, and erosion impacts. However, accretion is neither uniform nor permanent and must be evaluated in terms of its duration, spatial extent, and relationship to broader coastal processes (Bird, 2008).

Episodic coastal accretion refers to short-term sediment deposition that occurs following discrete events or over limited periods, such as between storm seasons. This form of accretion is typically associated with the return of sediment from offshore bars or adjacent shoreline segments to the beach through cross-shore or alongshore transport processes (Davidson-Arnott, 2010).

Episodic accretion may result in temporary increases in:

- Beach width,
- Beach elevation, and
- Dune volume following storm-related erosion.

These changes may occur rapidly, sometimes within weeks or months; however, episodic accretion represents temporary profile adjustment rather than sustained

shoreline stabilization. Subsequent storms or shifts in hydrodynamic conditions may quickly redistribute or remove accreted sediments (Komar, 1998).
From a hazard mitigation perspective, episodic accretion may reduce short-term exposure to wave action or tidal inundation but should not be assumed to provide long-term protection unless supported by evidence of persistent sediment supply.

Long-term coastal accretion occurs when sediment deposition persists over years to decades, resulting in stable or progressively advancing shorelines. This form of accretion reflects a positive sediment budget within the coastal system, often supported by consistent sediment delivery and favorable transport conditions (USGS, 2018).

Long-term accretion is commonly associated with:

- Sustained sediment input from rivers or coastal ecosystems,
- Alongshore sediment transport that concentrates material in specific shoreline segments,
- Nearshore bathymetry that favors sediment retention, and
- Relatively stable mean sea-level conditions relative to land elevation (Bird, 2008).

While long-term accretion can enhance coastal resilience by reinforcing beaches and dunes, it is often spatially limited and may occur concurrently with erosion in adjacent areas. In many cases, accretion reflects sediment redistribution rather than net sediment gain across a regional coastline (Mentaschi et al., 2018).

Human activities can influence coastal accretion both directly and indirectly. In some cases, engineered interventions such as beach nourishment or coastal structures may promote localized sediment accumulation. In other cases, development and infrastructure interfere with natural sediment pathways, limiting accretion potential elsewhere (Komar, 1998).

Anthropogenic factors affecting accretion include:

- Beach nourishment and sediment placement projects,
- Coastal structures that trap sediment locally,
- Alterations to river systems that modify sediment delivery, and
- Shoreline development that restricts natural shoreline adjustment (NOAA, 2020).

While engineered accretion may provide short- to medium-term protective benefits, it typically requires long-term maintenance and should be evaluated within the context of sustained coastal dynamics.

Change in Base Sea Level Mean

Changes in the mean (base) sea level, commonly referenced using tidal datums such as mean sea level (MSL) or mean higher high water (MHHW), represent an important component of long-term coastal dynamics and influence the frequency and extent of coastal inundation. Mean sea level serves as a baseline against which shoreline position, wave interaction, and tidal flooding are measured, and gradual shifts in this baseline affect how coastal systems respond over time (NOAA, 2026). Sustained increases in mean sea level relative to the land surface allow wave energy to act on higher portions of the coastal profile, increasing the frequency of tidal flooding and accelerating shoreline adjustment processes. These incremental changes can lead to landward migration of beaches and dunes, greater exposure of low-lying areas to coastal flooding, and reduced effectiveness of natural and engineered protective features, even in the absence of major storm events. From a hazard mitigation planning perspective, changes in mean sea level contribute to long-term increases in coastal hazard exposure and should be considered when evaluating future risk, land-use suitability, and infrastructure resilience along the coast (USGS, 2018) (NOAA, 2026).

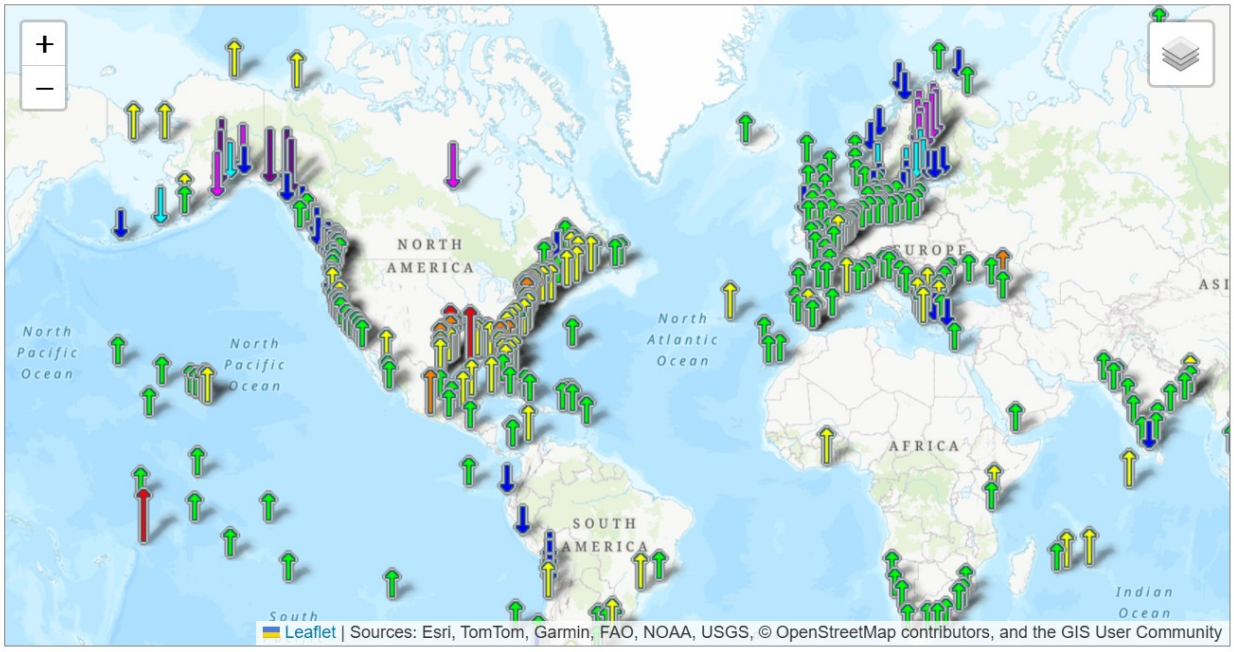
Sea level fluctuates over both short- and long-term timeframes as a result of multiple interacting factors. Short-term variations typically occur on daily to event-based timescales and are influenced by processes such as waves, tides, and discrete flooding events, including those associated with seasonal snowmelt, hurricanes, or other coastal storms. In contrast, long-term sea-level variations occur over extended periods ranging from months to multiple years and may manifest as recurring cycles, gradual trends, or episodic departures from typical conditions. These longer-term changes are influenced by a combination of factors, including seasonal atmospheric patterns, variations in the Earth's declination, changes in coastal and ocean circulation, human activities such as dredging, vertical land motion, and large-scale climate–ocean oscillations such as the El Niño–Southern Oscillation.

When evaluating long-term sea-level trends, a minimum observational record of 30 years is commonly used to capture these underlying variations and minimize uncertainty associated with shorter-term fluctuations in monthly mean sea level.

Accounting for predictable and repeatable processes—such as tidal cycles, seasonal variability, and interannual oscillations—allows for a more accurate representation of long-term sea-level behavior (NOAA, 2026).

NOAA's Relative Sea Level Trends website provides the up-to-date trends for sea levels at a global scale. The global sea-level trend has been measured using satellite altimetry since 1992, and the most recent global estimates, along with maps showing regional variations, are available from NOAA's Laboratory for Satellite Altimetry. The screen shot below shows the map provided by NOAA as of 4/29/2026 (NOAA, 2026).
As Figure 30 show, although there are various places where the sea level has decreased (specially to the south of Alaska, the west of British Columbia, Hudson Bay, the Nordic countries and among some parts of the South American western coast (Ecuador, Peru and northern Chile) the general trend is for an increasing sea level in varying degrees.

Figure 30: NOAA's Relative Sea Level Trend Map



As figure 30 show, although there are various places where the sea level has decreased (specially to the south of Alaska, the west of British Columbia, Hudson Bay, the Nordic countries and among some parts of the South American western coast (Ecuador, Peru and northern Chile) the general trend is for an increasing sea level in varying degrees.

In the case of Puerto Rico, according to this map there has been observed an increase in base sea levels.

Figure 31: NOAA's Relative Sea Level Trend Map (Zoom to Puerto Rico)



The gauges shown in the map present the following data:

Table 45: Puerto Rico Sea Level Observations

Gauge Name	Trend	Period	Commentary
Magueyes Island, PR 9759110	+ 2.06/year	1955 - 2025	The relative sea level trend is 2.06 mm/year with a 95% confidence interval of +/- 0.27 mm/year based on monthly mean sea level data from 1955 to 2025 which is equivalent to a change of 0.68 feet in 100 years.
San Juan, PR 9755371	+2.16/year	1962 - 2025	The relative sea level trend is 2.16 mm/year with

Gauge Name	Trend	Period	Commentary
			a 95% confidence interval of +/- 0.32 mm/year based on monthly mean sea level data from 1962 to 2025 which is equivalent to a change of 0.71 feet in 100 years.

Figures 32 and 33 are screen grabs from the Relative Sea Level Website and shows the trend for the Magueyes Island gauge.

Figure 32: Relative Sea Level Trend 9759110 Magueyes Island, PR

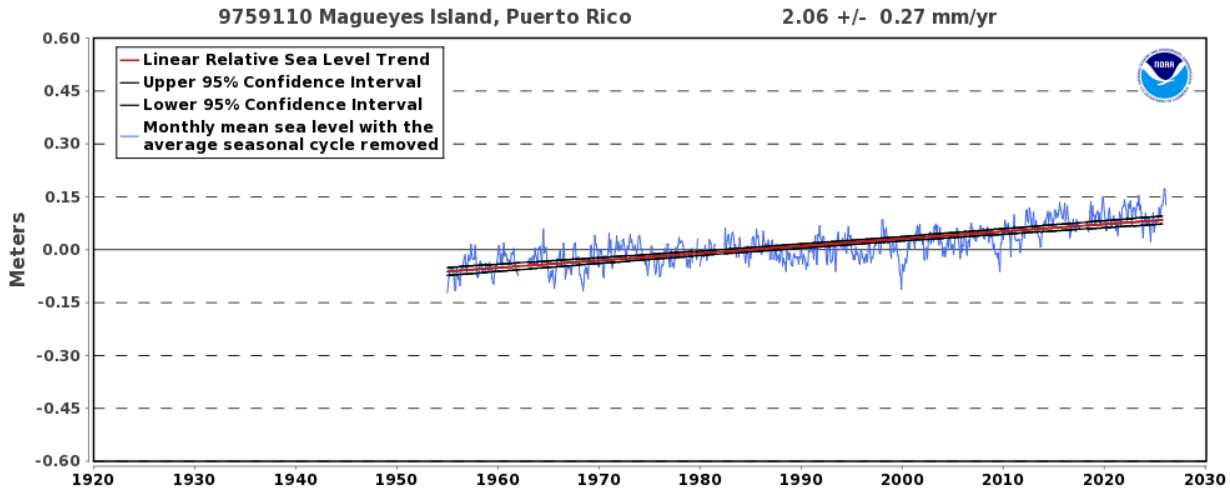
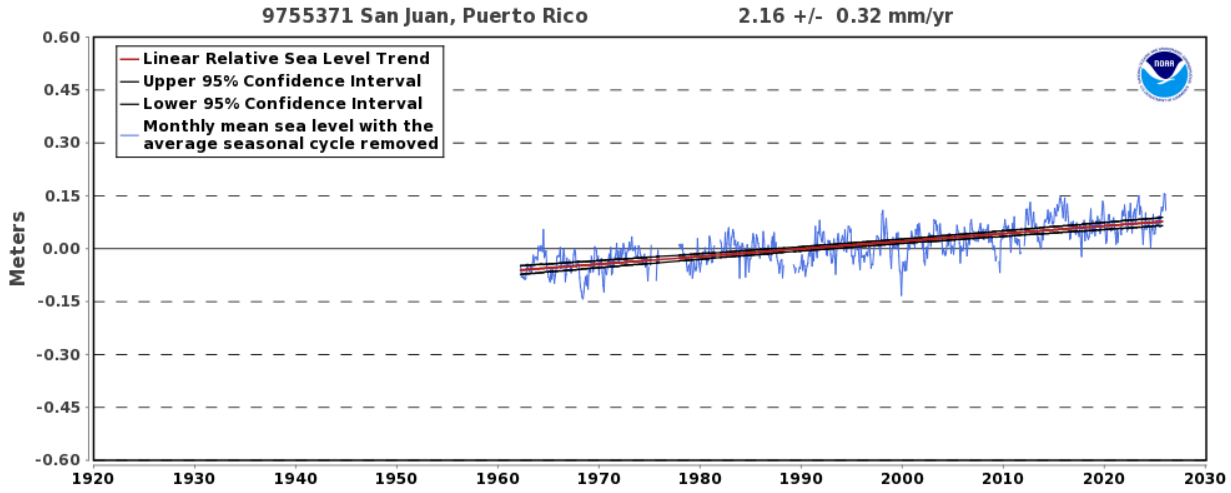


Figure 33: Relative Sea Level Trend 9755371 San Juan, PR



4.15.1.3 Past Events

Section 4.15.1.1 above details the changes in beach erosion or accretion for the beaches in Arecibo in the aftermath of Hurricane Maria as detailed in the COREPI-PR study.

This study brought forth the following key findings (COREPI-PR, 2020):

- Widespread Coastal Erosion: Significant erosion occurred along multiple beach segments following Hurricane María, particularly in Arroyo, Humacao, and Barceloneta, reducing beach width and elevation and increasing exposure to storm surge and flooding. https://storymaps.arcgis.com/stories/ac6e366a14d840e88a266d23b440ab0c
- Partial Natural Recovery: Ten months after the hurricane, many beaches exhibited sediment accretion and partial recovery; however, recovery was uneven and site-specific, with some areas remaining highly vulnerable to future events.
- Beach Migration: The study documented permanent inland migration of beaches in several municipalities, including Añasco, Humacao, Arecibo, Aguada, and Rincón. This indicates a long-term shift of the shoreline landward, increasing risk to inland infrastructure and properties.
- Influence of Built Infrastructure: Erosion was frequently observed adjacent to rigid shoreline structures (e.g., seawalls, rip-rap, coastal development), suggesting that hardened shorelines may exacerbate erosion processes and

reduce natural beach resilience.

- Loss of Protective Function: In several locations, the reduction of beach width and loss of sandbars diminished the beach's capacity to function as a natural protective barrier, resulting in greater susceptibility to storm surge damage during subsequent events (e.g., 2018 extra-tropical storms).

The findings of this study are important for hazard mitigation planning since beaches are a critical natural infrastructure that provide coastal protection by dissipating wave energy, reducing flooding extent, and protecting inland development. The documented erosion, beach migration, and reduced protective capacity highlight increased vulnerability to; coastal flooding, storm surge, wave action and progressive shoreline retreat.

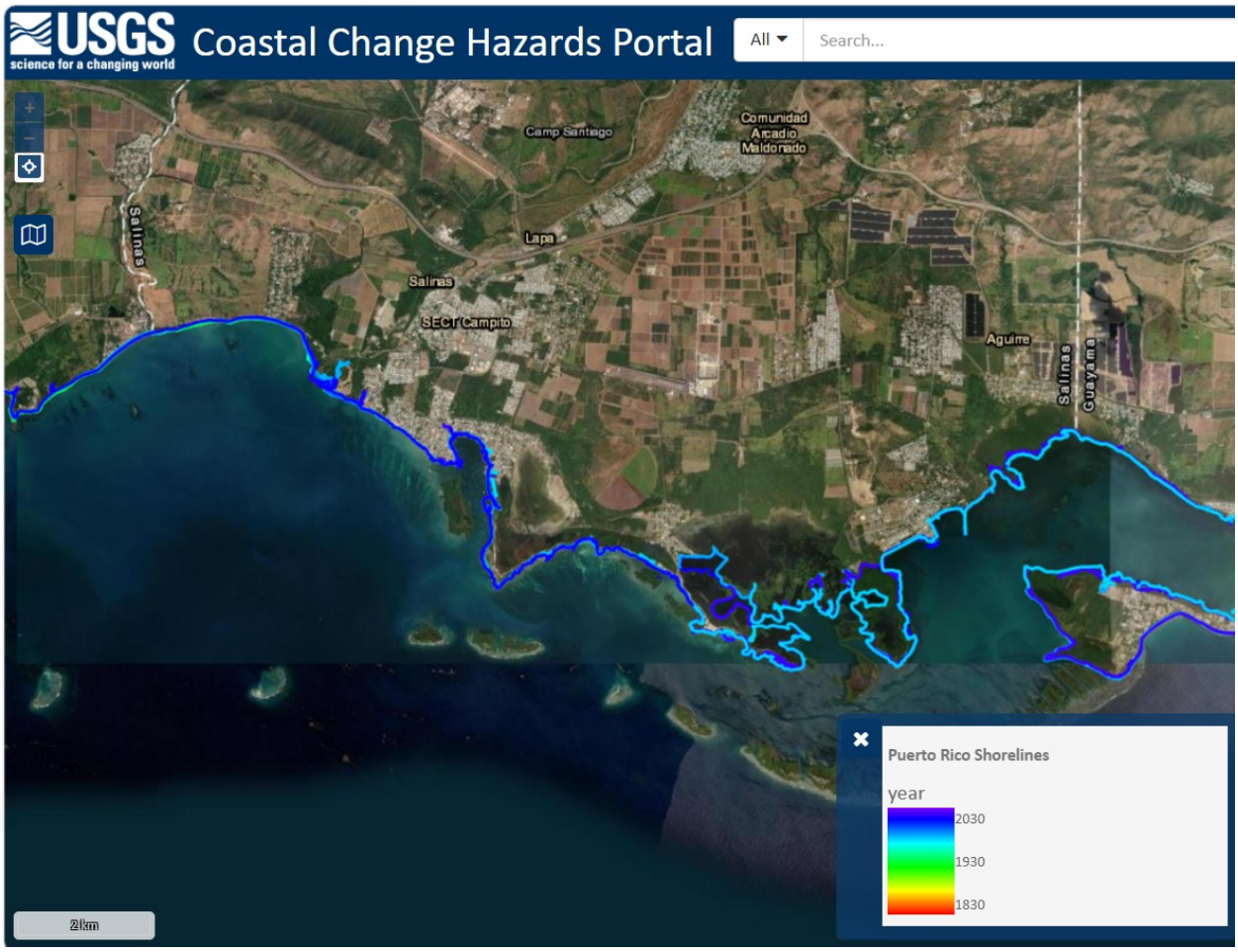
These findings support the integration of coastal erosion monitoring, nature-based solutions, land-use planning controls, and adaptive shoreline management strategies into local and regional hazard mitigation efforts. The assessment also provides a baseline for prioritizing mitigation projects and for validating requests for local, state, and federal mitigation funding.

In the case of Salinas, there is qualitative evidence of ongoing coastal change and erosion along several portions of the municipality's shoreline. The historical shoreline dataset available through the USGS Coastal Change Hazards Portal indicates that the coastline has experienced measurable shoreline migration over time, particularly along the low-lying coastal sectors extending from Barrio Pueblo through Río Jueyes and Aguirre. The mapped historical shoreline positions suggest that portions of the coast have retreated landward over the last two centuries, reflecting the cumulative effects of coastal erosion, storm impacts, wave action, sea-level rise, and sediment redistribution.

The most evident shoreline changes are observed along the coastal sectors surrounding Playa Salinas, Las Ochenta, Playita, Playa, Las Mareas, and Aguirre, where historical shoreline positions show a progressive landward migration pattern. These areas correspond closely with the locations identified by CoRePI-PR as experiencing erosion and shoreline instability following Hurricane María. The shoreline surrounding the Jobos Bay estuarine system also exhibits substantial historical variability due to the interaction of coastal processes, wetlands, tidal channels, and sediment transport. Overall, the historical shoreline record indicates that portions of the Salinas coastline have been subject to long-term erosional processes. Although rates vary significantly

along different shoreline segments, the available evidence suggests that coastal change remains an active process throughout the municipality, particularly along developed coastal sectors where future erosion may affect residential areas, transportation infrastructure, public facilities, natural resources, and coastal ecosystems.

Figure 34 - Historical Shoreline Changes



4.15.1.4 Future Events Probability

According to the USGS the coastline in Salinas displays multiple shoreline datasets collected over time, allowing for the evaluation of long-term coastal change patterns along the coastline extending from Salinas Bay to Bahía de Jobos, including the coastal sectors of Las Mareas, Mar Negro, and Aguirre.

The shoreline positions indicate that the coast of Salinas has experienced varying

degrees of shoreline migration over time. The greatest changes are observed along the low-lying coastal wetlands, mangrove forests, and estuarine environments associated with Bahía de Jobos, where the shoreline exhibits a more irregular pattern. These changes suggest the influence of coastal processes such as erosion, sediment deposition, storm impacts, tidal action, and relative sea-level rise. In contrast, portions of the more protected coastline near Salinas Bay appear to exhibit comparatively less shoreline variability.

The extensive mangrove systems and coastal wetlands located along the southern coast serve as natural buffers against storm surge, wave action, and coastal flooding. However, continued shoreline change may alter the effectiveness of these natural protective features and increase the vulnerability of adjacent communities, transportation corridors, recreational facilities, and critical infrastructure. Coastal communities such as Las Mareas, Mar Negro, and Aguirre may be particularly susceptible to future impacts associated with coastal erosion, shoreline retreat, and change in sea levels.

4.15.2 Risk Analysis

4.15.2.1 Estimated Losses

Currently there is no standard way to estimate losses due to long-term coastal erosion. This is due to the unpredictability of this hazard.

4.15.2.2 Lifelines and Critical Infrastructure

Coastal Erosion

Coastal erosion is a long-term, progressive hazard that results in the loss of shoreline, land instability, and the degradation of natural protective features such as beaches, dunes, and wetlands. This hazard is driven by wave action, coastal storms, flooding, and long-term shoreline change processes, and it poses increasing risks to developed coastal areas and supporting infrastructure. In coastal communities, erosion directly affects the Community Lifelines that are essential to public safety, economic stability, and effective emergency response (FEMA, 2024).

- Safety and Security Lifeline is particularly vulnerable to coastal erosion. Law enforcement facilities, fire stations, emergency operations centers, and

evacuation routes located near the shoreline may experience increasing exposure as erosion undermines foundations, access roads, and protective buffers. Roadway narrowing or collapse caused by shoreline retreat can reduce emergency response times and limit evacuation capacity during hazard events, placing residents and responders at greater risk (FEMA, 2021)

- The Food, Water, and Shelter Lifeline is also impacted as erosion threatens utility infrastructure and housing stock. Water distribution lines, wastewater systems, and stormwater infrastructure may become exposed or damaged as coastal land erodes, increasing the risk of service disruptions and water quality concerns. In areas where erosion leads to the loss of residential structures, displaced households may require emergency shelter and housing assistance. Additionally, erosion affecting ports, coastal roads, and access points can disrupt food supply chains and the delivery of essential goods, particularly in geographically isolated or island communities (FEMA, 2024).

- Coastal erosion can adversely affect the Health and Medical Lifeline by limiting access to healthcare facilities and emergency medical services. Hospitals, clinics, and pharmacies located in erosion-prone areas may face increased structural risk or reduced accessibility. Transportation disruptions caused by erosion can delay emergency medical response and impede the delivery of medical supplies. Secondary public health concerns may arise when erosion damages water and wastewater infrastructure, potentially increasing exposure to contaminants or unsanitary conditions (USGS, 2025); (FEMA, 2021).

- The Energy Lifeline, including power generation, transmission, and fuel systems, is highly susceptible to erosion-related impacts. As shorelines retreat, erosion can expose underground electrical lines, pipelines, substations, and fuel storage facilities that were previously protected by coastal landforms. Damage to this infrastructure can result in power outages or fuel shortages, affecting residents, critical facilities, and emergency response operations that rely on consistent energy supply (USACE, 2013); (FEMA, 2021)

- Erosion also threatens the Communications Lifeline by damaging or destabilizing physical infrastructure such as cell towers, fiber-optic cables, and communications hubs located in coastal areas. Loss of communications systems can impair emergency notification, 911 services, and coordination among response agencies. Reduced system redundancy along eroding shorelines increases the likelihood that communications outages will occur

during coastal hazard events (FEMA, 2024).

- The Transportation Lifeline experiences direct and cascading impacts from coastal erosion. Roads, bridges, ports, ferry terminals, and coastal airports may be undermined or rendered inoperable as erosion progresses. Transportation disruptions limit evacuation routes, restrict access for emergency responders, slow the delivery of supplies, and delay recovery operations. These impacts can have significant economic consequences and prolong community recovery following disaster events (USGS, 2023).

- Finally, coastal erosion may affect the Hazardous Materials Lifeline by exposing buried fuel tanks, contaminated soils, or legacy industrial sites located near the coast. Erosion can increase the risk of hazardous material releases, threatening environmental quality and public health, and complicating emergency response and cleanup efforts. Facilities handling hazardous materials lose natural protective buffers as shorelines retreat, increasing the likelihood of cascading impacts during severe weather events (USGS, 2023); (FEMA, 2021).

Variations in Mean Base Sea-Level

Sea level rise is a chronic and progressive coastal hazard that increases the frequency, depth, and duration of coastal flooding while accelerating erosion and shoreline instability. As relative sea levels rise, coastal communities experience more frequent high-tide flooding, expanded floodplains, and greater storm surge impacts. These changes place increasing stress on the y Lifelines that support public safety, economic stability, and emergency response, even in the absence of major storm events (FEMA, 2024).

- The Safety and Security Lifeline is affected as sea level rise increases the exposure of emergency facilities and evacuation routes to recurrent flooding. Police stations, fire stations, and emergency operations centers located in low-lying coastal areas may experience reduced functionality or loss of access due to chronic inundation. Rising seas can also compromise evacuation routes, bridges, and ingress/egress corridors, limiting the ability to conduct timely evacuations and delaying emergency response during hazard events (FEMA, 2021); (USGS, 2025).

- Sea level rise presents significant challenges to the Food, Water, and Shelter Lifeline. Potable water systems, wastewater treatment plants, and stormwater

infrastructure are increasingly vulnerable to tidal flooding and saltwater intrusion as sea levels rise. These impacts can disrupt service delivery, degrade water quality, and increase maintenance and operational costs. In addition, repetitive flooding can damage residential structures, reduce housing availability, and increase demand for emergency shelter and long-term housing assistance, particularly in socially vulnerable communities (USGS, 2025).

- The Health and Medical Lifeline is impacted through both direct and indirect effects. Healthcare facilities located in flood-prone coastal zones may experience operational disruptions, equipment damage, or access constraints due to flood-impacted transportation networks. Frequent flooding can hinder patient movement, delay emergency medical services, and disrupt supply chains for pharmaceuticals and medical equipment. Public health concerns may also increase as rising groundwater and flooded sanitation systems elevate the risk of contamination and disease exposure (USGS, 2025; FEMA, 2024).

- Sea level rise also threatens the Energy Lifeline by increasing flood risk to power generation facilities, substations, fuel terminals, and transmission infrastructure located near the coast. Even minor but repeated flooding events can degrade electrical components and reduce system reliability, leading to power outages that affect residences, businesses, and critical facilities. Fuel distribution systems and ports may also experience operational interruptions, limiting fuel availability for generators, emergency vehicles, and recovery operations (FEMA, 2024).

- Communications Lifeline is vulnerable as increase in base sea level potentiates exposure of communications infrastructure, including cell towers, fiber-optic networks, and data facilities, to chronic flooding and corrosion. Disruptions to communications systems can impair emergency notification, 911 services, and interagency coordination. Repeated flood exposure without permanent mitigation measures may result in cumulative damage and decreased system reliability over time (FEMA, 2024).

- Transportation systems associated with Transportation Lifeline are particularly sensitive to increase in base sea levels. Roads, bridges, ports, ferries, and coastal airports may experience more frequent closures or long-term service reductions due to flooding and infrastructure degradation. Transportation

disruptions can isolate communities, delay emergency response, limit evacuation options, and impede the movement of goods, services, and recovery resources (USGS, 2025).

- Finally, increase in the mean base sea level can affect the Hazardous Materials Lifeline by increasing exposure of industrial sites, fuel storage areas, landfills, and wastewater facilities to flooding. Inundation of these sites raises the potential for releases of hazardous substances, posing risks to human health, ecosystems, and drinking water supplies. Managing these risks becomes more complex as flood frequencies increase and protective buffers are lost (FEMA, 2021); (USGS, 2025).

4.15.2.3 Social Vulnerabilities

Long-term coastal dynamics can be not only a physical hazard but also a social stressor that disproportionately affects certain populations due to preexisting social, economic, and environmental conditions.

Low-income households are among the most socially vulnerable to long-term coastal dynamics. These populations are more likely to reside in older or lower-cost housing located in high-risk coastal areas and may lack the financial resources needed to invest in mitigation measures, such as structural reinforcement or relocation. As erosion or inward changes in shoreline progresses, declining property values can further reduce household wealth and limit access to insurance, credit, and recovery assistance, thereby prolonging vulnerability and recovery timelines (FEMA, 2023).

Housing insecurity is a significant concern associated with long-term coastal dynamics. Gradual land loss can render homes unsafe or uninhabitable, leading to chronic displacement rather than sudden disaster-related relocation. Renters are particularly vulnerable, as they often have limited control over mitigation decisions and may be displaced without sufficient notice or long-term relocation support. In communities with limited affordable housing options, erosion-related housing loss can increase overcrowding, homelessness, or permanent out-migration (FEMA, 2023).

Elderly individuals, people with disabilities, and those with chronic health conditions face heightened risks as coastal erosion disrupts access to essential services and infrastructure. Eroded or flooded roadways and transportation networks can isolate neighborhoods from healthcare facilities, pharmacies, grocery stores, and social services. These populations may also experience limited mobility or depend on

in-home medical equipment, increasing their sensitivity to infrastructure disruptions associated with erosion (FEMA, 2023).

Communities that rely on coastal and marine resources for their livelihoods are also socially vulnerable to erosion. Fishing communities, small tourism-dependent businesses, and subsistence users may experience economic losses as shorelines retreat, beaches narrow, and access to coastal infrastructure is reduced. These impacts can lead to job loss, reduced household income, and community-wide economic stress, particularly in rural and island settings where economic diversification is limited (USGS, 2023).

4.15.2.4 Natural and Cultural Resources

Long-term coastal dynamics can significantly impact natural resources by altering shorelines, degrading habitats, and disrupting ecological processes. As beaches, dunes, wetlands, and mangroves erode or become permanently inundated, the natural systems that provide storm protection, water filtration, and wildlife habitats are reduced or lost. These changes can lead to declines in biodiversity as plant and animal species lose critical breeding, feeding, and nesting areas. Saltwater intrusion caused by rising sea levels can also degrade freshwater ecosystems, affecting groundwater, estuaries, and coastal forests. Increased erosion can mobilize sediments and pollutants, diminish water quality and harm coral reefs and seagrass beds. Over time, the loss of natural coastal features reduces ecosystem resilience and increases inland exposure to flooding and storm impacts. (USGS, 2023)

Long-term coastal dynamics can also pose serious threats to cultural resources, particularly those located near shorelines. Historic buildings, archaeological sites, cemeteries, and cultural landscapes may be damaged or permanently lost as shorelines retreat and soils are destabilized. Gradual erosion can undermine foundations and expose artifacts, making sites vulnerable to destruction, looting, or environmental decay. As these resources are often irreplaceable, coastal erosion and sea level rise represent not only physical loss but also the loss of cultural memory and heritage passed through generations (USGS, 2023).

4.15.2.5 Future Conditions

As discussed in section 4.11.1 long-term coastal dynamics are understood to contribute to loss of shoreline, either due to coastal erosion or increases in mean base sea level. Specific mitigation actions to deal with expected future conditions will be included as

part of Section 6.5.

4.16 Pandemic/Epidemic

4.16.1 Description (B1-a)

An epidemic occurs when the incidence of a disease or health-related event rises suddenly and significantly above what is expected in a specific community or region. According to the CDC, an epidemic represents a sudden increase in cases over the normal baseline in a population, and outbreaks—often used interchangeably—refer to such events in more limited geographic areas (CDC, 2012).

A pandemic is essentially an epidemic that has expanded to span multiple countries or continents, affecting a large portion of the global population. The CDC describes it as an epidemic with broad geographic spread, while the World Health Organization defines it as the worldwide transmission of a new disease to which people generally have little or no immunity (CDC, 2012).

These terms emphasize both the magnitude of cases and their geographical distribution: an epidemic is localized, but a pandemic reaches across international borders and impacts global public health systems. Consequently, emergency response strategies must escalate accordingly—from targeted regional interventions during epidemics to coordinated global action in pandemics.

4.16.1.1 Affected Area (B1-b)

This LHMP considers that all areas of the municipality are equally vulnerable to the Epidemic/Pandemic Hazard.

4.16.1.2 Risk Magnitude (B1-c)

Although all these events can result in loss of life and economic disruption, to distinguish between the following terms:

- Epidemic: refers to a sudden increase in the number of disease cases beyond what is normally expected within a specific population and geographic area.
- Outbreak: shares the same definition as epidemic but is typically used for a more localized area.

- Cluster: describes a grouping of cases in a particular place and time that appears to exceed the expected number, even if that expected number is unknown.
- Pandemic: refers to an epidemic that has spread across multiple countries or continents, usually affecting a large population (CDC, 2012).

4.16.1.3 Past Events (B1-D)

The following table listing epidemics and pandemics in Puerto Rico has been collected from various sources. This list does not intend to be exhaustive:

Table 46: Pandemics and Epidemic in Puerto Rico 1855 - 2020

Disease	Date	Classification	Description
Cholera Epidemic	1855 - 1856	Epidemic	Between 1855 and 1856, Puerto Rico suffered a major cholera outbreak that claimed over 25,820 lives, representing approximately 4–10% of the island's population at the time. (Vega Lugo, 2021)
Measles and Malnutrition	1917 - 1918	Epidemic	A severe measles outbreak occurred between 1917 and 1918, resulting in nearly 9,000 cases and approximately 2,000 deaths. High infant mortality—59% of deaths within six months were in children under two—was driven by malnutrition and poor living conditions (Rigau-Pérez & Vallejo - Calzada, 2020).
Spanish Flu (A/H1N1 influenza pandemic)	1918 - 1919	Pandemic	Puerto Rico was affected by the global A/H1N1 influenza pandemic, also known as the Spanish flu. Beginning around June 1918, community spread produced as many as 1,000 cases in four days in areas like Puerta de Tierra. Misdiagnosis

Disease	Date	Classification	Description
			as dengue initially obscured the true impact (Rosario Urrutia, 2021).
Poliomyelitis	1960	Epidemic	The 1960 polio epidemic in Puerto Rico was the most severe paralytic polio outbreak in the Western Hemisphere at the time. It impacted 68 of 76 municipalities, causing 495 cases of paralysis, predominantly among school-age children (Timothee, Morris, Filiberti, & Mainardi, 1963).
Dengue	2013, 2024	Outbreak	Dengue is endemic in Puerto Rico, with significant outbreaks occurring in 2013 and again in 2024. The 2024 outbreak triggered a public health emergency, with 6,291 confirmed cases, a 4.2% rate of severe dengue, and 11 deaths reported (Rodríguez, et al., 2024) (Ware-Gilmore, et al., 2025)
Chikungunya	2014	Epidemic	The first locally acquired chikungunya case in Puerto Rico was confirmed on May 5, 2014, triggering expanded surveillance efforts using Puerto Rico's dengue infrastructure. Between May 5 and August 12 of that year, 10,201 suspected cases (approximately 282 per 100,000 residents) were reported, of which 1,975 (68%) were laboratory-confirmed. During this period, four deaths were

Disease	Date	Classification	Description
			also recorded. (Sharp, et al., 2014)
Zika	2015 - 2016	Epidemic	The first locally transmitted Zika case in Puerto Rico was reported in December 2015. By April 2016, over 6,000 suspected cases had been evaluated, with 683 confirmed cases. Pregnant women and related neurological issues (e.g., Guillain-Barré syndrome) were of particular concern. (Thomas, et al., 2016) (Dirlikov, et al., 2016)
COVID - 19	2020 - 2022	Pandemic	See narrative below

COVID – 19 Pandemic

Puerto Rico confirmed its first COVID-19 case—a European tourist—on March 8, 2020, leading the governor to declare an emergency on March 12 and implement early measures including airport screening and mandatory isolation, as outlined in the Puerto Rico Department of Health's epidemic situation reports (PRDH, 2022), (COR3, n.d.). By April 6, 2022, official data reported 270,485 confirmed cases and 4,171 deaths due to COVID-19 in Puerto Rico, according to detailed government spreadsheets and dashboards maintained by the Puerto Rico Health Department (PRDH, 2022), (COR3, n.d.).

The municipality experienced significant economic and social disruptions. A Bayesian analysis revealed a clear causal relationship between rising COVID-19 infections and increased unemployment, and engineering studies from the University of Puerto Rico–Mayagüez estimated that unemployment soared above 17%, also noting elevated operating costs for businesses due to personal protective equipment (PPE) and safety measures (Hernández - Padilla & Méndez-Piñero, 2020).

Subsequent public health research revealed widespread mental health consequences. One study found that 31% of healthcare workers scored in the range of depressive symptomatology following combined stress from prior disasters (e.g.,

hurricanes) and the pandemic; another identified high levels of anxiety (26.9%) and stress (69.9%) among physicians during the second COVID-19 wave (Hernández - Torres, et al., 2023), (Sánchez - Plazas, García - De Jesús, Martínez - González, Amaya - Ardila, & Almodóvar - Rivera, 2024).

4.16.1.4 Future Events Probability (B1-e)

Puerto Rico's susceptibility to future pandemics or epidemics is underscored by its subtropical climate, population distribution, and healthcare infrastructure. A university-developed emergency preparedness model—commissioned by Puerto Rico's Department of Health—simulated influenza pandemics and demonstrated how variations in disease transmissibility, healthcare capacity, and mitigation efforts can significantly influence outbreak trajectories and the likelihood of healthcare system overload. Furthermore, the U.S. Department of Health and Human Services' Hospital Preparedness Program (HPP) in Puerto Rico operates under the Assistant Secretary for Preparedness and Response, with coordinated health care coalitions and special pathogen systems explicitly designed to reduce pandemic risk by strengthening surge capacity and infection-control readiness. These combined efforts reflect a data-driven recognition that, without sustained investment in public health infrastructure and preparedness modeling, Puerto Rico remains at an elevated probability for experiencing another epidemic or pandemic (Hirsh & Centeno - Marín, 2015), (ASPR, n.d.)

4.16.2 Risk Assessment (B2-a, B2-b)

4.16.2.1 Estimated Losses

The COVID-19 pandemic resulted in significant mortality across Puerto Rico, underscoring the importance of public health hazards in local mitigation planning. Official data from the Puerto Rico Department of Health indicate that COVID-19 mortality is tracked through an epidemiological surveillance system that compiles death certificate data and case investigations and is made publicly available through government data portals. At the territorial level, thousands of deaths have been attributed to COVID-19 since 2020, as reported in official datasets and federal summaries. However, cumulative mortality totals for individual municipalities, including Salinas, revision are not consistently published as single static figures in official reports. Instead, municipality-level death counts must be obtained by querying downloadable datasets provided by the Puerto Rico Department of Health, which allow users to filter results by municipality.

These datasets are considered provisional and subject to due to reporting delays and ongoing validation of death records, as acknowledged by public health authorities. Consequently, while Salinas-specific COVID-19 mortality was not recorded as fixed published figure. Based on the currently available data, the total number of COVID-19-related deaths in Salinas cannot be reliably determined.

4.16.2.2 Critical Infrastructure and Lifelines

In the event of a pandemic or epidemic, the most significantly affected lifeline is typically the healthcare and medicine lifeline. During widespread disease outbreaks, hospitals, clinics, and other healthcare facilities often face overwhelming demand for services. Surges in patient volume can exceed system capacity, leading to shortages of personal protective equipment (PPE), critical medical devices (such as ventilators during COVID-19), hospital beds, and qualified medical personnel. As resources are redirected to address the immediate public health emergency, non-urgent and even some essential non-related medical services may be postponed or delayed. Additionally, mortality management systems—including morgues, funeral services, and vital records processing—may experience severe strain during periods of elevated death rates.

However other lifelines can be affected such as the Food, Hydration and Shelter Lifeline, due to increase food insecurity from unemployment and economic shutdowns ort closed or reduced shelters due to infection control requirements. The Safety and Security Lifelines can be affected by high absenteeism due to illness, quarantine or caregiving responsibilities and increase levels of stress and burnout among first responders and law enforcement officers.

Other lifelines and critical infrastructures can be affected by increased demand, like increased residential water demand) or the lack of trained personnel to maintain existing operations.

4.16.2.3 Social Vulnerability

For this hazard, the whole population of Salinas is considered equally vulnerable. Nonetheless besides factors of age and poverty, the 2019 - 2023 ACS shows that a total of 23,521 people in Salinas did not have health insurance coverage (US Census Bureau, 2025). This means that 5.7% of the total population of Salinas is uninsured.

Of those most of the uninsured group belonged to the 6-to-18-year cohort (3,560 persons) followed by the cohort of 55 to 64 years (3,056 persons).[16] The results given by the ACS show that the young adult population is the most vulnerable in terms of uninsured in the face of a pandemic or epidemic.

The table below shows the breakdown of uninsured people in Salinas according to the 2019 - 2023 ACS.

Table 47: Number of People in Salinas without Healthcare Coverage

Age Cohort	Number of people uninsured
Under 6 years	987
6 to 18 years	3,560
19 to 25 years	1,971
26 to 34 years	2,653
35 to 44 years	2,743
45 to 54 years	2,924
55 to 64 years	3,056
65 to 75 years	2,963
75 years or older	2,664
Total	23,521

Further information regarding social vulnerability can be found in Section 3.4.

4.16.2.4 Natural and Cultural Resources

The scientific literature shows that the COVID-19 Pandemic produced mixed environmental outcomes. While temporary lockdowns initially led to short-term improvements in air quality and reductions in greenhouse gas emissions in many regions, broader evidence suggests that the pandemic also generated significant negative environmental impacts.

These impacts included increased pollution from the widespread use of personal protective equipment, deforestation, illegal poaching and logging, overfishing, and disruptions to conservation programs and projects. The findings also note that the spread of pandemics may be intensified by environmental pollution and rapid global

[16] US Census 2019 - 2023 ACS Table S2701

population growth (Muche, Yemata, Molla, Muasya, & Tsegay, 2022) (Guo & Lee, 2021).

At the same time, despite these adverse impacts, the period of reduced human activity—often referred to as the *anthropause*—also produced several positive effects on natural resources. These included short-term reductions in indoor and outdoor air pollutants including $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and CO_2, as well as a decrease in noise pollution from ships, boats, vehicles, and aircraft. Collectively, these changes benefited aquatic ecosystems and water quality, influenced bird behavior, supported wildlife biodiversity, and contributed to temporary ecosystem recovery (Muche, Yemata, Molla, Muasya, & Tsegay, 2022).

When it comes to cultural and heritage sites, a report from UNESCO notes that the crisis has produced both negative and positive effects across different types of World Heritage properties (UNESCO, 2021). The sudden cessation of travel and tourism disrupted visitor flows and eliminated a critical source of revenue for many sites, where tourism income is essential to supporting conservation activities, routine maintenance, and staff salaries. Local communities surrounding these properties were similarly affected, with widespread loss of employment and income.

Conversely, in some cases, the reduced level of human activity enabled rehabilitation and restoration efforts to proceed more efficiently, while anthropogenic pressures were temporarily reduced across many natural areas. This contrast highlights the diverse and uneven impacts of the crisis on World Heritage properties. At the same time, it highlights opportunities to build upon the environmental benefits observed during reduced activity periods, while advancing targeted research, sustainable tourism strategies, and long-term recovery planning (Guo & Lee, 2021) (Guibert & Hyde, 2021), (UNESCO, 2021).

4.16.2.5 Future Conditions (E1-a)

Puerto Rico faces structural and environmental conditions that elevate its exposure and vulnerability to future pandemics relative to many mainland U.S. locations. As a tropical island with high population density in urban corridors, frequent international travel, and climatic conditions favorable to vectors and pathogens, Puerto Rico is particularly susceptible to emerging and re-emerging infectious diseases, especially those with zoonotic or vector-borne origins. The CDC and peer-reviewed research document ongoing transmission of diseases such as dengue and previous outbreaks of Zika and Chikungunya, demonstrating the island's continued exposure to pathogens with outbreak and epidemic potential. This exposure holds regardless of

the development pattern of the municipality.

4.17 Hazard Prioritization

After receiving feedback from the public and stakeholders (see Section 2.3) along with their own expertise the planning committee has determined that the following is the prioritization for the hazard discussed in this LHMP.

Table 48: Hazard Prioritization

Hazard	Priority
Earthquake	High Priority
Landslide	Mid Priority
Tsunami	High Priority
Flooding	High Priority
Tropical Cyclones/Extreme Winds	High Priority
Storm Surge	High Priority
Extreme Heat	Mid Priority
Drought	High Priority
Wildfire	High Priority
Long-Term Coastal Dynamics	High Priority
Pandemics	Low Priority

4.18 Planning Mechanism

Understanding and recognizing regulatory and planning capacities enables more effective management of land use and economic growth. These capacities consist of the legal frameworks and public policy provisions that influence land use to guide sustainable development, while also supporting actions that mitigate the vulnerability of communities and their resources to natural hazards.

Besides the Public Policies already discussed in Section 1.1, what follows is a list in chronological order of the regulatory and planning mechanisms available to the municipality for the implementation of this LHMP.

4.18.1 Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (2023)

Figure 35: Joint Regulation Cover



The Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use, and Business Operations (*Reglamento Conjunto* in Spanish) is a regulatory instrument created by the Planning Board in compliance with Law No. 161, as amended. Its main purpose is to regulate land use, territorial planning, and the granting of permits related to development, construction, and business operations within a uniform and centralized framework. The Joint Regulation aims to harmonize public policy on land use planning with the principles of sustainable development, seeking a balance between economic growth, environmental protection, and social well-being. This regulation establishes the rules to classify land, define zoning districts, regulate zoning, and determine the permitted uses in each category. Additionally, it sets the procedures to evaluate projects, issue permits, and monitor compliance with the applicable provisions. Its purpose is to provide a uniform regulatory framework for the evaluation and issuance of permits, ensure the proper use of land, protect natural resources, and facilitate economic development under criteria of competitiveness and sustainability, integrating planning with permit management.

Of particular importance in the Joint Regulation is the zoning district *Distrito de Riesgo para Espacios Abiertos* – Open Space (RE-A).[17] The RE-A zoning district is established to identify lands designated as open space in accordance with federal regulations (44 CFR Part 80) or another federal program, due to the presence of a risk condition resulting from a natural event. These spaces may include, but are not limited to, severe flooding and landslides. There are conditions in these areas that are unfavorable or harmful to health, safety, or general welfare, and there may be a risk of loss of life and property. Land within this district may be susceptible to one or more of the identified hazards.

[17] Joint Regulation Rule 6.1.30

The purpose of the district is to preserve the open space condition established in perpetuity by federal regulation, which the government or the community must uphold, with the objective of protecting health, life, and property; preventing severe losses and repetitive use of affected properties; reducing the investment of public and federal funds in mitigation; and limiting rescue efforts, among other goals.

4.18.2 Special Flood Hazards Areas Regulation (2021)

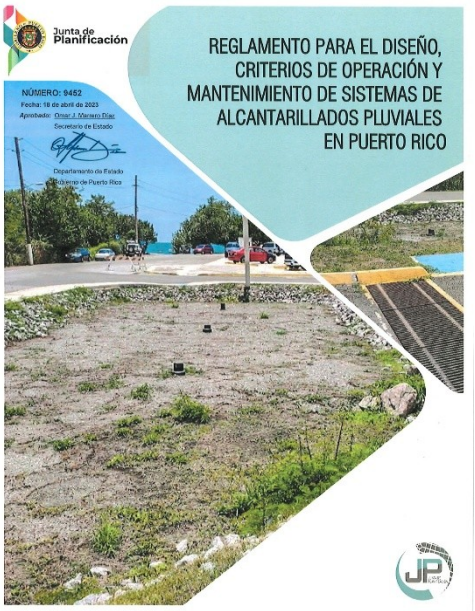
The 2021 regulation was adopted by the Puerto Rico Planning Board under its authority from Public Law No. 75 of 1975 and Public Law No. 3 of 1961 to control development in flood-prone zones. It aligns Puerto Rico's floodplain management requirements with the minimum standards of the National Flood Insurance Program (NFIP), administered by FEMA. The regulation establishes updated criteria for construction, land use, and development within Special Flood Hazard Areas (SFHAs), including requirements such as elevating structures above Base Flood Elevation and submitting technical certifications. It applies to new construction, substantial improvements, and land-use changes across designated flood zones such as AE and VE, using FEMA Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for zone identification. The revision clarifies and expands regulatory provisions to enhance public safety and prevent harmful development in high-risk areas.

4.18.3 Puerto Rico Building Code

The Puerto Rico Building Code sets minimum requirements for the design, construction, modification, and upkeep of buildings to ensure the safety, health, and well-being of the public. It is derived from nationally and internationally recognized model codes and is updated periodically to incorporate improvements in construction practices and lessons learned from past hazard events. The code includes provisions addressing structural safety, fire protection, accessibility, energy conservation, and resistance to natural hazards such as earthquakes, hurricanes, floods, and strong winds. Adherence to the Building Code is mandatory for all new construction and substantial renovations throughout Puerto Rico. Enforcement is carried out through local permitting, planning review, and inspection processes to verify compliance with established standards. Overall, the Puerto Rico Building Code is a key instrument for advancing resilient, safe, and sustainable development across the island.

4.18.4 Regulation for the Design, Operation Criteria and Maintenance of Stormwater Systems in Puerto Rico

Figure 36: Regulation 40 Cover



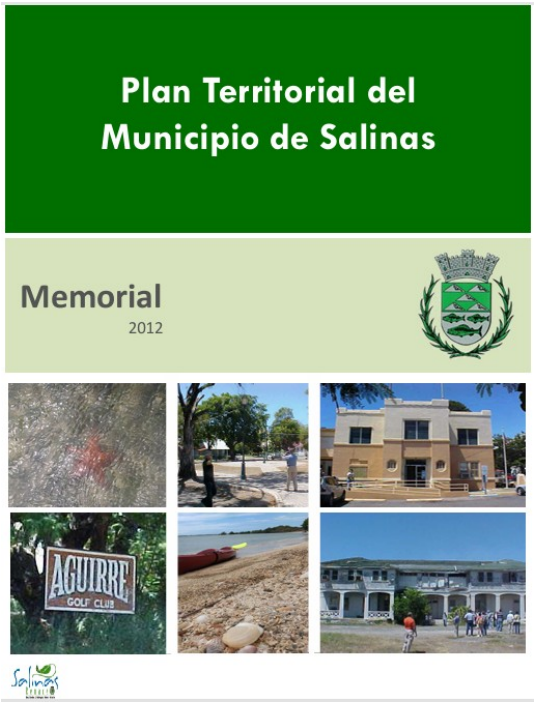
Adopted in 2023 as Planning Regulation No. 40, this regulation updates and replaces the island's outdated 1975 standards to address current engineering practices, environmental considerations, and increased flood risk. The regulation is designed to provide developers, engineers, contractors, and municipalities with modern technical criteria for designing, operating, and maintaining public and private stormwater systems, incorporating updated scientific knowledge and methodologies necessary for managing stormwater infrastructure under present-day conditions. Its objectives include minimizing flood-related damage, improving the capture and management of runoff, reducing impacts to water resources and ecosystems, and supporting safer, more resilient community development. The regulation integrates risk management principles and aligns with Puerto Rico's climate adaptation policies, requiring consideration of urban flooding, karst hydrology, low-impact development practices, and stormwater control structures such as retention and detention systems. It also establishes minimum design considerations for all land development projects and provides a comprehensive framework for planning, monitoring, and maintaining stormwater systems across the island.

4.18.5 Salinas Territorial Plan (2012)

This Territorial Plan was carried out under Chapter XIII of Law No. 81 of 1991, as amended, known as the Autonomous Municipalities Law. It authorizes municipalities to adopt Zoning Plans (Territorial Plans, Expansion Plans, and Area Plans) to organize land use within their territorial limits and promote the social and economic well-being of the population. The Territorial Plan consists of three documents: the Memorial, the Program, and the Regulations. Its preparation involved four stages that were submitted to public hearings: Statement of Objectives and Work Plan, Memorial, Plan Progress, and Final Territorial Plan. The latter, in turn, is made up of three narrative documents: the Memorial, the Program, and the Regulations. This document, the Memorial, essentially consists of the Plan's Report, which summarizes its general

content; an inventory that describes Salinas' role in its region, its natural resources, infrastructure and their socioeconomic condition; as well as a situational analysis, which is accompanied by objectives and general recommendations. The Program presents the projects that the Municipality aims to carry out in line with its objectives, the analyzed information, and the municipal capacity. The Regulation of Planning, for its part, is the key document for regulating land use and construction in the Municipality.

Figure 37: Salinas Land Land Use Plan Cover Page



4.18.6 National Flood Insurance Program

The National Flood Insurance Program falls within the category of planning mechanisms, as it imposes certain floodplain management requirements. FEMA provides flood insurance to communities that are following the NFIP criteria. This includes adopting and enforcing floodplain management practices that promote appropriate development in these flood-prone areas.

The National Flood Insurance Program of the Federal Emergency Management Agency allows homeowners, business owners, and renters in participating NFIP communities to purchase federally backed flood insurance. This insurance provides assistance to help cover the costs of repairing damage caused by flooding to buildings and their contents. This is an insurance program established to help property owners, renters, and businesses recover more easily and at a lower cost. Likewise, the program aims to reduce the impact of flooding on both public and private structures. These efforts help mitigate the effects of flooding on new and improved structures within each community.

The NFIP has several components, including:

- Floodplain management — for which the community must adopt and enforce measures for managing flood-prone lands in accordance with NFIP regulations;
- The preparation of Flood Insurance Rate Maps (FIRMs); and
- Flood insurance.

The Puerto Rico Planning Board has a collection of FIRM maps that can be consulted to determine whether your property is in a high-risk area or in a low- to moderate-risk zone. FIRMs refer to the official map developed and approved by FEMA and adopted by the Puerto Rico Planning Board to designate areas at risk of a 100-year flood (or a 1% annual chance of occurrence). In addition, these maps serve as a tool for managing special areas due to their susceptibility to flooding events.

While the Write Your Own Program (WYO) began in 1983 as a partnership between insurance companies and FEMA. This arrangement allows property and casualty insurance companies to underwrite and service federal flood insurance policies in their own company name. A key feature of this type of policy is that all companies participating in the WYO program provide the same coverage, and their rates must comply with NFIP rules and regulations.

Communities, for their part, adopt and require compliance with the NFIP's minimum standards for construction and development in designated Special Flood Hazard Areas. However, many communities seek to achieve a higher level of safety and protection for their residents beyond the NFIP minimum standards. For this purpose, communities have the option of participating in the NFIP's Community Rating System (CRS), which allows them to obtain reductions in flood insurance premiums.

This is because the CRS recognizes additional community efforts to: 1) Reduce flood damage to insurable property; 2) strengthen and support NFIP insurance provisions; and 3) encourage a comprehensive approach to floodplain management. These additional efforts provide residents with greater safety, reduce property damage, enhance community resilience, and promote a better quality of life. The municipality's participation in the NFIP will be discussed in Section 6.6

4.18.7 National Pollutant Discharge Elimination System (NPDES)

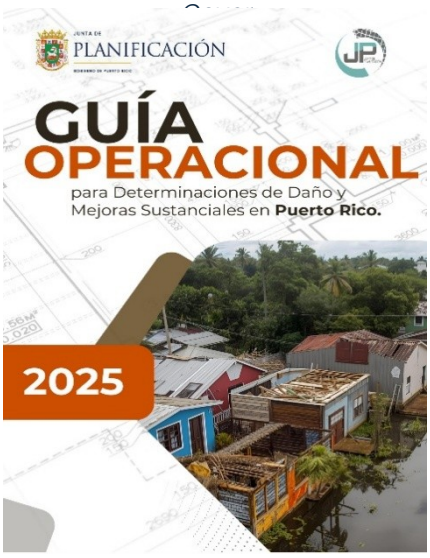
The NPDES is a program authorized under the United States Clean Water Act and administered by the Environmental Protection Agency (EPA). This program requires Municipal Separate Storm Sewer Systems (MS4s) to obtain a permit for the discharge of stormwater into water bodies. In the case of Puerto Rico, the EPA issued a general permit in 2016, under which municipalities can obtain coverage by submitting a Notice of Intent (NOI) and adopting a Stormwater Management Program (SWMP). If any of

the mitigation measures listed in Section 6.5 modify the NOI or the SWMP, they will be properly amended.

4.18.8 Operational Guidelines for Determining Damages and Substantial Improvements in Puerto Rico (2025)

The Floodplain Administrator or the Participating Community may review, require, and audit permits in accordance with the provisions of Act No. 3 of September 27, 1961, known as the "Floodplain Building Control Act"; Act No. 75, the "Puerto Rico Planning Board Organic Act"; Act No. 161 of December 1, 2009, as amended, the "Puerto Rico Permit Process Reform Act"; and Act No. 38 of June 30, 2017, the "Uniform Administrative Procedure Act of the Government," as amended, and in compliance with the regulations of the National Flood Insurance Program (NFIP) of the Federal Emergency Management Agency (FEMA), Title 44 of the Code of Federal Regulations (CFR), Part 60.3 [d, e, and Subpart B], and its related sections.

Figure 38: Operational Guidelines



As of the effective date of this guidance, an evaluation of substantial damage or substantial improvement will be required as part of the permitting requirements in Special Flood Hazard Areas. The Floodplain Administrator will require that both new structures and substantial improvements be constructed in a manner that minimizes or prevents damage during a regulatory flood.

4.18.9 Green Infrastructure and Nature Based Solutions

Section 502 of the United States Clean Water Act defines green infrastructure as the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvesting and reuse, or landscaping to store, infiltrate, or evapotranspiration stormwater and reduce flows to sewer systems or surface waters.

Green infrastructure is a cost-effective and resilient approach to managing wet weather impacts that provide many benefits to the community. While conventional single-purpose gray stormwater infrastructure (such as pipe drainage and water

treatment systems) is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at its source while providing environmental, social, and economic benefits.

Stormwater runoff is a major cause of water pollution in urban areas. When it rains on rooftops, streets, and parking lots in cities and suburbs, the water cannot soak into the ground as naturally would. Instead, stormwater drains through gutters, storm sewers, and other collection systems and is discharged into nearby water bodies. This runoff carries trash, bacteria, heavy metals, and other pollutants from the urban landscape. Higher flows resulting from heavy rainfall can also cause erosion and flooding in urban streams, damaging the environment, property, and infrastructure.

When rain falls in undeveloped natural areas, the water is absorbed and filtered by soil and vegetation. Stormwater runoff is cleaner and less problematic. Green infrastructure uses vegetation, soil, and other elements and practices to restore some of the natural processes needed to manage water and create healthier urban environments. At the municipal scale, green infrastructure is a network of natural areas that provide habitat, flood protection, cleaner air, and cleaner water. At the neighborhood, development, or sector scale, managing stormwater systems in a way that mimics natural processes help absorb and store runoff that can otherwise cause localized flooding (EPA, 2019).

Some green infrastructure measures that may be considered to mitigate flooding problems include:

- Rainwater harvesting
- Rain gardens (bio-retention/bio-infiltration)
- Urban rain gardens (“planter boxes”)
- Bioswales
- Porous pavements
- Green streets
- Green parking lots
- Green roofs
- Land conservation
- Creation or maintenance of urban tree canopy
- Wetland restoration
- Riparian area rehabilitation
- Sand dune restoration, among others.

The Municipality will consider green infrastructures measures when developing or championing flood control measures with the state or the federal government. In addition to flood control, green infrastructure provides benefits such as improved water quality, enhanced water supply, reduced stormwater management costs (public and private), improved habitat quality, increased spaces for recreation and physical activity, job creation in the maintenance of natural areas, and increased property values (EPA, 2019).

4.18.10 Four – Year Investment Program

The Four-Year Investment Program 2022–2023 to 2025–2026 (hereinafter, the PICA) is a short- and medium-term planning instrument designed to guide, coordinate, and direct public investments during the period it covers. Through this instrument, the Planning Board integrates the efforts of various government entities aimed at improving the quality of life of the people of Puerto Rico, in line with established public policies.

The Framework of Reference for the Four-Year Investment Program for the period 2022–2023 to 2025–2026 guides agencies and public corporations in preparing their investment and capital improvement programs. The framework includes a demographic and socioeconomic profile of Puerto Rico as a whole and by regional organization, a diagnosis of the recent performance of the economy, and information on development patterns and priority projects for the competitive Puerto Rico to which all aspire.

The full PICA document for the 2022–2023 to 2025–2026 period incorporates all information on capital improvement projects to be carried out by government entities. It includes a detailed analysis of the distribution of recommended resources by program areas and the origin of those resources. This analysis is the result of an integration process designed to guide budget recommendations formulated by the Office of Management and Budget regarding the Annual Capital Improvements Program included in Puerto Rico's budget.

This program serves as a short- and medium-term planning tool to guide, coordinate, and direct public investments during its period of effectiveness. It uses Puerto Rico's demographic and socioeconomic profile, along with a regional analysis as established by the Planning Board (JP, 2022).

With respect to the municipality's Hazard Mitigation Plan, the PICA is used to integrate information on the current performance of Puerto Rico's economy, including data on public debt and development trends, as well as projects designated as priorities for implementation on the Island. Within this framework, the PICA provides municipalities with information from government entities regarding funding allocations and investments in improvements they are responsible for implementing, which contribute to municipal efforts to mitigate natural hazards.

As part of the projects influencing all Functional Areas of Puerto Rico, the review of municipal Mitigation Plans is included. The Planning Board was designated by the Government Authorized Representative (GAR) as the agency responsible for reviewing and developing Hazard Mitigation Plans in coordination with the 78 municipalities[18].

5. Municipal Capacities

5.1 Regulatory and Planning Mechanism (C1-a)

These capabilities refer to the legal provisions that influence land used to manage economic growth and that could support the municipality in its efforts to mitigate the vulnerability of its communities and resources to natural hazards. The municipality identified existing regulations and planning documents that could support its actions, as well as opportunities to promote the development of studies or plans for the same purpose of advancing its mitigation goals. These regulatory and planning tools are described in Section 4.18.

5.2 Technical and Administrative Capacities (C1-a)

The Municipality has enough staff to implement this LHMP. Any additional resources will be procured through existing or future external resources.

Table 49 shows the Municipality's Technical and Administrative Capacity

. [18] GAR function is currently held by COR3

Table 49: Hazard Prioritization Municipal Technical and Administrative Human Resources

Personnel Team / Resources	Yes	No	Future Positions	Department or Agency	Opportunities to Integrate into LHMP	Comments
Planners with experience in land use and mitigation		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have a planning department. Any planning related issue is worked through the mayor's office, or subcontracted staff.
Engineers or professionals trained in construction practices related to buildings and infrastructure		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Planners or engineers with a broad understanding of natural hazards		X	Through contract services if needed	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Emergency Manager	X		Director of the Municipal Emergency Management Office	Municipal Emergency Management Office, Department of Public Safety	The LHMP may be used to update the EOP	None

Personnel Team / Resources	Yes	No	Future Positions	Department or Agency	Opportunities to Integrate into LHMP	Comments
Scientists familiar with natural hazards		X	Through contract services if needed	University of Puerto Rico, Puerto Rico Seismic Network, other universities in Puerto Rico		Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Personnel with expertise or education regarding the vulnerabilities and natural hazards affecting the community		X	Community Representative	N/A	N/A	Currently the municipality does not have this staff. If the need arises this position will be procured by external professional services.
Resource development staff or grant writers		X	Director of Municipal Federal Programs	Municipal Federal Programs Office	This staff may write and administer grants to cover the mitigation strategies mentioned below.	N/A

5.3 Financial Capacity (C1-a)

The Municipality has experience administering federal funds from various streams and maintains a dedicated office responsible for the administration and oversight of federally funded programs.

5.3.1 FEMA Funding Streams

For hazard mitigation projects the municipality has identified the following FEMA – administered possible funding streams which it could draw from.

Stafford Act - Section 404

Section 404 refers to Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, which authorizes the Hazard Mitigation Grant Program (HMGP), administered by FEMA. Its primary purpose is to reduce future disaster losses by funding long-term mitigation projects after a major disaster is declared.

Under Section 404, funding is made available to states, territories, tribes, and local governments to implement mitigation measures that lessen the impacts of future hazards such as floods, earthquakes, hurricanes, wildfires, and droughts. Unlike Section 406, Section 404 projects do not have to be tied to facilities that were damaged by the declared disaster. This allows communities to take a proactive approach by investing in mitigation actions that address known risks before damage occurs.

Eligible projects under Section 404 may include activities such as elevation or acquisition of flood-prone structures, drainage improvements, seismic retrofits, safe rooms, wildfire mitigation measures, and hazard mitigation planning. Projects must be cost-effective, technically feasible, and consistent with an approved Hazard Mitigation Plan. The program typically provides up to 75 percent federal funding, with the remaining share provided by non-federal sources.

Under Section 404 is also the Hazard Mitigation Grant Program (HMGP) that can support plan development, data collection, risk assessments, and engagement activities required to maintain FEMA approval following a presidential disaster declaration.

Stafford Act – Section 406

Section 406 of the Stafford Act supports mitigation projects by allowing hazard-mitigation measures to be incorporated directly into the repair or replacement of public facilities damaged during a declared disaster. This provision enables communities to strengthen damaged infrastructure against future hazards, such as elevating flood-damaged buildings, reinforcing structures to withstand high winds, or improving drainage systems during repairs. Mitigation measures funded under Section 406 must be cost-effective and directly related to the damaged facility. By integrating mitigation into recovery activities, Section 406 helps reduce the likelihood of repetitive damage and future repair costs. Overall, it ensures that rebuilding efforts contribute to long-term resilience rather than simply restoring

pre-disaster conditions.

Stafford Act - Section 428

Section 428 of the Stafford Act can support mitigation projects by allowing communities to integrate hazard-resilient and risk-reduction measures directly into disaster recovery projects funded through FEMA's Public Assistance Program. Through its alternative procedures, Section 428 enables flexible project design, fixed-cost funding, and consolidation of damaged facilities, making it easier to incorporate mitigation improvements such as relocation, elevation, floodproofing, or structural hardening. Applicants may also reinvest cost savings from efficiently managed projects into additional mitigation features, as long as project objectives are met. By emphasizing outcomes rather than strict cost reimbursement, Section 428 encourages rebuilding that reduces future risk rather than simply restoring pre-disaster conditions. This approach allows mitigation to become an integral part of recovery, strengthening resilience and reducing the likelihood of repetitive losses.

Flood Mitigation Assistance Program

The **Flood Mitigation Assistance (FMA) Program** reduces flood hazards by providing funding to help communities identify and implement measures that lessen long-term flood risk to National Flood Insurance Program (NFIP)insured properties. The program focuses on projects such as elevating, acquiring, relocating, or floodproofing flood-prone structures, with particular priority given to repetitive loss and severe repetitive loss properties. By mitigating flood damage before disasters occur, FMA helps protect lives and property, reduces future flood insurance claims, and lowers the overall cost of disaster assistance. The program encourages proactive risk reduction by aligning mitigation investments with floodplain management and local hazard mitigation planning.

Stafford Act – Section 203 (BRIC)

The Building Resilient Infrastructure and Communities (BRIC) program supports mitigation projects by providing pre-disaster funding to help communities reduce risks from natural hazards before disasters occur. Administered by FEMA, BRIC focuses on long-term, cost-effective investments that enhance the resilience of critical infrastructure, lifelines, and communities. The program funds activities such as infrastructure retrofits, flood control projects, seismic upgrades, and nature-based solutions, as well as hazard mitigation planning and capacity building. BRIC

emphasizes innovative, large-scale projects that address multiple hazards and provide measurable community benefits. By investing in mitigation prior to disasters, the BRIC program helps protect lives and property, reduce future disaster costs, and support more resilient and sustainable development.

5.3.2 Non-FEMA Federal Funding Streams

Non-FEMA federal Funding Streams can include:[19]

CDBG-DR

The Department of Housing and Urban Development's Community Development Block Grant–Disaster Recovery (CDBG-DR) program can fund hazard mitigation planning and projects by supporting activities that reduce long-term disaster risk and address unmet recovery needs following a major disaster. CDBG-DR funds may be used to develop or update hazard mitigation plans, conduct risk assessments, and support resilience and mitigation planning efforts that guide future investments. In addition, the program can finance mitigation projects such as drainage improvements, flood control infrastructure, elevation or acquisition of flood-prone properties, utility hardening, and other measures that reduce vulnerability to natural hazards. Unlike some recovery programs, CDBG-DR allows communities to target mitigation actions even if facilities were not damaged in the most recent disaster, as long as the activities address identified risks.

CDBG-MIT

The Department of Housing and Urban Development's Community Development Block Grant–Mitigation (CDBG-MIT) program supports hazard mitigation planning and projects by providing federal funding specifically dedicated to reducing future disaster risks in communities that have experienced major disasters. CDBG-MIT funds can be used for mitigation planning activities such as risk assessments, data analysis, and development of strategies that guide long-term resilience investments. The program also finances a wide range of mitigation projects, including flood risk reduction, stormwater management, wildfire mitigation, resilient infrastructure upgrades, and nature-based solutions. CDBG-MIT emphasizes addressing identified vulnerabilities and repetitive loss areas, even if they were not directly damaged in a recent disaster. By focusing on forward-looking risk reduction, the program helps

[19] Please note that the following list is not intended to be exhaustive.

communities proactively adapt to climate impacts and future hazards. Overall, CDBG-MIT integrates mitigation into long-term recovery and development efforts, strengthening community resilience and reducing future disaster losses.
It should be noted that CDBG-DR and CDBG-MIT differ primarily in their purpose and how they support hazard mitigation planning and projects. CDBG-DR focuses on post-disaster recovery, with mitigation activities integrated into rebuilding efforts to address unmet needs and reduce future risk as communities recover. Under CDBG-DR, mitigation planning and projects must be closely tied to disaster recovery goals and justified by disaster impacts or recovery assessments. In contrast, CDBG-MIT is specifically dedicated to hazard mitigation and long-term risk reduction, allowing communities to fund mitigation planning and projects even if areas or facilities were not damaged in the most recent disaster.

Resilience and Emergency Relief Programs

The Federal Highway Administration (FHWA) Resilience and Emergency Relief Programs support Hazard Mitigation Plans by promoting the identification and reduction of risks to transportation infrastructure from natural hazards. Through the Emergency Relief Program, FHWA allows mitigation and resilience measures—such as improved drainage, roadway elevation, and bridge reinforcement—to be incorporated into post-disaster repairs. FHWA resilience initiatives also encourage vulnerability assessments and risk-based planning that align with the risk assessment and mitigation strategy components of FEMA-approved HMPs. By integrating hazard mitigation and climate resilience into transportation planning, these programs help ensure that roads and bridges are addressed as critical lifelines. Overall, FHWA programs complement Hazard Mitigation Plans by supporting transportation-focused mitigation actions that reduce future disruption and repair costs.

National Resource Conservation Service

The Environmental Quality Incentives Program (EQIP) and the Watershed and Flood Prevention Operations (WFPO) program support hazard mitigation projects by addressing risks at the landscape and watershed scale through conservation and infrastructure improvements. EQIP, administered by the USDA Natural Resources Conservation Service (NRCS), provides financial and technical assistance to landowners to implement conservation practices that reduce erosion, manage runoff, improve soil health, and mitigate risks from flooding, drought, and wildfires. These practices—such as vegetation management, streambank stabilization, and water retention—help lessen downstream flood impacts and enhance resilience to climate

variability. The Watershed and Flood Prevention Operations program support larger-scale mitigation through structural and non-structural measures, including small dams, floodwater retarding structures, channel improvements, and watershed planning. Together, these programs reduce hazard exposure upstream, protect communities and infrastructure downstream, and integrating natural resource management into long-term flood and drought mitigation strategies.

5.3.3 Local Funds

Salinas, like other municipalities in Puerto Rico, receives revenue from the Municipal Revenue Collection Center (MRCC). Other funding sources include revenue from the Sales and Use Tax (IVU, by its Spanish acronym), legislative funds that might be assigned from time to time and other sources. Depending on the state of municipal finances, the municipality might determine that there are some funds that can be used to pay for or cover local funds match for mitigation projects.

However, most major capital improvement projects depend on federal funds transfers. The use of federal funds varies widely from year to year. In some cases, these funds are used to cover costs associated with the creation and monitoring of specific programs (for example, Section 8 or housing programs). In other cases, the funds are used to finance major capital improvement projects.

5.4 Outreach and Communications Capacity (C1-a)

Building robust outreach and communication capacity is essential to the successful implementation of a Hazard Mitigation Plan, as effective risk communication enables residents to recognize their risks, actively participate in planning processes, and make informed decisions to reduce potential impacts. FEMA guidance underscores the importance of early and thoughtfully designed engagement strategies to ensure that key stakeholders exchange information at the right time, promoting shared awareness of hazards and broad support for mitigation actions. Communication is a fundamental preparedness capability because it provides timely, practical information that helps individuals and communities act to limit harm. Research further demonstrates that outreach efforts are most successful when messages are clearly defined, customized for specific audiences, and conveyed through trusted sources. Communities that prioritize outreach—by collaborating with local leaders, leveraging a variety of communication channels, and tailoring messages to different population groups—tend to achieve higher public involvement and more effectively incorporate

community feedback into hazard mitigation planning. These practices ultimately contribute to more effective plans and more resilient communities (FEMA, 2025).

The Municipality demonstrates adequate capacity to conduct effective outreach and communication activities. Municipal Emergency Management Office is responsible for coordinating these efforts, and an organizational chart for this office is provided in Appendix E. The Municipality utilizes both social media platforms for real-time communication and traditional methods to disseminate information to the public. In addition, the Planning Office administers the Community Board responsible for land-use decisions, which is largely composed of municipal residents. This board serves as an important forum for public engagement and provides an opportunity to further expand and strengthen the Municipality's outreach and communication capacity.

Table 50 details the communication tools available to the municipality.

Table 50: Outreach and Communications Tools

Tool or resource	Present or not present	Description	Agency in Charge
Municipal Social Media	Yes	Facebook Page @MunicipioSalinas	Mayor's Office
Planning Board Print Material	X	Print Material regarding hazard mitigation, focused on flood hazard	Puerto Rico Planning Board
Community Meetings	X	Community Outreach Meeting to reach people that do not have access to social media	Various

5.5 Capacity Development (C1-b)

Strengthening institutional and technical capacity is vital to the successful

implementation of a Hazard Mitigation Plan, as communities must have the expertise, resources, and organizational frameworks needed to move from planning to sustained risk-reduction actions. FEMA guidance stresses that effective mitigation planning relies on well-coordinated teams, access to reliable technical data, and the ability to collaborate across agencies and stakeholders—all of which directly affect the execution of mitigation strategies. National evaluations have shown that local and state governments often face challenges in implementing mitigation projects not due to a lack of commitment, but because of limited technical assistance, constrained administrative capacity, and insufficient engagement with federal support programs. Studies focused on low-capacity communities further demonstrate that gaps in technical knowledge, training, and leadership involvement can significantly hinder mitigation outcomes. These findings highlight the importance of strengthening workforce skills, enhancing guidance and tools, and reinforcing institutional support to achieve long-term resilience.

The Municipality continues to enhance its mitigation capacity by retaining qualified professionals as staff or contractors as needs arise. It also actively participates in training and continuing education opportunities offered through Commonwealth agencies and academic institutions to build and maintain the technical and institutional expertise necessary to support hazard mitigation efforts.

6. Mitigation Action Plan

The goals, objectives, and mitigation actions outlined in this Plan are based on discussions held by the designated Mitigation Plan Committee, as well as the public-participation activities conducted to date.

6.1 Mitigation Goals (C3-a)

6.1.1 Municipal Goals and Objectives

The Municipality of Salinas, through its Planning Committee and after having carried out on-site inspections and having citizen participation during the development of this document, determined that they are in a position to develop the local goals for natural hazard mitigation. The Committee had the opportunity to reassess the goals and objectives included in the original Plan and later in the 2020 Plan and decided to keep them in this revision, since most of the goals and objectives could not be completed. That said, the Committee will make every effort to achieve the goals and objectives over the next five (5) years. Likewise, the Committee prioritized and arranged the local goals according to levels of risk, recurrence, and affected communities in areas susceptible to natural hazards. (Municipio de Salinas, 2020)

- Goal # 1 - Promote community training about mitigation against natural hazards.
- Goal # 2 - Encourage prevention
- Goal # 3 - Protect human life
- Goal # 4 - Techniques to protect natural resources
- Goal # 5 - Community emergency services
- Goal # 6 - Techniques for mitigating natural hazards in businesses, industries, institutions, among others

6.1.2 National Mitigation Investment Strategy

The Municipality also adopts the National Mitigation Investment Strategy and the following goals.

- Goal 1: Show How Mitigation Investments Reduce Risk - The whole community

will build a shared understanding of mitigation investment and its value. Specifically, the whole community will understand how effective mitigation investments can protect people, homes, neighborhoods, cultural and historic resources, ecosystems and lifelines (for example, communications, energy, transportation and water). The federal government and its non-federal partners will create a shared vocabulary and common measures to communicate information about risk and find opportunities to educate, hire, train and develop a base of qualified mitigation professionals.

- Goal 2: Coordinate Mitigation Investments to Reduce Risk - The whole community will coordinate mitigation investments through shared risk information, reinforced strategies for risk reduction, and easier access to existing funding. Such coordination will help the whole community justify mitigation investments and choose the most cost-effective and reasonable actions.
- Goal 3: Make Mitigation Investment Standard Practice The whole community will factor mitigation into investment decisions, especially for buildings and infrastructure. The federal government and its non-federal partners will use and expand financial products and approaches for mitigation investment, including funding, incentives and financial risk transfer opportunities. The federal government and its non-federal partners also will make mitigation standard professional practice critical to safeguarding lifelines, services, and national safety and security.

6.2 Mitigation Strategy Selection Criteria

The following methodologies were used to select the mitigation actions:

- The Planning Committee reviewed mitigation actions from the previous Mitigation Plan.
- The Committee evaluated those actions and determined which ones were appropriate to include in the current Plan. Actions were excluded if:
    - The measure had already been implemented during the previous plan's period and was not a recurring or ongoing action.
    - The measure was no longer necessary or useful based on new information. This applies to mitigation actions linked to identified hazards, risks, and vulnerabilities.
- The Committee considered the Letters of Intent (LOIs) submitted by the municipality to COR3 in 2019 to participate in the Hazard Mitigation Grant

Program. These projects were incorporated into the current Plan, ensuring no duplication of projects included in the previous Plan.
- Committee members evaluated and added new measures. These new actions were proposed based on the Committee members' professional experience and suggestions received from community members.

The mitigation strategies of the Municipality of Salinas were evaluated by the Committee using the STAPLEE methodology. This methodology was considered in the selection of the strategies included in Section 6.5. This methodology has seven evaluation criteria:

- S – Social: The proposed action must be socially acceptable.
- T – Technical: The proposed action must be technically feasible.
- A – Administrative: The community must have the capacity to implement the action (for example, determining whether the responsible agency is capable of supervising the mitigation project).
- P – Political: Mitigation actions must be politically acceptable.
- L – Legal: The community must have the authority to implement the proposed action.
- E – Economic: Economic considerations must include the current economic base, projected growth, and opportunity costs.
- E – Environmental: The environmental impact must be considered, given statutory requirements and the public's interest in maintaining sustainable and environmentally healthy communities.

6.3 Mitigation Strategy Categorization

To further understand the chosen mitigation strategies, this LHMP classifies said strategies in five broad categories as shown below.

- Prevention - Prevention activities aim to keep hazards from creating or worsening problems. These actions are typically carried out through government programs or regulatory measures that guide land-use development and building practices. Prevention is especially effective for reducing future vulnerability in areas that have not yet been developed. Examples include:
    - Planning and zoning
    - Building codes
    - Open-space preservation

    - Floodplain regulations
    - Stormwater management regulations
    - Maintenance of drainage systems
    - Capital improvement programming
    - Riverbank realignment
    - Projects addressing fault zones

- Property protection – measures involve modifying existing buildings and structures so they can withstand natural hazards, or removing structures located in high-risk areas. Examples include:
    - Acquisition of properties
    - Relocation
    - Elevating structures
    - Protection of critical facilities
    - Structural retrofits (wind protection, floodproofing, seismic techniques)
    - Safe rooms, shutters, impact-resistant windows
    - Insurance policies

- Natural resource protection – activities reduce the impact of natural disasters by preserving or restoring natural areas that offer protective benefits. These areas include flood plains, wetlands, steep slopes, and sand dunes. Parks, recreational agencies, and conservation organizations commonly implement measures such as:
    - Flood protection
    - Watershed management
    - Riparian buffers
    - Forest and vegetation management (including wildfire and fuel-load control)
    - Erosion and sediment control
    - Wetland preservation and restoration
    - Habitat preservation
    - Slope stabilization

- Structural mitigation – Projects aim to reduce the impact of disasters by controlling or altering the natural flow of hazard events through engineered construction. These projects are usually designed by engineers and maintained by public works teams. Examples include:
    - Reservoirs
    - Dams, levees, and retaining walls

    - Diversion, detention, and retention systems
    - Channel modifications
    - Stormwater drainage systems
    - Installation of storm drains and related infrastructure

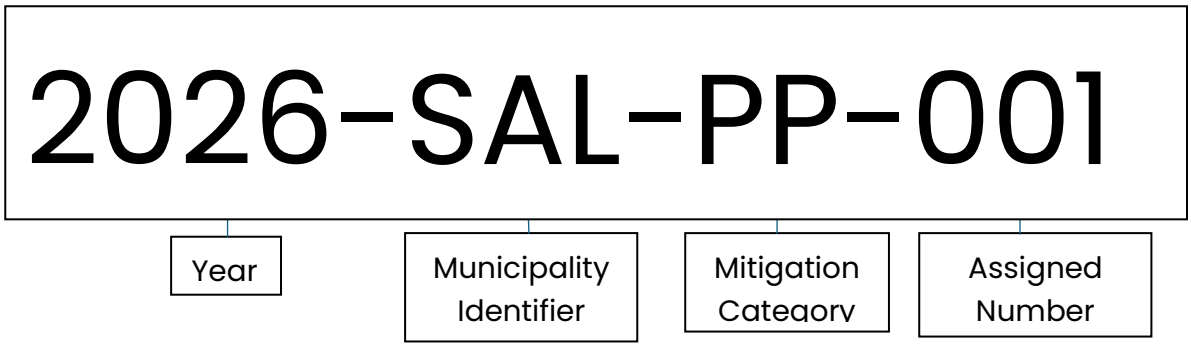
- Emergency Services - Although not typically classified as mitigation, emergency management measures reduce the human, and property impacts of natural hazards. These actions occur immediately before, during, or after a disaster. Examples include:
    - Warning systems
    - Evacuation management and planning
    - Emergency response drills and training
    - Flood-fighting measures
    - Installation of shutters

- Public awareness and outreach - Efforts to help inform residents, elected officials, business owners, homebuyers, and visitors about hazard-prone areas and mitigation techniques they can use to protect themselves and their property. Examples include:
    - Outreach projects
    - Demonstration events and guest presentations
    - Hazard information materials
    - Property-specific risk information
    - Library materials
    - Educational programs for children
    - Exposure to risk-related information

6.4 Mitigation Strategies (C4-a, C4-b, C5-a, C5-b, E2.b)

To improve tracking and updating, each mitigation strategy has been giving a unique identification number. The following figure shows the meaning of the nomenclature.

Figure 39: Unique Id Nomenclature



Each identified mitigation strategy shall include:

- Assigned category,
- Hazard(s) Mitigated
- Priority
- Responsible entity
- Founding source
- Estimated cost (when available)
- Qualitative Benefit
- Time Horizon
- Status
- Location in 2018 (if applicable)

Table 51: Mitigation Strategies – Prevention (Local Policies and Regulations)

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-001	P-1	Review, analysis and implementation of ordinance (Law) to restrict development in risk areas or zones.	All	High	Security	Territorial Planning	Municipal, state, and federal government	Immediate	Current Status: In Execution – Ordinance No. 7 Series 2022-23 was approved on December 6, 2022, prohibiting the development and/or establishment of mobile units in flood zones. This strategy will provide the following qualitative benefits: The ordinance strengthens municipal control over land uses in residential and flood-prone areas.
2026-SAL-LP-002	P-2	Inter-agency coordination for the programmatic creation of a plan for maintenance and identification of those responsible for damage in the municipality (state jurisdiction).	All	High	Security	OMME	Premises State Federal	Long Term	Current Status: Ongoing Implementation – This strategy is being implemented by OMME in coordination with state agencies for the identification and maintenance of potential culprits within the municipality. This strategy will provide the following qualitative benefits as a risk mitigation strategy and in turn provides us with a better response to future events.

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-003	P-3	Identification of Federal and State funds and resources for mitigation projects related to the control and management of waters within the jurisdiction (rainwater and natural runoff, reservoirs and others).	Flood Storm surge	High	Security	Territorial Planning	Premises State Federal	Medium Term	Current Status: Ongoing Execution – This strategy has been implemented and the city has remained in communication with agencies such as FEMA for the approval of projects submitted as part of the Hurricane Maria disaster. The Niguas River channeling project is in the field studies and design stage (U.S. Corps of Engineers)
2026-SAL-LP-004	P-4	Involve the private sector to voluntarily contribute to improving the physical conditions of public structures for maximum performance to the community.	All	High	Communication	Mayor's Office	Premises State Federal	Long Term	Current Status: In Execution – Strategies have been implemented to promote citizen participation in decision-making; Community Board of the Territorial Planning Plan and participation of community groups in the preparation of the Municipal Recovery Plan. This strategy will provide the following qualitative benefits of multisectoral integration for the benefit of the people at large.
2026-SAL-LP-005	P-5	Implement the International Building Codes (IBC) for compliance with future projects to be developed by the jurisdiction (Municipality).	All	High	Security	Territorial Planning	Premises State Federal	Short Term	Current Status: Ongoing Execution – This building code compliance strategy is required by state government permitting agencies including the CCVS Permitting Consortium of which the Autonomous Municipality of Salinas is a part This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-006	P-6	Implementation and application of public policy through the Land Use Plan to stop development in areas susceptible to natural hazards.	All	Medium	Security	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – This strategy is in the process of execution with the comprehensive review of the Land Use Plan, which is underway through a collaborative agreement with the Planning Board. This strategy will provide the following qualitative benefits
2026-SAL-LP-007	P-7	Restrict developments in maritime-terrestrial areas.	Coastal Modification Tsunamis	High	Security	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – This strategy The Municipality does not endorse any project within the maritime-terrestrial zone. Measures have been taken so that permits are not authorized, audits have been requested of permits granted by entities outside the Municipality and cases have been brought to the attention of courts of justice. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-008	P-8	Prohibit or restrict construction in areas identified as storm surge, EVs, and areas identified as tsunami-susceptible, unless an effective mitigation measure has been implemented and is strictly necessary.	Coastal Modification Tsunamis	High	Security	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – Compliance with the regulations of the Planning Board is required, in particular the joint permitting regulations and the regulations on flood-prone areas. This strategy will provide the following qualitative benefits
2026-SAL-LP-009	P-9	Encourage the Puerto Rico Planning Board and the Office of Permit Management to incorporate, as part of their regulations, the limitation of construction in areas of high population density and susceptible to tsunamis.	Tsunami	Medium	Security	Territorial Planning	Premises State Federal	Long Term	

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-010	P-10	Develop a water reserve management program by implementing a rainwater collection system in cisterns or other alternative water storage tools in critical municipal facilities.	Drought	High	Water Systems	Public Works OMME	Federal State Municipaless	Short Term	Current Status: In Execution – The Municipality of Salinas began an installation process in critical facilities that include: Mayor's Office, Police, OMME, OP among others. Still pending: Museum, Library, Permits Office/ Crim, Integrated Services Center [Esc.]) In addition, construction of ponds in the Húcar and Hacienda Fortuna is in process under NRCS · -PREPA project completed the construction of ponds and pipelines to bring water from Patillas and avoid extraction to the aquifer · -PRASA – project for the construction of a new filtration plant at a cost of $50M is in the design phase, auction 6/26
2026-SAL-LP-011	P-11	The City and its agencies will actively participate in the effort to implement land use controls to prohibit the development of illegal structures in flood-prone areas pursuant to the Special Flood Risk Areas Regulation, better known as Planning Regulation #13, as amended.	Flooding	High	Security	Territorial Planning	Federal State Municipal	Immediate	Current Status: Running Continuously – The Municipality does not endorse any project in areas prone to flooding. They have measures have been taken so that permits are not authorized, audits have been requested of permits granted by entities outside the municipality and cases have been brought to the attention of the Court of Justice

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-012	P-12	The Municipality of Salinas and its dependencies will be custodians of land use controls to prohibit the development of illegal structures in flood-prone areas pursuant to Planning Regulation 13 of the Puerto Rico Planning Board and applicable federal and state laws.	Flood Storm Surge:		Security	Territorial Planning	Federal State Municipal	Immediate	Current Status: In Execution – "The legal division on The municipality is evaluating alternatives to address this issue through an ordinance or bill at the state level. This strategy will provide the following qualitative benefits
2026-SAL-LP-013	P-13	Electric power generation systems such as the installation of diesel electric power generators in critical facilities, alternative energy generation through the installation of solar panels and energy storage systems. Also, implement other energy generation systems such as Micro Grids and their components. The capacity of these must be sufficient to sustain the activities carried out in these facilities. [1]	Tropical Cyclone	High	Security	Public Works OMME	Premises Federal State	Short Term	Current Status: Ongoing Implementation – This strategy is carried out through collaborative agreements with state agencies to provide services on an ongoing basis. This strategy will provide the following qualitative benefits.
2026-SAL-LP-014	P-14	Maintain an inventory in the Municipal Office of Emergency Management of the occurrence of fires in the Municipality of Salinas.	Vegetative Fire	Medium	Security	OMME	Federal State Premises	Immediate	Current Status: In Continuous Execution – This strategy is carried out in collaboration with the Fire Department. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-015	P-15	*New Project* Create a plan for the management of runoff for the urban area.	Flooding	High	Security	OMME Territorial Planning	Federal State Premises	Long Term	Current Status: Funding – The Municipality is in the phase of identifying funds to implement the strategy. This strategy will provide the following qualitative benefits
2026-SAL-LP-016	P-16	*New Project* Work out a plan to address aquifer problems.	Drought	High	Water Systems	OMME Territorial Planning	Federal State Premises	Long Term	Current Status: Under Design – This strategy is being implemented by PRASA with the design and forthcoming construction of a treatment plant within the City's jurisdiction. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-001	P-1	Review, analysis and implementation of ordinance (Law) to restrict development in risk areas or zones.	All	High	All	Territorial Planning	Municipal, state, and federal government	Immediate	Current Status: In Execution – Ordinance No. 7 Series 2022-23 was approved on December 6, 2022, prohibiting the development and/or establishment of mobile units in flood zones. This strategy will provide the following qualitative benefits: The ordinance strengthens municipal control over land uses in residential and flood-prone areas.
2026-SAL-LP-002	P-2	Inter-agency coordination for the programmatic creation of a plan for maintenance and identification of those responsible for damage in the municipality (state jurisdiction).	All	High	Safety and Security	OMME	Premises State Federal	Long Term	Current Status: Ongoing Implementation – This strategy is being implemented by OMME in coordination with state agencies for the identification and maintenance of potential culprits within the municipality. This strategy will provide the following qualitative benefits as a risk mitigation strategy and in turn provides us with a better response to future events.
2026-SAL-LP-003	P-3	Identification of Federal and State funds and resources for mitigation projects related to the control and management of waters within the jurisdiction (rainwater and natural runoff, reservoirs and others).	Flood Storm surge	High	Water Systems	Territorial Planning	Premises State Federal	Medium Term	Current Status: Ongoing Execution – This strategy has been implemented and the city has remained in communication with agencies such as FEMA for the approval of projects submitted as part of the Hurricane Maria disaster. The Niguas River channeling project is in the field studies and design stage (U.S. Corps of Engineers)

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-004	P-4	Involve the private sector to voluntarily contribute to improving the physical conditions of public structures for maximum performance to the community.	All	High	Communication	Mayor's Office	Premises State Federal	Long Term	Current Status: In Execution – Strategies have been implemented to promote citizen participation in decision-making; Community Board of the Territorial Planning Plan and participation of community groups in the preparation of the Municipal Recovery Plan. This strategy will provide the following qualitative benefits of multisectoral integration for the benefit of the people at large.
2026-SAL-LP-005	P-5	Implement the International Building Codes (IBC) for compliance in future projects to be developed by the jurisdiction (Municipality).	All	High	All	Territorial Planning	Premises State Federal	Short Term	Current Status: Ongoing Execution – This building code compliance strategy is required by state government permitting agencies including the CCVS Permitting Consortium of which the Autonomous Municipality of Salinas is a part This strategy will provide the following qualitative benefits
2026-SAL-LP-006	P-6	Implementation and application of public policy through the Land Use Plan to stop development in areas susceptible to natural hazards.	All	Medium	All	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – This strategy is in the process of execution with the comprehensive review of the Land Use Plan, which is underway through a collaborative agreement with the Planning Board. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-007	P-7	Restrict developments in maritime-terrestrial areas.	Coastal Modification Tsunamis	High	Safety and Security	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – This strategy The Municipality does not endorse any project within the maritime-terrestrial zone. Measures have been taken so that permits are not authorized, audits have been requested of permits granted by entities outside the Municipality and cases have been brought to the attention of courts of justice. This strategy will provide the following qualitative benefits
2026-SAL-LP-008	P-8	Prohibit or restrict construction in areas identified as storm surge, EVs, and areas identified as tsunami-susceptible, unless an effective mitigation measure has been implemented and is strictly necessary.	Coastal Modification Tsunamis	High	Safety and Security	Territorial Planning	Premises State Federal	Immediate	Current Status: In Execution – Compliance with the regulations of the Planning Board is required, in particular the joint permitting regulations and the regulations on flood-prone areas. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-009	P-9	Encourage the Puerto Rico Planning Board and the Office of Permit Management to incorporate, as part of their regulations, the limitation of construction in areas of high population density and susceptible to tsunamis.	Tsunami	Medium	Safety and Security	Territorial Planning	Premises State Federal	Long Term	
2026-SAL-LP-010	P-10	Develop a water reserve management program by implementing a rainwater collection system in cisterns or other alternative water storage tools in critical municipal facilities.	Drought	High	Water Systems	Public Works OMME	Federal State Municipaless	Short Term	Current Status: In Execution – The Municipality of Salinas began an installation process in critical facilities that include: Mayor's Office, Police, OMME, OP among others. Still pending: Museum, Library, Permits Office/ Crim, Integrated Services Center [Esc.]) In addition, construction of ponds in the Húcar and Hacienda Fortuna is in process under NRCS · -PREPA project completed the construction of ponds and pipelines to bring water from Patillas and avoid extraction to the aquifer · -PRASA – project for the construction of a new filtration plant at a cost of $50M is in the design phase, auction 6/26

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-011	P-11	The City and its agencies will actively participate in the effort to implement land use controls to prohibit the development of illegal structures in flood-prone areas pursuant to the Special Flood Risk Areas Regulation, better known as Planning Regulation #13, as amended.	Flooding	High	Water Systems	Territorial Planning	Municipality of Salinas (operating funds), Federal State Municipal	Immediate	Current Status: Running Continuously – The Municipality does not endorse any project in areas prone to flooding. They have measures have been taken so that permits are not authorized, audits have been requested of permits granted by entities outside the municipality and cases have been brought to the attention of the Court of Justice
2026-SAL-LP-012	P-12	The Municipality of Salinas and its dependencies will be custodians of land use controls to prohibit the development of illegal structures in flood-prone areas pursuant to Planning Regulation 13 of the Puerto Rico Planning Board and applicable federal and state laws.	Flood Storm Surge:	Medium	Water System	Territorial Planning	Municipality of Salinas (operating funds), HMGP, BRIC	Immediate	Current Status: In Execution – "The legal division on The municipality is evaluating alternatives to address this issue through an ordinance or bill at the state level. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-013	P-13	Electric power generation systems such as the installation of diesel electric power generators in critical facilities, alternative energy generation through the installation of solar panels and energy storage systems. Also, implement other energy generation systems such as Micro Grids and their components. The capacity of these must be sufficient to sustain the activities carried out in these facilities. [1]	Tropical Cyclone	High	Energy	Public Works OMME	HMGP, BRIC	Short Term	Current Status: Ongoing Implementation – This strategy is carried out through collaborative agreements with state agencies to provide services on an ongoing basis. This strategy will provide the following qualitative benefits.
2026-SAL-LP-014	P-14	Maintain an inventory in the Municipal Office of Emergency Management of the occurrence of fires in the Municipality of Salinas.	Vegetative Fire	Medium	Safety and Security	OMME	Federal (USDA Community Wildfire Defense Grant, HMGP, BRIC, FEMA Fire Prevention and Safety Grants) State Premises	Immediate	Current Status: In Continuous Execution – This strategy is carried out in collaboration with the Fire Department. This strategy will provide the following qualitative benefits
2026-SAL-LP-015	P-15	*New Project* Create a plan for the management of runoff for the urban area.	Flooding	High	Water System	OMME Territorial Planning	Federal, EPA MS4) State - DNER	Long Term	Current Status: Funding – The Municipality is in the phase of identifying funds to implement the strategy. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Danger	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-LP-016	P-16	*New Project* Work out a plan to address aquifer problems.	Drought	High	Water Systems	OMME Territorial Planning	Federal (EPA, NRCS, Bureau of Reclamantion, USGS State (DNER, PRASA)	Long Term	Current Status: Under Design – This strategy is being implemented by PRASA with the design and forthcoming construction of a treatment plant within the City's jurisdiction. This strategy will provide the following qualitative benefits

Table 52: Mitigation Strategies - Property Protection

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-PP-001	PP-1	Anchoring and/or reinforcement of homes. Use metal attachments to fix the wood with the cement as well as wood with wood. Tensioners can be used on the roofs of residences and/or storm shutters on the doors and windows of structures. In this way, the structures will be able to resist the onslaught of storm or hurricane winds.	Tropical Cyclone	Medium	Food, Hydration and Shelter	OMME Citizen Assistance	Municipality of Salinas (operating funds), State and/or Federal funds (HMGP, BRIC, etc.)	Medium Term	Current Status: Funding – This strategy is being implemented through grants for repairs to homes damaged by events. Request in new cases to implement anchoring measures - possible 428. This strategy will provide the following qualitative benefits: residential security.
2026-SAL-PP-002	PP-2	Anchoring and/or reinforcement of homes. It is based on using metal attachments to fix the wood with the cement just like wood with wood. Another measure is to make a metal skeleton to support the structure in case of telluric movements. In this way, the structures will be resistant to earthquakes.	Earthquake	Medium	Food, Hydration and Shelter	OMME	Municipality of Salinas (operating funds), State and/or Federal funds (HMGP, BRIC, etc.)	Long Term	Current Status: Funding – This strategy is being implemented through grants for repairs to homes damaged by events. Request in new cases to implement anchoring measures - possible 428. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-PP-003	PP-3	Identification of any structure that can be mitigated while maintaining cost effective mitigation (improvements to the structure from wood to concrete and others).	All	High	All	OMME Territorial Planning	Municipality of Salinas (operating funds), State and/or Federal funds (HMGP, BRIC, etc.)	Long Term	Current Status: Funding – For the implementation of this strategy, the Land Use Office is working on an inventory of structures in the different communities, mainly in communities located in coastal areas. This strategy will provide the following qualitative benefits
2026-SAL-PP-004	PP-4	Relocation of families exposed to risks in coastal areas.	Storm Surge, Tsunamis	Medium	Food, Hydration and Shelter	OMME Citizen Assistance Department of Housing	Municipality of Salinas (operating funds), State and/or Federal funds (HMGP, BRIC, etc.)	Long Term	Current Status: Funding – This strategy, after review in the implementation process, was identified for elimination in consultation with the public. This strategy will provide the following qualitative benefits
2026-SAL-PP-005	PP-5	Elevation of structures above flood levels to minimize damage to structures, loss of life and property.	Storm Surge, Tsunamis	High	All	OMME Territorial Planning	Federal funds (HMGP, BRIC, etc.)	Long Term	Current Status: Ongoing Execution – This strategy is being implemented in the permitting application process for new construction and remodeling where compliance with Planning Board Regulation 13 is requested. This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-PP-006	PP-6	Carry out an updated inventory of types of housing in the municipality.	All	High	Food, Hydration and Shelter	OMME	Municipality of Salinas (operating funds), State	Immediate	Current Status: In Continuous Execution – This strategy is implemented through OMME and the Office of Land Use by creating inventories of structures that include, abandoned, structures in areas of risk and finally inventory by construction material. This strategy will provide the following qualitative benefits
2026-SAL-PP-007	PP-7	Carry out an inventory of the municipality's critical facilities, vulnerable to damage due to hurricane winds for the installation of storm shutters in these assets. [1]	Tropical Cyclone	High	Safety and Security	Finance Department Territorial Planning	Municipality of Salinas (operating funds), State	Immediate	Current Status: Running – This strategy is implemented through the Property Office. This strategy will provide the following qualitative benefits

Table 53: Mitigation Strategies - Structural Projects

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-SI-001	PE-1	Channeling of bodies of water. Combination of several techniques on the route such as: concrete walls, speed bumps, gabion wall and dredging.	Flooding	High	Water Systems	Territorial Planning Public Works OMME	Municipality of Salinas (operating funds), State and/or Federal funds	Short - Term	Current Status: Funding – This strategy is in the process of being implemented through temporary City efforts pending the completion of federal funding approvals Nigua River - Design Development Phase Coquí - Retention Pond 404 Paseo & Trinitarias Pte. Catoy (Bado) This strategy will provide the following benefits:
2026-SAL-SI-002	PE-2	Make improvements to the drainage system, replace existing pipes, construction of gutters.	Flooding	High	Water Systems	Territorial Planning Public Works OMME	Municipality of Salinas (operating funds), State and/or Federal funds	Municipality of Salinas (operating funds), State and/or Federal funds	Current Status: Funding – This strategy is currently being implemented through temporary municipal labor and funds and efforts are being made for funding under federal programs Playa Calle C (via com.) Estero & Salistral Villa Verde This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-SI-003	PE-3	Increase sewer capacity.	Flooding	High	Water Systems	Territorial Planning Public Works OMME	Territorial Planning Public Works OMME	Municipality of Salinas (operating funds), State and/or Federal funds	Current Status: Funding – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits
2026-SAL-SI-004	PE-4	Construction of Wave Breakers or other construction necessary to protect areas susceptible to storm surges. For example, the Bo. Río Jueyes Beach Sector, Arenal Sector, Bo. Aguirre Central Aguirre and Playita Sector.	Storm surge	Medium	Water Systems	Territorial Planning Public Works OMME	Territorial Planning Public Works OMME	Municipality of Salinas (Operating Funds), State and Federal Funds	Current Status: Funding – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits
2026-SAL-SI-005	PE-5	Unified project for the collection of water in different flood areas such as Coquí and San Felipe. This project involves different engineering techniques such as: (1) improvements to the drainage system; (2) channeling of bodies of water; (3) installation of pipes and sewers and/or increase their capacity; (4) speed reducers for the channel, among others.	Flooding	High	Water Systems	To be determined	Municipality of Salinas (Operational Funds), FEMA Mitigation Programs, Private Sector	To be determined	Current Status: Choose an item. – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-SI-006	PE-6	Unified project for the collection of water in different areas flooded by the Nigua River. This project involves different engineering techniques such as: (1) improvements to the existing drainage system; (2) channeling of bodies of water; (3) increase its capacity through widening; (4) speed reducers for the channel, among others. [1]	Flooding	High	Water Systems	To be determined	Municipality of Salinas (Operational Funds), FEMA Mitigation Programs, Private Sector	To be determined	Current Status: Choose an item. – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits
2026-SAL-SI-007	PE-7	Unified project for the collection of water in different flood areas of the Playa and Playita Sectors. This project involves different engineering techniques such as: (1) improvements to the existing drainage system; (2) channeling of bodies of water; (3) installation of pipes and sewers and/or increase their capacity; (4) speed reducers for the channel, among others. [2]	Flooding	High	Water Systems	To be determined	Municipality of Salinas (Operational Funds), FEMA Mitigation Programs, Private Sector	To be determined	Current Status: Choose an item. – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits
2026-SAL-SI-008	PE-8	Construction of a bridge located in the Bo. Aguirre Coquí sector (Betances Street).	Flooding	High	Transportation	To be determined	Municipality of Salinas (operating funds), State and/or Federal funds	To be determined	Current Status: Choose an item. – This strategy (brief explanation of status. We suggest no more than 140 characters This strategy will provide the following qualitative benefits

Table 54: Mitigation Strategies - Emergency Services

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-ES-001	SE-1	Maintain approved Tsunami Ready Plan certification, including maintenance or acquisition of warning siren systems. This mitigation strategy will be implemented in coordination with the Puerto Rico Seismic Network	Tsunami	Medium	Safety and Security	Federal State Municipal	To be determined	To be determined	To be determined

Table 55: Mitigation Strategies: Education and Outreach

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-EA-001	ECP-1	Establish effective and direct coordination with the private sector, business, government agencies, religious institutions, and the community on the development of mitigation projects.	All	High	N/A	To be determined	To be determined	To be determined	To be determined
2026-SAL-EA-002	ECP-2	Creation of educational seminars and permanent training for residents in vulnerable areas or at risk where they can be directed to create, adopt and maintain economical and viable mitigation measures.	All	High	N/A	To be determined	To be determined	To be determined	To be determined
2026-SAL-EA-003	ECP-3	Develop an awareness and education program, through workshops, talks and/or publications, for traders, stakeholders and the general public about the importance of water and alternatives for its conservation, storage and protection.	Drought	High	N/A	To be determined	To be determined	To be determined	To be determined

2026 ID	2020 ID	Description	Hazard	Priority	Lifeline	Municipal Office in Charge	Possible Sources of Funds	Implementation term	Status
2026-SAL-EA-004	ECP-4	Educate businesses, stakeholders, the general public, through workshops, talks, publications, external resources, on how to prevent spontaneous burning of pastures in Salinas.	Vegetative Fire	High	N/A	To be determined	Federal State Municipal	To be determined	To be determined
2026-SAL-EA-005	ECP-5	Inform the public through workshops, talks and/or publications, about the importance and benefits of participating in the National Flood Insurance Program (NFIP)	Flooding	High	N/A	To be determined	Federal State Premises	To be determined	To be determined
2026-SAL-EA-006	ECP-6	Establish an effective and direct coordination project with the private sector, businesses, government agencies, faith-based organizations, and the community in order to implement mitigation projects.	All	High	N/A	To be determined	Federal State Premises	To be determined	To be determined

6.5 Participation in the NFIP

Covered under the PRPB, the Municipality maintains continuous participation in the National Flood Insurance Program (NFIP) and remains committed to meeting all program requirements to reduce flood risk and protect life and property. Ongoing participation in the NFIP enables residents and businesses to access federally backed flood insurance while promoting sound floodplain management practices. The PRPB, on the municipality's behalf, enforces floodplain management regulations consistent with FEMA requirements, including the adoption and use of Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FIS) for development decisions. Local permitting, inspection, and enforcement activities help ensure that new construction and substantial improvements in Special Flood Hazard Areas comply with applicable elevation and floodproofing standards. The Municipality also supports public awareness and education activities related to flood risk, insurance requirements, and mitigation measures. Continued compliance with the NFIP strengthens eligibility for federal hazard mitigation funding and supports the long-term reduction of flood-related damages.

7. Plan Maintenance

This chapter describes the procedures and actions necessary to ensure that the Plan is effectively implemented, regularly reviewed, and maintained in alignment with the established mitigation goals and objectives. In some instances, Plan updates may require adjustments to proposed mitigation actions to reflect changes in on-site conditions that could either increase or reduce the level of risk affecting certain areas.

In accordance with federal requirements, the Local Hazard Mitigation Plan (LHMP) review process must include the following elements:

- A description of the methods and schedule for monitoring, evaluating, and updating the Mitigation Plan within a five-year period.
- A process for integrating the Mitigation Plan's requirements into other applicable local planning mechanisms, such as comprehensive plans or capital improvement plans.
- A description of how the community will continue to participate in the Plan's review and maintenance process.

7.1 Point of Contact

The designated point of contact is responsible for the monitoring, revision, and update of the Salinas. LHMP is as follows:

Name: Nailin M. Santiago Perez
Position: Deputy Director
Office: Ordenamiento Territorial
Telephone: 787-824-3050 Ext. 2332
Email: nsantiago@salinas.pr.gov

7.2 Continuous Public Participation (D1-a)

The Municipality of Salinas is committed to ensuring ongoing public participation by implementing the following engagement methods:

- Public education and awareness initiatives
- Surveys
- Community workshops and meetings held throughout the municipality

Consistent with this commitment, public participation and community education are integral components of several mitigation strategies included in this Plan. Residents are encouraged to submit comments and participate in LHMP updates at any time, including requesting copies of the Plan during its development, monitoring, and maintenance phases.

Each time a progress report is completed, it will be made available for public review. Plan progress will also be discussed periodically during public meetings and shared through social media and other communication platforms. Public participation notices will be distributed throughout all monitoring and oversight stages of the Plan. Additionally, the Municipality will continue providing presentations to community groups regarding the LHMP and the status of mitigation strategy implementation. These groups may include elected officials, schools, and other community organizations. The Municipality will also promote civic engagement and preparedness education by offering training courses and workshops—such as Community Emergency Response Team (CERT) programs—and by informing residents about the National Flood Insurance Program (NFIP) and other relevant initiatives.

Mitigation efforts will be tailored to address the specific vulnerabilities and needs of individual communities, supporting the development of a more informed, prepared, and resilient population. This approach underlines the Municipality's commitment to sustained community engagement throughout the Plan's effective period, updating cycles, and post-adoption activities.

7.3 LHMP Oversight (D2-a)

The Municipality's strategy for Plan implementation, monitoring, and evaluation establishes a framework that promotes collaboration, information sharing, and innovation. Through its Planning Committee, composed of representatives from various municipal agencies and departments, the Municipality will work with partners and residents to apply a localized and coordinated approach to hazard mitigation. This collaborative strategy is intended to reduce losses, address community needs, and strengthen the Municipality's capacity to withstand future hazard events.
The Plan will be monitored to assure:

- Maintain current and accurate hazard and risk information
- Ensure mitigation strategies reflect community and stakeholder priorities

- Comply with federal and Commonwealth LHMP requirements
- Maintain eligibility for mitigation funding
- Ensure consistency with other local and regional planning efforts

To support effective implementation, the Municipality will leverage existing resources and infrastructure planning processes. Mitigation actions identified as immediate or short-term will be pursued over the next five (5) years, subject to available funding and resources.

7.4 LHMP Evaluation and Monitoring

Evaluation of the LHMP will be an ongoing process. In addition to FEMA's required five-year review, the Municipality will conduct annual evaluations, or more frequently if conditions warrant. Following each annual review, the Planning Committee will meet to approve a yearly progress report documenting updates, accomplishments, and progress toward mitigation goals and objectives. This report will be submitted to the Office of the Mayor and made available to the public.

A preliminary schedule for Planning Committee meetings is outlined below:

Table 56: Preliminary Planning Committee Meeting Schedule

Time Period	Participants	Purpose of the Meeting
Annual Meeting (2027)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will identify funding needs, reassess hazard priorities, develop strategies for grant applications, and conduct site visits to high-risk areas to monitor progress and engage directly with communities.
Annual Meeting (2028)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will review mitigation implementation status, identify emerging risks, and evaluate community

Time Period	Participants	Purpose of the Meeting
		needs. Site visits will be conducted as necessary.
Annual Meeting (2029)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will confirm progress on mitigation actions and assess the need for additional funding.
Annual Meeting (2030)	Planning Committee (Can be open to the public if deemed necessary)	The Committee will hold its final meeting prior to the next LHMP update to verify mitigation implementation status, which will be documented in the updated Plan.

7.5 LHMP Update and Revision (D2-c, D3-a)

7.5.1 Revision Following a Major Disaster

If a major emergency or disaster declaration affecting the Municipality occurs during the Plan's five-year term, the Planning Committee—along with stakeholders, community representatives, and nonprofit organizations—will convene to identify newly affected areas, revise mitigation priorities, and incorporate lessons learned. This meeting will replace the annual review scheduled for that year.

7.5.2 Five-Year Comprehensive Update

In accordance with federal guidance, the LHMP will be comprehensively updated five (5) years after approval and submitted to the State Hazard Mitigation Officer and FEMA for review and approval. Approximately eighteen (18) months prior to the Plan's expiration, the review process will begin, including a full evaluation of the municipal profile, risk assessment, and mitigation strategies, with attention to updated guidance and requirements.

7.6 Integration with Other Planning Mechanisms (D3-A)

The following public policies and planning documents were considered in the development of this LHMP:

Commonwealth Level:

- Puerto Rico Land Use Plan (PUT-PR)
- Salinas Territorial Plan (PT)
- Joint Regulation for the Evaluation and Issuance of Permits
- Special Flood Hazard Areas Regulation (2021)
- Stormwater System Design, Operation, and Maintenance Regulation
- Salinas Emergency Operations Plan

Following adoption, the LHMP will guide updates to the Territorial Plan, special area plans, and urban expansion plans, and will inform municipal budget priorities. Once FEMA approval is received, a digital copy of the Plan will be submitted to the Puerto Rico Planning Board to support updates to the PUT-PR and other relevant Commonwealth planning documents.

8. Adoption and Approval (F1-A, F1-B)

8.1 LHMP Adoption

Federal policy establishes LHMPs must include "Documentation that the LHMP has been formally adopted by the governing body of the jurisdiction requesting approval of the Plan. The municipality has one (1) year to adopt the Plan once it receives an *Approval Pending Adoption (APA).*"[27]

This LHMP was adopted by the Municipality of Salinas on **XXXXXX**. A copy of **Resolution**, titled *"To Adopt the 2026 Natural Hazard Mitigation Plan of the Municipality of Salinas, and for Other Related Purposes,"* is included as part of **Appendix A**.

8.2 LHMP Approval

This LHMP was approved by FEMA and the SHMO on **XXXXX**. A copy of the Approval Letter, titled *"Approval of the Local Hazard Mitigation Plan, Municipality of Salinas,"* is

included in **Appendix A**. FEMA's approval of the Plan is valid for a period of **five (5) years**, through **XXXXXX**

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Appendix A: Adoption and Approval

Adoption

Approval by FEMA

FEMA APA Letter FEMA

Review Tool Sheet

Appendix B: Planning Committee

Letter of Agreement Municipality and Puerto Rico Planning Board

Planning Committee Appointments

SALINAS
CAPITAL DEL MAR CARIBE

OFICINA DE LA ALCALDESA
KARILYN BONILLA COLÓN

NOTIFICACIÓN DE DESIGNACIÓN
Comité de Planificación del Municipio de Salinas

Yo, Hon. Karilyn Bonilla Colón, Alcaldesa del Municipio de Salinas, designo a los siguientes funcionarios y representantes como integrantes del *Comité de Planificación para la actualización del Plan de Mitigación contra Peligros Naturales del Municipio de Salinas*, con el deber de apoyar, asesorar, coordinar y evaluar los trabajos de revisión, actualización, implementación y monitoreo del Plan mencionado.

Nombre	Puesto y Oficina	Correo electrónico	Teléfono (Ext.)
Gilberto Vega Braciale	Director OMME	vegagilberto96@yahoo.com	787-824-3050 (4103)
Nailin M. Santiago Pérez	Subdirectora Ordenamiento Territorial	nsantiago@salinas.pr.gov	(2332)
Pedro L. Burgos Romero	Director Obras Publicas	pburgos@salinas.pr.gov	(4203)
Yarida Oppenheimer Sánchez	Directora Prog. Federales	yoppenheimer@salinas.pr.gov	(4007)
Lercy E. Pastrana Cruz	Ayudante Ejecutiva	lpstrana@salinas.pr.gov	(2102)
María L. Rivera González	Auxiliar Administrativo OMME	ommesalinas@yahoo.com	(4101)
Victor Ortiz Figueroa	Ayudante Especial	raditos0111@yahoo.com	(2505)
Plan. Raul Torres	Consultor	planificadortorres@yahoo.com	

Funciones principales del Comité:

- Coordinar con los trabajos relacionados con la actualización del Plan de Mitigación.
- Participar de talleres, presentaciones y reuniones sobre la actualización del Plan de Mitigación de Riesgos
- Proporcionar información, y datos sobre la evaluación de los riesgos y vulnerabilidades del municipio, así como las capacidades y los proyectos prioritarios de mitigación.
- Asegurar el cumplimiento con los requisitos estatales y federales para la elegibilidad de fondos de mitigación.

DIRECCIÓN: PO BOX 1149 SALINAS, PUERTO RICO 00751 TEL: (787) 824-3050 EXT. 2102 EMAIL: ALCALDESA@SALINAS.PR.GOV
MUNICIPIOSALINAS.COM

- Ayudar a diseñar y proponer acciones y proyectos de mitigación al municipio para fortalecer la resiliencia y reducir los riesgos de desastres.
- Mantener comunicación con la ciudadanía y promover la participación comunitaria en el proceso de mitigación.
- Apoyar la adopción e implantación del Plan de Mitigación.

Esta designación tendrá vigencia inmediata y se mantendrá en efecto hasta que se notifique lo contrario.

Firmada hoy, 22 de enero de 2026, en Salinas, PR.

Cordialmente,

KARILYN BONILLA COLÓN
Alcaldesa

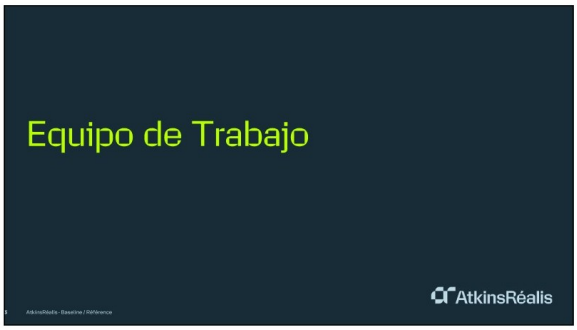
First Planning Committee Meeting

Presentation

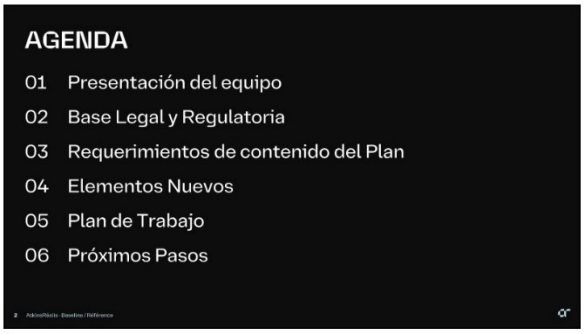
February 3, 2026



1



3



2



4



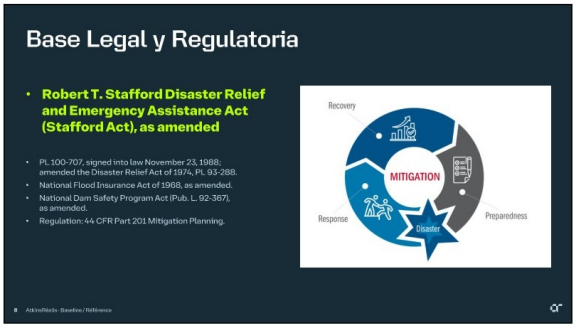
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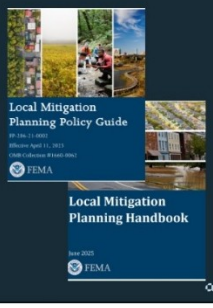
6



8

Requerimientos del Plan de Mitigación

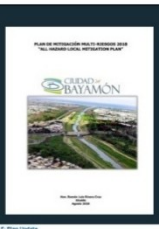
- Elemento A: Proceso de Planificación
- Elemento B: Identificación de Peligros y Evaluación de riesgos
- Elemento C: Estrategias de Mitigación
- Elemento D: Plan de Seguimiento e Implementación
- Elemento E: Actualización del Plan
- Elemento F: Adopción del Plan
- Elemento G: Peligros Potenciales ante fallos en Represas (opcional)
- Elemento H: Requisitos Estatales Adicionales



9

Elementos nuevos del Plan

- **Actualización del Plan: "Review Tool" especifica los elementos que se deben documentar para reflejar los cambios**
  - El Plan describe los cambios en las áreas propensas a peligros (ha incrementado o disminuido la vulnerabilidad o peligro)
  - Deberá reflejar los cambios en prioridades y progreso de los esfuerzos locales de mitigación.





11

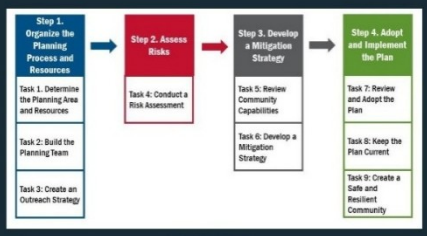
Elementos nuevos del Plan

1. **Identificación y evaluación de riesgos**
   - Se clasifica la infraestructura crítica por servicio vital o línea de vida
   - Se analiza su exposición y vulnerabilidad
   - Se prioriza por línea de vida
2. **Evaluación de capacidades**
   - Se evalúa la capacidad local para proteger servicios vitales
   - Se identifican brechas y se proponen acciones
3. **Estrategia de Mitigación**
   - Se incluyen acciones específicas para proteger, estabilizar y restaurar servicios vitales
4. **Participación de Partes Interesadas**
   - Se invita a agencias responsables o representantes de servicios vitales y se documenta su participación
   - Se comunica al público y recopila retroalimentación sobre los servicios vitales



10

Proceso del Plan de Mitigación



12

Riesgos a Evaluar

13

Represas





Aguas Buenas



Comerío

15

Peligros a considerar


Terremoto


Modificaciones costeras


Marejada Ciclónica


Fuego Forestal


Deslizamientos


Inundaciones


Calor Extremo


Pandemia/ Epidemia


Tsunami


Ciclones Tropicales


Sequías

14

¿Qué necesitamos del Municipio?

- Designación del Comité de Planificación
- Apoyo en la actualización de las estrategias de mitigación del plan anterior.
- Incorporación de nuevas estrategias de mitigación.
- Actualizacion de capacidades

16

Evaluación de Capacidades

17

Capacidades

- Planificación y Reglamentación
- Técnica
- Financiera
- Alcance Comunitario
- Desarrollo de Capacidades

18

Ventana para la primera actividad de participacion ciudadana



2 de marzo al 13 de marzo

Debe informar su fecha de reunion antes del lunes 9 de febrero.

Favor proveer varias fechas para que su analista de Planificación pueda estar.

De no recibir las fechas en o antes del lunes 9, su reunión será calendarizada después de las de otros municipios.

21

Comunicación

22

Participación Ciudadana

19

Participación Ciudadana

- Dos reuniones de participación ciudadana.
- Notificación sera publicada por Junta de Planificación.
- Publicar 15 días antes de la reunion
- Se otorga 15 días para comentarios
- Para la Segunda reunion se discute el primer borrador.
- El primer borrador sera comentado por el publico, el municipio y la Junta de Planificación



20

PLANIFICACION

Información de Contacto

Programa	Junta de Planificación	prpb.lhmp@atkinsrealis.com
Plan. Ivette Colón	Junta de Planificación	colon_i@jp.pr.gov
Plan. William Pitre	AtkinsRéalis Caribe	William.Pitre@atkinsrealis.com /+19392051336

Pedimos que el título de todo correo comience únicamente con el nombre del municipio.
Ej.: "San Germán – Tablas de Mitigación Actualizadas"

Solicitamos que en todo correo electrónico relacionado con el programa se copie siempre al correo oficial: **prpb.lhmp@atkinsrealis.com**

23

Grupos de Trabajo

24

Documentation

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

HOJA DE ASISTENCIA

Fecha: 9 de febrero de 2026 Hora: 9:00am Asunto: 1era Reunión –Revisión Plan de Mitigación contra Peligros Naturales

Nombre y dos apellidos	Teléfono	Municipio	Firma	Correo Electrónico
María L. Rivera Gonzalez				
Gilberto Vega Braclale				
Pedro L. Borgos Romero				
Nairin M. Santiago Pérez				
Raul A Tomas Ortiz				

Protected PII

MINUTA

PROYECTO:	PRPB 25 LHMP Update		
TITULO:	Salinas First Committee Meeting		
LUGAR DE LA REUNIÓN:	Junta de Planificación Salón A	**# REUNIÓN:**	1
FECHA Y HORA:	2/09/2026 @ 9:00AM	**MINUTA POR:**	Armando E. Rodríguez Aponte

Lista de Asistencia:

NOMBRE	INICIALES	COMPAÑÍA
Nailin Santiago	NS	Municipio de Salinas
Gilberto Vega	GV	Municipio de Salinas
Pedro Burgos	PB	Municipio de Salinas
Mari Rivera	MR	Municipio de Salinas
Raúl Torres	RT	Municipio de Salinas
Armando E. Rodríguez Aponte	AER	AtkinsRéalis

Asuntos Discutidos:

ID	ASUNTOS DISCUTIDOS
AD-1	Aprobación de Minuta Reunión Anterior: • N/A
AD-2	Asunto Relacionado con Alcance de Servicio Contratado y Entregables • N/A
AD-3	Plan de Trabajo Propuesta (Two Weeks Ahead / Four Week Ahead) • N/A
AD-4	Asuntos Nuevos • Se comenzó la reunión con una presentación que brindó el planificador William Pitre, de AtkinsRéalis, explicando en que consiste el proyecto, actividades,

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

ID	ASUNTOS DISCUTIDOS
	requisitos y como la Junta de Planificación y AtkinsRéalis van a estar preparando el Plan de Mitigación para los municipios. • Luego de la presentación, se inició la mesa de trabajo con el municipio. • A.Rodríguez se presentó y brindó un breve trasfondo de su experiencia con el Programa de Hazard Mitigation Grant Program. • A.Rodríguez solicitó al municipio confirmar los Puntos de Contacto (POC). El municipio indicó que el POC es Nailin Santiago. • Se repasó la lista del "Local Hazard Mitigation Plan" (LHMP) anterior, para que el municipio identificara el status de los proyectos como completados, en diseño, en subasta o que no se realizarán. o El municipio discutió los siguientes proyectos: ▪ P-10 – La AEE completo proyecto de construcción de charcas y una línea para traer agua de Patillas al municipio de Salinas. También indicó que la Autoridad de Acueductos y Alcantarillados tiene una nueva planta de filtración en diseño. ▪ PP-1 - El municipio indicó que han dado donativos a viviendas que no han recibido fondos de Mitigación, FEMA o seguros para sus reparaciones. Continúa pendiente. ▪ PP-3 - El municipio notificó que este proyecto está pendiente de revisarce con la Oficina de Ayuda al Ciudadano. Se está brindando ayuda a viviendas de madera y el municipio continúa buscando fondos e identificando fuentes de financiamiento para trabajar este proyecto ▪ PP-4 - El municipio ha identificado comunidades como, Villa Esperanza, Brisas del Mar y Borinquen, que pudieran beneficiarse de este proyecto. ▪ PP-6 - El municipio indicó que realizaron un inventario en la oficina de Oficina Municipal para el Manejo de Emergencias con 13k viviendas y el Plan de Recuperación municipal que trabajó con fondos de MRP también tiene data sobre las viviendas. El municipio trabajó un inventario de casas de maderas por barrio. ▪ PRN-2 – El municipio mencionó que sembró árboles pero, dadas las circunstancias secas del terreno no se han dado los mismos. En Aguirre se sembraron 100 palmas. En la PR-714, PR-1 y PR-52 se realizaron trabajos atendiendo deslizamientos. ▪ PR-1 – Añadió el municipio que tienen un proyecto de 60 millones de dolares, para la canalización del Río Nigua. Tienen otro proyecto con fondos de 404 para la Extensión Margarita y se está realizando un proyecto para el reemplazo de tubería y la salida hacia el río. ▪ PE-4 - Para la tormenta Fiona el Departamento de Obras Publicas reparó unas áreas de la PR-1 afectadas por la marejada ciclónica. El municipio en estos momentos no tiene proyectos para atender este problema y están identificando fondos. ▪ PE-2 - Atender casos nuevos por parte del municipio. Se está trabajando en el área de la playita con fondos municipales. ▪ PR- En espera de FEMA para aprobación del Proyecto de 404. ▪ PR-13 – Según indicado por el municipio, este tuvo varias reuniones de esto, pero por falta de fondos se ha aguantado. El

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

ID	ASUNTOS DISCUTIDOS
	diseño del soterrado eléctrico y telecomm del casco urbano se trabajó. Comunicaciones, liberty y claro estan realizando tareas para soterrar la fibra óptica en el municipio. • AER realizó una dinámica con el municipio llamada "Planning Poker" ○ Se le preguntó al municipio que si recibieran fondos ilimitados para realizar un solo proyecto de mitigación, cual sería y por qué. ▪ Entre los proyectos seleccionados por el personal están los siguientes: • Curva de Melquiades - PR-701 el proyecto ya cuenta con dinero de 404 para poner unas bombas y el reemplazo de la tubería existente. Está en proceso de subasta. • Bombas DRNA de playa y playita, el lugar tiene tuberías colapsadas, y se están alquilando bombas para sacar el agua. • Proyecto extensión La Carmen, inundación, El municipio quiere continuar la construcción de la tubería. Este es un proyecto que se comenzó y no se ha terminado. Habría que evaluar diseño nuevamente y construcción de la tubería. • Control de escorrentías en el casco urbano • AER realizó una segunda dinámica en la que indicó que nuevamente contaban con fondos ilimitados y preguntó cuál sería el segundo proyecto de mitigación seleccionado por el municipio. ○ El equipo del municipio respondió con los siguientes proyectos: ▪ Construcción de rompeolas y trabajos para atender la erosión costera en el municipio. ▪ Trabajar con el acuífero. • A.Rodríguez preguntó que, del uno (1) al tres (3), siendo tres (3) el mayor impacto, cómo el municipio entiende que en cada peligro representa impacto para el municipio: ○ Sequía - 3 ○ Inundación 3 ○ Terremoto - 2 ○ Fuego - 2 ○ Deslizamiento - 1 ○ Tsunami -3 ○ Modificaciones Costa - 3 ○ Ciclones Tropicales - 3 ○ Marejada Ciclónica - 3 ○ Calor Extremo - 3 ○ Pandemia - 3 A.Rodríguez dio por culminada la dinámica e indicó que el correo electrónico para enviar o solicitar información es prpb.lhmp@atkinsrealis.com. También informó que es importante que, cada vez que envíen un correo electrónico, el título comience con el nombre del municipio, en este caso Salinas, seguido de una breve descripción del contenido, con el fin de archivar y atender las comunicaciones de manera más eficiente. • A.Rodríguez solicitó al municipio el envío del logooficial. Este será enviado vía correo electrónico.

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

ID	ASUNTOS DISCUTIDOS
	• El municipio confirmó la fecha de la reunión comunitaria para el 12 de marzo de 2026 a las 6:00 p.m. en el Teatro de La Escuela Luis Muñoz Rivera.
AD-5	Discusión de Acciones por Tomar • Tabla Inferior
AD-6	Coordinación Próxima Reunión • TBD

Acciones Por Tomar:

ID	ACCIONES POR TOMAR	FECHA LÍMITE	ENTIDAD RESPONSABLE
AT-1	Recibir logo	2/13/2026	Mun. Salinas

Acuerdos/Aclaraciones:

ID	DESCRIPCIÓN
AC-1	N/A

Anejos:

ID	DESCRIPCIÓN ANEJO	NÚMERO DE PÁGINAS
AN-1	N/A	

PRÓXIMA REUNIÓN:	TBD		
MEDIO DE DISTRIBUCIÓN:	Email		
FECHA DISTRIBUCIÓN:	02/12/2026	**ARCHIVO DE REFERENCIA:**	First Planning Committee Meeting (Isabela)

NOTA A LOS DESTINATARIOS:
Estas notas de la reunión reflejan la interpretación de AtkinsRéalis sobre la reunión y las acciones previstas que se derivan de la misma. Se asumirá su conformidad en que estas notas constituyen un registro fiel de lo discutido, a menos que se reciban comentarios adversos por escrito dentro de los cinco (5) días posteriores a su recepción.

Appendix C – Public Participation and Outreach

First Public Meeting Notification



Municipio Salinas
Mar 11 ·

MAÑANA: PRIMERA REUNIÓN DE PLANIFICACIÓN

El Municipio de Salinas se encuentra actualizando su Plan de Mitigación contra Peligros Naturales, por lo que, junto a la Junta de Planificación, les invitamos a participar de nuestra primera reunion cpmuniaria para escuchar sus sugerencias y necesidades para una preparación efectiva de peligros naturales.

Día: Jueves, 12 de marzo de 2026
Hora: 6:00pm
Lugar: Teatro Esc. Luis Muñoz Rivera

¡Ayúdenos a compartir esta información!



Write a comment...

MUNICIPIO AUTÓNOMO DE SALINAS
OFICINA MUNICIPAL PARA EL MANEJO DE EMERGENCIAS
Sr. Gilberto Vega Braciale - Director

INFORME OFICIAL DE REUNIÓN

Convocatoria a la Comunidad – Primera Reunión para la Planificación del Plan de Mitigación

Fecha: 12 de marzo de 2026
Hora de convocatoria: 6:00 p.m.
Hora de inicio de presentación: 6:20 p.m.
Lugar: Teatro de la Escuela Luis Muñoz Rivera, Salinas, Puerto Rico

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1. Propósito de la reunión

La reunión tuvo como propósito convocar a la comunidad del Municipio de Salinas para participar en el proceso de revisión y actualización del Plan de Mitigación contra Peligros Naturales, promoviendo la integración de recomendaciones ciudadanas, estrategias, metas y objetivos dirigidos a la prevención y manejo de emergencias.

---

2. Apertura y presentación

La actividad dio inicio a las 6:20 p.m. con la presentación de los miembros del comité municipal presentes:

- Sr. Gilberto Vega
- Sra. María L. Rivera
- Sr. Víctor Ortiz
- Sra. Nailin Santiago
- Sr. Raúl Torres
- Sr. Pedro Burgos

La Sra. Vanessa Marrero, representante de la Junta de Planificación, estuvo a cargo de dirigir la reunión.

---

3. Exposición principal

La Sra. Vanessa Marrero informó los siguientes puntos relevantes:

- El Plan de Mitigación de Emergencias se encuentra en proceso de actualización.
- Este plan se revisa cada cinco (5) años.
- Está enfocado en la identificación y manejo de peligros naturales.
- Su propósito principal es fortalecer la capacidad de respuesta ante emergencias.
- Una vez finalizado, el plan será presentado al municipio para su revisión y adopción.
- La reunión tiene como objetivo recopilar insumos de la ciudadanía para el desarrollo de estrategias, metas y objetivos preventivos.
- Se continúa con el mantenimiento y documentación del plan.

- La Junta de Planificación agrupa un total de 25 municipios.
- La actualización del plan se realiza conforme a las guías de FEMA 2025.

Además, solicitó a los participantes:

- Completar una encuesta mediante un código QR.
- Evaluar los mapas del Municipio de Salinas para identificar áreas de riesgo y proponer cambios.

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4. Información adicional del comité

El Sr. Gilberto Vega informó que el municipio cuenta con cuatro (4) refugios, para los cuales se están proveyendo las coordenadas correspondientes.

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5. Participación ciudadana y recomendaciones

Durante la sesión de participación, los asistentes presentaron diversas preocupaciones y recomendaciones:

- El Hon. Elvin Negrón señaló problemas de escorrentía desde el Barrio Sabana Llana hacia el Barrio Coco, así como situaciones en la quebrada del sector Húcar.
- La Hon. Mildred Correa identificó áreas de riesgo en el Barrio Playita, mencionó la necesidad de mantenimiento de bombas, inundaciones en Calle Villa Sol, marejadas e inundaciones en la Calle 3 del Barrio Playa.
- El Sr. Carlos M. Santiago indicó inundaciones en Extensión La Carmen (Calle Antonio Ledee) debido a tuberías incompletas, al no llegar a la calle Colon Pacheco, además de la acumulación de agua en un terreno cercano a un restaurante de comida rápida (KFC), lo que provoca desbordes hacia la comunidad, alcanzando niveles de hasta cinco (5) pies.
- La Sra. Diana Santi informó inundaciones en Barrio Coquí, Urbanización Paseo Costa Sur y Urbanización Las Trinitarias, atribuidas a construcciones recientes de placas solares.
- El Sr. José Cora advirtió sobre el alto riesgo de incendios forestales en Rancho Guayama.
- La Sra. Yamilet Rodríguez destacó inundaciones del Río Nigua y canales, recomendando medidas de prevención contra la deforestación, control de sedimentación y la inclusión de medidas protectoras en el plan. También expresó preocupación sobre la instalación de una planta de gas propano en la termoeléctrica del Aguirre y sus posibles riesgos de derrames con las residencias que están pagadas a la división (verja) de la termoeléctrica. A su vez está solicitando copia de cada uno de los planes de futuros proyectos.
- La Sra. Ruth Santiago cuestionó si los proyectos contemplan estudios hidrológicos y solicita la publicación de esta información.
- El Sr. Carlos Santiago solicitó información sobre la fecha de presentación del plan.
- El Sr. José Cora preguntó si el plan abarcará y será presentado a todos los barrios y sectores.
- La Sra. Diana Santi reiteró preocupaciones sobre el impacto de proyectos nuevos en comunidades y expresó su expectativa de que el plan esté actualizado para el verano para que todas sus preocupaciones estén plasmadas en el plan.

- La Sra. Zinnia Vélez solicitó inspecciones en áreas donde se desarrollan construcciones tipo Airbnb que afectan el drenaje y las comunidades, además de visitar las comunidades para documentar el impacto real en el Plan.
- La Sra. Lourdes Ramos alertó sobre riesgos asociados a la fábrica Steri Tech debido al uso de químicos.
- La Sra. Ruth Santiago presentó un estudio sobre el ecosistema para que observaran el impacto de la deforestación en el aumento de los desastres en Salinas. Reiterando nuevamente las preocupaciones sobre la termoeléctrica de Aguirre.

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6. Clausura

La reunión concluyó a las 7:43 p.m., con una asistencia total de treinta (30) participantes.

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7. Conclusión

La actividad permitió recopilar información valiosa de la comunidad sobre riesgos existentes, necesidades y recomendaciones. Estos insumos serán considerados en la actualización del Plan de Mitigación del Municipio de Salinas, fortaleciendo así la planificación estratégica y la resiliencia ante eventos naturales.

Preparado por: Sra. Cynthia Cruz
OMME Salinas

Fecha: 19 de marzo de 2026.

JUNTA DE PLANIFICACIÓN
GOBIERNO DE PUERTO RICO

PLANES DE MITIGACIÓN
CONTRA PELIGROS NATURALES
Planificar para proteger

HOJA DE ASISTENCIA

Asunto: 1era Reunión de Planificación con la Comunidad- Municipio de Salinas
Fecha: 12 de marzo de 2026
Lugar: Teatro Escuela Luis Muñoz Rivera, 12 calle Monserrate Bo. Puelo
Hora: 6:00 pm

Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
Ruth Santiago				
Nora Pérez Alvarado				
Dany Santos				
Lourdes Rivas				
Abdiel Colón				
Ada Ramona Alb				
Gerónimo Vazquez				
Yamirets Rodríguez				
Diana Santi				

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HOJA DE ASISTENCIA

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Hora: 6:00 pm

Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
Pedro L. Burgos				
Maria Ruiz				
Elvis E. Nieves				
Milagros Franco				
Mildred Correa				
José J. Cora				
Zinnia Velez				
Emilio Nieves				
Rosa Moreno				
Vanessa Marrero				

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Hora: 6:00 pm

Nombre completo (en letra de molde)	Municipio/Barrio/ Comunidad	Teléfono	Correo electrónico	Firma
Gilberto Vega Bracetti				
María L. Rivera González				
Sherlene Ortiz				
Carlos Alonso				
[illegible]				
Víctor R. Ortiz				
Héctor L. Santiago Torres				
Nailin M. Santiago				
Raúl Torres Ortiz				
Carlos Santiago				

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PLANIFICACIÓN
REVISIÓN Y ACTUALIZACIÓN DEL
PLAN DE MITIGACIÓN CONTRA
PELIGROS NATURALES




1925
ESCUELA LUIS MUÑOZ RIVERA






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CONCEPTOS IMPORTANTES

Appendix D: Stakeholder Involvement