

## **Memorandum – Coastal Engineering Review**

### **Summary of Geologic Resources Inventory (GRI) Support Documents: Fire Island National Seashore (FIIS)**

February 2026

#### **Review Request Summary**

The Geologic Resource Inventory (GRI) is one of 12 baseline natural resource inventory efforts within the National Park Service (NPS) Inventory and Monitoring (I&M) Division. The GRI is a cooperative effort between the NPS, Colorado State University, and the University of Alaska Fairbanks. It strives to advance science-based management of natural resources in the national parks and raise awareness about geology and the role that geologic features and processes play in the environment.

The GRI team, working closely with a variety of partners, provides each of the approximately 270 parks in the I&M networks with a geologic scoping meeting, digital geologic map data and poster, and a park-specific geologic report. These products are designed to enhance stewardship of park resources by providing valuable information about geologic formations, processes, hazards, and links among geology, history, and other natural resources. The National Park Service identified 13 coastal parks that have geologic scoping meeting summaries and at least one digital geologic map, but do not have a traditional GRI report: Biscayne National Park (BISC), Cape Cod National Seashore (CACO), Canaveral National Seashore (CANA), Castillo de San Marcos National Monument (CASA), Cumberland Island National Seashore (CUIS), Fire Island National Seashore (FIIS), Fort Caroline National Memorial (FOCA), Fort Frederica National Monument (FOFR), Fort Matanzas National Monument (FOMA), Fort Pulaski National Monument (FOPU), Fort Sumter and Fort Moultrie National Historical Park (FOSU), Gateway National Recreation Area (GATE), and Timucuan Ecological and Historic Preserve (TIMU). As of spring 2024, the GRI team is transitioning to a proposal-based system, and not all parks will receive a traditional report, including all 13 of the identified coastal parks. Many of these coastal parks were originally scoped in the early 2000s and have map products approaching or now exceeding 20 years old. Therefore, to provide a status update to the coastal parks in lieu of a traditional report, the GRI team requested assistance from EA Engineering, Science, and Technology, Inc., PBC (EA), with the following:

- Prepare park-specific literature reviews focused on geologic resources to provide data resource for future work
- Prepare a literature review of service-wide and regional resources that could be useful to multiple parks
- Evaluate available digital geologic map data for each park and assess its relevance to coastal management needs

## Literature Reviews

### Introduction

The literature review for each park consists of an Excel spreadsheet listing all identified sources and PDF files for each source. The spreadsheet includes a link that opens the associated PDF file directly. These files for Fire Island National Seashore can be downloaded from the NPS DataStore at:  
<https://irma.nps.gov/DataStore/Reference/Profile/2317164>.

### Methodology

To ensure consistency across parks, EA followed the steps below when searching for sources:

- Checked EA servers for project files already in EA possession or previously cataloged in literature reviews, annotated bibliographies, memorandum reference lists, and related materials.
- Reviewed the GRI Product Page (NPS 2024a) to identify GRI products previously compiled by the National Park Service for each park unit.
- Conducted an advanced search of NPS DataStore using the following methods:
  - In the Text Fields section, enter:
    - *Description* contains geolog\*
    - OR *Title* contains geolog\*
    - OR *Keyword* contains geolog\*
  - In the Content Units section, enter the four-letter code for the park unit/select it from the list
- Completed a general Google search focused on scholarly articles. When results were excessive, searches were refined by applying a publication date cutoff of 2016 or 2017.
- Reviewed the following resources relevant to multiple parks:
  - Coastal engineering inventories of select parks (NPS 2013a)
  - The NPS Paleontology Library, a repository for electronic copies of geology and paleontology publications, reports, and other media, including the following paleontological resource inventory types:
    - Park-specific Paleontological Resource Inventories (NPS 2024b)
    - Service-wide Thematic Paleontological Resource Inventories (NPS 2023a)
    - I&M Network Based Paleontological Resource Inventories (NPS 2023b)
  - Shoreline change project maps for 88 ocean and Great Lake park units (NPS 2022a)
- Reviewed reference lists from reports already identified, particularly those that were comprehensive, relevant, and/or recently published.
- Used the following resource topics as a starting point for search terms (this list is not exhaustive, and additional terms were added based on park-specific topics):

- |                           |                                      |
|---------------------------|--------------------------------------|
| – Surficial features      | – Saltwater intrusion                |
| – Hydrogeomorphic map     | – Sediment transport                 |
| – Unconsolidated deposits | – Hydrology and hydrogeology         |
| – Storm impacts           | – Nearshore/seafloor/benthic habitat |
| – Erosion                 | – Shoreline evolution                |
| – Overwash                | – Paleontology/fossils               |
| – Breaches                | – Land disturbance                   |
| – Inlet formation         | – Seismicity                         |
| – Sea level rise          | – Waves, currents, and tides         |
| – Marshes                 | – Wind                               |

### Spreadsheet Details

**Column A, File Name:** Each row in this column includes a unique filename identifier corresponding to a specific PDF file stored in the park folder. Each filename begins with the park four-letter identifier, followed by GRI, and then a sequential number (for example, FIIS GRI\_001).

**Column B, First-Level Grouping:** One of the following groupings was selected from the list below to best match the document scope:

- General/natural Resources
- Geology
- Coastal processes/geomorphology
- Habitat
- Engineering

**Column C, Date of Publication:** This is provided separately from the citation for ease of review.

**Column D, Citation:** These use a modified APA-style format. Examples are provided below.

Example of a journal article:

Schwab, W.C., W.E. Baldwin, C.J. Hapke, E.E. Lentz, P.T. Gayes, J.F. Denny, J.H. List, and J.C. Warner. 2013. Geologic Evidence for Onshore Sediment Transport from the Inner Continental Shelf: Fire Island, New York. *Journal of Coastal Research* Volume 29, Issue 3: pp. 526–544.

Example of an agency report:

US Army Corps of Engineers. 2007. *Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York Storm Damage Reduction Reformulation Study, Work Order 28, Inlet Modifications*. US Army Corps of Engineers, New York District, North Atlantic Division. 493 pp.

**Column E, Short Title/Access:** This includes the document title or a shortened version of the title and is linked directly to the associated PDF file.

**Column F, Literature Review Summary:** This includes the document abstract (if sufficiently concise) or a brief summary describing the scope and contents of the document, with a focus on relevance to geologic resources.

**Column G, Keywords:** This includes three to five keywords based on review of the document or keywords identified in NPS DataStore.

**Column H, Notes:** This is optional and is used to provide additional information, such as whether appendices are included as separate files or entries in the literature review.

### FIIS Literature Review Summary

FIIS consists of 26 miles of shoreline including beaches, dunes, interdune scrub, maritime forest, and wetland habitats that make up the chain of barrier islands. A total of 42 sources are provided in the park's literature review, dated from 1980 to 2022. EA developed keywords based on relevant coastal resources included in each reviewed source. They are provided in column G of the spreadsheet and are summarized below.

- |                                         |                                     |                                 |
|-----------------------------------------|-------------------------------------|---------------------------------|
| ▪ Aerial photograph                     | ▪ Cross-shore transport             | ▪ Geologic resources inventory  |
| ▪ Alongshore transport                  | ▪ Deposition                        | ▪ Geological features           |
| ▪ Barrier Island Breach management plan | ▪ Digital shoreline analysis system | ▪ Geomorphic analysis           |
| ▪ Barrier island                        | ▪ Dune breach                       | ▪ Geomorphological mapping      |
| ▪ Bathymetry data                       | ▪ Dune dynamics                     | ▪ Geomorphology                 |
| ▪ Bayside sediment                      | ▪ Dunes                             | ▪ Habitat classification        |
| ▪ Beach elevation                       | ▪ Ebb-tidal shoal                   | ▪ Historical changes            |
| ▪ Beach replenishment                   | ▪ Environmental impact statement    | ▪ Horizontal dispersion process |
| ▪ Beach                                 | ▪ Eolian transport                  | ▪ Human impacts                 |
| ▪ Benthic habitat mapping               | ▪ Erosion                           | ▪ Hurricane Sandy               |
| ▪ CMECS                                 | ▪ Estuarine resources               | ▪ Inlet modifications           |
| ▪ Coastal change                        | ▪ Flood mitigation                  | ▪ Landward migration            |
| ▪ Coastal engineering                   | ▪ Foredunes                         | ▪ LIDAR                         |
| ▪ Coastal erosion                       | ▪ Geologic features                 | ▪ Littoral sediment             |
| ▪ Coastal flooding                      | ▪ Geologic framework                | ▪ Major storm                   |
| ▪ Coastal geomorphology                 | ▪ Geologic issues                   | ▪ Model calibration             |
| ▪ Coastal processes                     | ▪ Geologic processes                | ▪ Morphology change             |

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- |                              |                                          |                                     |
|------------------------------|------------------------------------------|-------------------------------------|
| ▪ Ocean beach-dune ecosystem | ▪ Sediment transport                     | ▪ Surficial sediment classification |
| ▪ Ocean shoreline position   | ▪ Shore protection                       | ▪ Tidal inlets                      |
| ▪ Overwash                   | ▪ Shoreline change                       | ▪ Topography development            |
| ▪ Physical processes         | ▪ Shoreline management                   | ▪ Vehicle access                    |
| ▪ Reformulation study        | ▪ Storm damage reduction                 | ▪ Water levels                      |
| ▪ Sand                       | ▪ Stratigraphy                           | ▪ Wave run up                       |
| ▪ Seafloor mapping           | ▪ Sub-bottom seismic reflection profiles | ▪ Wilderness breach                 |
| ▪ Sediment budget            | ▪ Submerged habitat                      | ▪ Wilderness stewardship plan       |

In addition to park-specific literature reviews, a review was completed that includes service-wide and regional resources that may benefit multiple parks. These resources include vulnerability assessment protocols, monitoring protocols, climate change inventories/impacts, sea level rise scenarios/evaluations, coastal hazard assessments, and mapping tools that provide data for all parks, among others. Although resources are ideally provided as PDF documents, some are only useful when accessed digitally (e.g., mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a foundation for understanding the range of geologic resources in each park, as well as relevant internal National Park Service guidance and resources. The methodology described above may be used for future searches to update information, if desired.

## **Geologic Map Assessment**

### **Introduction**

Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps, such as coastal or geologic hazard maps, may be used by the GRI to create digital geographic information systems (GIS) data that meet park needs. These GIS data allow geologic information to be easily viewed and analyzed alongside other resource management information.

The GRI team compiled digital geologic maps for each of the 13 coastal parks: BISC, CACO, CANA, CASA, CUIS, FIIS, FOCA, FOFR, FOMA, FOPU, FOSU, GATE, and TIMU. As part of, and in parallel with, the GRI literature review process, EA assessed the relevance of the GRI GIS data sets (all available on the NPS DataStore; some exceeding 20 years old) to each park's current coastal management needs. This assessment is based in part on EA's perspective as technical experts well versed in NPS management requirements.

## Methodology

This work was completed without the use of GIS software and instead relied on review of the GRI Scoping Meeting Summary and the GRI Ancillary Map Information document, both available on NPS DataStore. For each park, EA's assessment focused on answering the following questions about the GRI digital geologic map(s):

1. Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?
2. Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park's current configuration?
3. Does an online search yield any maps that are more relevant?

In addition to park-specific literature reviews, a review was completed that includes service-wide and regional resources that may benefit multiple parks. These resources include vulnerability and monitoring protocols, climate change inventories and impacts, sea-level-rise scenarios and evaluations, coastal hazard assessments, and mapping tools that provide data for all parks. Although resources are ideally provided as PDF documents, some are only useful when accessed digitally (for example, mapping data).

Research and data are continually being published. These literature reviews may not be exhaustive; however, they provide a basis for understanding the range of geologic resources in each park, as well as internal National Park Service guidance documents and resources that may be used. The methodology described above can be followed in future searches to update information, if desired.

## FIIS Map Assessment

The information summarized below is based on information presented in the *Geologic Resources Inventory Scoping Summary Fire Island National Seashore* (Thornberry-Ehrlich 2011), the *Fire Island National Seashore GRI<sup>1</sup>* and the *Ancillary Map Information Document* (NPS 2016a), and the NPS DataStore page data for the FIIS GRI maps produced by GRD (NPS 2016a, NPS 2016b, and NPS 2016c). Information on the FIIS GRI maps is presented in table 1.

The scoping summary (Thornberry-Ehrlich 2011) identified a wide range of significant geologic resource management issues in FIIS (table 2). Table 2 lists each of the groups in the first column and identifies which existing GRI map products address them. Where existing maps provide incomplete information, the data-gap column is also shaded.

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<sup>1</sup> Note that the GRI program was briefly named the Geologic Resource Evaluation (GRE) program. The abbreviations GRI and GRE refer to the same program although products of different vintages may display either of the abbreviations.

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**Table 1-1. Summary of GRI map products for CUIS**

| GRI Map Product                           | Citation  | Data Layers                                                                                                                                                     | Sources                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Geomorphological Map                      | NPS 2016a | <ul style="list-style-type: none"> <li>– WIFEMRPHA (Geomorphologic Unit Boundaries)</li> <li>– WIFEMRPH (Geomorphologic Units)</li> </ul>                       | Psuty, N., Schmelz, W., and Spahn, A. 2014. <i>Development of the Geomorphological Map for William Floyd Estate, a unit of the Fire Island National Seashore: Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:6,000.</i> (Geomorphological Map for William Floyd Estate). (GRI Source Map ID 75946).                                          |
| Pre-Hurricane Sandy geomorphological map  | NPS 2016b | <ul style="list-style-type: none"> <li>– FIISMRPHA_pre_sandy (Geomorphologic Unit Boundaries)</li> <li>– FIISMRPH_pre_sandy (Geomorphologic Units)</li> </ul>   | Psuty, N. P., Patel, M., Freeman J., Schmelz, W., Robertson, W., and Spahn, A. 2013. <i>Development of the Geomorphological Map for Fire Island National Seashore: Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:12,000.</i> (preHurricane Sandy Geomorphological Map of Fire Island). (GRI Source Map ID 75677).                           |
| Post-Hurricane Sandy geomorphological map | NPS 2016c | <ul style="list-style-type: none"> <li>– FIISMRPHA_post_sandy (Geomorphologic Unit Boundaries)</li> <li>– FIISMRPH_post_sandy (Geomorphologic Units)</li> </ul> | Psuty, N. P., Patel, Schmelz, W., Greenberg, Joshua, Beal, Irina., and Spahn, A. 2015. <i>Development of the Geomorphological Map of Fire Island National Seashore (Post-Hurricane Sandy): Rutgers University, Institute of Marine and Coastal Sciences, unpublished digital data and map, scale 1:12,000.</i> (post-Hurricane Sandy Geomorphological Map of Fire Island). (GRI Source Map ID 76043). |

**Table 1-2. Geologic resource management issues addressed in existing GRI map products**

| Geologic Resource Management Issues           | Bedrock Geology Map | Pre-Hurricane Sandy Geomorphological Map | Post-Hurricane Sandy Geomorphological Map | Data Gap |
|-----------------------------------------------|---------------------|------------------------------------------|-------------------------------------------|----------|
| Coastal stabilization and management          |                     |                                          |                                           | X        |
| Climate change impacts                        |                     |                                          |                                           | X        |
| Fluvial and lacustrine features and processes |                     | X                                        | X                                         |          |
| Seismicity                                    | X                   |                                          |                                           |          |
| Visitor and resident use                      |                     |                                          |                                           | X        |
| Slope processes                               |                     | X                                        | X                                         |          |

Geologic Resource Management issues are provided in scoping meeting summary (Thornberry-Ehrlich 2011)

***Are the source maps (i.e., the maps that GRI digitized to create the GIS data sets) reasonably comprehensive in terms of features relevant to the coastal park? If not, what gaps are there?***

Several gaps exist in the GRI GIS datasets, relative to the list of park geologic resource management concerns listed above. These gaps include sea level rise to assess impacts on coastal features, a sediment budget assessment, and a re-assessment of the Coastal Erosional Hazard Area, defined by the New York Department of Environmental Conservation (DEC).

Geologic-GIS data for Fire Island National Seashore consists of a (bedrock) geology map (NPS 2013b), a pre-Hurricane Sandy geomorphological map (NPS 2016b), a post-Hurricane Sandy (NPS 2016c) geomorphological map, and a map of the William Floyd Estate unit (NPS 2016a). Data files for the geomorphology maps are named using the park four letter code (FIIS) as a prefix, whereas the bedrock geology map uses the four-letter code FIIB (GRI map abbreviation for Fire Island Bedrock). The William Floyd Estate map uses an abbreviation of WIFE (GRI map abbreviation for William Floyd Estate). Although pre- and post-Hurricane Sandy geomorphological maps share the same four-letter FIIS code, individual files for each map include either “\_pre-sandy” or “\_post-sandy” in their filenames to distinguish the map to which they belong. Files common to both geomorphological maps such as the ancillary information document (fiis\_geomorphology.pdf) do not include this designation in their file name because they apply to both geomorphological maps. The FIIS pre-sandy, FIIS post-sandy, and FIIB datasets each provide complete coverage of the park and surrounding area.

***Are the source maps recent enough (relative to extreme storms, especially) to accurately represent the park’s current configuration?***

The source maps are dated 2014 and 2015 and reflect impacts from major hurricanes that occurred prior to that period. However, they do not capture shoreline changes that have occurred since then, which may be substantial given the highly dynamic nature of the coastal system.

***Does an online search yield any maps that are more relevant?***

The geologic classification map (LaFrance Bartley 2017) may be useful in providing an updated application of the Coastal and Marine Ecological Classification Standard (CMECS). The Coastal Engineering Review (EA Engineering 2021) evaluates basic site characteristics, existing conditions along Burma Road and surrounding protected wetland habitat, potential future impacts due to climate change, and options for restoring the functionality of both the roadway and adjacent wetlands. This review helps address several climate-change-related knowledge gaps identified above. In addition, the *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part I—Ocean Shoreline Position, Version 2* provides updated shoreline change metrics. These data help address gaps related to coastal stabilization, management, and slope-processed shoreline change information identified in the list above.

Additional online sources of GIS information relevant to the park's identified geologic resource management issues include:

- Digital Elevation Models and LiDAR data from NOAA Digital Coast: Data Access Viewer (NOAA Office for Coastal Management [OCM] 2024)
- NOAA OCM Sea Level Rise Viewer (NOAA OCM 2024b)
- NOAA OCM Historical Hurricane Tracks (NOAA OCM 2024c)

**Reference List:**

LaFrance Bartley M. 2017. Geological Classification Map of Fire Island National Seashore, NY

EA Engineering, Science, and Technology, Inc., PBC (EA).

- 2021 *Coastal Engineering Review, Fire Island National Seashore (FIIS): Burma Road Flooding*. Geologic Resources Division (GRD), National Park Service (NPS). 6 pp.

LaFrance Bartley M.

- 2017 *Geological Classification Map of Fire Island National Seashore, NY*. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2278252>. Accessed March 2024.

National Oceanic and Atmospheric Administration Office for Coastal Management (NOAA OCM).

- 2024a “2022 USACE USGS Topobathy Lidar DEM: East Coast (NY, NJ)”. Available online: <https://www.fisheries.noaa.gov/inport/item/70179>. Accessed March 2024.
- 2024b Sea Level Rise Viewer. Available online: <https://coast.noaa.gov/slr/#/layer/slr>. Accessed March 2024.
- 2024c Historical Hurricane Tracks. Available online: <https://coast.noaa.gov/hurricanes/#map=4/32/-80>. Accessed March 2024.

National Park Service (NPS)

- 2013a “Coastal Engineering Projects Inventory.” National Park Service, Natural Resource Stewardship and Science. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2193512>. Accessed March 2024.

- 2013b “Unpublished Digital Geologic Map of Long Island, New York (NPS, GRD, GRI, FIIS, FIIB digital map) adapted from a U.S. Geological Survey Professional Paper map by Fuller (1914)”. National Park Service Geologic Resources Inventory Program. Lakewood, Colorado. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2202595>.
- 2016a “Unpublished Digital Geomorphological Map of the William Floyd Estate, Fire Island National Seashore, New York (NPS, GRD, GRI, FIIS, WIFE digital map) adapted from a Rutgers University, Institute of Marine and Coastal Sciences map by Psuty, Schmelz and Spahn (2014)”. National Park Service Geologic Resources Inventory Program. Lakewood, Colorado. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2229137>. Accessed February 2026.
- 2016b “Unpublished Digital Pre-Hurricane Sandy Geomorphological Map of Fire Island National Seashore and Vicinity, New York (NPS, GRD, GRI, FIIS, FIIS pre-Hurricane Sandy digital map) adapted from a Rutgers University, Institute of Marine and Coastal Sciences map by Psuty, Patel, Freeman, Schmelz, Robertson and Spahn (2014 National Park Service Geologic Resources Inventory Program. Lakewood, Colorado. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2202596>. Accessed February 2026.
- 2016c “Unpublished Digital Post-Hurricane Sandy (2015) Geomorphological Map of Fire Island National Seashore and Vicinity, New York (NPS, GRD, GRI, FIIS, FIIS post-Hurricane Sandy digital map) adapted from a Rutgers University, Institute of Marine and Coastal Sciences map by Psuty, Schmelz, Greenberg, Beal and Spahn (2015)”. National Park Service Geologic Resources Inventory Program. Lakewood, Colorado. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2229136>. Accessed February 2026.
- 2022a “Shoreline Change Project.” National Park Service, Natural Resource Stewardship and Science. Available online: <https://irma.nps.gov/DataStore/Collection/Profile/9272>. Accessed March 2024.
- 2022 Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part I—Ocean Shoreline Position, Version 2. Natural Resource Report. NPS/NCBN/NRR—2022/2415. National Park Service. Fort Collins, Colorado.
- 2023a “Thematic Paleontological Resource Inventories.” Available online: <https://www.nps.gov/subjects/fossils/thematic-inventories.htm>. Accessed March 2024.
- 2023b “I&M Network Based Paleontological Resource Inventories.” Available online: <https://www.nps.gov/subjects/fossils/network-surveys.htm>. Accessed March 2024.
- 2024a “Geologic Resources Inventory—Products.” National Park Service, Geologic Resources Division. Available online: <https://www.nps.gov/subjects/geology/geologic-resources-inventory-products.htm>. Accessed March 2024
- 2024b “Park-specific Paleontological Resource Inventory Reports.” Available online: <https://www.nps.gov/subjects/fossils/park-surveys.htm>. Accessed March 2024.

Thornberry- Ehrlich, Trista L.

- 2011 *Geological Resources Inventory Scoping Summary Fire Island National Seashore*. Prepared for the Geologic Resources Division. National Park Service. Available online: <https://irma.nps.gov/DataStore/Reference/Profile/2250168>. Accessed February 2026.