

Pamlico County

FEMA Building Resilient Infrastructure and
Communities Grant Program

Benefit-Cost Analysis Methodology

January 6, 2023

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1. PROJECT OVERVIEW

This report will cover the data and methodology used to complete the Benefit Cost Analysis (BCA) for the Bay River Metropolitan Sewer District (BRMSD) Facultative Lagoon System Renovation and Capacity Upgrades project. This project will repair damage to an existing wastewater treatment plant and construct additional treatment facilities to provide a safe and economic solution to provide wastewater services to areas of Pamlico County that are experiencing failed septic tank systems and also prevent raw sewage from spilling into local water ways during flood events.

1.1 Project Background

1.1.1 Oriental Wastewater Treatment Plant

Bay River Metropolitan Sewer District, Oriental Wastewater Treatment Plant is located outside of the Town of Oriental at 790 White Farm Road (SR 1349), Latitude: 35.045353° and Longitude: -76.685403°. This facility is currently permitted for 200,000 gpd using facultative lagoon treatment. In 2016 the facility was permitted for a capacity of 400,000 gpd conditioned upon conversion from facultative lagoons to partial mix aerated lagoons. The lagoons walls have eroded and settled since construction in 1984. Which have led to the BRMSD to receive Notice of Violations for excessive erosion of the dike walls and for exceeding the freeboard limits in the treatment lagoon. The treatment facility is located in the 500-year flood zone, see **Appendix B**.

This project will convert the facultative lagoon to a partial mix aerated lagoon by installation of surface aerators and floating baffle curtains. The erosion and settlement of the dyke walls will be repaired and raised to increased. This will mitigate the possibility of raw sewage overtopping the dykes and prevent failure of the dyke walls due to erosion.

1.1.2 Arapahoe Treatment Facility

The next area of the project will be Arapahoe Facility. This facility is located at 5044 NC 306 Highway South, Latitude: 35.061288° and Longitude: -76.841056°. This facility land applies treated wastewater by spray irrigation. Arapahoe facility suffered capacity loss during Hurricane Florence. The facility loss was approximately 25% sewage disposal capacity, 156,500 gallons per day, due to destruction of loblolly pine trees. Replacement at the Arapahoe site is not feasible due to the loss of trees necessary for nitrogen uptake. Soil Scientist and Hydrogeologist investigation have identified a site on Lee Landing Road as being the most technologically feasible stie for construction of replacement irrigation fields. The location of this site is Latitude: 35.107874° and Longitude: -76.926221°.

This project will include the purchase of approximately 165 acres of land. Because this site is not along the route of the effluent force main, which conveys treated sewage effluent from Bayboro effluent storage pond, a new aerated lagoon and wet weather storage pond will be constructed onsite. Construction of replacement irrigation fields will be constructed on site.

2. FEMA GUIDANCE AND SOFTWARE

Information provided in this report relied on the methodology provided in FEMA BCA Reference Guide and Supplement and BCA Toolkit Version 6.0. Statistical determination of likely occurrence and engineering assessments was used to provide data for the BCA.

3. HISTORIC EVENTS

In accordance with FEMA BCA Reference Guide and Supplement, Historical loss data can be used to calculate benefits to be used in the BCA. Alternatively, expected losses associated with modeled events may be used in the BCA Toolkit. BRMSD has a long history with precipitation-based flood events due to being located along the Neuse River with little elevation relief. BRMSD lacked the adequate documentation of historical flooding events and to show a history of erosion at the Oriental Lagoon. This report relied on the precipitation event frequencies to calculate the Benefit-Cost-Ration (BCR), see **Appendix C**.

4. PROJECT AND MAINTENANCE COSTS

The total project cost and annual maintenance costs for this project is provided below. Annual Maintenance costs for operational maintenance of the dykes of each lagoon and ground maintenance.

Project	Project Cost	Annual Maintenance Cost
BRMSD Facultative Lagoon System Renovation and Capacity Upgrade	\$9,700,00.00	\$5,580.00

5. PROJECT USEFUL LIFE

Useful life of the project assets was determined using FEMA BCA Reference Guide 2009 – Project Useful Life Table, see **Appendix D**. A useful life of 50 years will be applied to major infrastructure assets (lagoons) and 5 years for minor assets (pumps, generators, wastewater system). These values were used in the BCA Toolkit.

6. SERVICE POPULATION

Utility benefits were calculated in the BCA Toolkit based on number of customers served by BRMSD. BRMSD has ±3000 customers. Based on US Census data for Pamlico County the number of persons per household is 2.26 (**Appendix F**). Number of customers served was calculated based on the number of customers (3000) and the persons per household (2.26).

$$3000 \times 2.26 = 6780 \text{ customers served}$$

7. RECURRENCE INTERVALS

The recurrence intervals used for the for this project is based off of a large storm event that occurred in September 2018. During this storm BRMSD received 9.7 inches of rain in 24 hours. The rain amount was recorded on the monthly operating report for the wastewater treatment plant. Rainfall data was compared to the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates (**Appendix C**). Based off of 10 inches of rainfall in 24 hours the recurrence interval is 50 years.

8. LOSS OF SERVICE

During the September storm event a loss of service of 0.50 hours occurred.

9. RESULTS

The BCR for this project is 0.01. The BCA report is provided in **Appendix A** and the BCA Excel Spreadsheet is attached to the project application.

Appendix A

Benefit Cost Analysis Toolkit Export



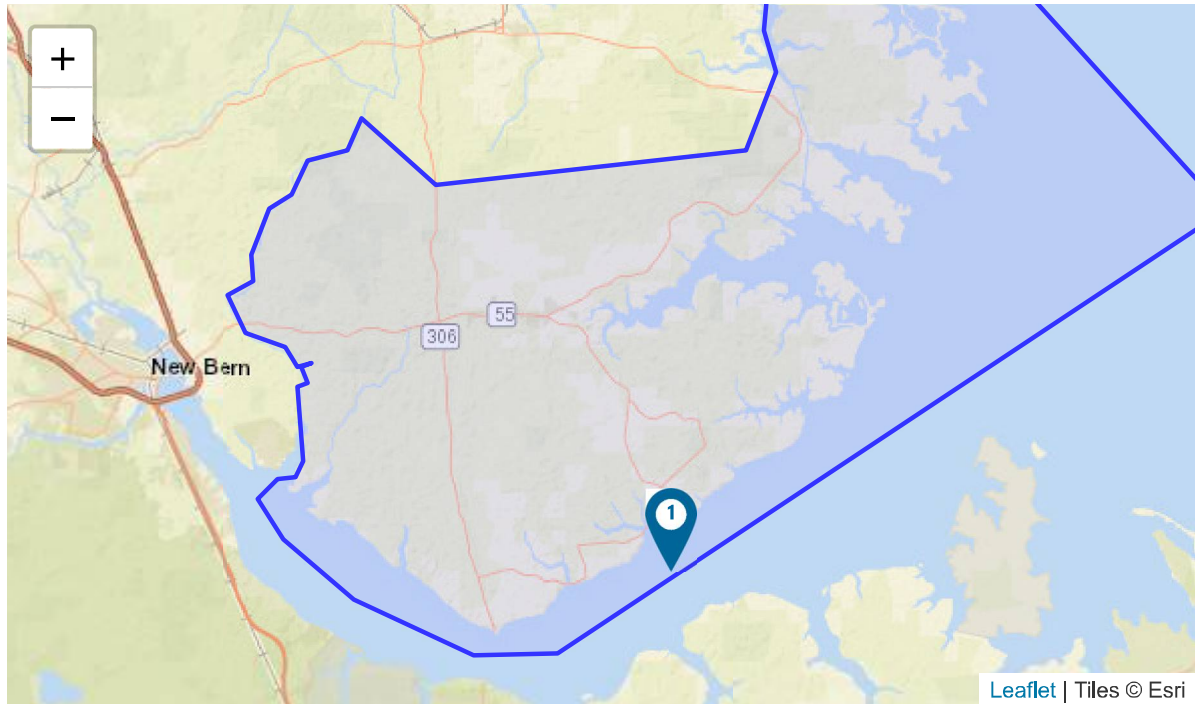
FEMA


Benefit-Cost Calculator

V.6.0 (Build 20230103.1822 | Release Notes)

Benefit-Cost Analysis

Project Name: Bay River Metropolitan Sewer District Facultative Lagoon System Renovation and Capacity Upgrades



Using 7% Discount Rate							Using 3% Discount Rate (For FY22 BRIC and FMA only)			
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)	
1	Other @ 35.0000000; -76.6833500		DFA - Infrastructure Failure	\$ 45,128	\$ 9,777,008	0.00	\$ 84,137	\$ 9,843,572	0.01	
TOTAL (SELECTED)				\$ 45,128	\$ 9,777,008	0.00	\$ 84,137	\$ 9,843,572	0.01	
TOTAL				\$ 45,128	\$ 9,777,008	0.00	\$ 84,137	\$ 9,843,572	0.01	

Property Configuration

Property Title: Other @ 35.0000000; -76.6833500

Property Location: 28515, Pamlico, North Carolina

Property Coordinates: 35.000000, -076.683350

Hazard Type: Infrastructure Failure

Mitigation Action Type: Other

Property Type: Utilities

Analysis Method Type: Historical Damages

Cost Estimation

Other @ 35.0000000; -76.6833500

Project Useful Life (years): 50

Project Cost: \$9,700,000

Number of Maintenance Years: 50 Use Default:Yes

Annual Maintenance Cost: \$5,580

Damage Analysis Parameters - Damage Frequency Assessment

Other @ 35.0000000; -76.6833500

Year of Analysis was Conducted: 2022

Year Property was Built: 1984

Analysis Duration: 39 Use Default:Yes

Utilities Properties

Other @ 35.0000000; -76.6833500

Type of Service: Wastewater

Number of Customers Served: 6,780

Value of Unit of Service (\$/person/day): \$60 Use Default:Yes

Total Value of Service Per Day (\$/day): \$406,800

Historical Damages Before Mitigation

Other @ 35.0000000; -76.6833500

Damage Year	Recurrence Interval (years)	WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL		
		Impact (days)	Category 1 (\$)	Category 2 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)	Current Dollars?	Inflated Damages (\$)
2018	50	0.5	0	0	0	0	0	203,400	No	203,400

Annualized Damages Before Mitigation

Other @ 35.0000000; -76.6833500

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
50	203,400	4,068
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	203,400	4,068

Expected Damages After Mitigation

Other @ 35.0000000; -76.6833500

	WASTEWATER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 (\$)	Category 2 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)
51	0.1	0	0	0	0	0	40,680

Annualized Damages After Mitigation

Other @ 35.0000000; -76.6833500

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
51	40,680	798
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	40,680	798

Benefits-Costs Summary

Other @ 35.0000000; -76.6833500

Total Standard Mitigation Benefits: \$45,128

Total Social Benefits: \$0

Total Mitigation Project Benefits: \$45,128

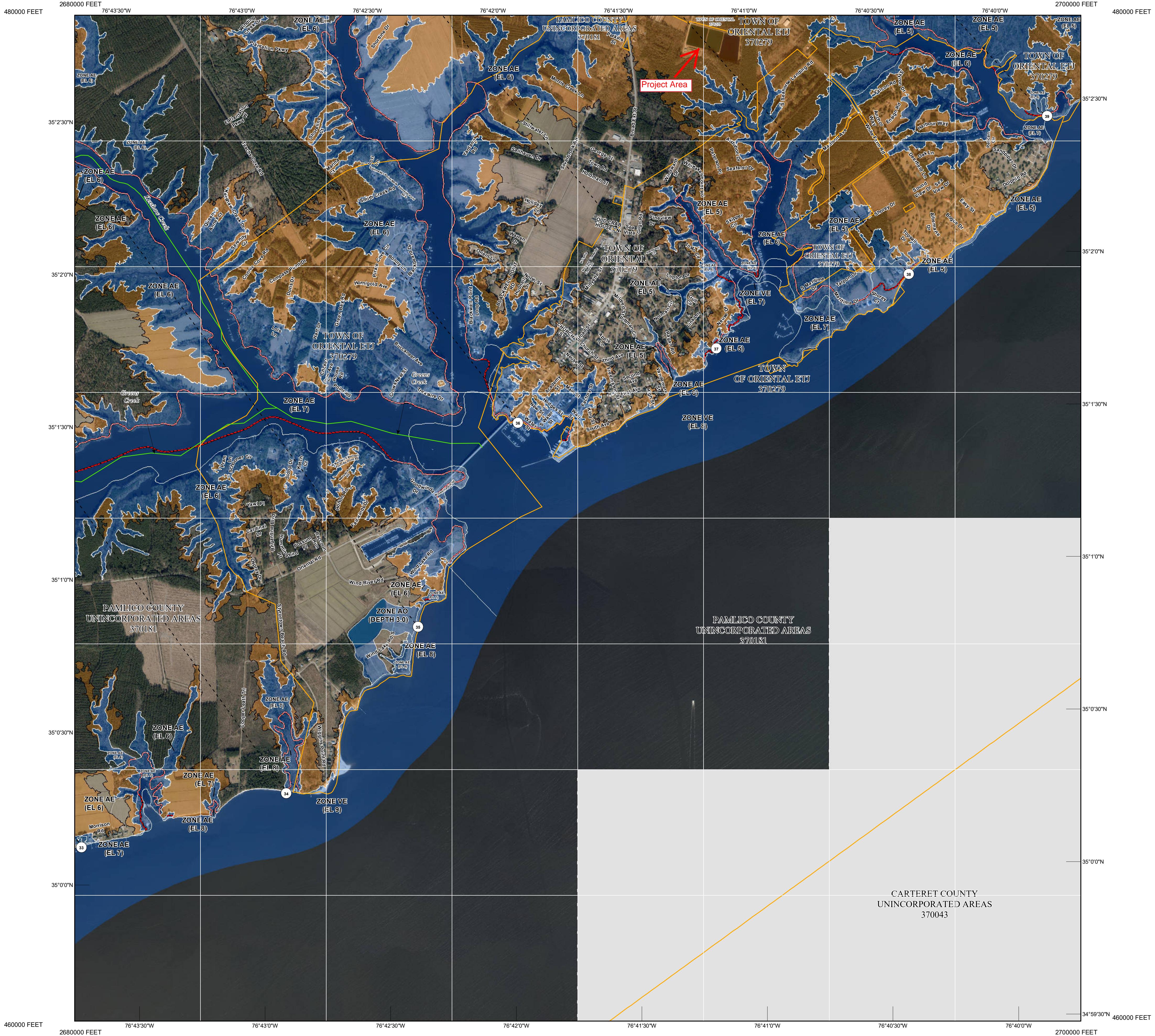
Total Mitigation Project Cost: \$9,777,008

Benefit Cost Ratio - Standard: 0.00

Benefit Cost Ratio - Standard + Social: 0.00

Appendix B

Flood Insurance Rate Map (FIRM)



This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map flood hazard areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

[HTTPS://FRIS.NC.GOV/FRIS](https://fris.nc.gov/fris)

[HTTPS://MSC.FEMA.GOV](https://msc.fema.gov)

SPECIAL FLOOD HAZARD AREAS

OTHER AREAS OF FLOOD HAZARD

OTHER AREAS

GENERAL STRUCTURES

OTHER FEATURES

Without Base Flood Elevation (BFE)
Zone A,V, A99
With BFE or Depth Zone AE, AO, AH, VE, AR

Regulatory Floodway

0.2% Annual Chance Flood Hazard, Areas of 1% Annual Chance Flood with Average Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile Zone X

Future Conditions 1% Annual Chance Floodplain Zone X

Area with Reduced Flood Risk due to Levee See Notes Zone X

Areas Determined to be Outside the 0.2% Annual Chance Floodplain Zone X

Channel, Culvert, or Storm Sewer

Levee, Dike, or Floodwall

Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)

Coastal Transect

Coastal Transect Baseline

Profile Baseline

Hydrographic Feature

Limit of Study

Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at <https://msc.fema.gov>. An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the North Carolina Floodplain Mapping Program website at <https://fris.nc.gov/fris>, or contact the FEMA Map Service Center.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Flood Insurance Study (FIS) means an examination, evaluation, and determination of flood hazards, corresponding water surface elevations, flood hazard risk zones, and other flood data in a community issued by the North Carolina Floodplain Mapping Program (NCFMP). The Flood Insurance Study (FIS) is comprised of the following products used together: the Digital Flood Hazard Database, the Water Surface Elevation Raster, the digitally derived, autogenerated Flood Insurance Rate Map and the Flood Insurance Survey Report. A Flood Insurance Survey is a compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. This report contains detailed flood elevation data, data tables and FIRM indices. When a flood study is completed for the NFIP, the digital information, reports and maps are assembled into an FIS. Information shown on this FIRM is provided in digital format by the NCFMP. Base map information shown on this FIRM was provided in digital format by the NCFMP. The source of this information can be determined from the metadata available in the digital FLOOD database and in the Technical Support Data Notebook (TSDN).

ACCREDITED LEEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at <https://www.fema.gov/national-flood-insurance-program>.

PROVISIONALLY ACCREDITED LEEVEE NOTES TO USERS: If a Provisionally Accredited Levee (PAL) note appears on this panel, check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at <https://www.fema.gov/national-flood-insurance-program>.

LIMIT OF MODERATE WAVE ACTION NOTES TO USERS: For some coastal flooding zones the AE Zone category has been divided by a Limit of Moderate Wave Action (LIMWA). The LIMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between the VE Zone and the LIMWA (or between the shoreline and the LIMWA for areas where VE Zones are not identified) will be similar to, but less severe than those in the VE Zone.

Limit of Moderate Wave Action (LIMWA)

SCALE

Map Projection:
North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)

1 inch = 1,000 feet

1:12,000

0 500 1,000 2,000

0 150 300 600

Feet

Meters

PANEL LOCATOR

FEDERAL EMERGENCY MANAGEMENT AGENCY

National Flood Insurance Program

Little Creek

046

048

050

052

054

056

058

060

062

064

066

068

070

072

074

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098

100

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 6486

Panel Contains:

COMMUNITY

CID

PANEL

SUFFIX

CARTERET COUNTY

370043

6486

K

ORIENTAL TOWN OF

370279

6486

K

PAMLICO COUNTY

370181

6486

K

VERSION NUMBER

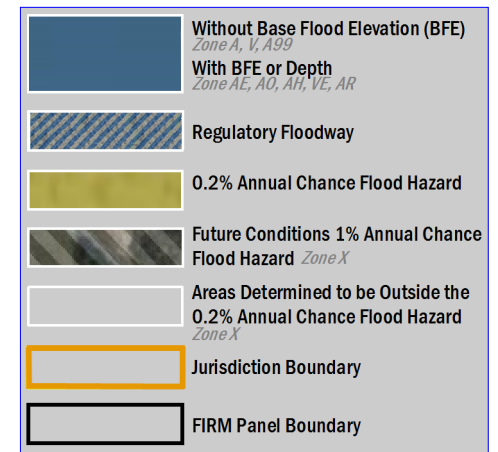
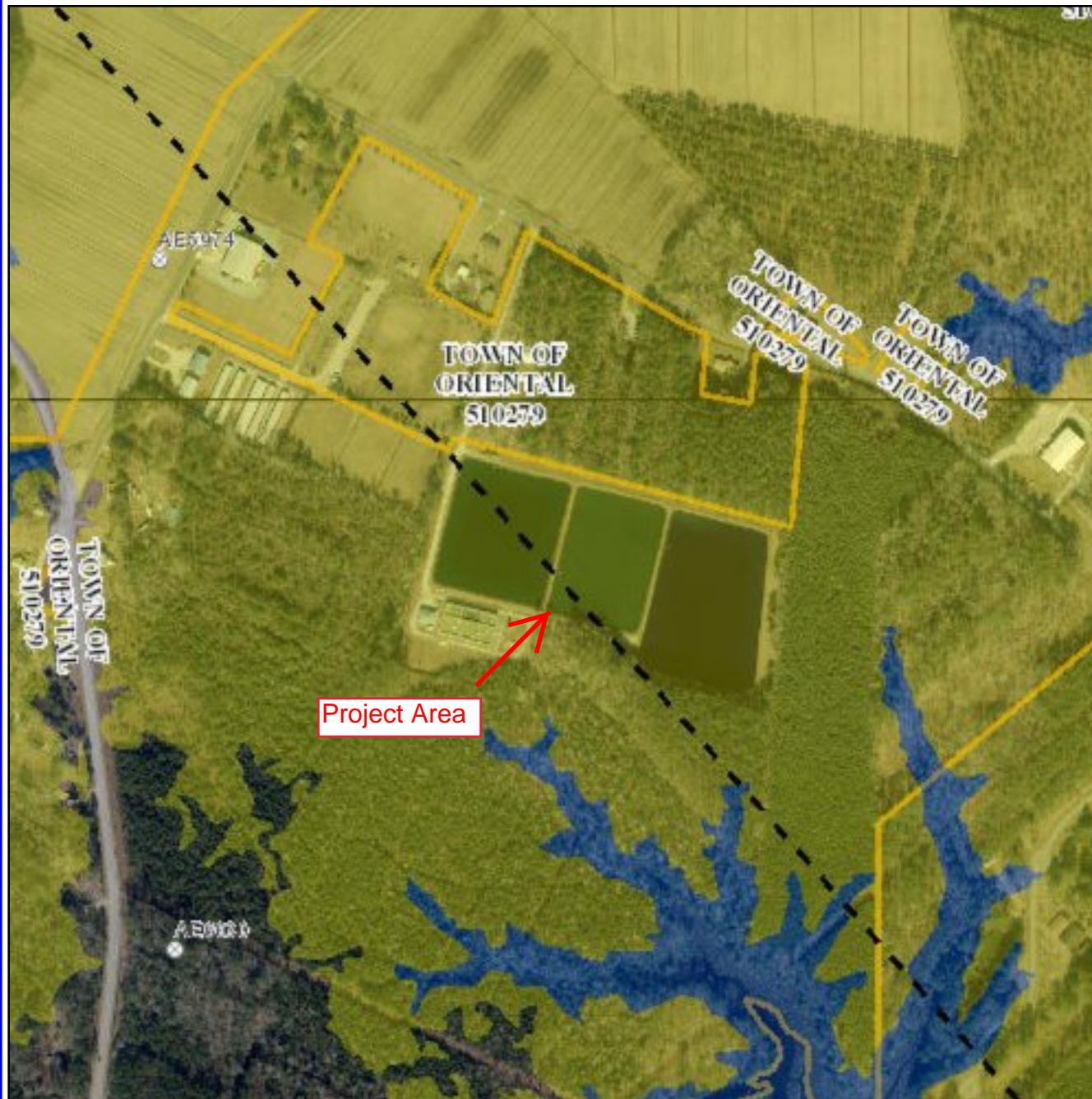
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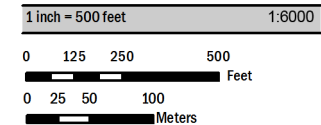
3720648600K

MAP REVISED

June 19, 2020



North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)



FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM FLOOD INSURANCE RATE MAP

Panel(s): 6488, 6486

CONTAINS:

COMMUNITY	CID
PAMLICO COUNTY	370181
TOWN OF ORIENTAL	370279

Notice to User: The Map Number(s) shown below should be used when placing map orders; the Community Number(s) shown above should be used on insurance applications for the subject community.

SELECTED PANELS:

MAP NUMBER	EFFECTIVE DATE
3720648800K	6/19/2020
3720648600K	6/19/2020





FEMA: National Flood Insurance Program

Page 2 of 2



Panel(s):6488,6486

CONTAINS:

COMMUNITY	CID
PAMLICO COUNTY	370181
TOWN OF ORIENTAL	370279

Notice to User: The Map Number(s) shown below should be used when placing map orders; the Community Number(s) shown above should be used on insurance applications for the subject community.

SELECTED PANELS:

MAP NUMBER	EFFECTIVE DATE
3720648800K	6/19/2020
3720648600K	6/19/2020

NOTES TO USERS

This is an official FIRMette of a portion of the effective panels listed in the Title Block shown on Page 1. The information represented on this FIRMette was extracted from the effective digital flood hazard data available at <http://fris.nc.gov/fris>.

Base flood elevation data, floodway, nonencroachment widths, information on certain areas no in the Special Flood Hazard Areas protected by flood control structures, and other pertinent data are available in the Flood Insurance Study (FIS) available at <http://fris.nc.gov/fris>. Users should be aware that flood elevations shown on this FIRMette represent elevations rounded to one tenth of a foot (0.1') and should be utilized in conjunction with data available in the FIS.

NOTES TO USERS

Base map information and geospatial data used to develop this FIRMette were obtained from various organizations, including the participating local community(ies), state and federal agencies, and/or other sources. The primary base for this FIRM is aerial imagery acquired by the State in 2010. Information and geospatial data supplied by the local community(ies) that met FEMA base map specifications were considered the preferred source for development of the base map.

See geospatial metadata for the associated digital FIRMette for additional information about base map preparation. Base map features shown on this FIRMette, such as corporate limits, are based on the most up-to-date data available at the time of publication. Changes in the corporate limits may have occurred since this map was published. Map users should consult the appropriate community official or website to verify current conditions of jurisdictional boundaries and base map features. This map may contain roads that were not considered in the hydraulic analysis of streams where no new hydraulic model was created during the production of this statewide format FIRM.

Flood elevations on this map are referenced to either or both the North American Vertical Datum of 1988 (NAVD 88) or National Geodetic Datum of 1929 (NGVD 29), and are labeled accordingly. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. To obtain current elevation, description, and/or location information for bench marks shown on this map, or for information regarding conversion between NGVD 29 and NAVD 88, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

MORE INFORMATION

Letters of Map Amendment (LOMA)	1-877-336-2627 http://msc.fema.gov/
Letters of Map Revision (LOMR)	919-715-5711 www.ncfloodmaps.com
Flood Insurance Availability	
North Carolina Division of Emergency Management (NCDEM)	919-715-5711 http://www.nccrimecontrol.org/nfip
National Flood Insurance Program (NFIP)	1-877-638-6620 http://www.fema.gov/business/nfip
Questions about this FIRMette	1-877-336-2627 http://fema.gov

LEGEND

LEGEND

MAP REVISIONS

There are no map revisions for the selected area.

Appendix C

NOAA Point Precipitation Frequency Estimates



NOAA Atlas 14, Volume 2, Version 3
Location name: Oriental, North Carolina, USA*
Latitude: 35.0401°, Longitude: -76.691°
Elevation: 8.25 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.481 (0.440-0.528)	0.565 (0.516-0.619)	0.651 (0.595-0.712)	0.735 (0.669-0.804)	0.829 (0.751-0.906)	0.907 (0.819-0.991)	0.981 (0.881-1.07)	1.06 (0.941-1.15)	1.15 (1.02-1.26)	1.23 (1.08-1.35)
10-min	0.769 (0.703-0.844)	0.903 (0.826-0.990)	1.04 (0.952-1.14)	1.18 (1.07-1.29)	1.32 (1.20-1.44)	1.44 (1.30-1.58)	1.56 (1.40-1.71)	1.67 (1.49-1.83)	1.82 (1.61-1.99)	1.94 (1.70-2.13)
15-min	0.961 (0.879-1.06)	1.14 (1.04-1.24)	1.32 (1.21-1.44)	1.49 (1.35-1.63)	1.68 (1.52-1.83)	1.83 (1.65-2.00)	1.97 (1.77-2.16)	2.11 (1.88-2.31)	2.29 (2.02-2.51)	2.44 (2.14-2.68)
30-min	1.32 (1.21-1.45)	1.57 (1.43-1.72)	1.87 (1.71-2.05)	2.15 (1.96-2.36)	2.48 (2.25-2.71)	2.75 (2.49-3.01)	3.02 (2.71-3.30)	3.29 (2.93-3.59)	3.64 (3.22-3.99)	3.95 (3.46-4.33)
60-min	1.64 (1.50-1.80)	1.97 (1.80-2.16)	2.40 (2.19-2.63)	2.80 (2.56-3.07)	3.30 (2.99-3.61)	3.73 (3.37-4.08)	4.16 (3.73-4.55)	4.61 (4.11-5.04)	5.22 (4.62-5.72)	5.76 (5.05-6.32)
2-hr	1.98 (1.79-2.19)	2.39 (2.17-2.64)	2.98 (2.70-3.30)	3.55 (3.21-3.91)	4.30 (3.86-4.72)	4.95 (4.42-5.44)	5.63 (5.01-6.19)	6.37 (5.62-7.00)	7.40 (6.46-8.15)	8.31 (7.20-9.17)
3-hr	2.14 (1.93-2.40)	2.58 (2.33-2.89)	3.24 (2.91-3.63)	3.88 (3.48-4.34)	4.75 (4.23-5.29)	5.54 (4.90-6.15)	6.37 (5.61-7.07)	7.28 (6.35-8.08)	8.61 (7.42-9.56)	9.80 (8.36-10.9)
6-hr	2.58 (2.31-2.94)	3.11 (2.79-3.53)	3.91 (3.49-4.44)	4.69 (4.18-5.33)	5.76 (5.10-6.51)	6.73 (5.92-7.61)	7.77 (6.79-8.76)	8.92 (7.72-10.0)	10.6 (9.03-11.9)	12.1 (10.2-13.6)
12-hr	3.03 (2.71-3.47)	3.67 (3.28-4.18)	4.63 (4.13-5.28)	5.59 (4.97-6.37)	6.91 (6.09-7.84)	8.13 (7.11-9.19)	9.44 (8.17-10.7)	10.9 (9.35-12.3)	13.1 (11.0-14.7)	15.0 (12.5-17.0)
24-hr	3.55 (3.19-3.98)	4.32 (3.88-4.84)	5.58 (5.02-6.25)	6.65 (5.95-7.43)	8.23 (7.31-9.17)	9.59 (8.45-10.7)	11.1 (9.69-12.3)	12.7 (11.0-14.2)	15.2 (12.9-17.0)	17.3 (14.5-19.4)
2-day	4.11 (3.69-4.61)	4.97 (4.47-5.58)	6.39 (5.73-7.17)	7.60 (6.79-8.51)	9.43 (8.36-10.5)	11.0 (9.68-12.3)	12.8 (11.1-14.3)	14.8 (12.7-16.5)	17.8 (15.0-19.9)	20.4 (16.9-23.0)
3-day	4.37 (3.94-4.88)	5.29 (4.78-5.91)	6.76 (6.09-7.55)	8.00 (7.18-8.93)	9.84 (8.77-11.0)	11.4 (10.1-12.7)	13.2 (11.5-14.6)	15.1 (13.1-16.8)	18.0 (15.3-20.1)	20.5 (17.2-23.1)
4-day	4.64 (4.20-5.15)	5.61 (5.08-6.24)	7.14 (6.45-7.94)	8.40 (7.58-9.35)	10.2 (9.18-11.4)	11.8 (10.5-13.1)	13.5 (11.9-15.0)	15.4 (13.4-17.1)	18.2 (15.6-20.3)	20.6 (17.5-23.2)
7-day	5.40 (4.93-5.95)	6.51 (5.94-7.18)	8.18 (7.45-9.02)	9.56 (8.68-10.5)	11.5 (10.4-12.7)	13.2 (11.8-14.5)	15.0 (13.3-16.5)	16.9 (14.9-18.7)	19.7 (17.1-21.8)	22.0 (18.9-24.6)
10-day	6.10 (5.59-6.71)	7.31 (6.69-8.04)	9.06 (8.29-9.96)	10.5 (9.58-11.5)	12.6 (11.4-13.8)	14.3 (12.9-15.7)	16.1 (14.4-17.7)	18.1 (16.1-19.9)	20.9 (18.3-23.2)	23.2 (20.1-25.9)
20-day	8.20 (7.55-8.93)	9.76 (9.01-10.6)	11.9 (10.9-12.9)	13.6 (12.5-14.8)	16.1 (14.7-17.5)	18.1 (16.4-19.7)	20.2 (18.2-22.0)	22.4 (20.1-24.5)	25.6 (22.6-28.0)	28.1 (24.6-31.0)
30-day	10.1 (9.36-10.9)	12.0 (11.1-13.0)	14.5 (13.4-15.6)	16.4 (15.1-17.7)	19.1 (17.6-20.6)	21.3 (19.4-23.0)	23.5 (21.3-25.4)	25.7 (23.3-27.9)	28.8 (25.8-31.4)	31.3 (27.8-34.2)
45-day	12.5 (11.6-13.5)	14.8 (13.8-16.0)	17.7 (16.4-19.1)	20.1 (18.6-21.7)	23.5 (21.6-25.3)	26.2 (24.0-28.3)	29.0 (26.5-31.4)	32.0 (28.9-34.6)	36.1 (32.3-39.3)	39.4 (34.9-43.1)
60-day	15.0 (14.0-16.2)	17.8 (16.5-19.1)	21.0 (19.5-22.5)	23.5 (21.9-25.3)	27.1 (25.0-29.1)	29.8 (27.5-32.1)	32.7 (30.0-35.2)	35.5 (32.4-38.4)	39.4 (35.6-42.8)	42.4 (38.0-46.3)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

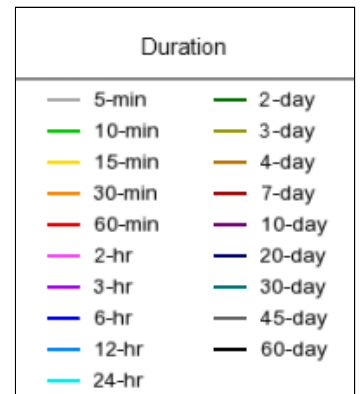
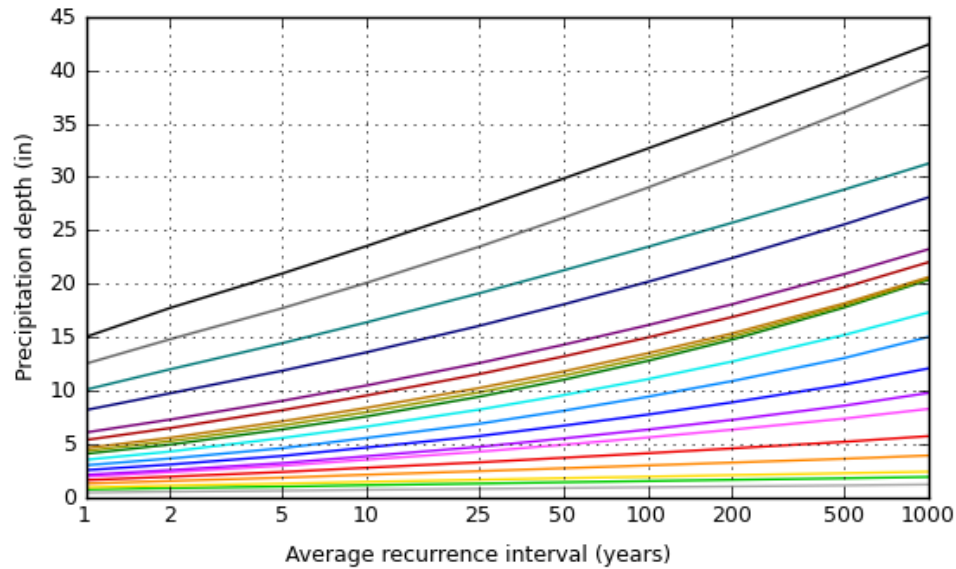
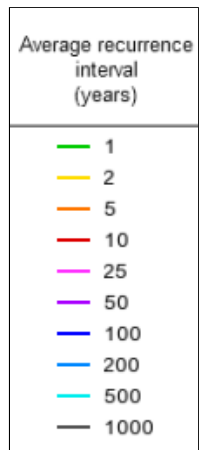
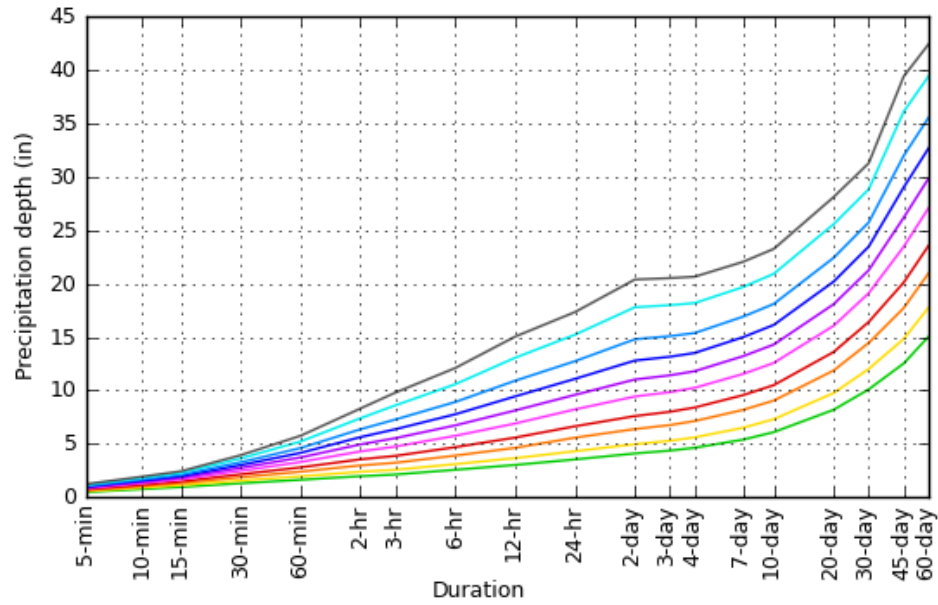
Please refer to NOAA Atlas 14 document for more information.

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PF graphical

PDS-based depth-duration-frequency (DDF) curves

Latitude: 35.0401°, Longitude: -76.6910°



Maps & aerials

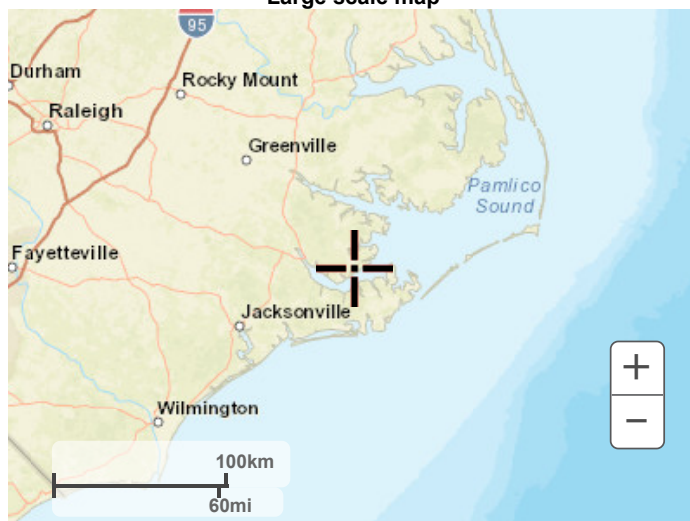
Small scale terrain



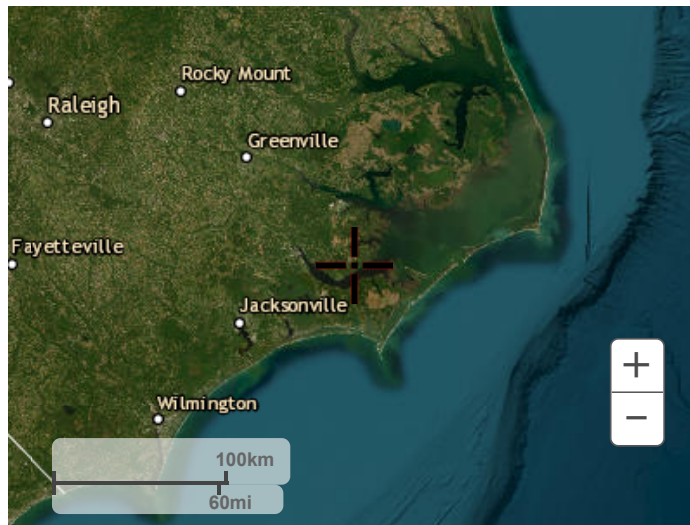
Large scale terrain



Large scale map



Large scale aerial



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Appendix D

FEMA 2009 BCA Reference Guide – Project Useful Life Table

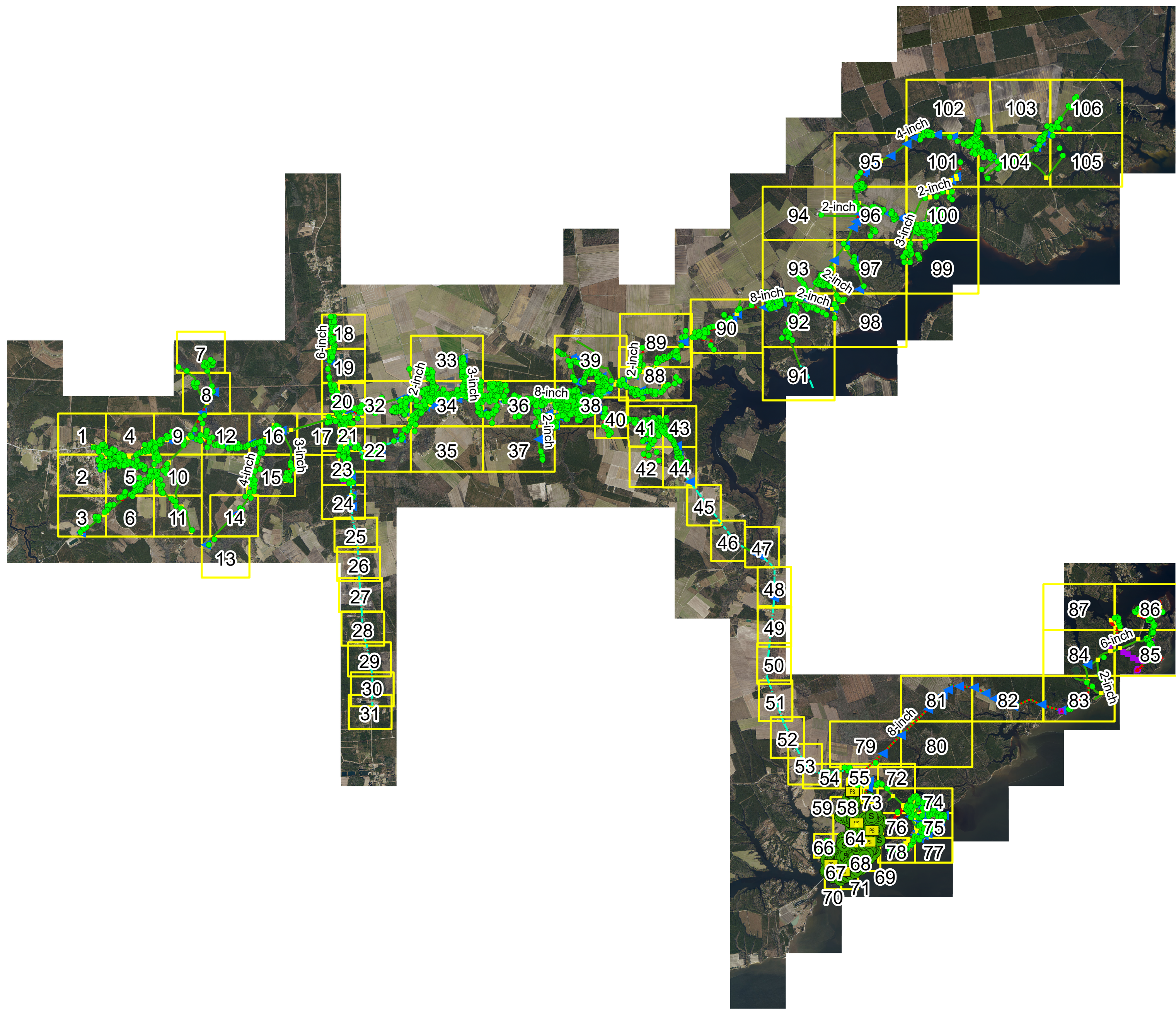
APPENDIX D
Project Useful Life Summary

Project Type	Useful Life (years)		Comment
	Standard Value	Acceptable Limits (documentation required)	
Acquisition/Relocation			
All Structures	100	100	
Elevation			
Residential Building	30	30–50	
Non-Residential Building	25	25–50	
Public Building	50	50–100	
Historic Buildings	50	50–100	
Structural/Non-Structural Building Project			
Residential Building Retrofit	30	30	
Non-Residential Building Retrofit	25	25–50	
Public Building Retrofit	50	50–100	
Historic Building Retrofit	50	50–100	
Roof Diaphragm Retrofit	30	30	Roof hardening and roof clips
Tornado Safe Room – Residential	30	30	
Tornado Safe Room – Community	30	30–50	Retrofit or small community safe room ≤ 16 people (30 yr), New (50 yr)
Non-Structural Building Elements	30	30	Ceilings, electrical cabinets, generators, parapet walls, or chimneys
Non-Structural Major Equipment	15	15–30	Elevators, HVAC, sprinklers
Non-Structural Minor Equipment	5	5–20	Generic contents, racks, shelves
Infrastructure Projects			
Major Infrastructure (minor localized flood reduction projects)	50	35–100	
Concrete Infrastructure, Flood Walls, Roads, Bridges, Major Drainage System	50	35–50	
Culverts (concrete, PVC, CMP, HDPE, etc.)	30	25–50	Culvert with end treatment (i.e., wing walls, end sections, head walls, etc.)
	10	5–20	Culvert without end treatment (i.e., wing walls, end sections, head walls, etc.)
Pump Stations, Substations, Wastewater Systems, or Equipment Such as Generators	50	50	Structures
	5	5–30	Equipment
Hurricane Storm Shutters	15	15–30	Depends on type of storm shutter
Utility Mitigation Projects	50	50–100	Major (power lines, cable, hardening gas, water, sewer lines, etc.)
	5	5–30	Minor (backflow valves, downspout disconnect, etc.)

APPENDIX D
Project Useful Life Summary

Project Type	Useful Life (years)		Comment
	Standard Value	Acceptable Limits (documentation required)	
Miscellaneous Equipment Projects			
Equipment Purchases	2	2–10	Small, portable equipment (e.g., computer)
	30	5–30	Heavy equipment
Wildfire Mitigation Projects			
Defensible Space/Hazardous Fuels Reduction	4	2–4	Brush – Depends on drought conditions
Vegetation Management	1	1	Grass – Depends on geographic location and precipitation
	20	3–20	Forest canopy – Must be maintained every 3 years
Ignition-Resistant Construction	10	10–30	Depends on type of construction and materials used

Appendix E
Sewer Service Area Map



Legend

●

STEP_TANKS

■

SewerMainValve

▲

SERVICE_CONNECTION

PS

PumpStation

●

Gravity_Manhole

■

Blowoff_Valve

▲

Air_Release_Valve

PS

Oriental Gravity

TRANSMISSION

EFFLUENT

COLLECTION

BAY RIVER METROPOLITAN SEWER DISTRICT


SEWER SYSTEM ASSET MAP

PAMLICO COUNTY

NORTH CAROLINA

DATE 9/29/22

SCALE: 1" = N/A



STROUD ENGINEERING, P.A.

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GREENVILLE, NORTH CAROLINA 27858
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LICENSE NO. C-0647

Appendix F

US Census Bureau 2021 Population

Pamlico County






QuickFacts

Pamlico County, North Carolina


QuickFacts provides statistics for all states and counties, and for cities and towns with a **population of 5,000 or more**.


Table

<div>All Topics</div>	Pamlico County, North Carolina
Persons per household, 2017-2021	2.26
<div>  PEOPLE </div>	
Population	
Population Estimates, July 1 2022, (V2022)	NA
Population Estimates, July 1 2021, (V2021)	12,344
Population estimates base, April 1, 2020, (V2022)	NA
Population estimates base, April 1, 2020, (V2021)	12,276
Population, percent change - April 1, 2020 (estimates base) to July 1, 2022, (V2022)	NA
Population, percent change - April 1, 2020 (estimates base) to July 1, 2021, (V2021)	0.6%
Population, Census, April 1, 2020	12,276
Population, Census, April 1, 2010	13,144
Age and Sex	
Persons under 5 years, percent	3.2%
Persons under 18 years, percent	14.5%
Persons 65 years and over, percent	30.6%
Female persons, percent	48.8%
Race and Hispanic Origin	
White alone, percent	77.5%
Black or African American alone, percent (a)	18.8%
American Indian and Alaska Native alone, percent (a)	0.8%
Asian alone, percent (a)	0.6%
Native Hawaiian and Other Pacific Islander alone, percent (a)	0.2%
Two or More Races, percent	2.0%
Hispanic or Latino, percent (b)	4.6%
White alone, not Hispanic or Latino, percent	73.9%
Population Characteristics	
Veterans, 2017-2021	1,330
Foreign born persons, percent, 2017-2021	3.0%
Housing	
Housing units, July 1, 2021, (V2021)	7,239
Owner-occupied housing unit rate, 2017-2021	79.0%
Median value of owner-occupied housing units, 2017-2021	\$166,500
Median selected monthly owner costs -with a mortgage, 2017-2021	\$1,327
Median selected monthly owner costs -without a mortgage, 2017-2021	\$461
Median gross rent, 2017-2021	\$760
Building permits, 2021	70
Families & Living Arrangements	
Households, 2017-2021	5,120
Persons per household, 2017-2021	2.26
Living in same house 1 year ago, percent of persons age 1 year+, 2017-2021	93.4%
Language other than English spoken at home, percent of persons age 5 years+, 2017-2021	4.5%
Computer and Internet Use	
Households with a computer, percent, 2017-2021	88.0%
Households with a broadband Internet subscription, percent, 2017-2021	80.3%
Education	
High school graduate or higher, percent of persons age 25 years+, 2017-2021	89.6%
Bachelor's degree or higher, percent of persons age 25 years+, 2017-2021	23.5%

Health	
With a disability, under age 65 years, percent, 2017-2021	13.9%
Persons without health insurance, under age 65 years, percent	⚠ 14.4%
Economy	
In civilian labor force, total, percent of population age 16 years+, 2017-2021	43.9%
In civilian labor force, female, percent of population age 16 years+, 2017-2021	44.4%
Total accommodation and food services sales, 2017 (\$1,000) (c)	32,767
Total health care and social assistance receipts/revenue, 2017 (\$1,000) (c)	21,398
Total transportation and warehousing receipts/revenue, 2017 (\$1,000) (c)	6,471
Total retail sales, 2017 (\$1,000) (c)	131,398
Total retail sales per capita, 2017 (c)	\$10,403
Transportation	
Mean travel time to work (minutes), workers age 16 years+, 2017-2021	23.8
Income & Poverty	
Median household income (in 2021 dollars), 2017-2021	\$52,124
Per capita income in past 12 months (in 2021 dollars), 2017-2021	\$30,073
Persons in poverty, percent	⚠ 15.3%
 BUSINESSES	
Businesses	
Total employer establishments, 2020	242
Total employment, 2020	2,279
Total annual payroll, 2020 (\$1,000)	67,141
Total employment, percent change, 2019-2020	-0.3%
Total nonemployer establishments, 2019	1,045
All employer firms, Reference year 2017	254
Men-owned employer firms, Reference year 2017	148
Women-owned employer firms, Reference year 2017	S
Minority-owned employer firms, Reference year 2017	S
Nonminority-owned employer firms, Reference year 2017	203
Veteran-owned employer firms, Reference year 2017	S
Nonveteran-owned employer firms, Reference year 2017	178
 GEOGRAPHY	
Geography	
Population per square mile, 2020	36.5
Population per square mile, 2010	39.1
Land area in square miles, 2020	336.52
Land area in square miles, 2010	336.54
FIPS Code	37137

Value Notes

 Estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info  icon to the row in TABLE view to learn about sampling error.

The vintage year (e.g., V2022) refers to the final year of the series (2020 thru 2022). Different vintage years of estimates are not comparable.

Users should exercise caution when comparing 2017-2021 ACS 5-year estimates to other ACS estimates. For more information, please visit the [2021 5-year ACS Comparison Guidance](#) page.

Fact Notes

- (a) Includes persons reporting only one race
- (c) Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
- (b) Hispanics may be of any race, so also are included in applicable race categories

Value Flags

- Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper in open ended distribution.
- F Fewer than 25 firms
- D Suppressed to avoid disclosure of confidential information
- N Data for this geographic area cannot be displayed because the number of sample cases is too small.
- FN Footnote on this item in place of data
- X Not applicable
- S Suppressed; does not meet publication standards
- NA Not available
- Z Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and Poverty Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.

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