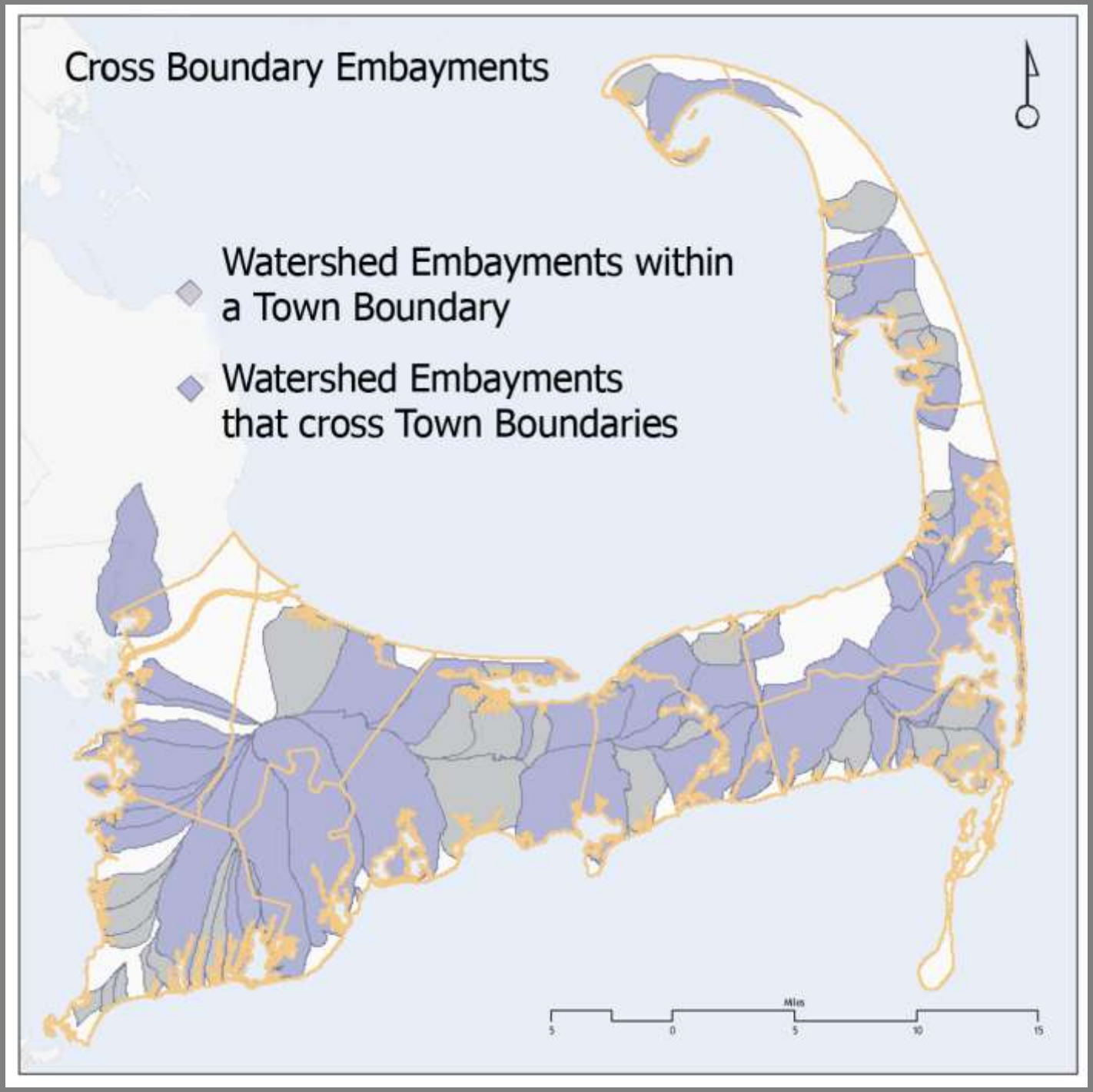
CAPE COD
COMMISSION

# Getting to Know Your Watershed: Lewis Bay


Cross Boundary Embayments
Watershed Embayments within a Town Boundary
Watershed Embayments that cross Town Boundaries
Miles
5
0
5
10
15

# Lewis Bay

# Watershed 101:
# How Does a Watershed Work?

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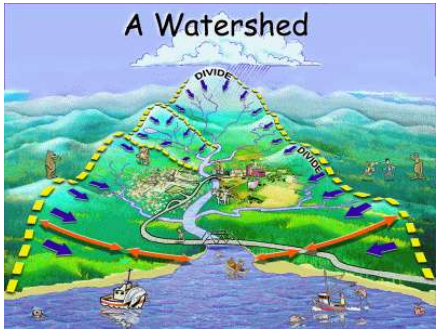


Cape Cod watersheds are the contributing areas to surface water bodies, and groundwater wells. They are defined by the movement of groundwater, and do not follow town boundaries.

# How long does it take water to move through the watershed?

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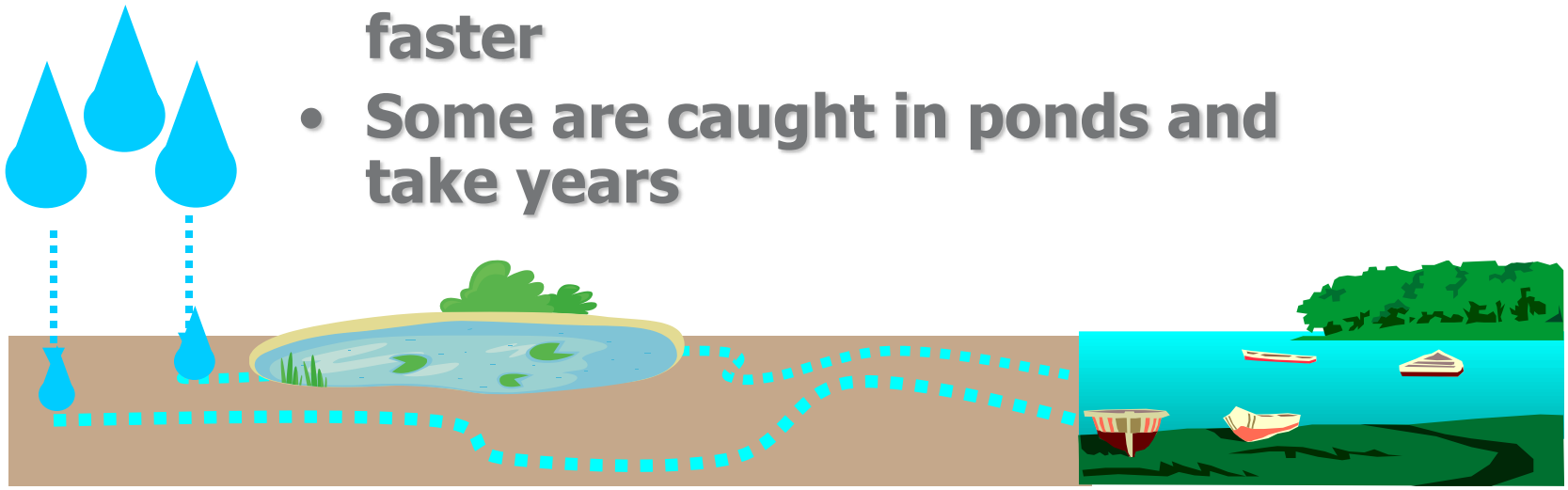
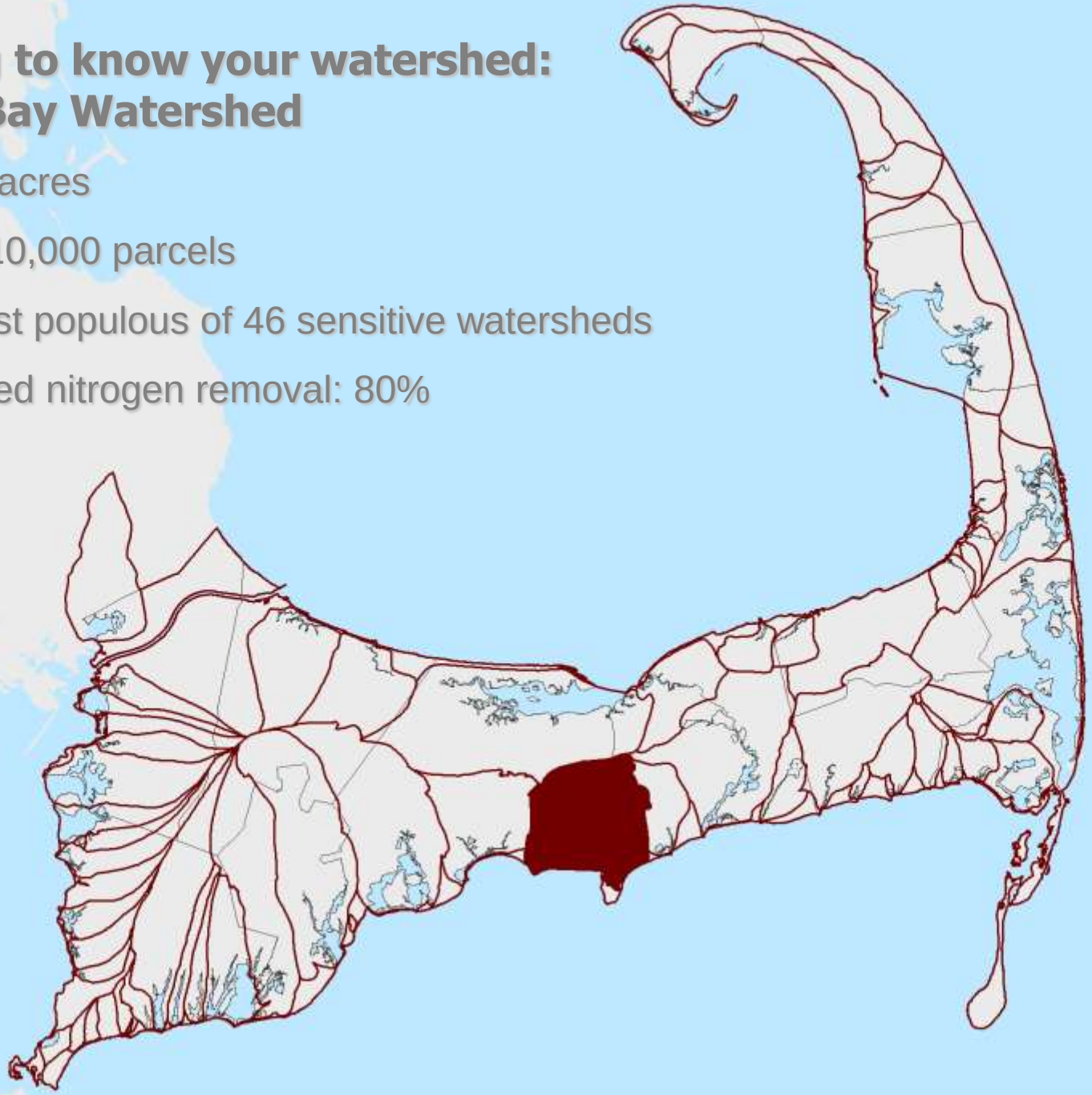
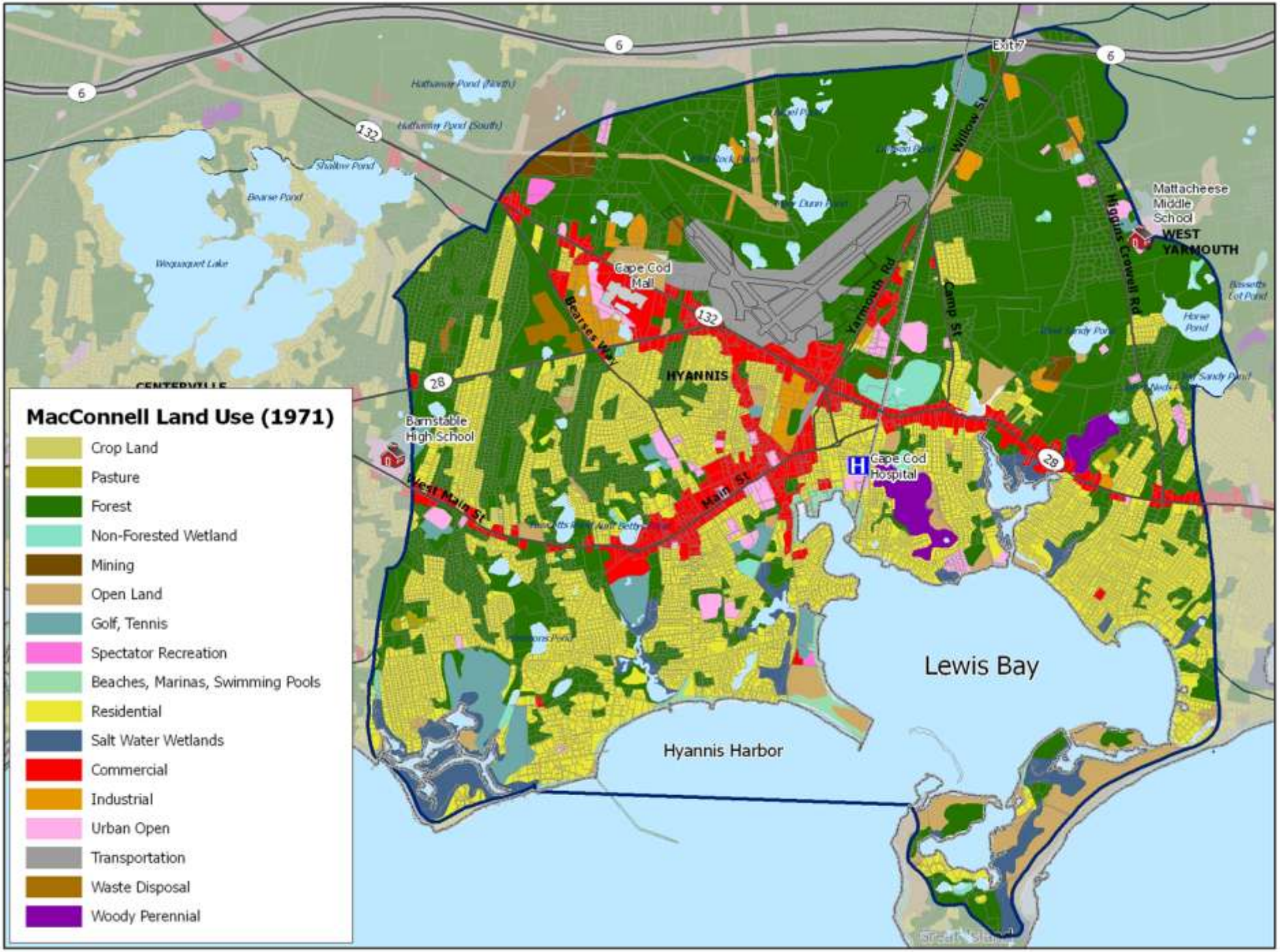
- 10-100 years
- Each drop of water takes a different path through the watershed
- Some travel in streams and travel faster
- Some are caught in ponds and take years

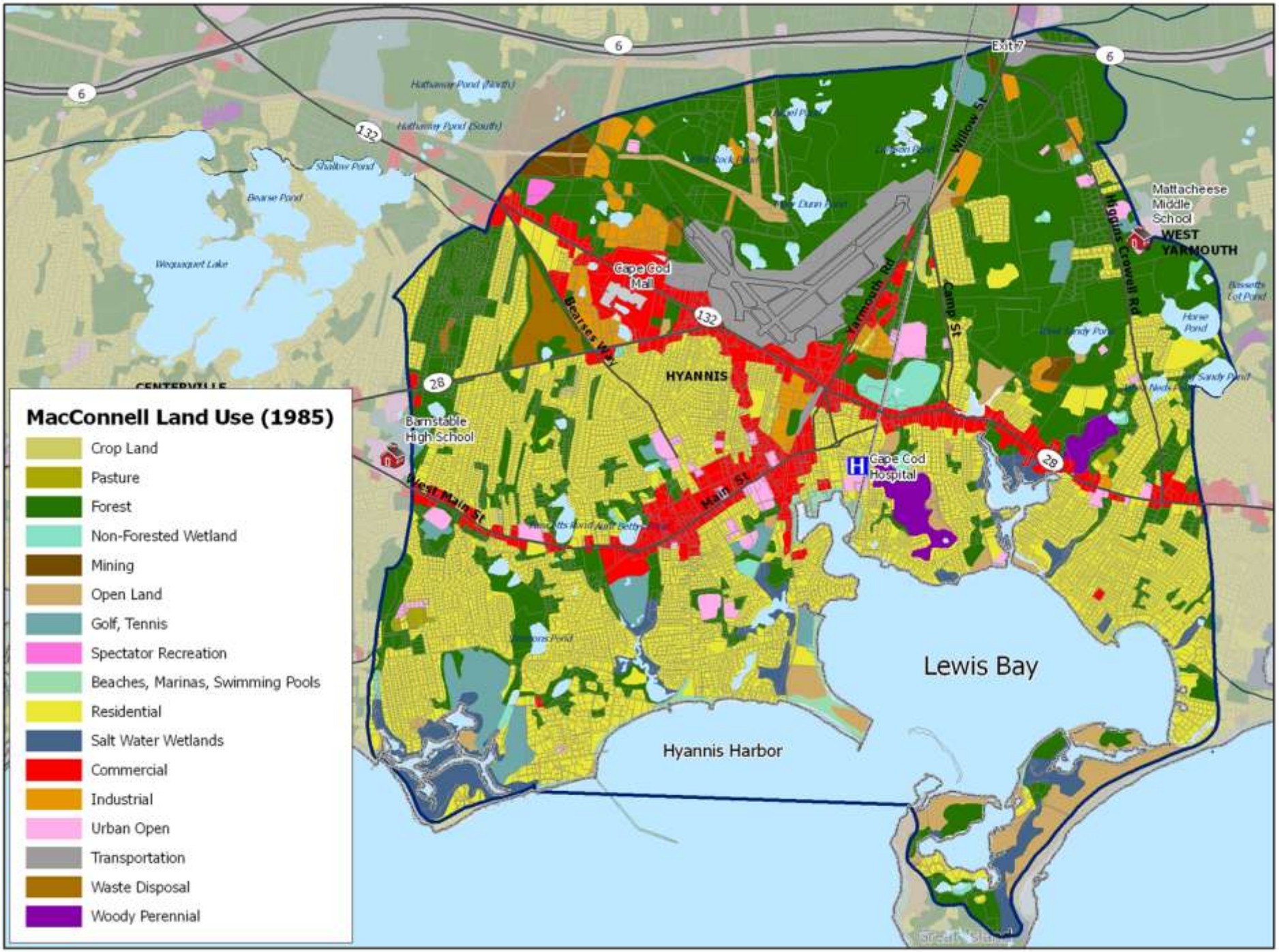


# Getting to know your watershed: Lewis Bay Watershed

- 7,414 acres
- Over 10,000 parcels
- 2nd most populous of 46 sensitive watersheds
- Required nitrogen removal: 80%




MacConnell Land Use (1971)
Crop Land
Pasture
Forest
Non-Forested Wetland
Mining
Open Land
Golf, Tennis
Spectator Recreation
Beaches, Marinas, Swimming Pools
Residential
Salt Water Wetlands
Commercial
Industrial
Urban Open
Transportation
Waste Disposal
Woody Perennial
Lewis Bay
Hyannis Harbor
HYANNIS
Cape Cod Mall
Cape Cod Hospital
Barnstable High School
Mattacheese Middle School
WEST YARMOUTH
Exit 7
Willow St
Yarmouth Rd
Camp St
Higgins Crowell Rd
Bearses Way
Main St
West Main St
Wequaquet Lake
Bearse Pond
Shallow Pond
Hathaway Pond (North)
Hathaway Pond (South)
Horse Pond
6
132
28


MacConnell Land Use (1985)
Crop Land
Pasture
Forest
Non-Forested Wetland
Mining
Open Land
Golf, Tennis
Spectator Recreation
Beaches, Marinas, Swimming Pools
Residential
Salt Water Wetlands
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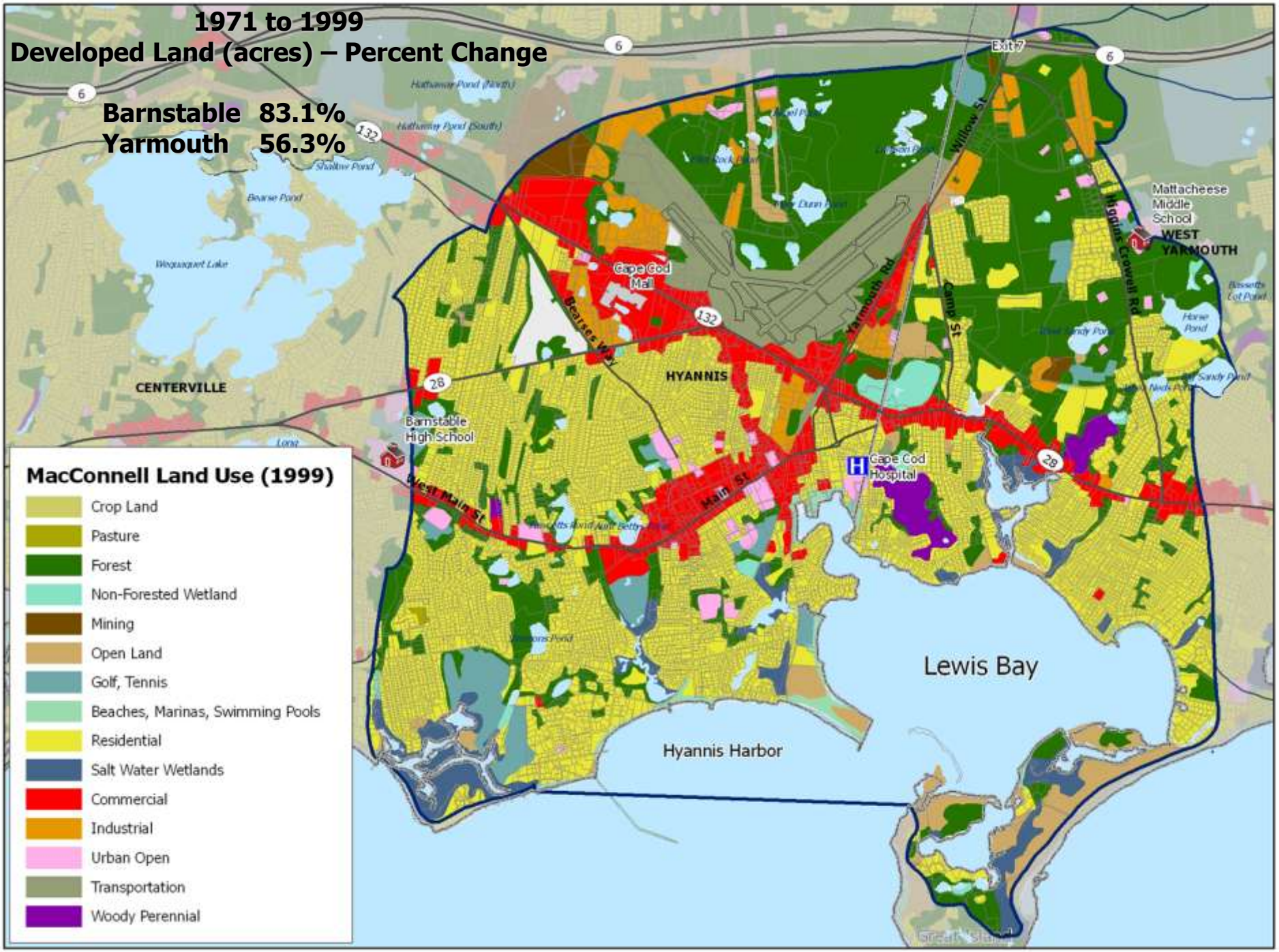
6
132
28


1971 to 1999
Developed Land (acres) – Percent Change
Barnstable 83.1%
Yarmouth 56.3%
MacConnell Land Use (1999)
Crop Land
Pasture
Forest
Non-Forested Wetland
Mining
Open Land
Golf, Tennis
Beaches, Marinas, Swimming Pools
Residential
Salt Water Wetlands
Commercial
Industrial
Urban Open
Transportation
Woody Perennial
Exit 7
Willow St
Mattacheese Middle School
WEST YARMOUTH
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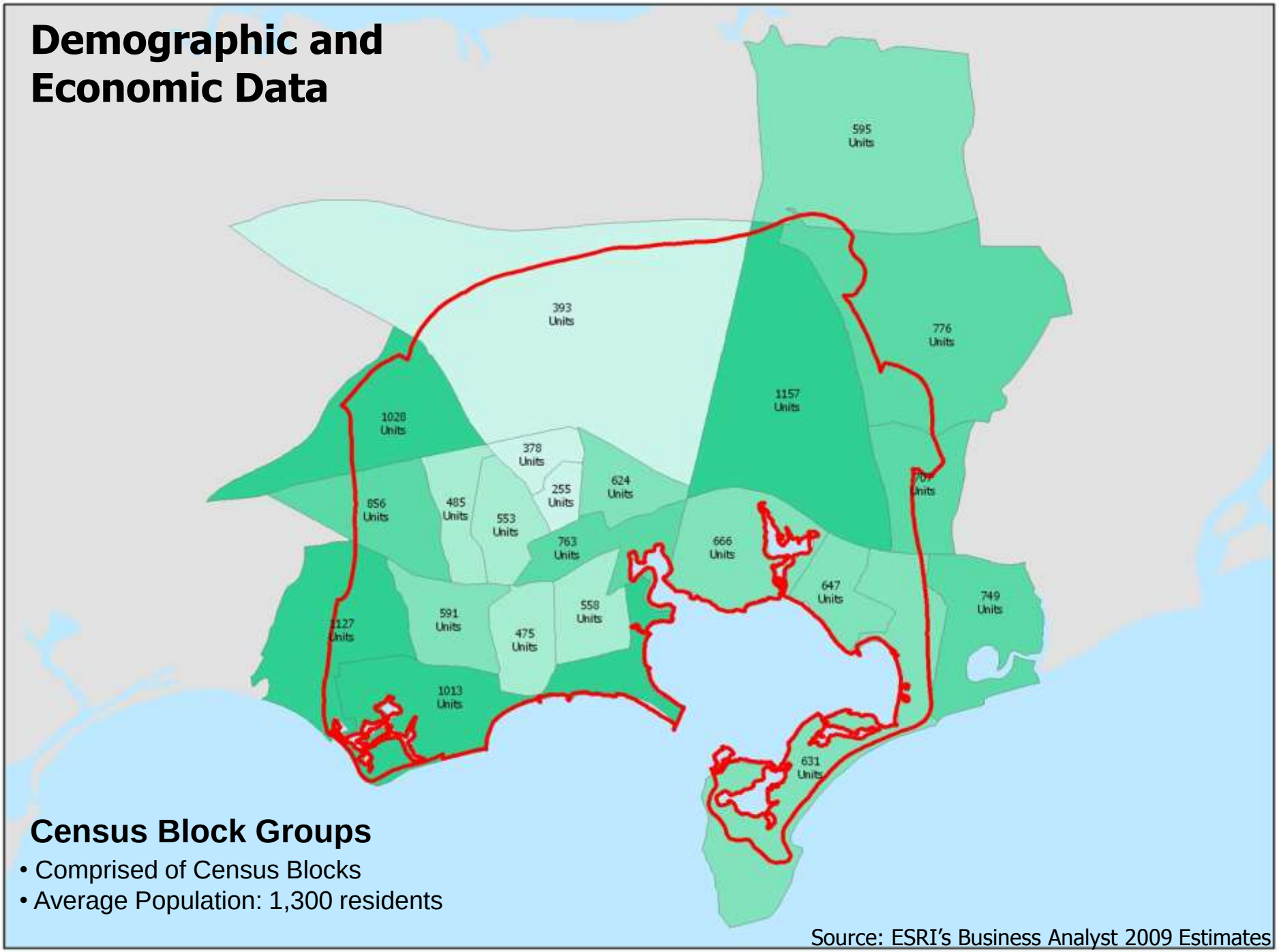
Cape Cod Mall
Bearses Way
Yarmouth Rd
Camp St
HYANNIS
CENTERVILLE
Barnstable High School
West Main St
Main St
Cape Cod Hospital
Lewis Bay
Hyannis Harbor

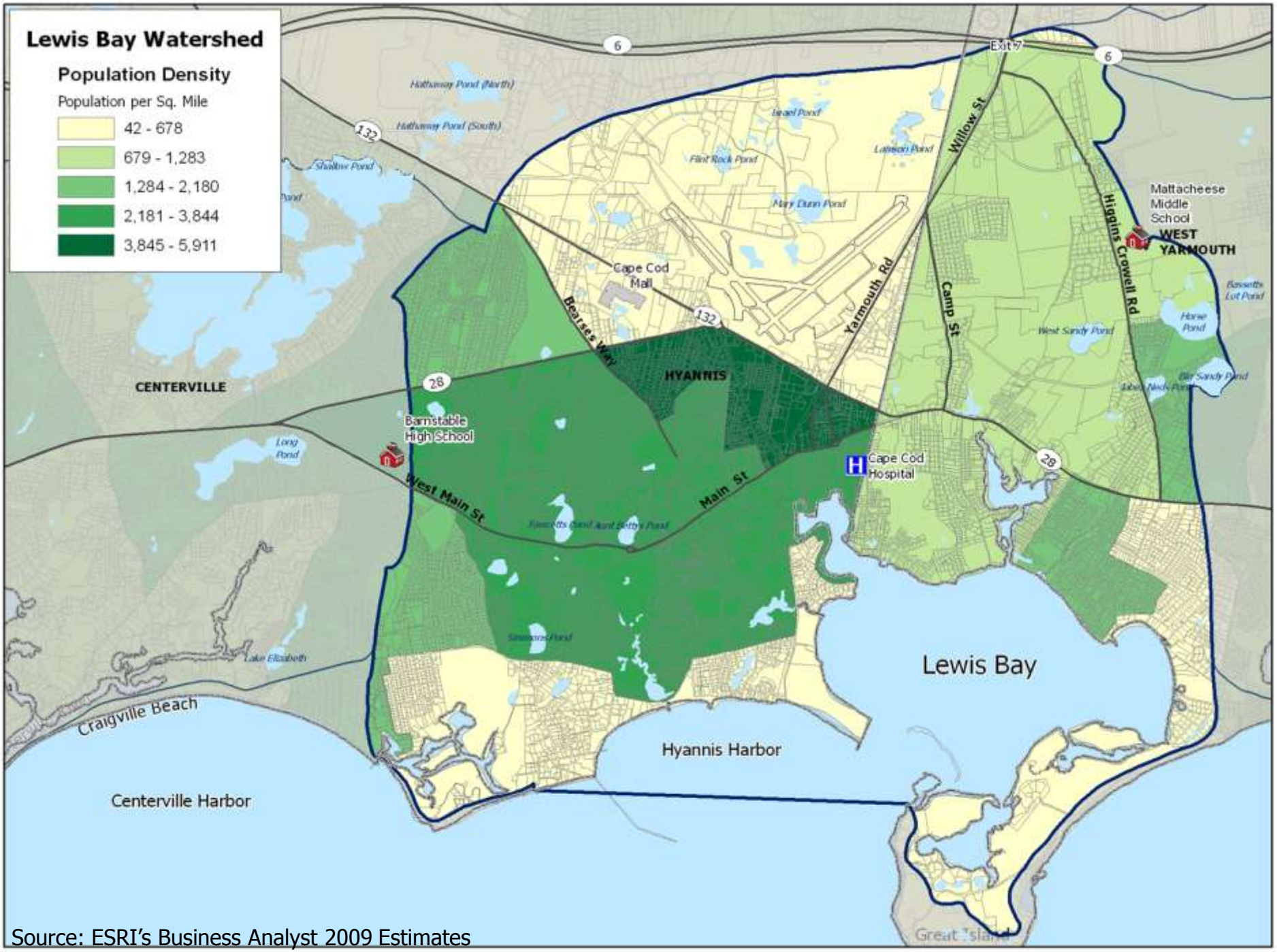
# Demographic and Economic Data



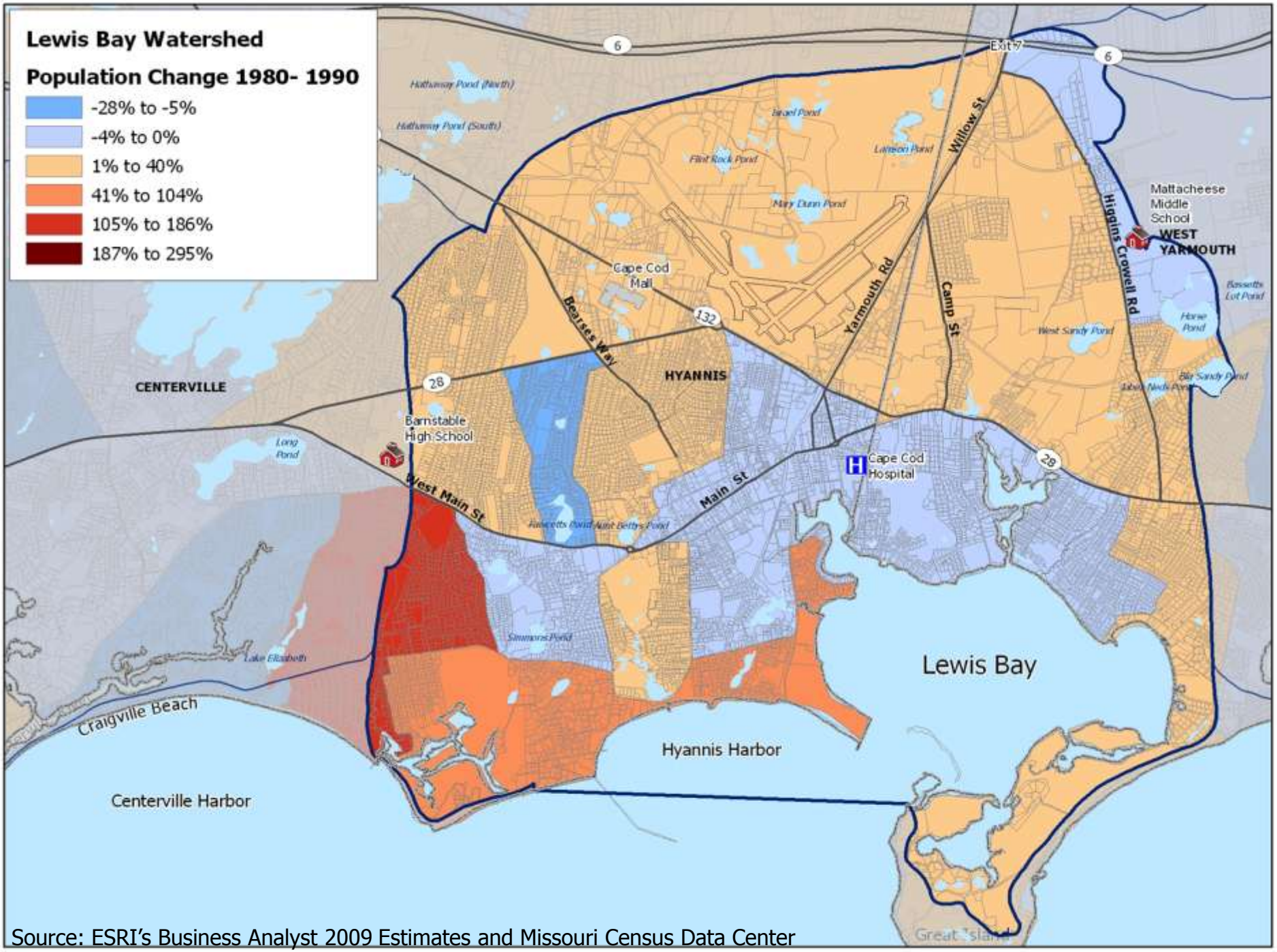

## Census Block Groups

- Comprised of Census Blocks
- Average Population: 1,300 residents

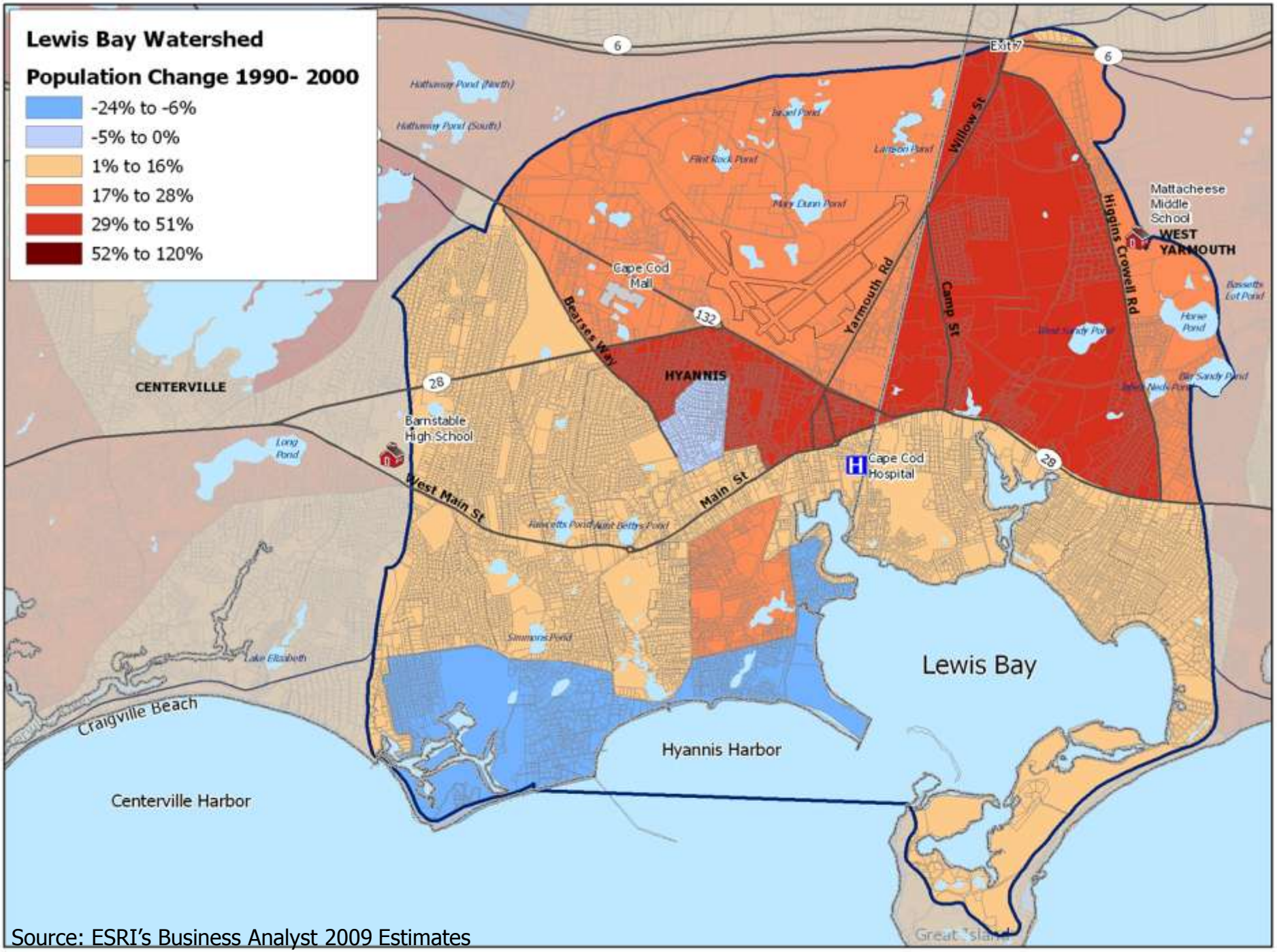
Source: ESRI's Business Analyst 2009 Estimates



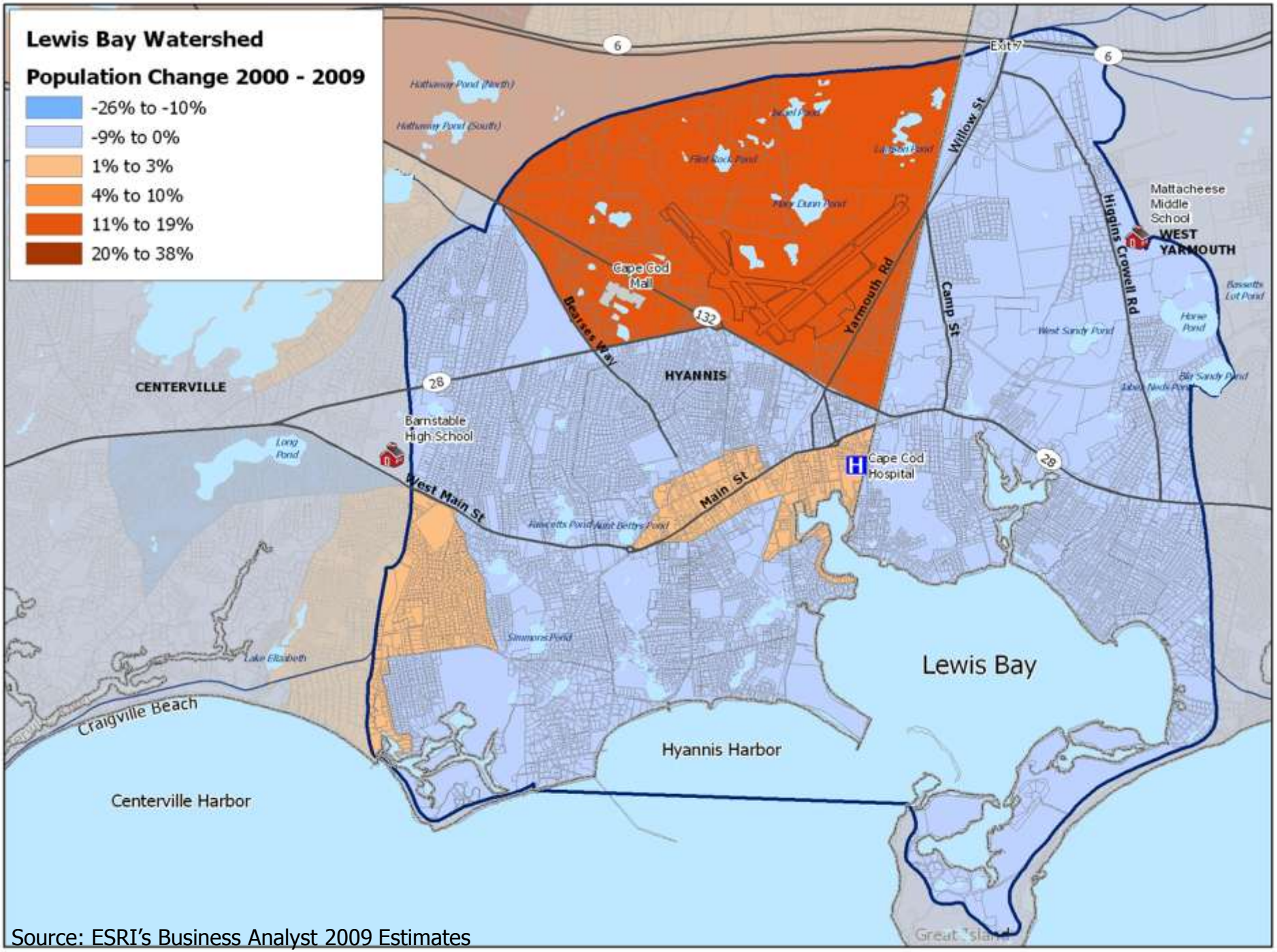

Source: ESRI's Business Analyst 2009 Estimates



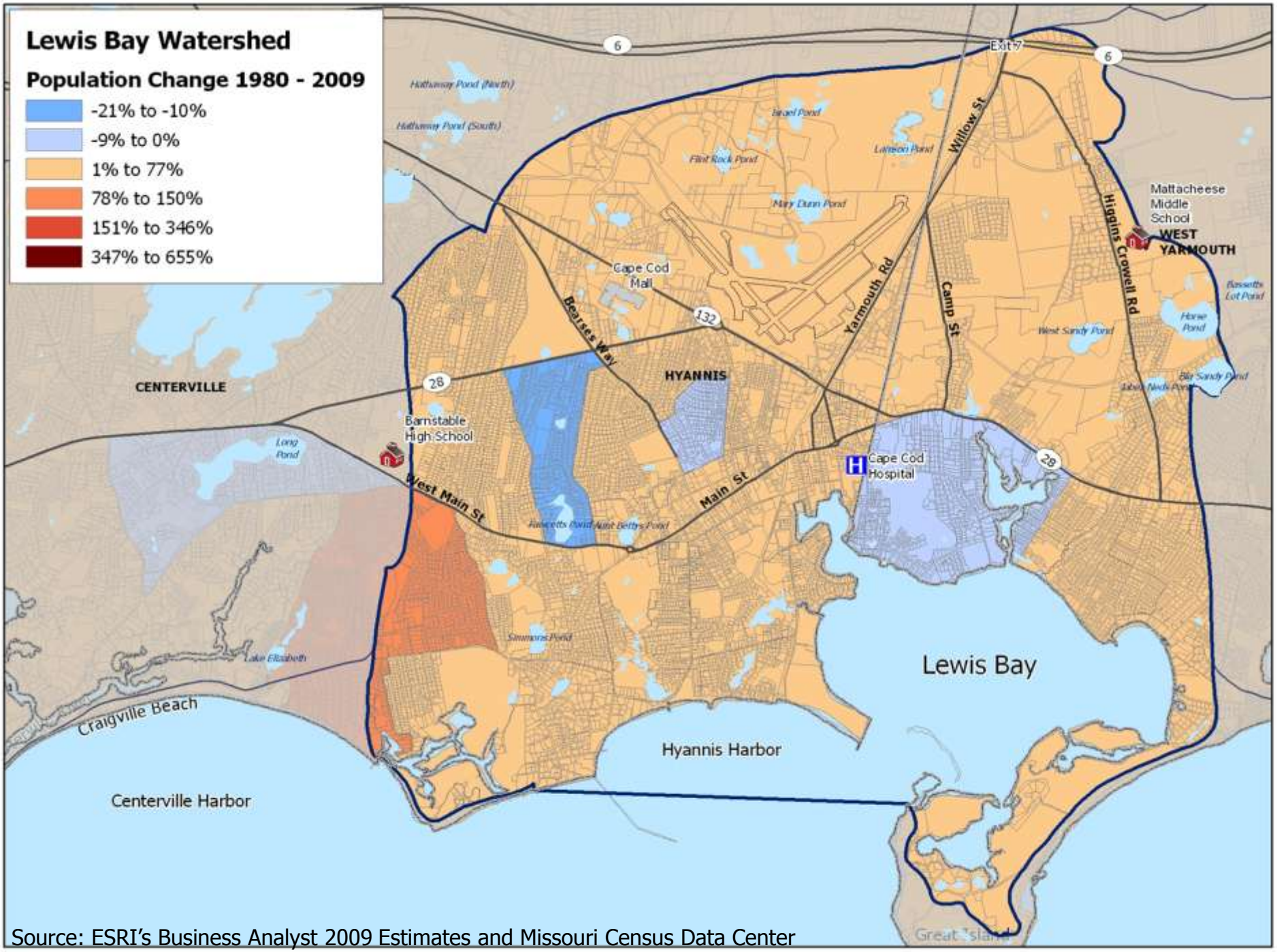

Source: ESRI's Business Analyst 2009 Estimates and Missouri Census Data Center



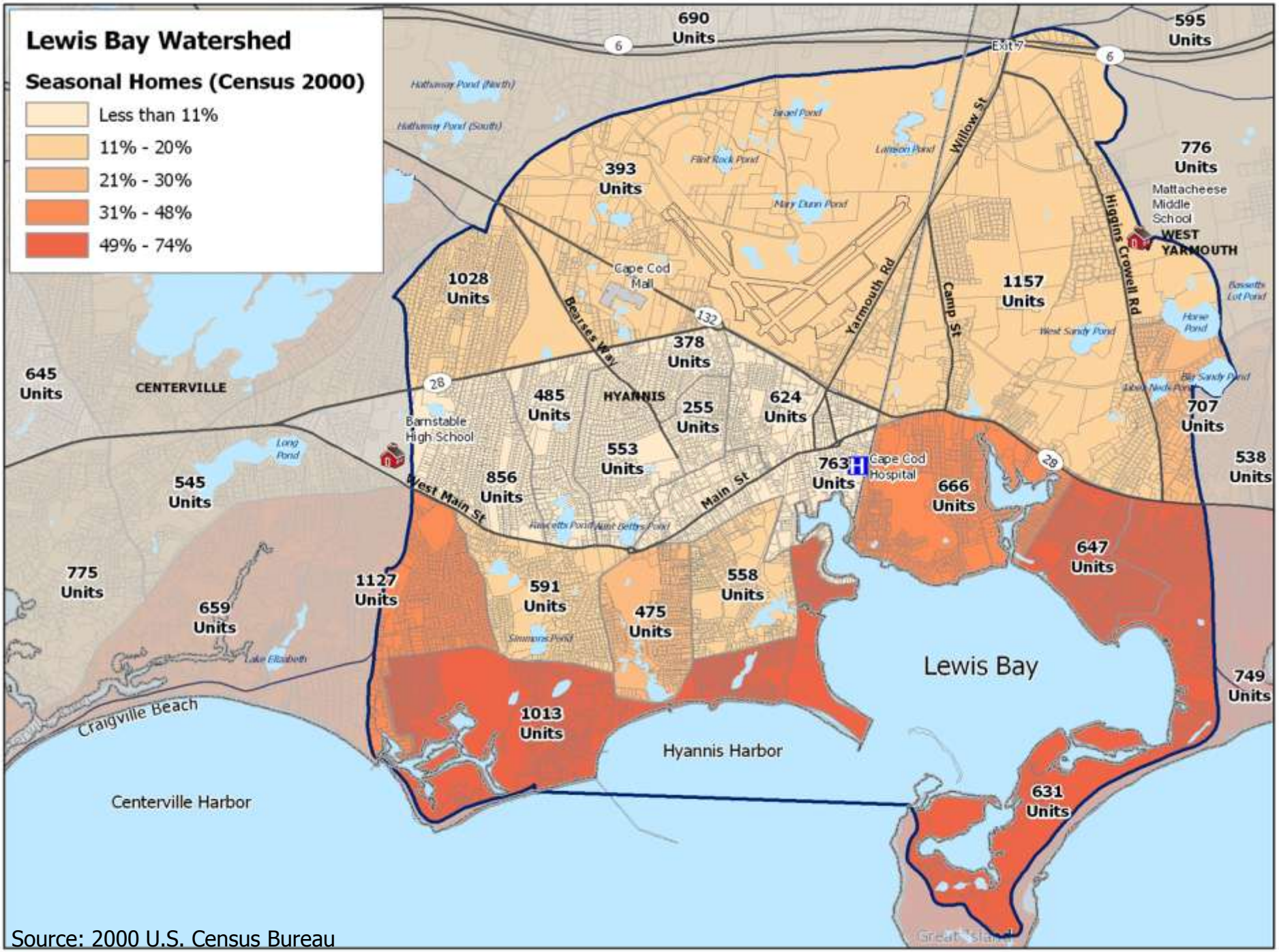

Source: ESRI's Business Analyst 2009 Estimates



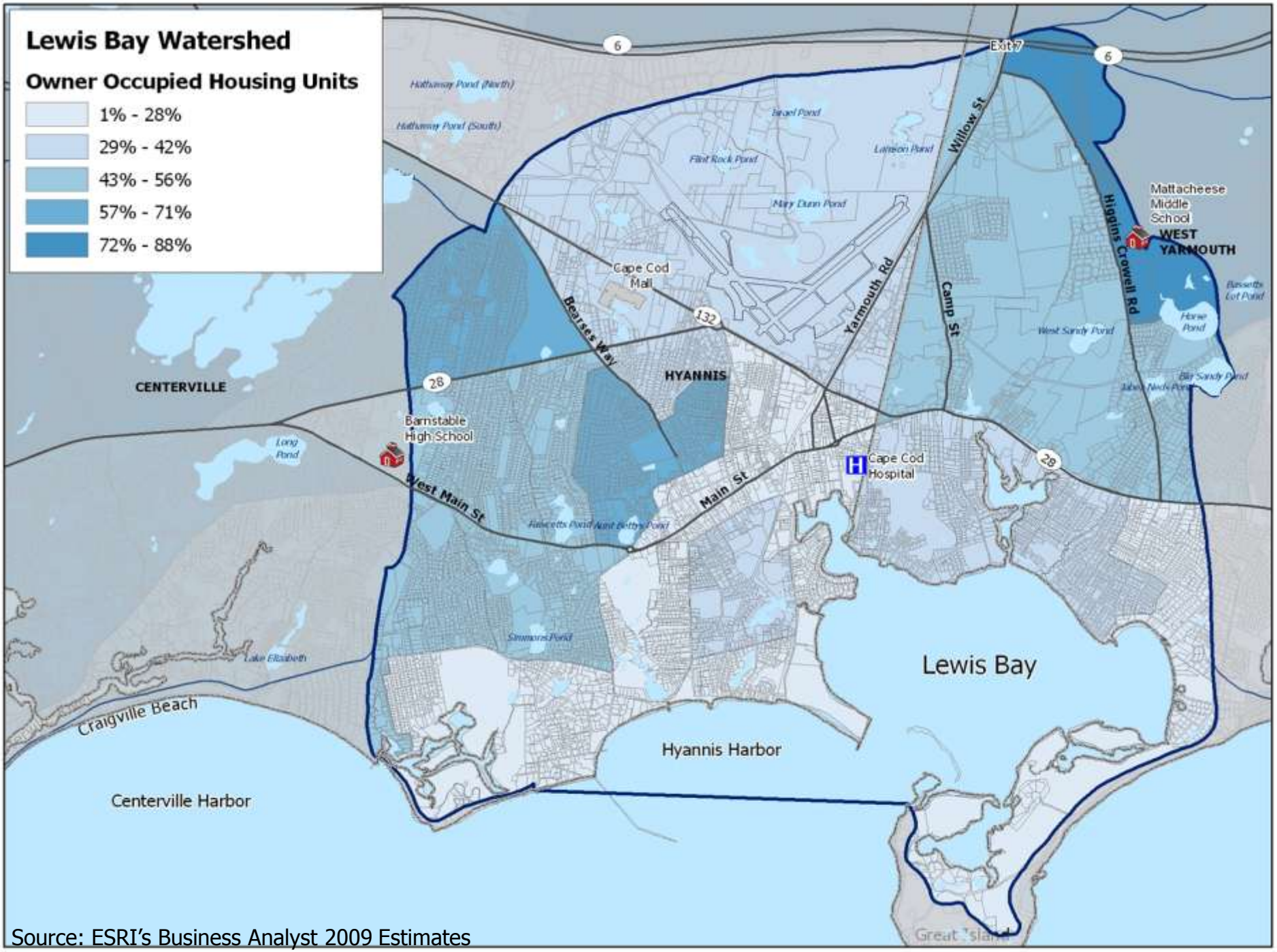

Source: ESRI's Business Analyst 2009 Estimates



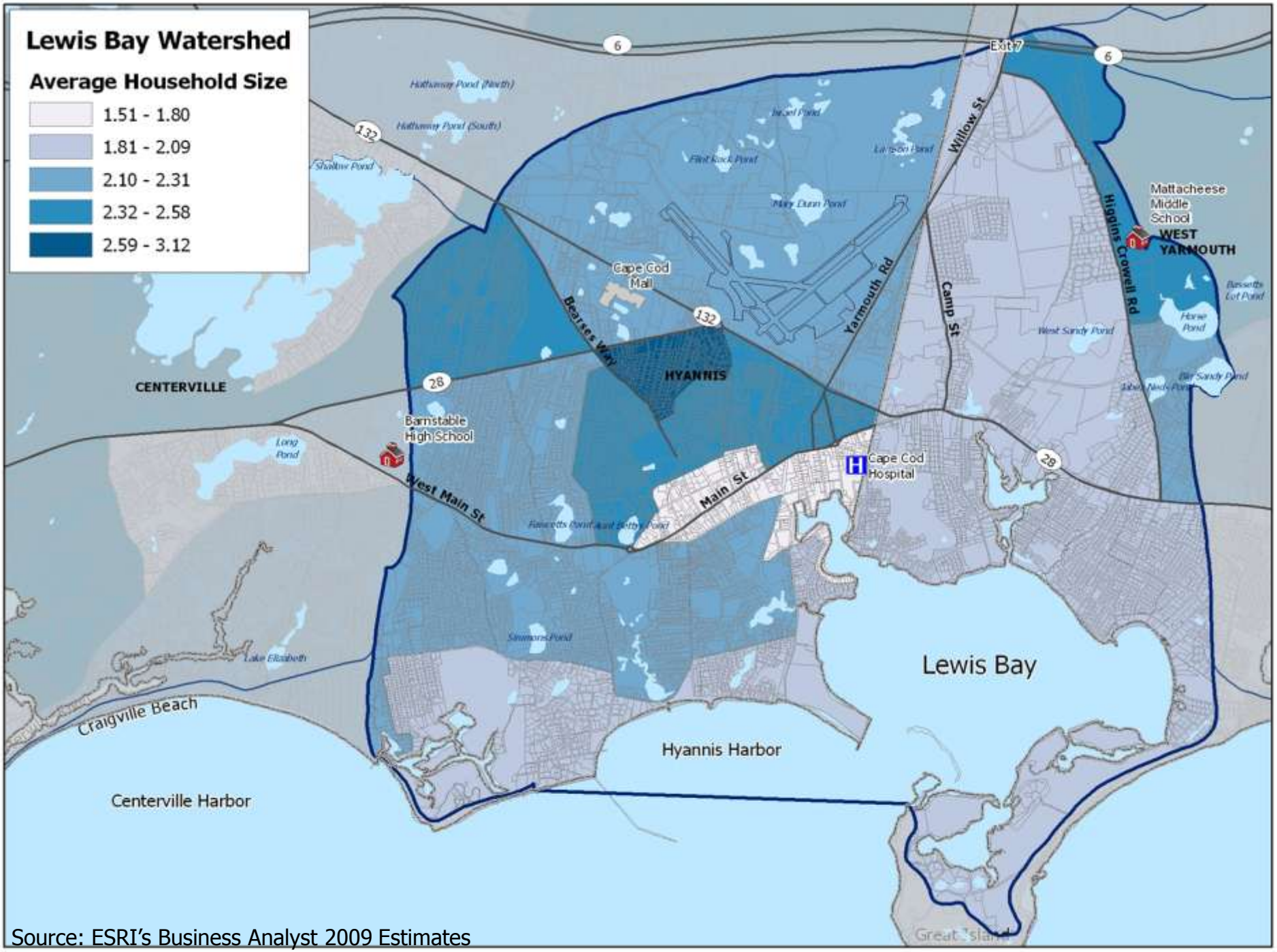

Source: ESRI's Business Analyst 2009 Estimates and Missouri Census Data Center



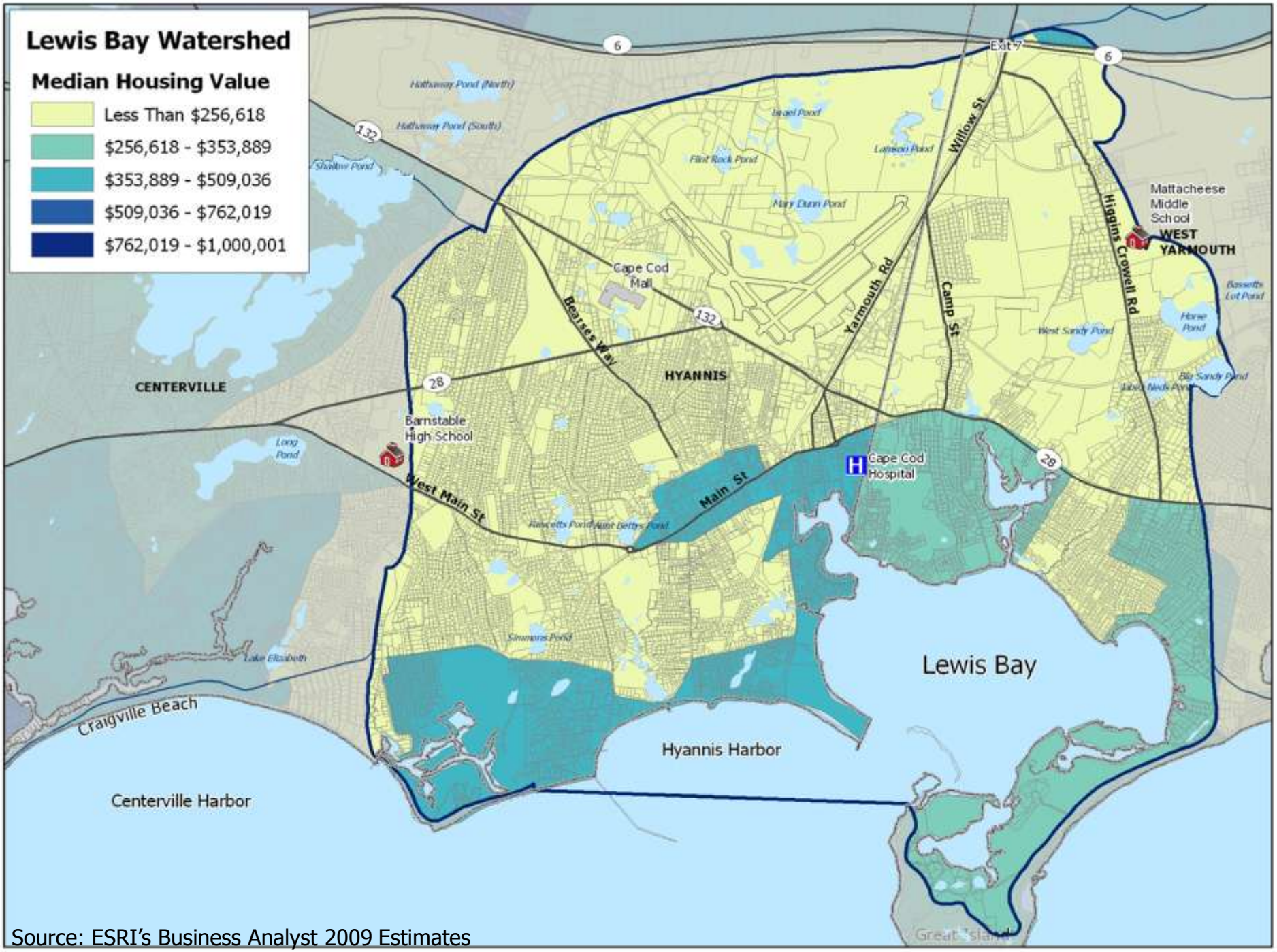

Source: 2000 U.S. Census Bureau



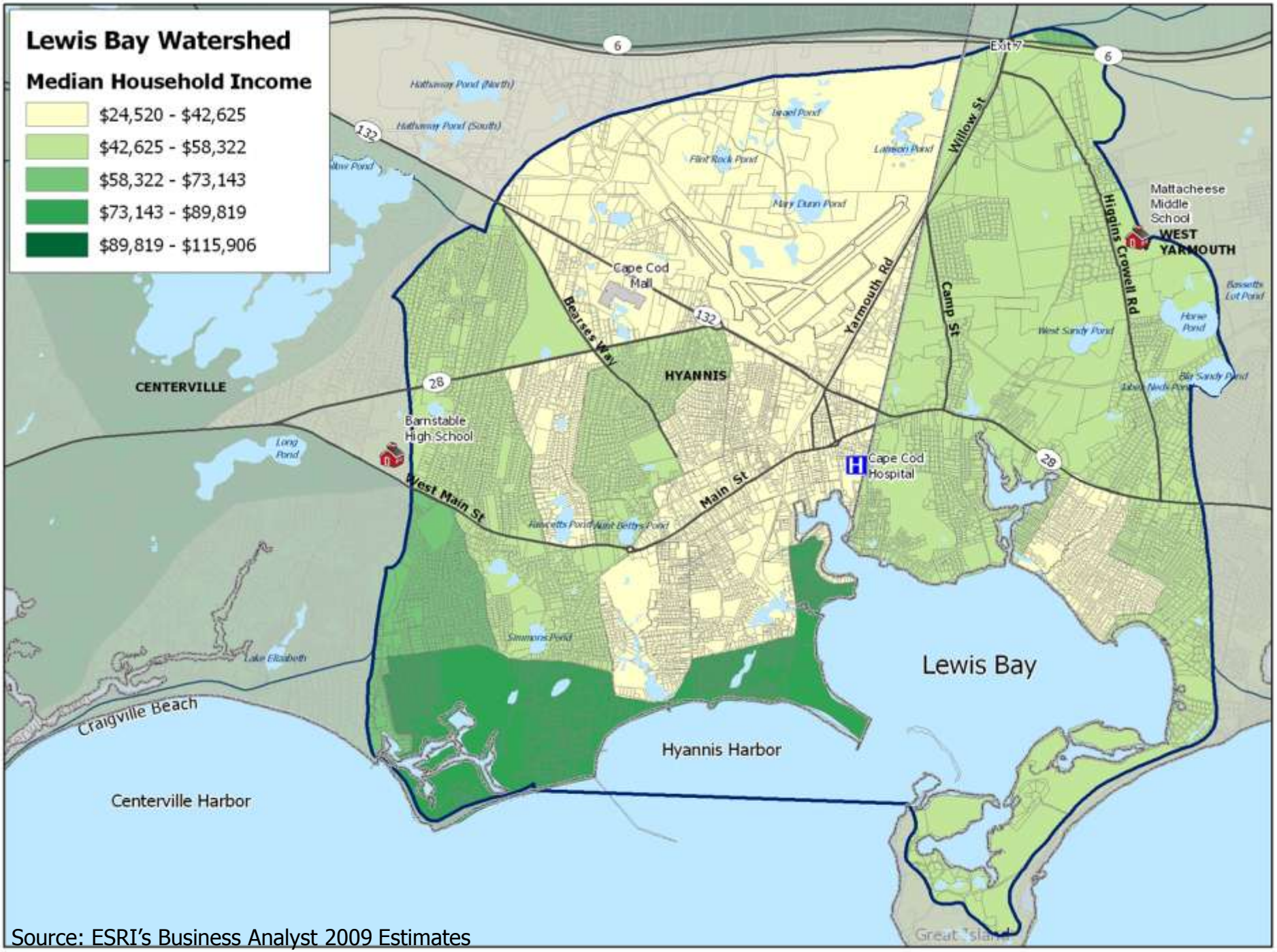

Source: ESRI's Business Analyst 2009 Estimates




Source: ESRI's Business Analyst 2009 Estimates




Source: ESRI's Business Analyst 2009 Estimates

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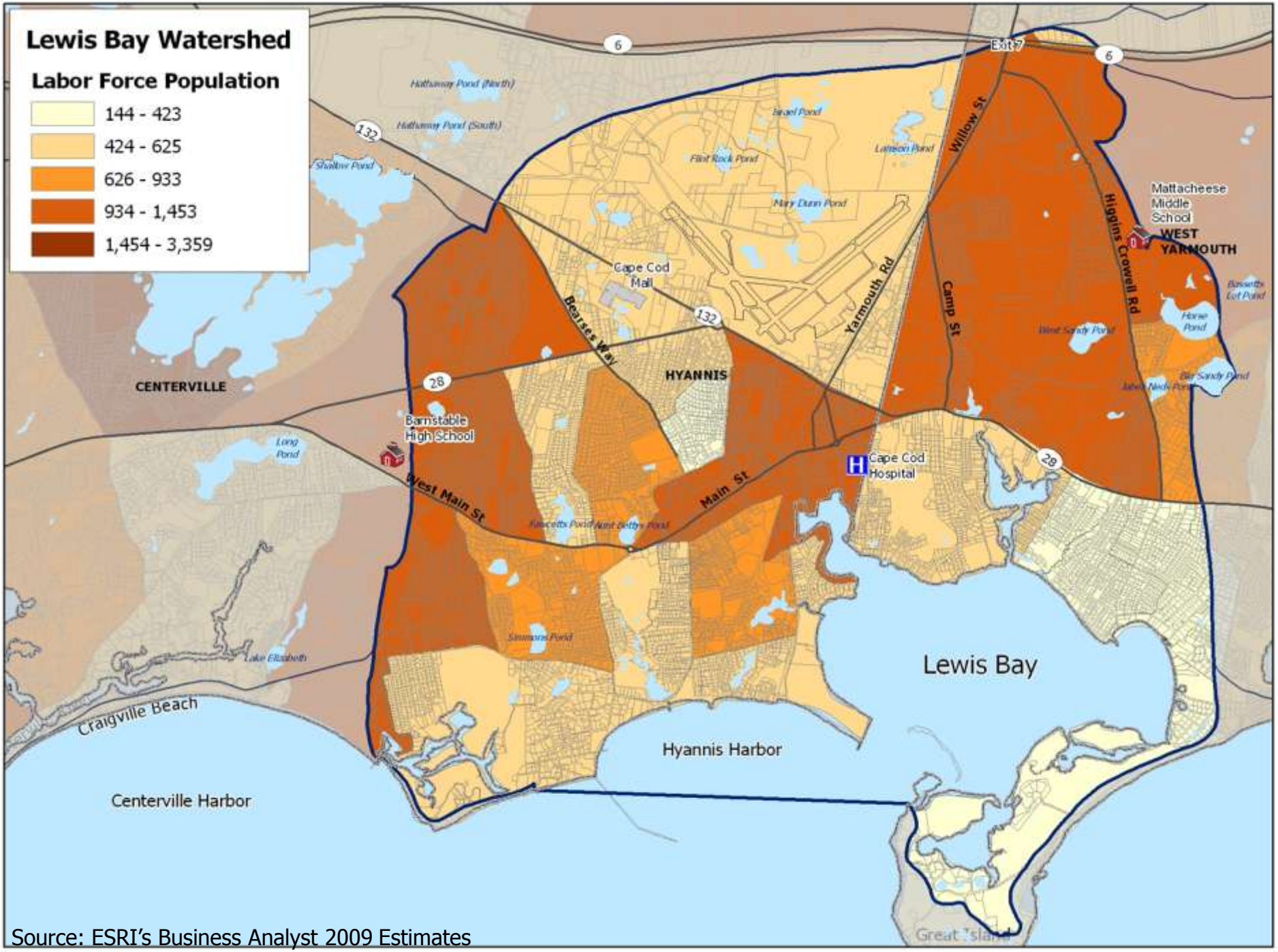
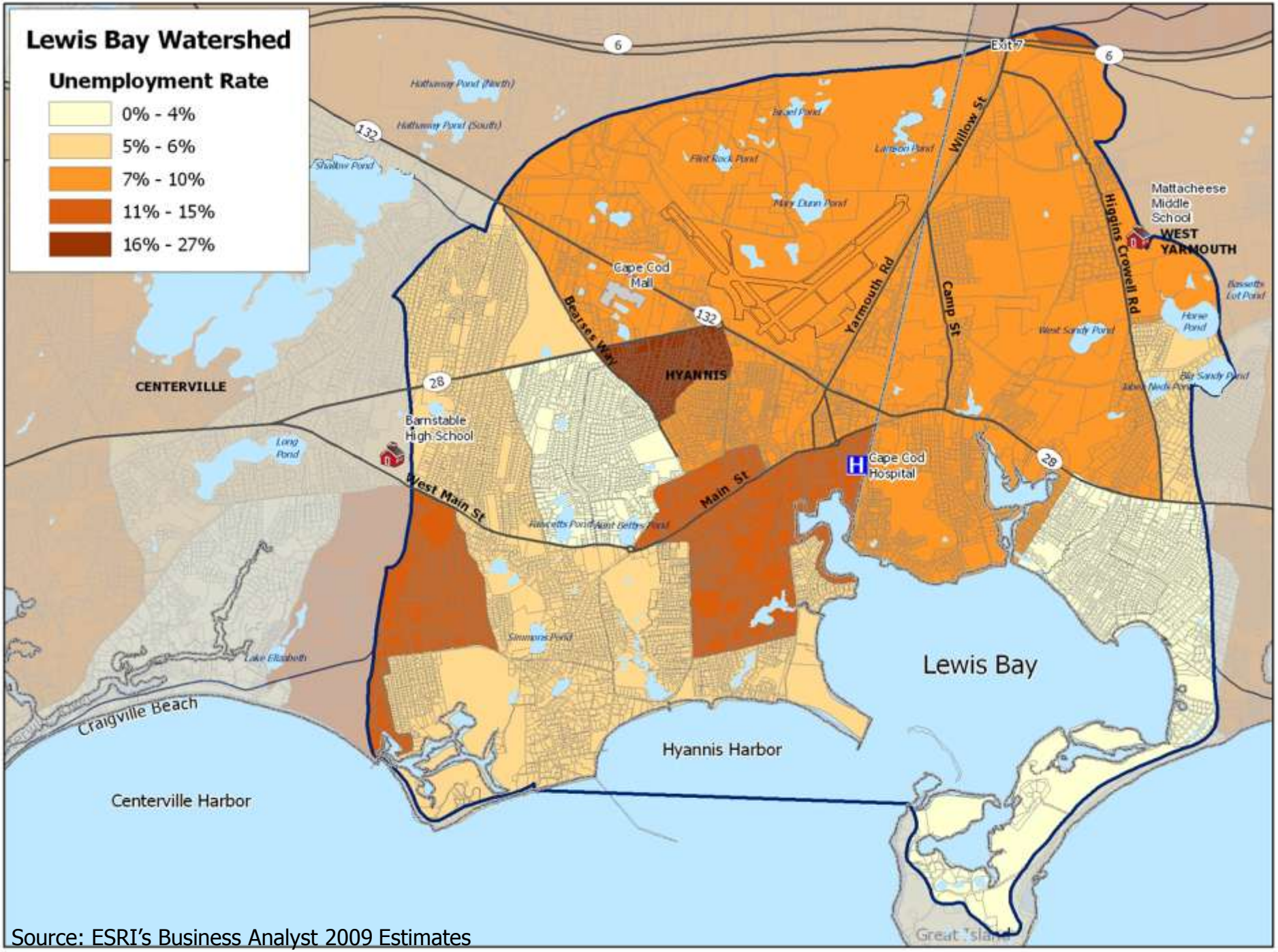
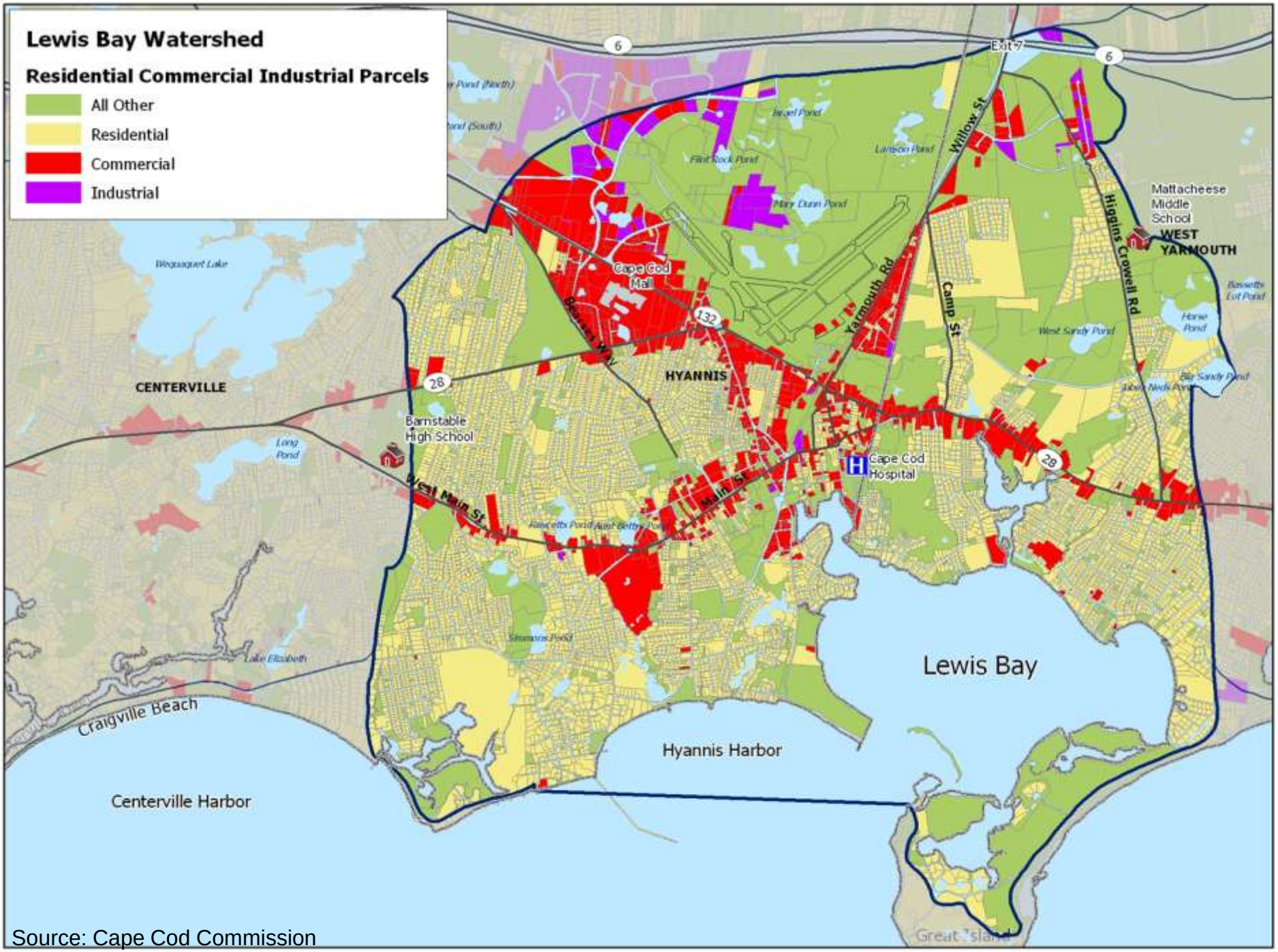


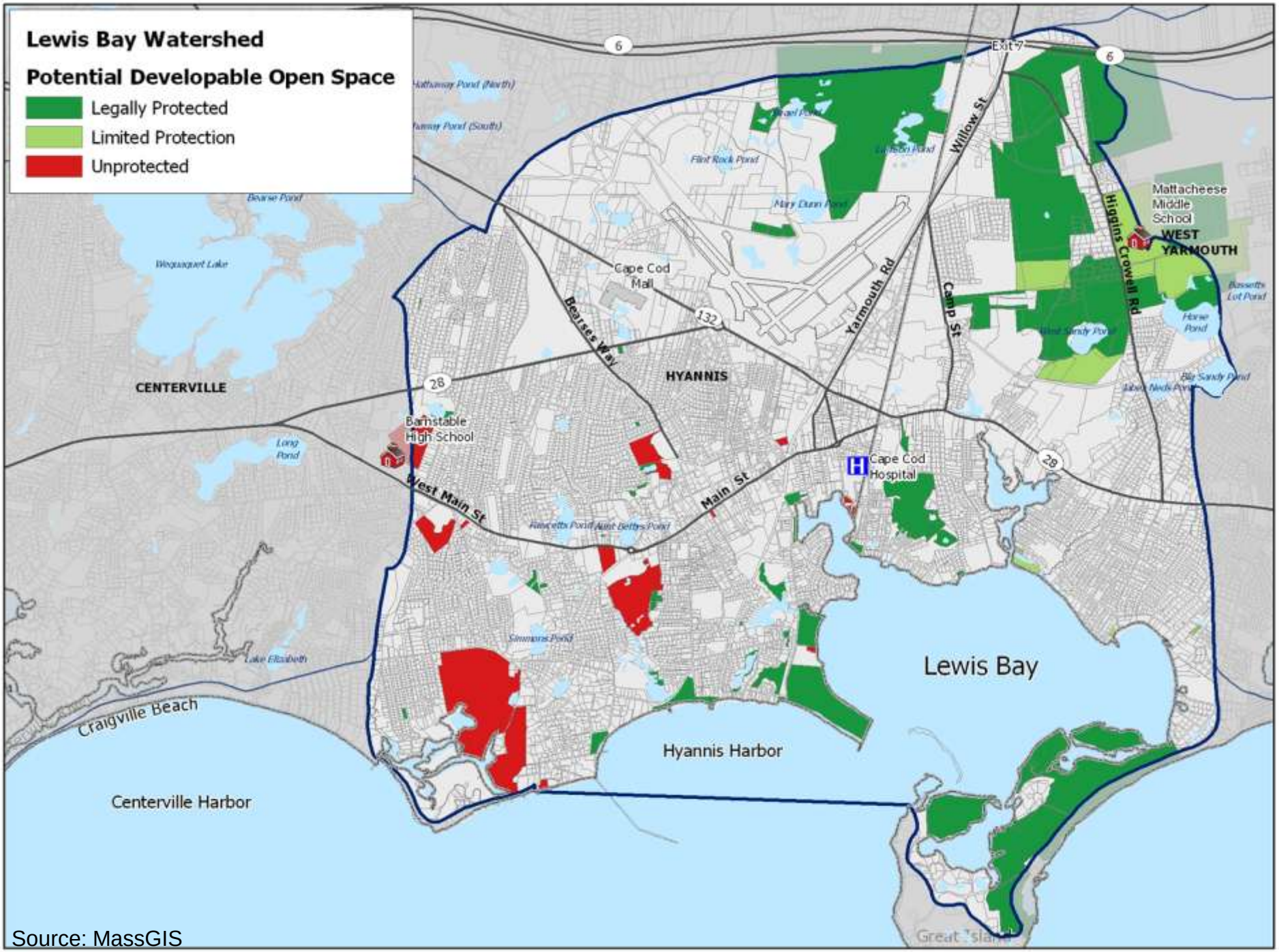

Source: ESRI's Business Analyst 2009 Estimates




Source: ESRI's Business Analyst 2009 Estimates




Source: Cape Cod Commission




Source: MassGIS

# The Problem

# Our Sole Source Aquifer

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- Replenished by Precipitation
- Six Separate Lenses
- Sole Source of Drinking Water
- Watersheds follow groundwater flow

# Lewis Bay Watershed and Water Table Contours

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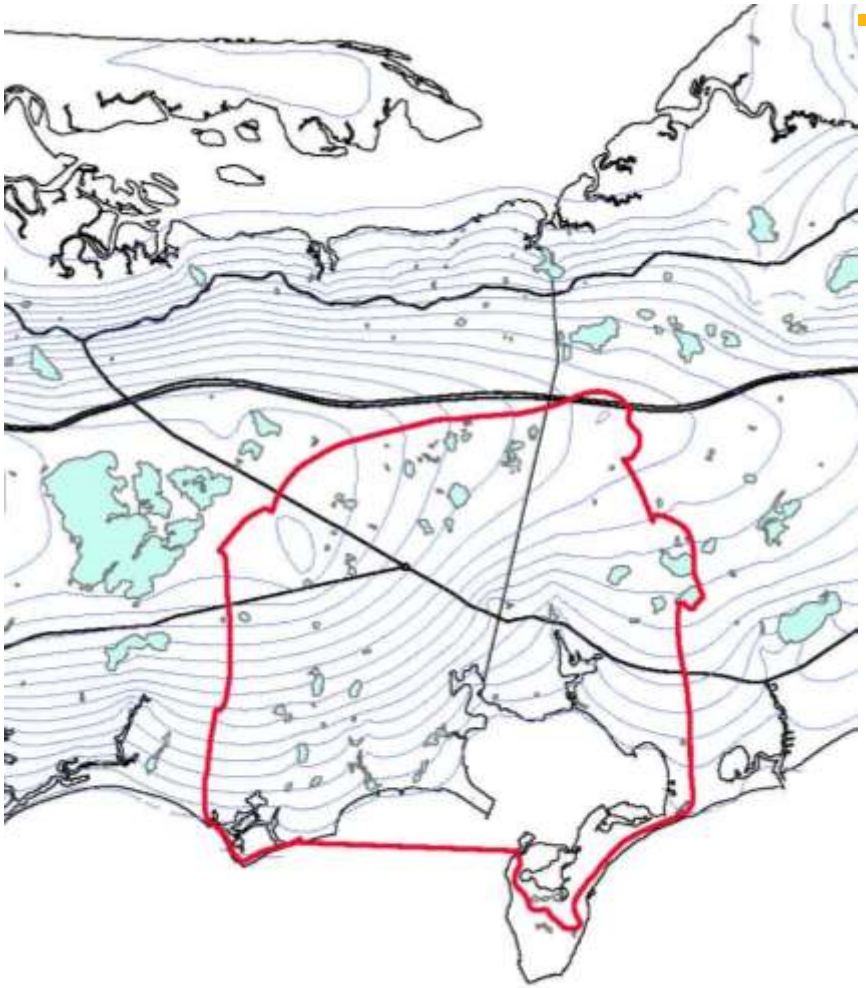

Average Groundwater flow rate is 1-2 feet per day

Groundwater flow times range up to 100 years but average up to10 years to arrive in the embayment

# Wellhead Protection Areas to Public Water Supply Wells

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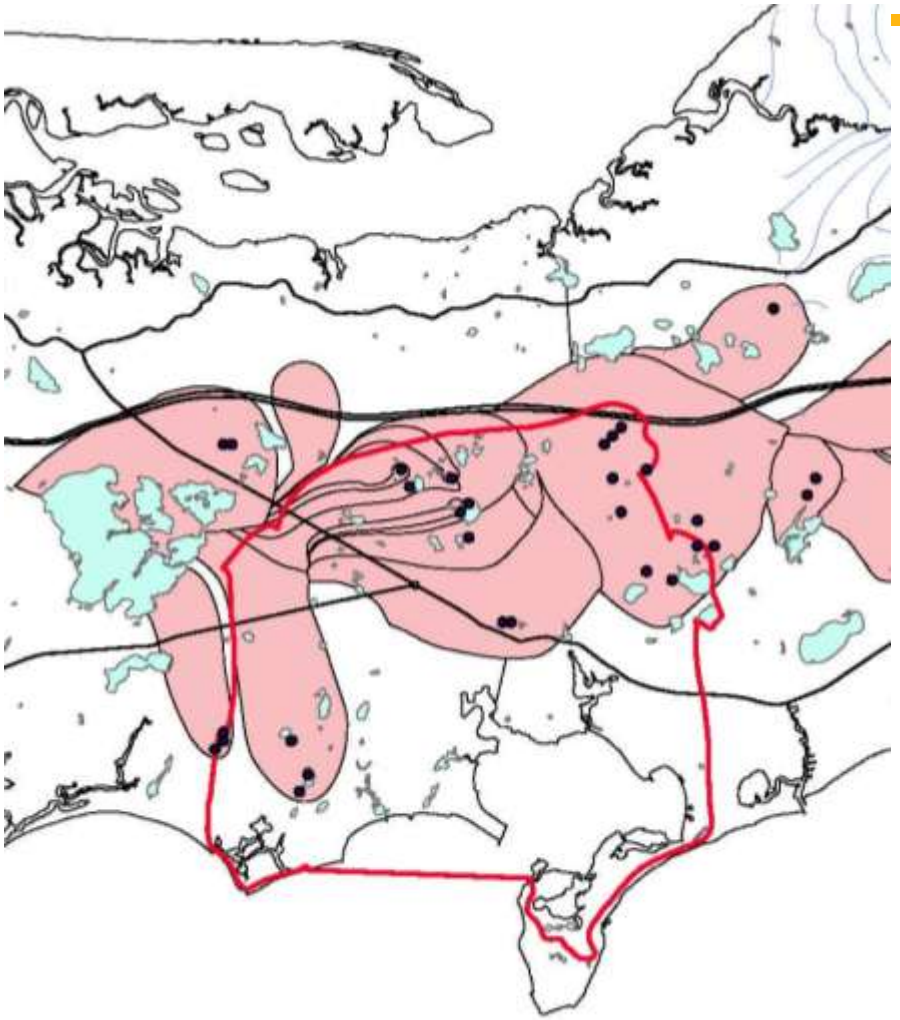

Zone IIs

Yarmouth Water Dept
COMM Water District
Hyannis Water Division
Barnstable Fire District

# Septic Systems and our Watershed

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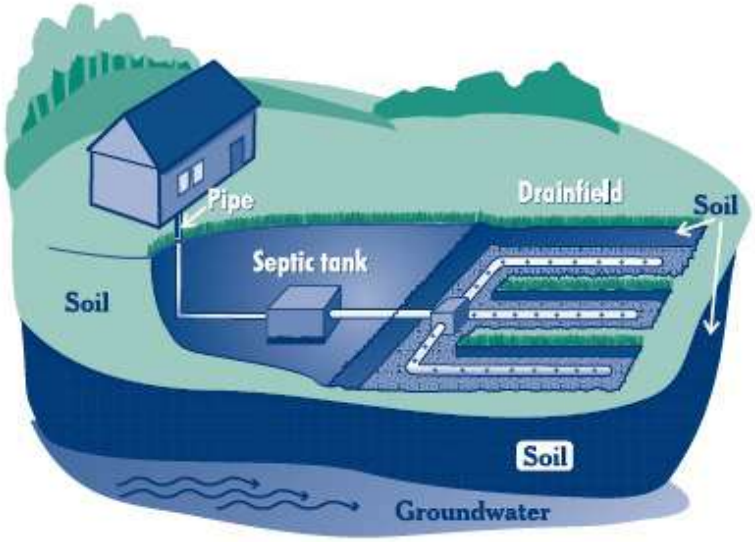


- **The septic system of an average three-bedroom home loads 8.5 pounds of nitrogen into the groundwater each year.**
- **Approximately 85% of the over 156,000 homes on Cape Cod presently use individual Title 5 septic systems.**

# Water Quality Assessment

## Massachusetts Estuary Project
## Watershed and Subwatersheds

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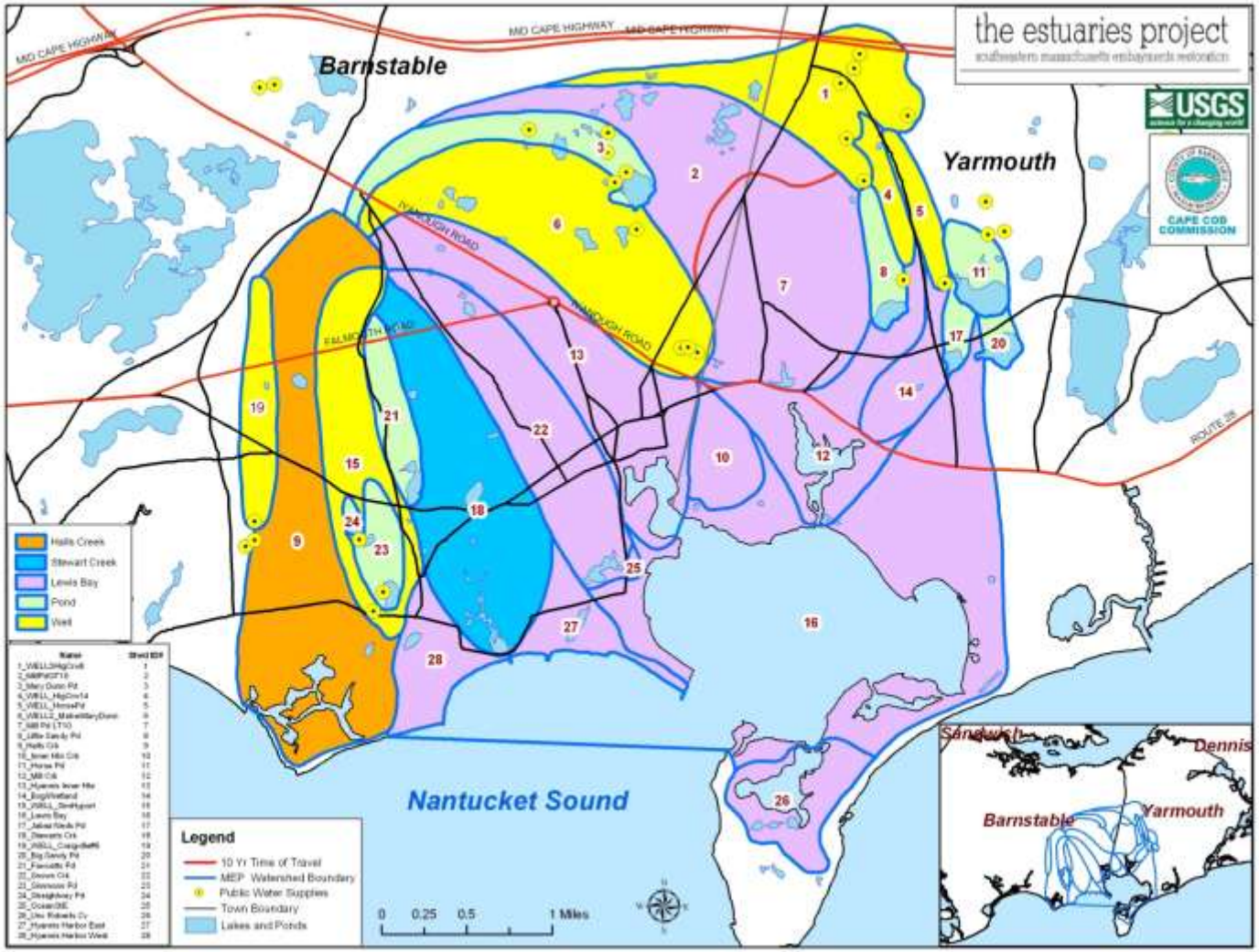

# Water Quality

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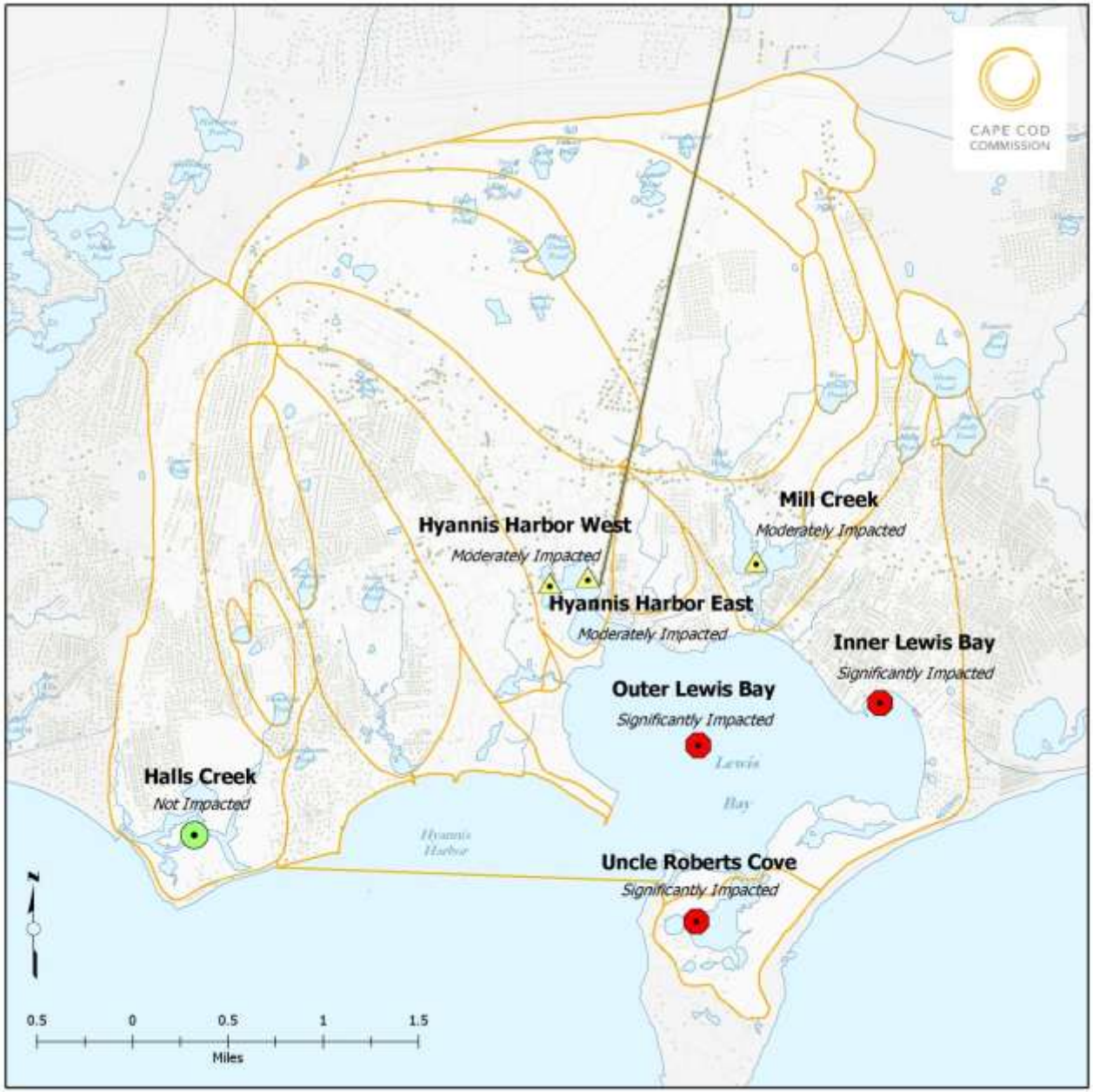
Water Quality Monitoring Stations

Sampled 10 to 4 times through the Summer

Coordinated by
- Town of Barnstable
- Lewis Bay Research Center
- Town of Yarmouth

Over Ten Years of Data

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# The Problem

## MEP Characterization:

**Dissolved Oxygen,**
**Chlorophyll,**
**Macroalgae,**
**Eelgrass,**
**Infaunal Animals**

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# Water Quality

## Present Conditions

## Nitrogen Concentration in water

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# Water Quality

## Buildout Conditions

## Nitrogen Concentration in water

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# Water Quality

Pre-Colonial Modeled Conditions

Nitrogen Concentration in water

# Eel Grass

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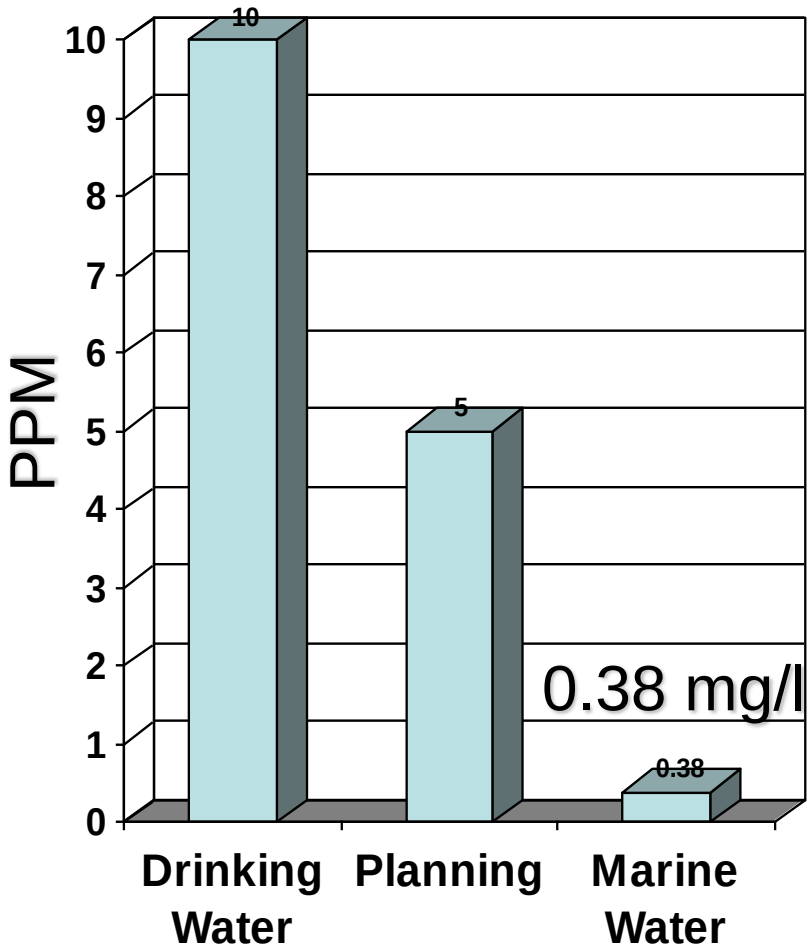
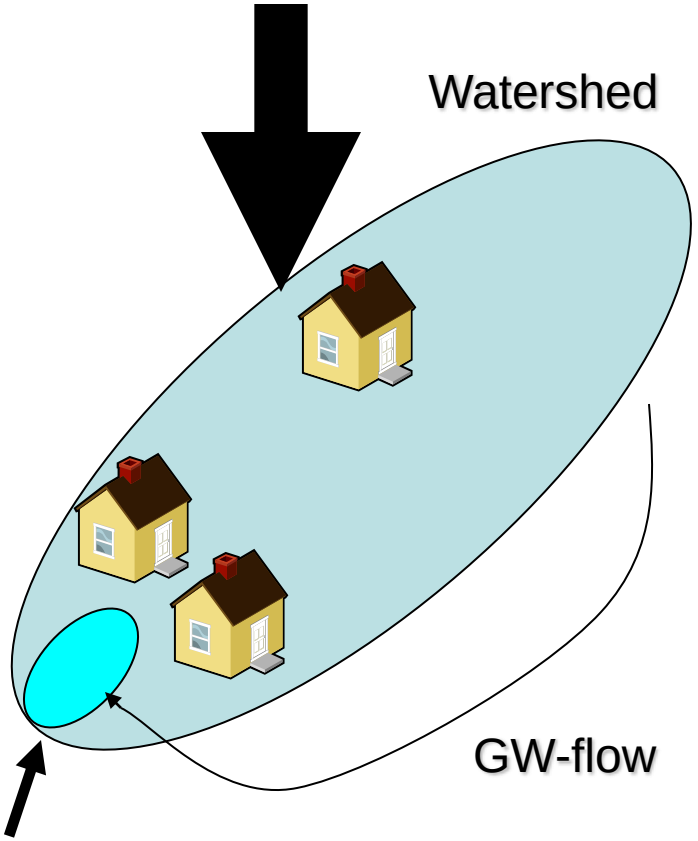
Loss of Eelgrass over Time

1951 -------
1995 -------
2001 -------

# Relative Nitrogen Thresholds

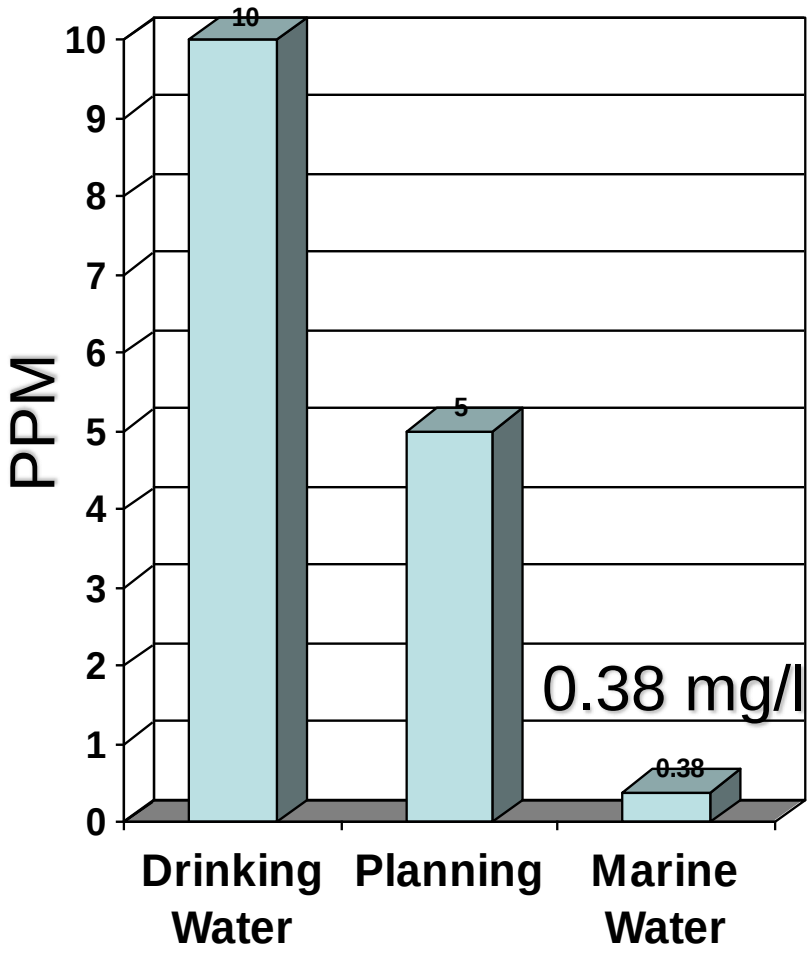


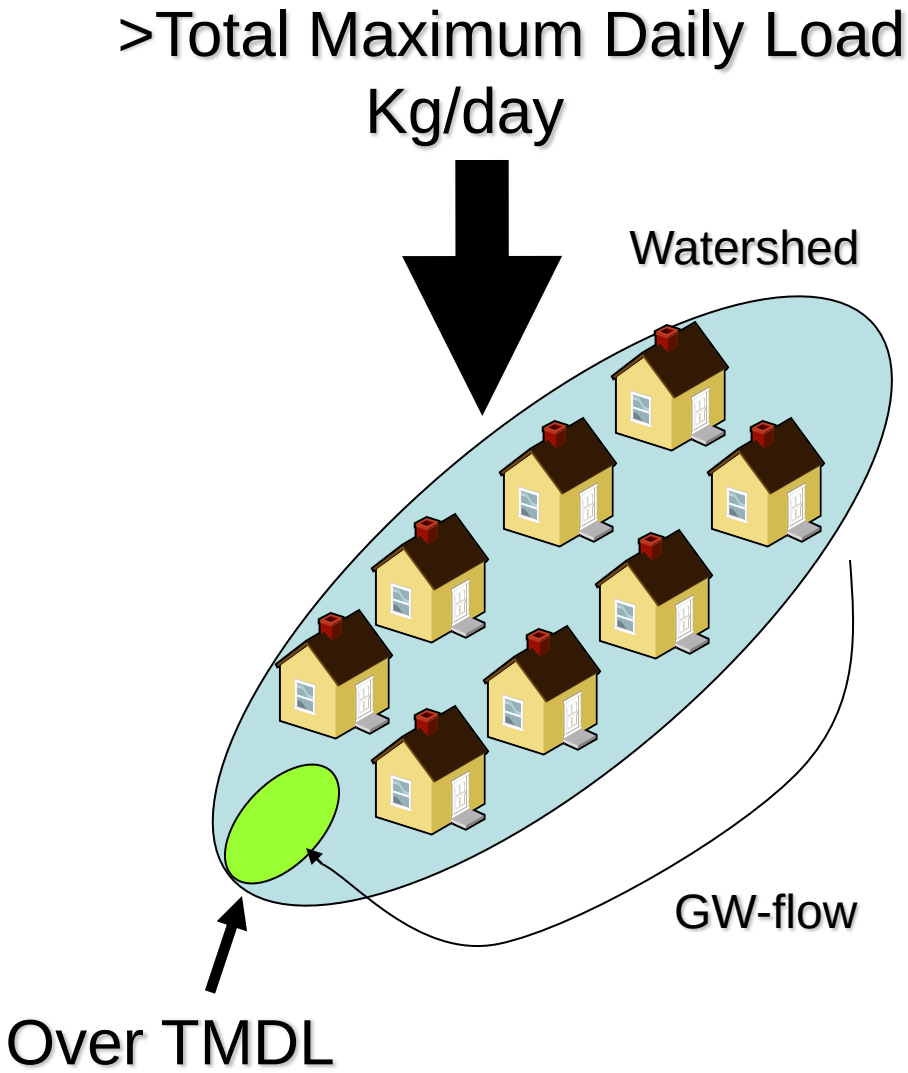

< Total Maximum Daily Load Kg/day




Meets TMDL

# Relative Nitrogen Thresholds



# Sources of Nitrogen

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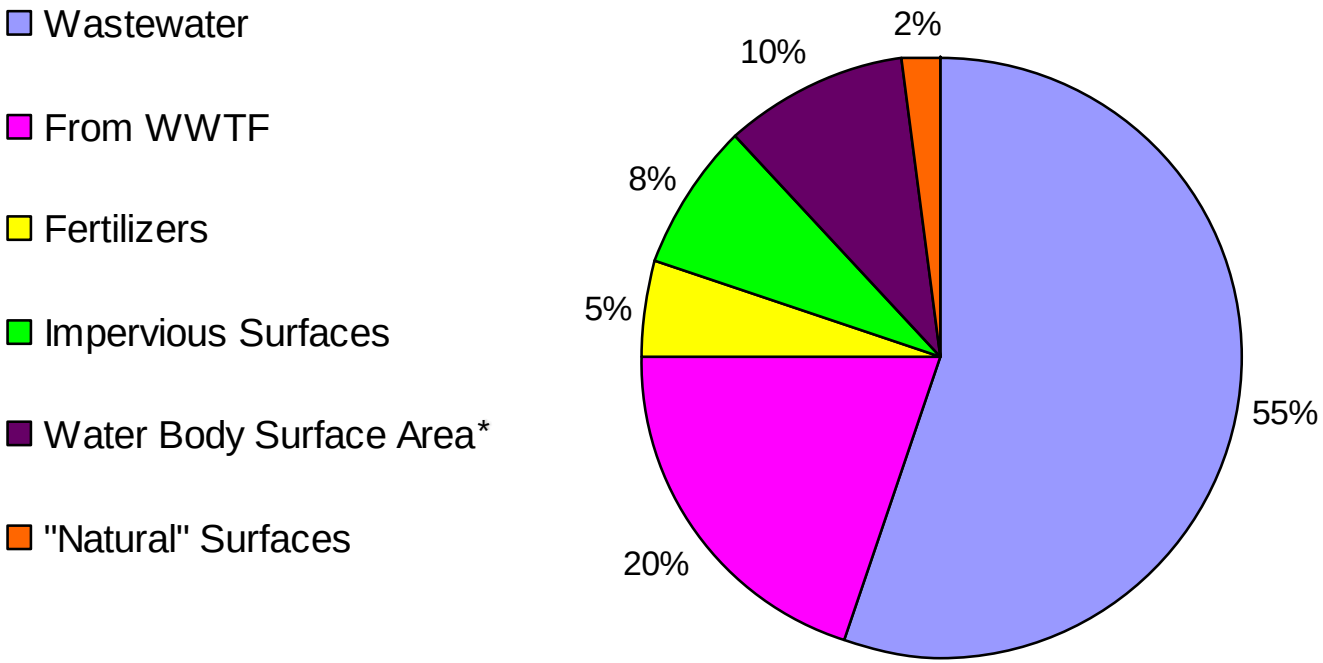


*Including atmospheric water

# Other Watershed Features
# Barnstable Water Pollution Control Facility
# Flow of Treated Effluent in Groundwater

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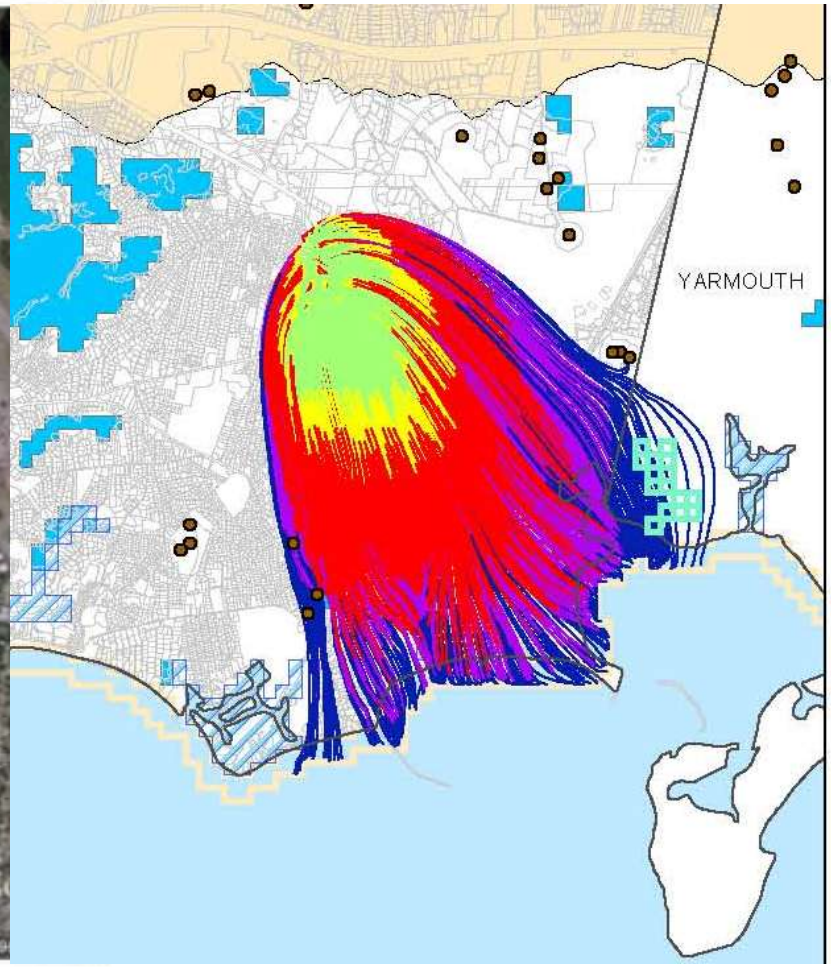

# Existing Wastewater Treatment in Lewis Bay Watershed

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## Barnstable Water Pollution Control Facility

1935 – Built to Serve Downtown Hyannis
8 Filter Beds 0.32 MGD
1955 – 10 Filter Beds 0.53 MGD
1967 – 16 Filter Beds 0.77 MGD
1980 – 49 filter Beds with 4.2 MGD Capacity at Secondary Treatment
- Flow limited to 2.7 MGD Peak
2001 – Tertiary Treatment
2007 – Facilities Plan Approved at 4.2 MGD Capacity

## Private Facilities

Mayflower Place – 25,000 GPD

Buck Island Condo – 30,000 GPD

# Facility Siting

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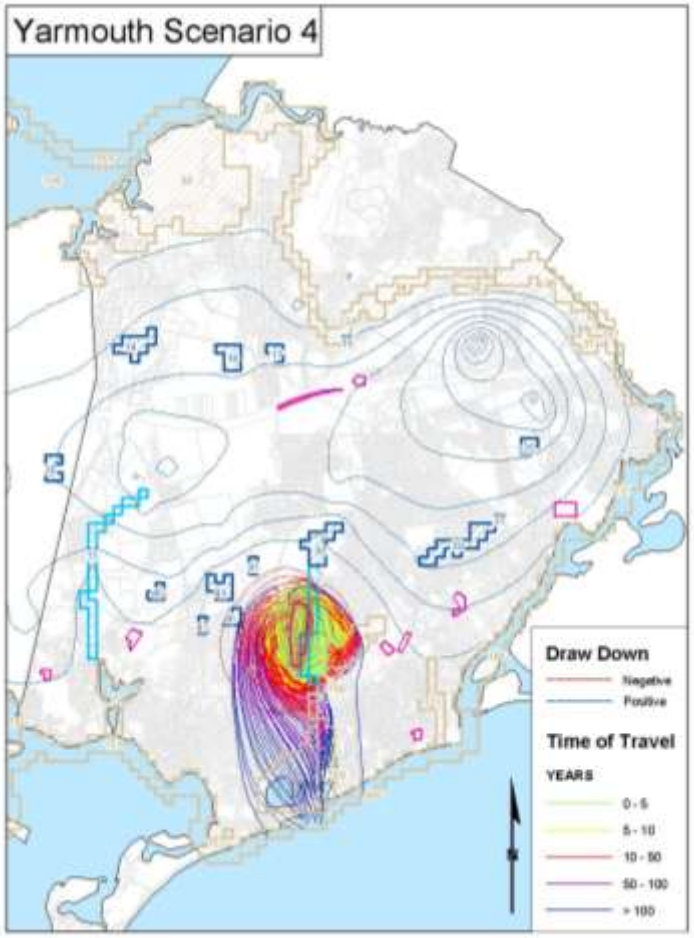
- Site Screening Considerations
- Preliminary Groundwater Modeling
- Site Characterization
  - Hydrogeology
  - Loading Capacity Tests
- Detailed Modeling
  - Mounding
  - Water Resource Impacts
- Costs



# Implementation, Adaptive Management and Compliance

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- Chatham – 20 +10 years
- Orleans – 20 Years

# Measuring Implementation Progress

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- Capital Expenditures to Date
- Amount Sewered
- Percent Removed from TMDL Watersheds
- Planned Capital Expenditures
- Projected Expansion Areas
- Non-Structural Management Progress

# TMDL Compliance Monitoring

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- Marine Water Quality
- Eelgrass
- Benthic Fauna

# Lewis Bay Percent of Required Septic Nitrogen Removal by Subwatershed

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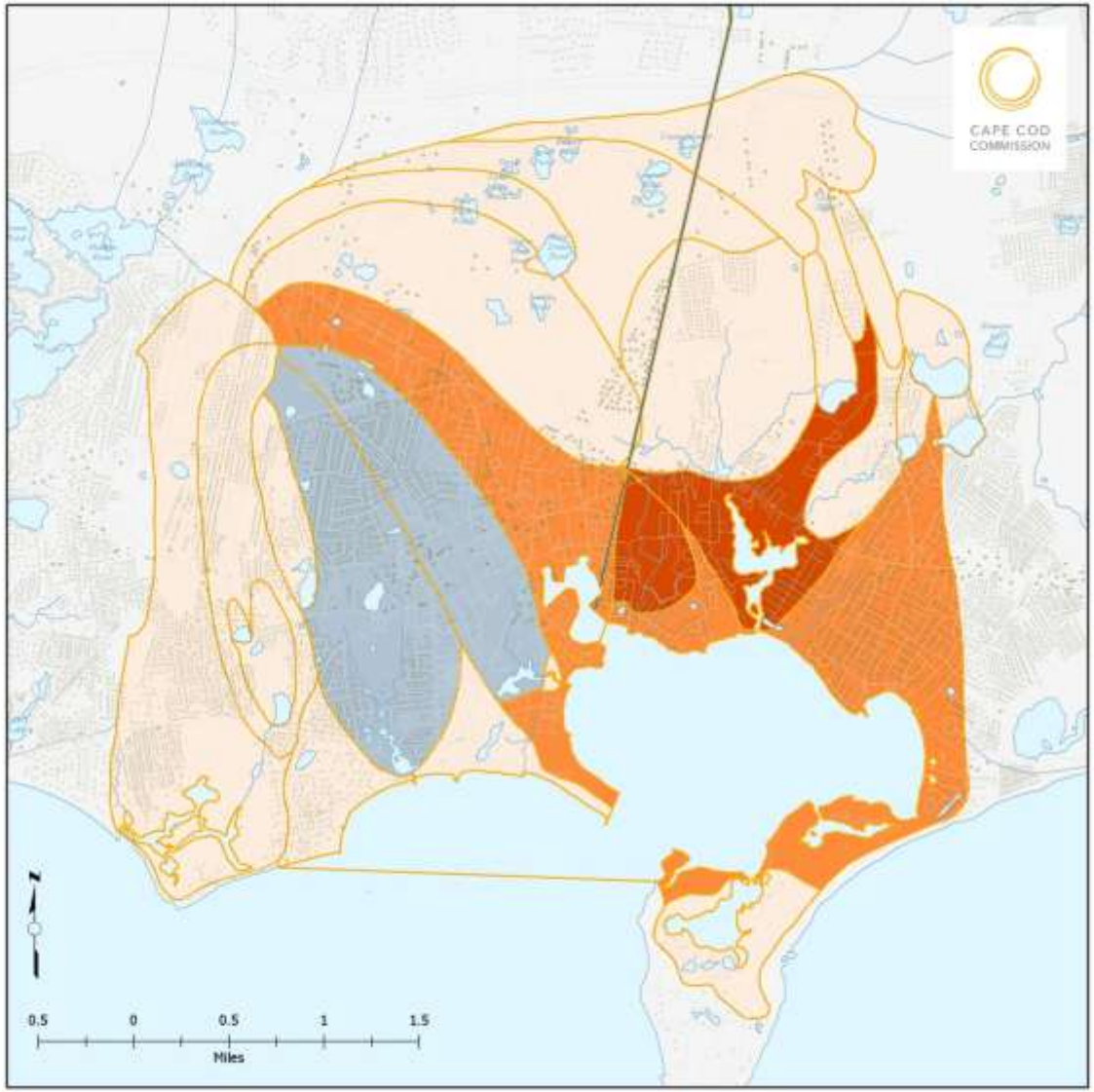


**85% Removal**

**80% Removal**

**Additional Capacity**

# Existing Sewer Service Areas

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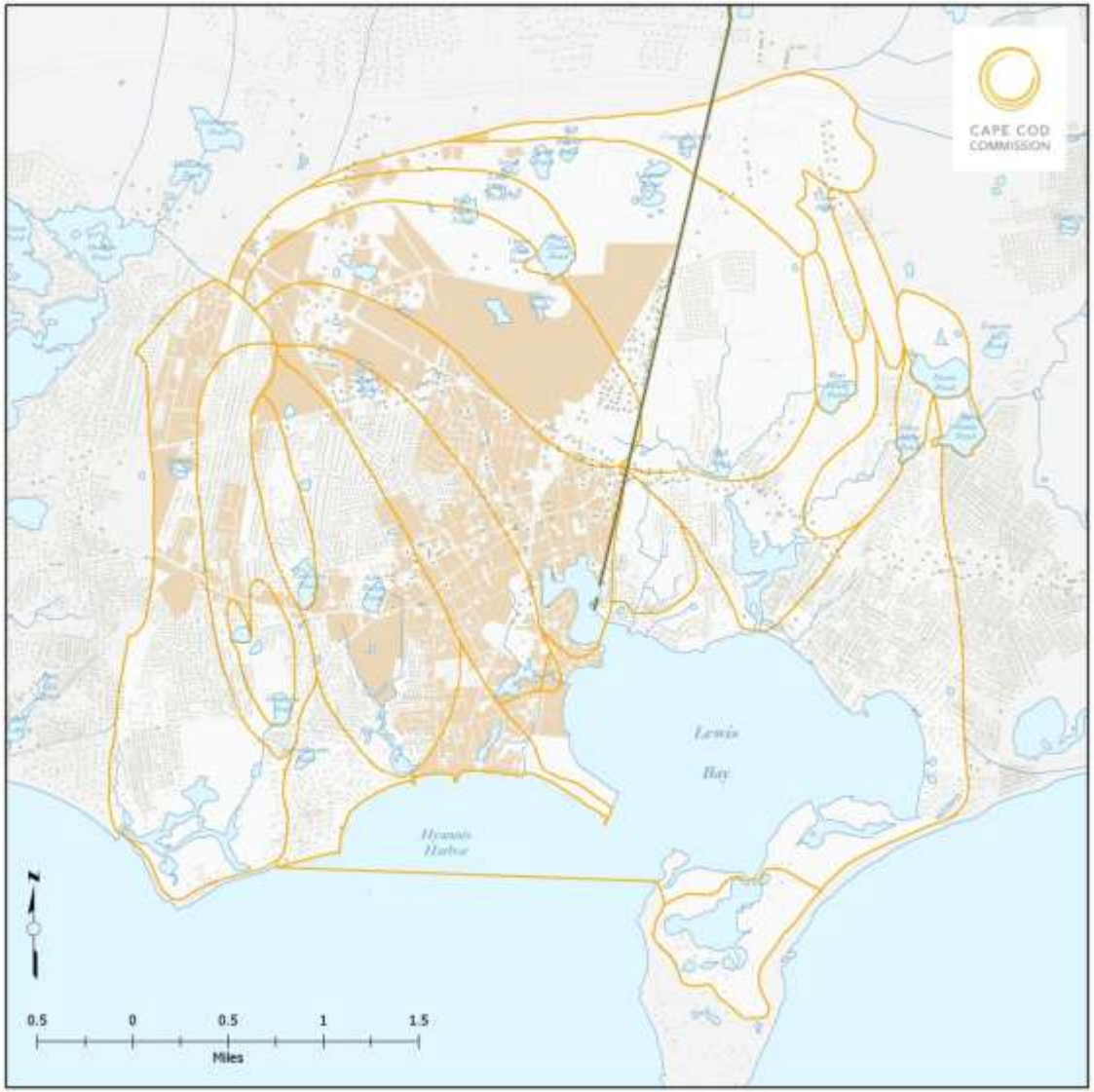


6,830 Total Parcels

1,410 Sewered Parcels

20% Sewered

# Areas of Concern from Barnstable Needs Assessment

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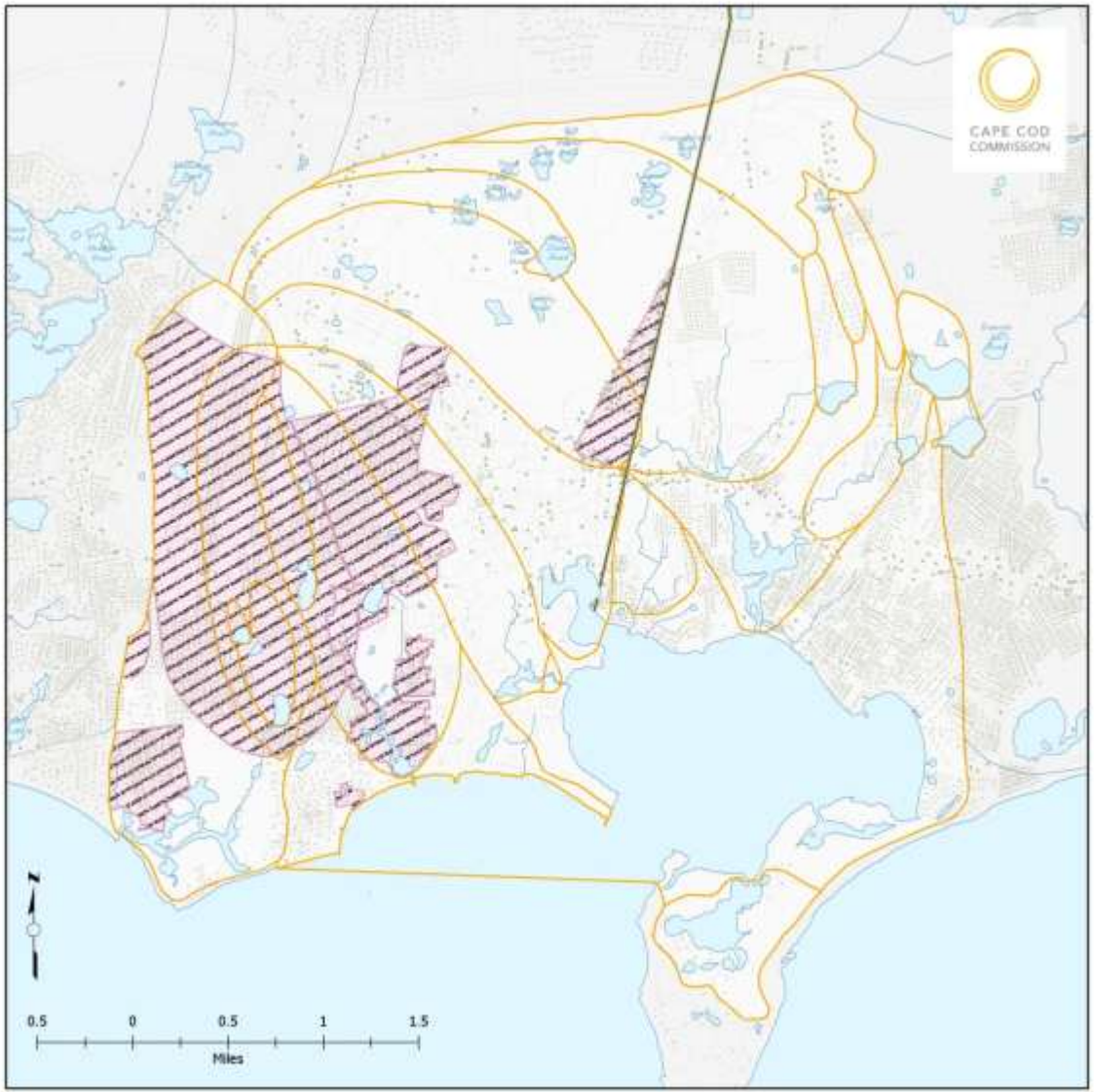


Title 5 Failures

Pathogens

Public Water Supply Well Protection

# Combining Existing Sewer Service Areas and Areas of Concern in Barnstable

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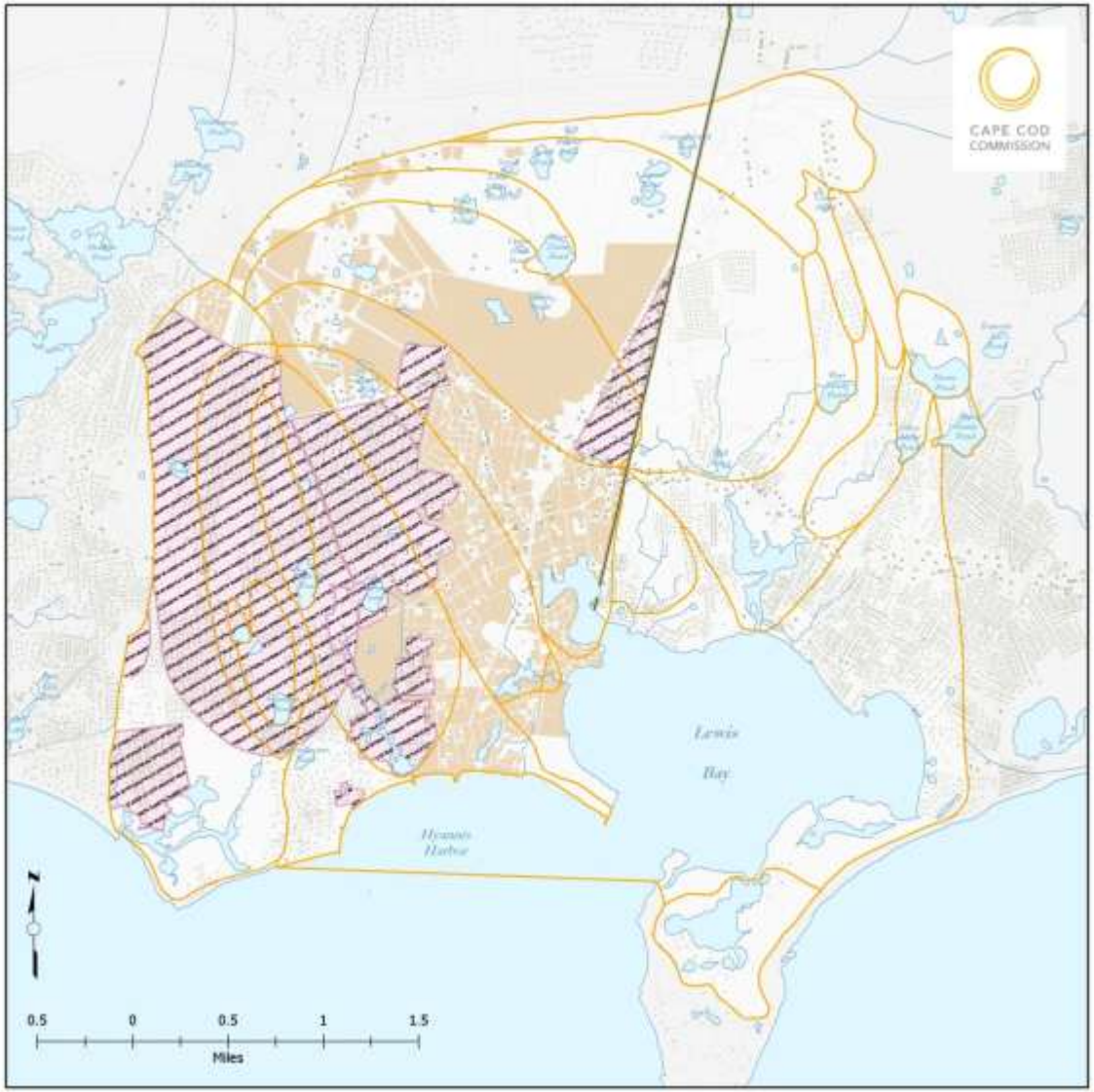

# Regional Solutions Combine All Wastewater Needs

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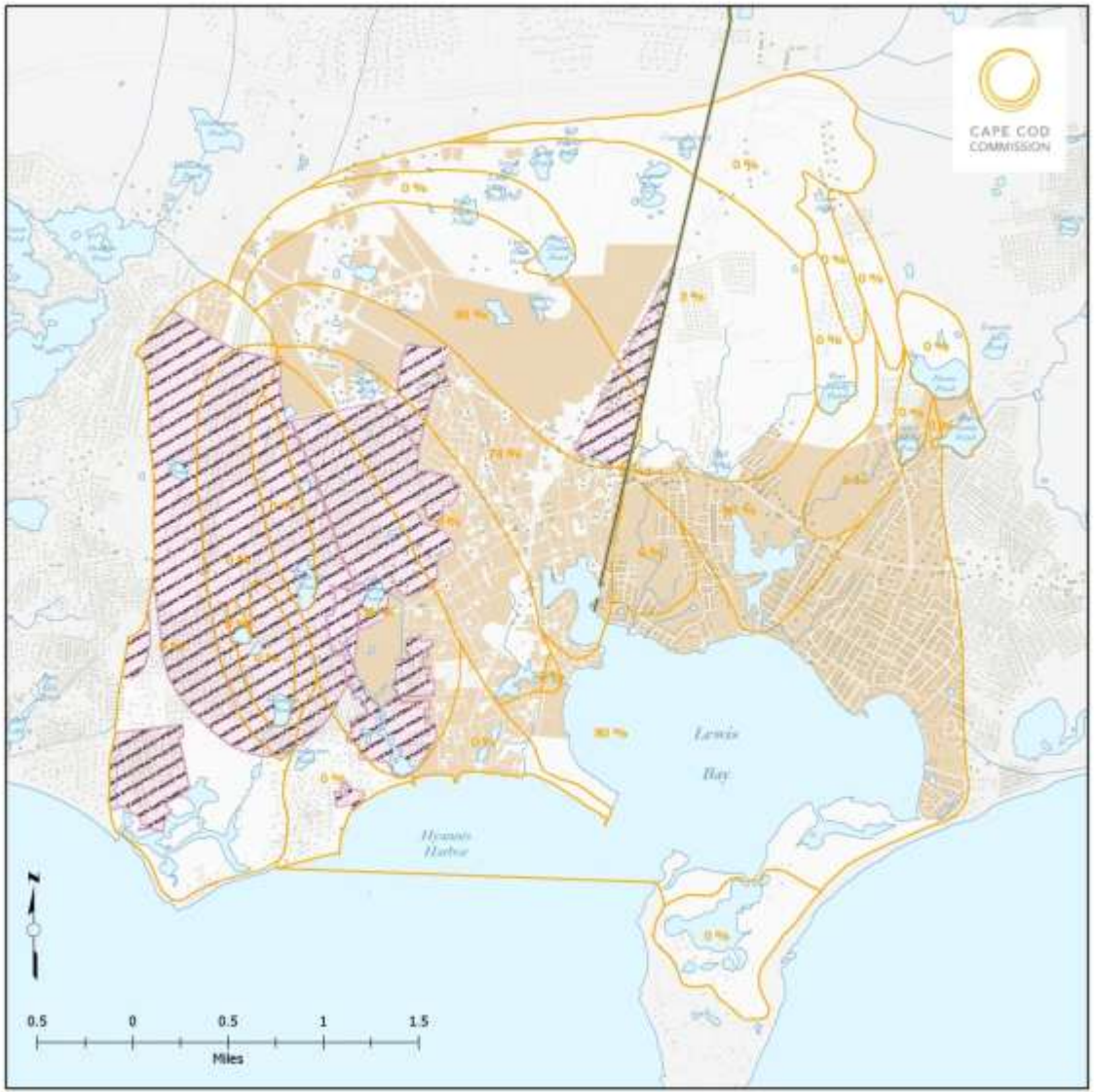
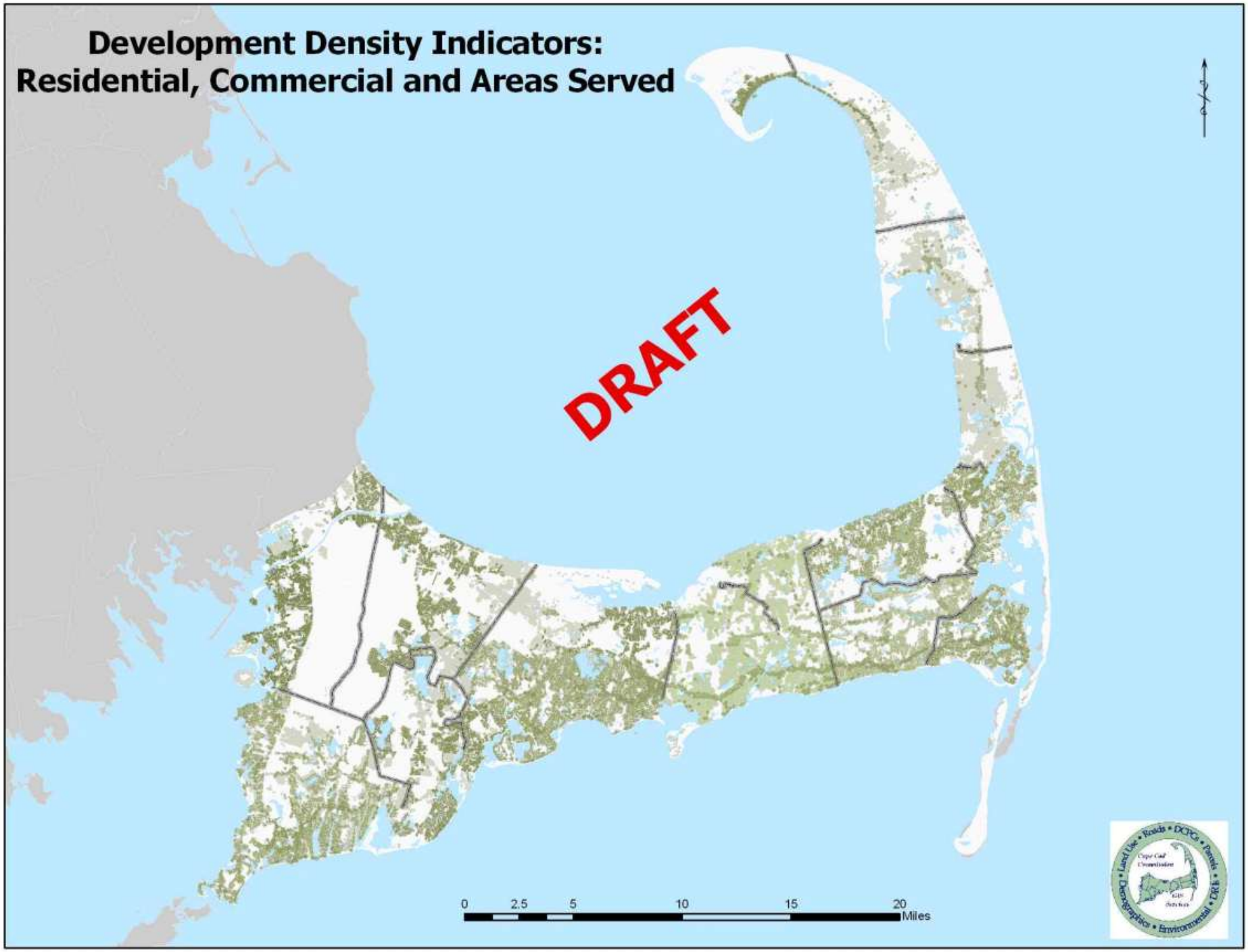


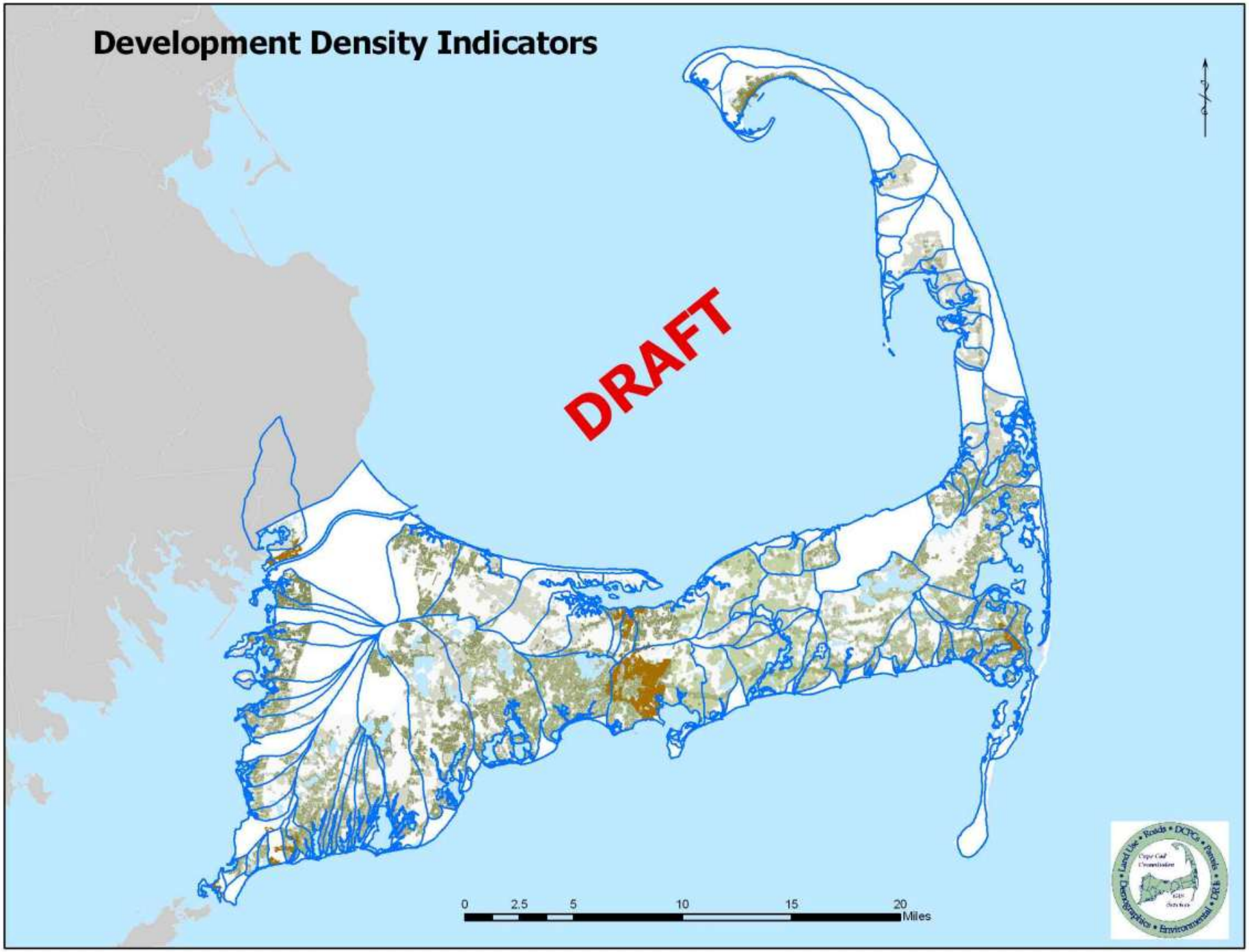

MEP Technical Scenario for Regional Approach

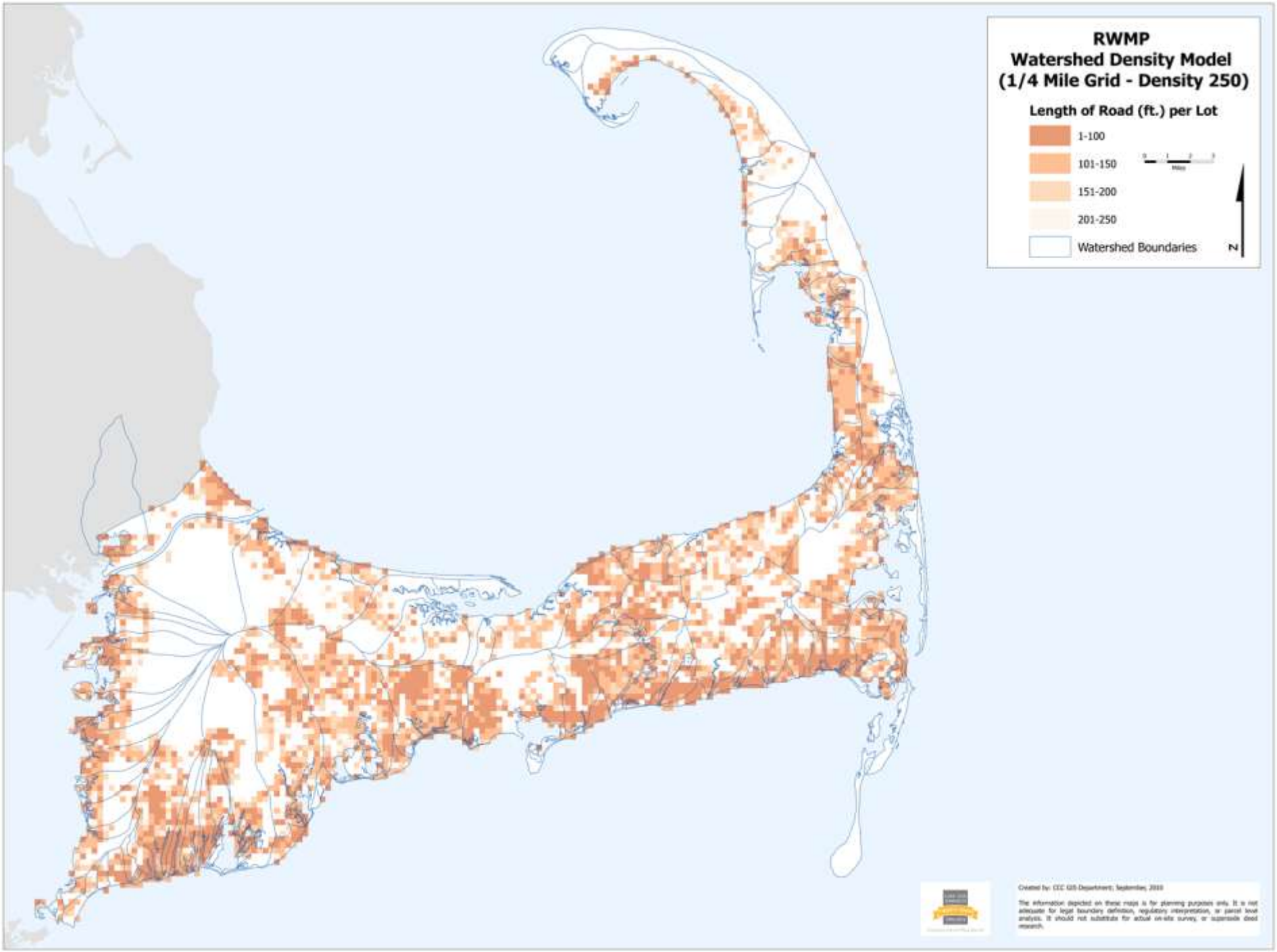
Includes sewering in Yarmouth portion of Watershed

# Development Density Indicators: Residential, Commercial and Areas Served



# Development Density Indicators




RWMP
Watershed Density Model
(1/4 Mile Grid - Density 250)
Length of Road (ft.) per Lot
1-100
101-150
151-200
201-250
Watershed Boundaries
N
Created by: CCC GIS Department, September, 2010
The information depicted on these maps is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analysis. It should not substitute for actual on-site survey, or supersede deed research.

# Density and Facilities Siting are Significant Considerations

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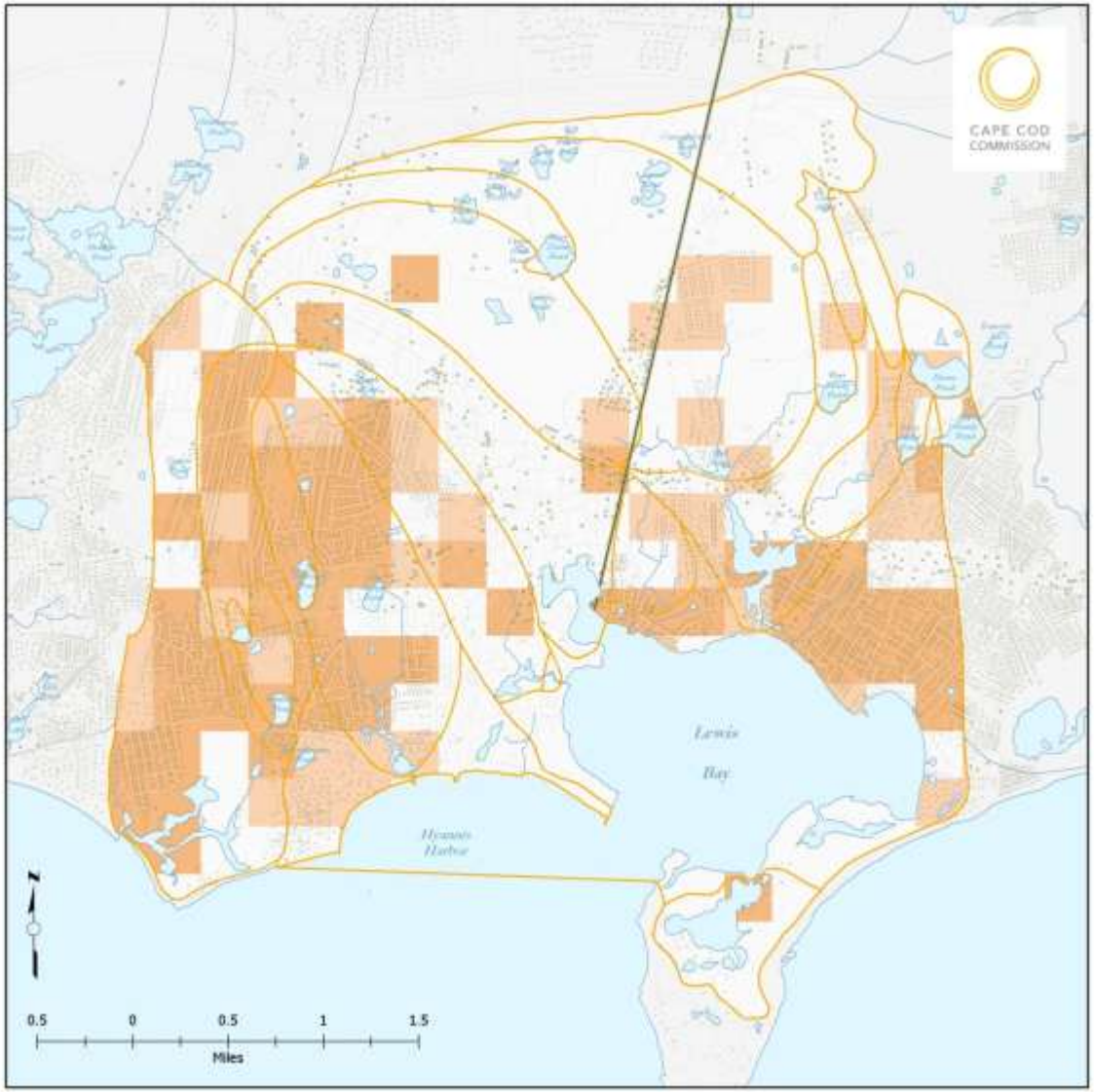
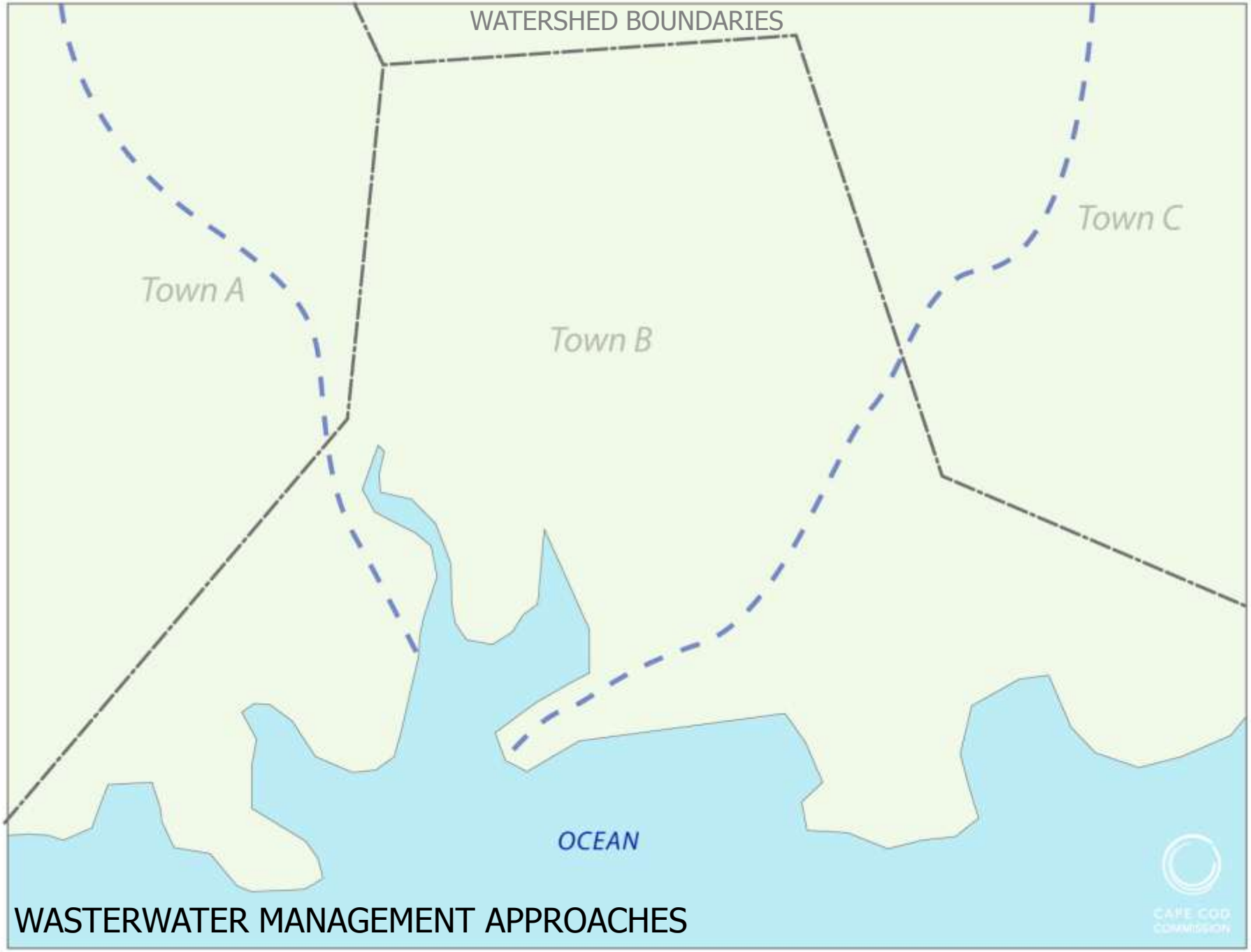


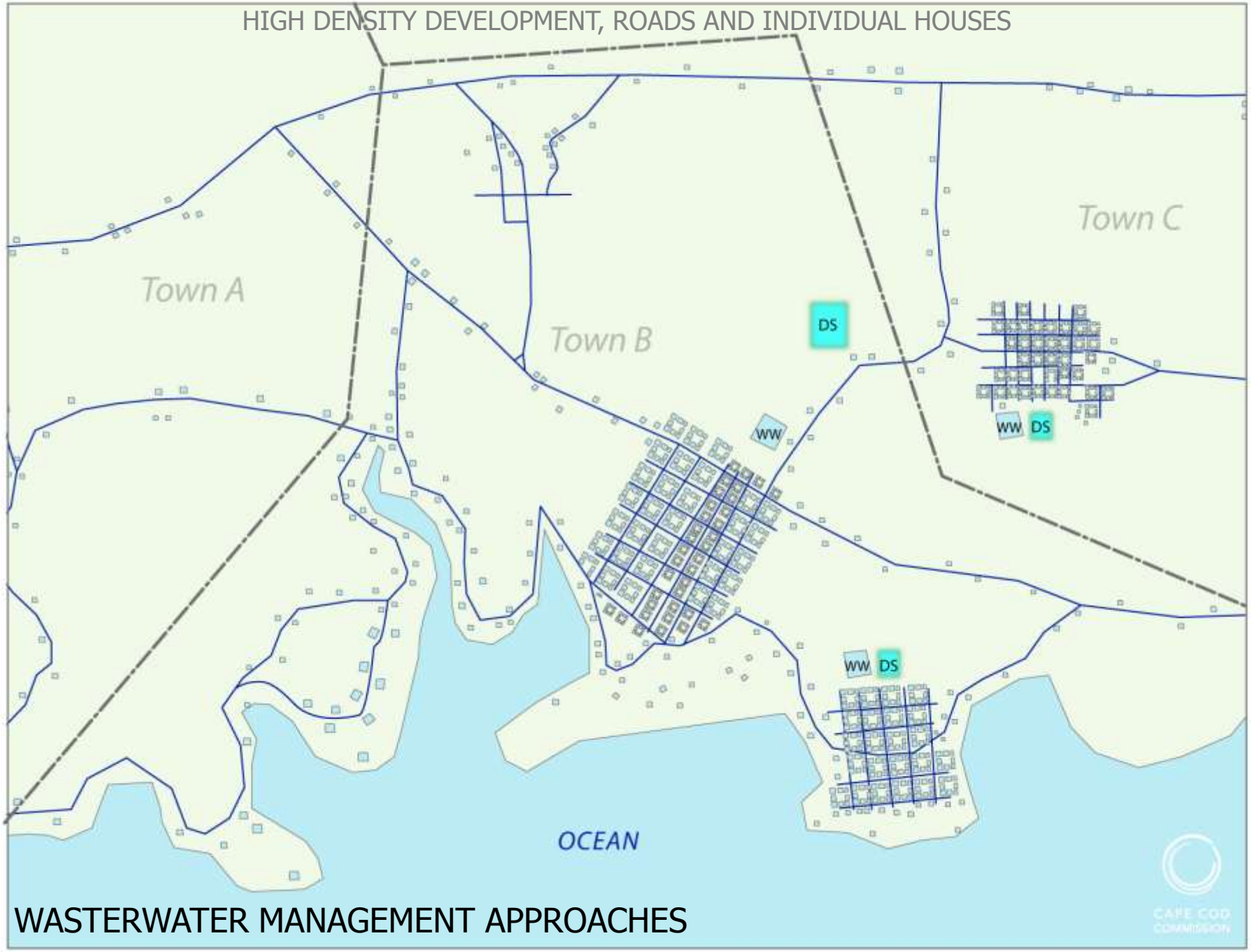

Length of Road/Lot

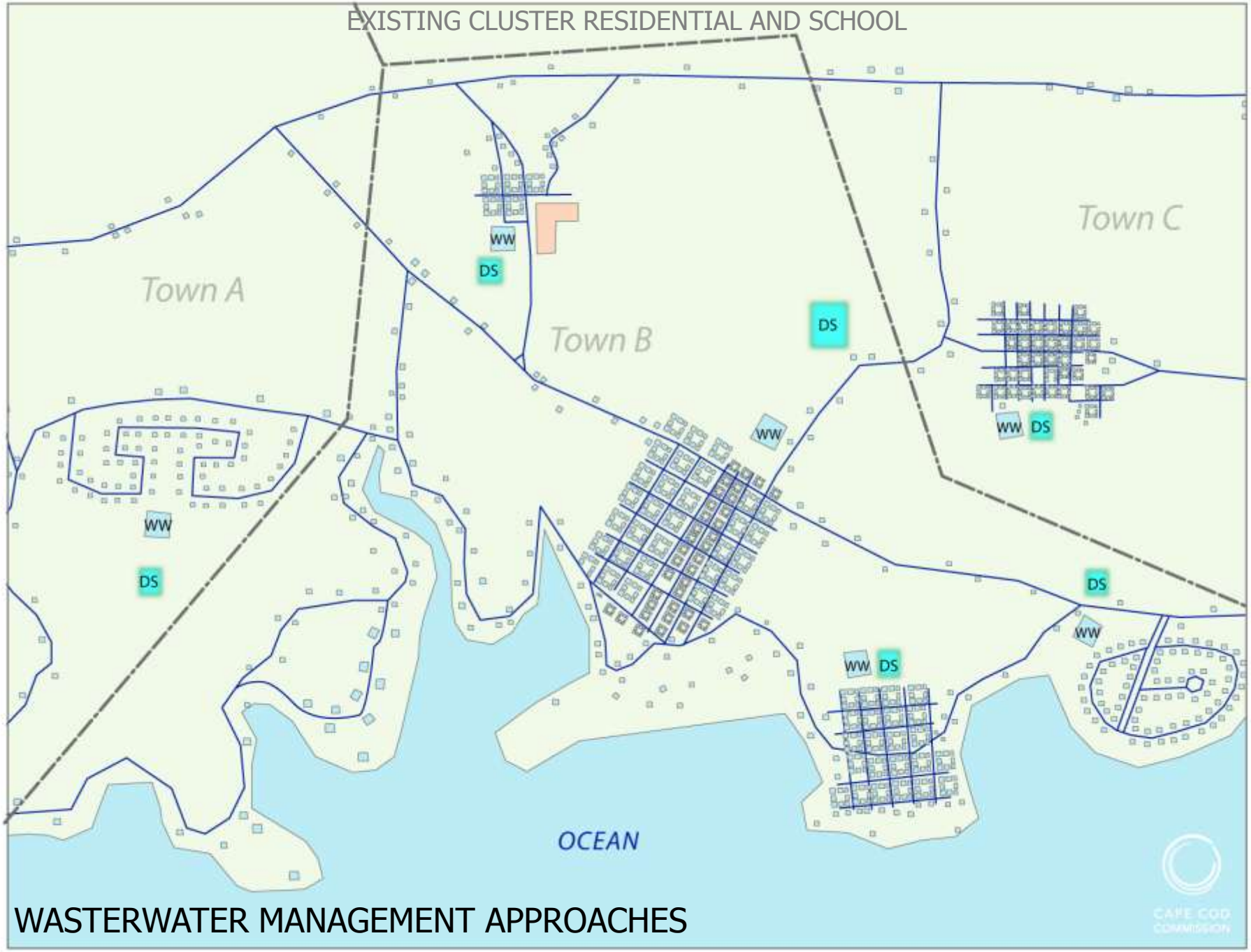
- 1-100
- 101-150

WASTERWATER MANAGEMENT APPROACHES

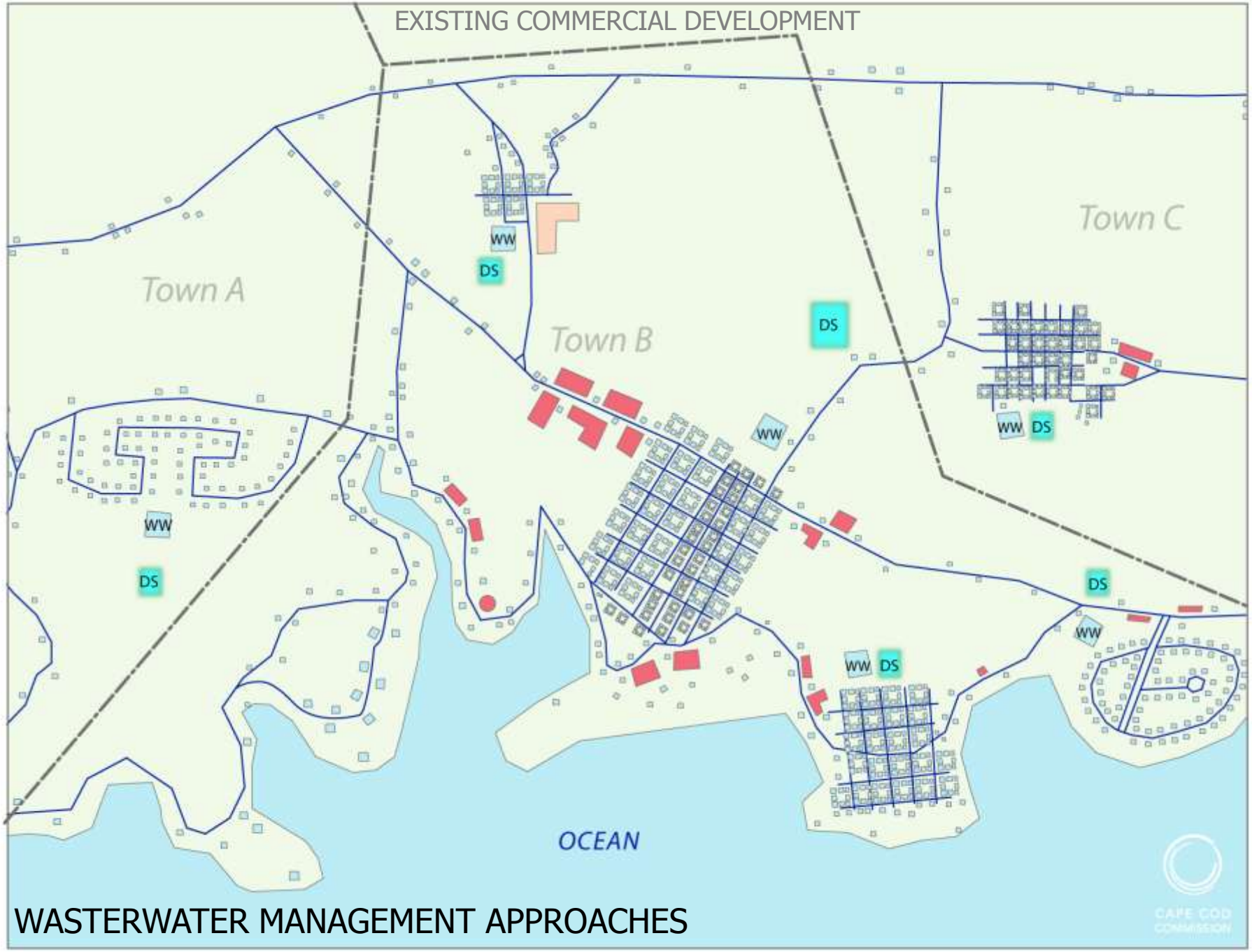



WASTERWATER MANAGEMENT APPROACHES

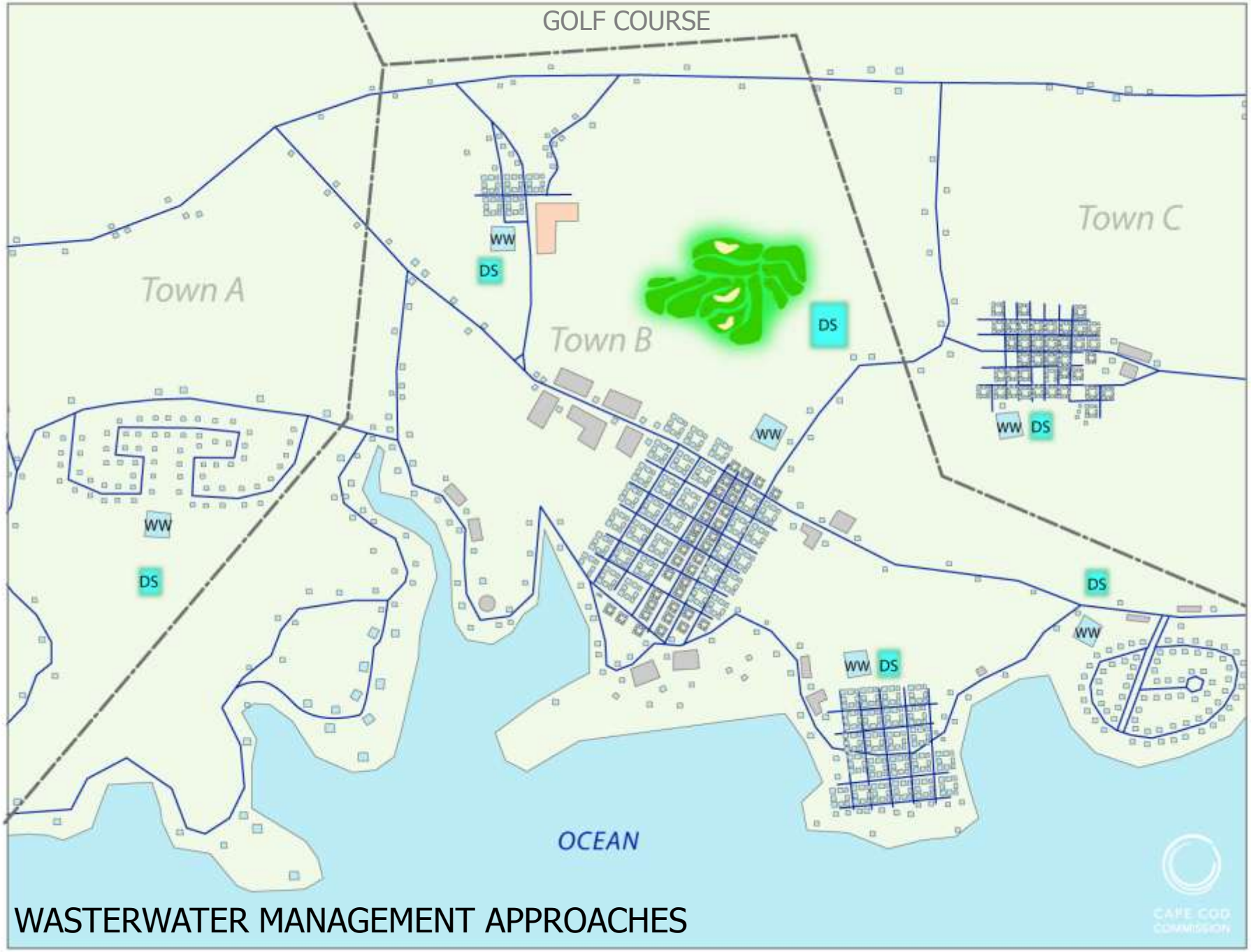

HIGH DENSITY DEVELOPMENT, ROADS AND INDIVIDUAL HOUSES
Town A
Town B
Town C
DS
WW
WW
DS
WW
DS
OCEAN
WASTERWATER MANAGEMENT APPROACHES
CAPE COD COMMISSION



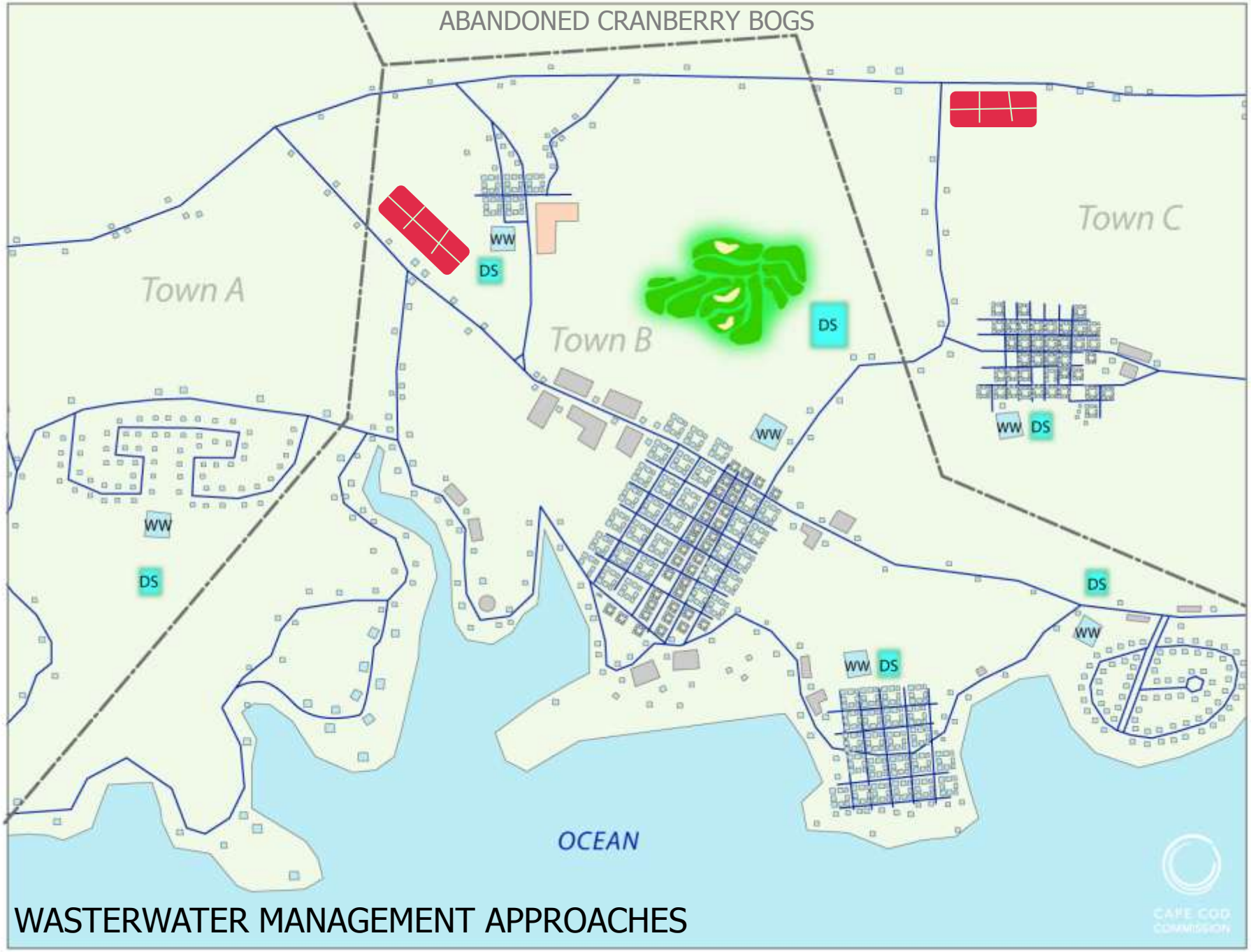

WASTERWATER MANAGEMENT APPROACHES




WASTERWATER MANAGEMENT APPROACHES




WASTERWATER MANAGEMENT APPROACHES

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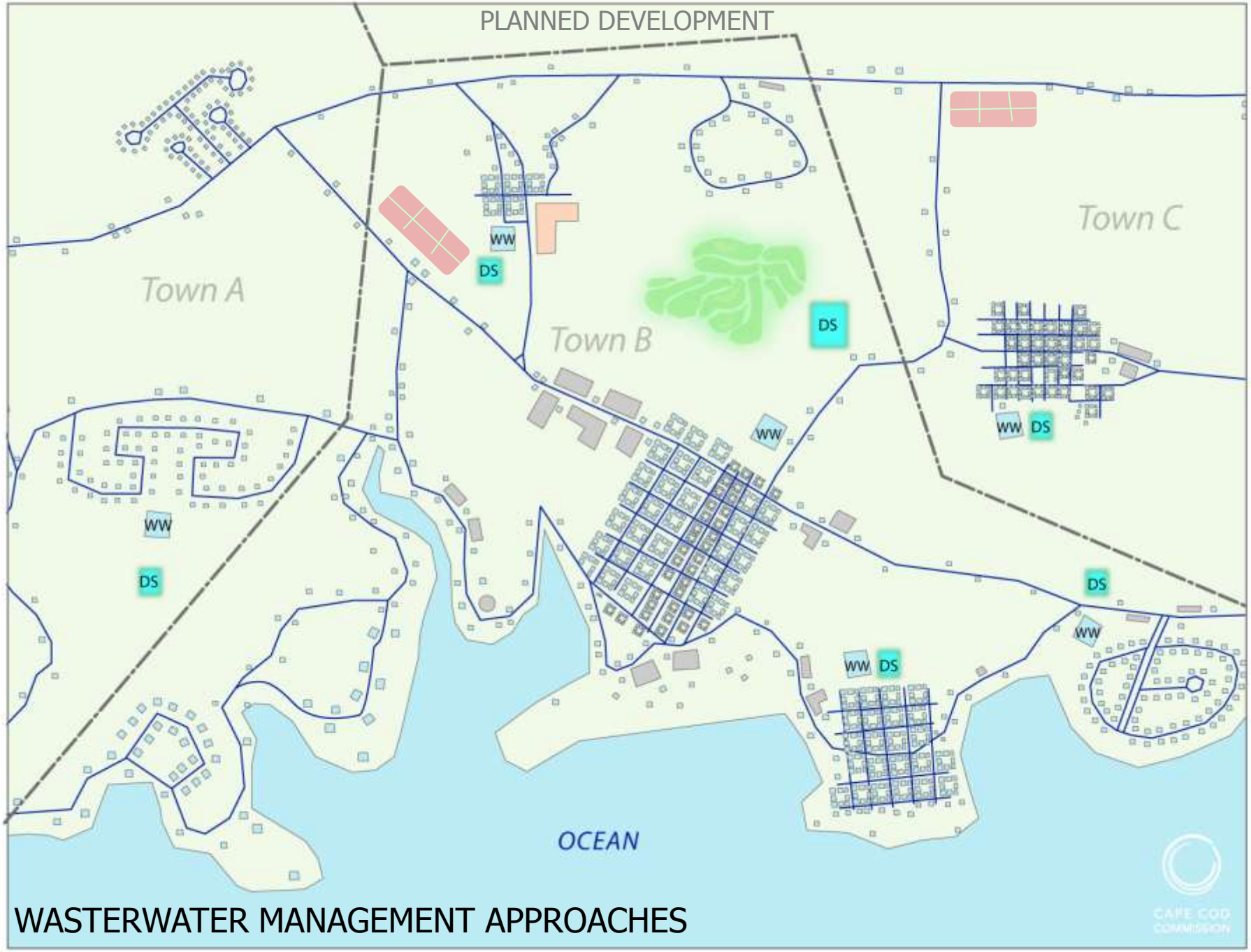


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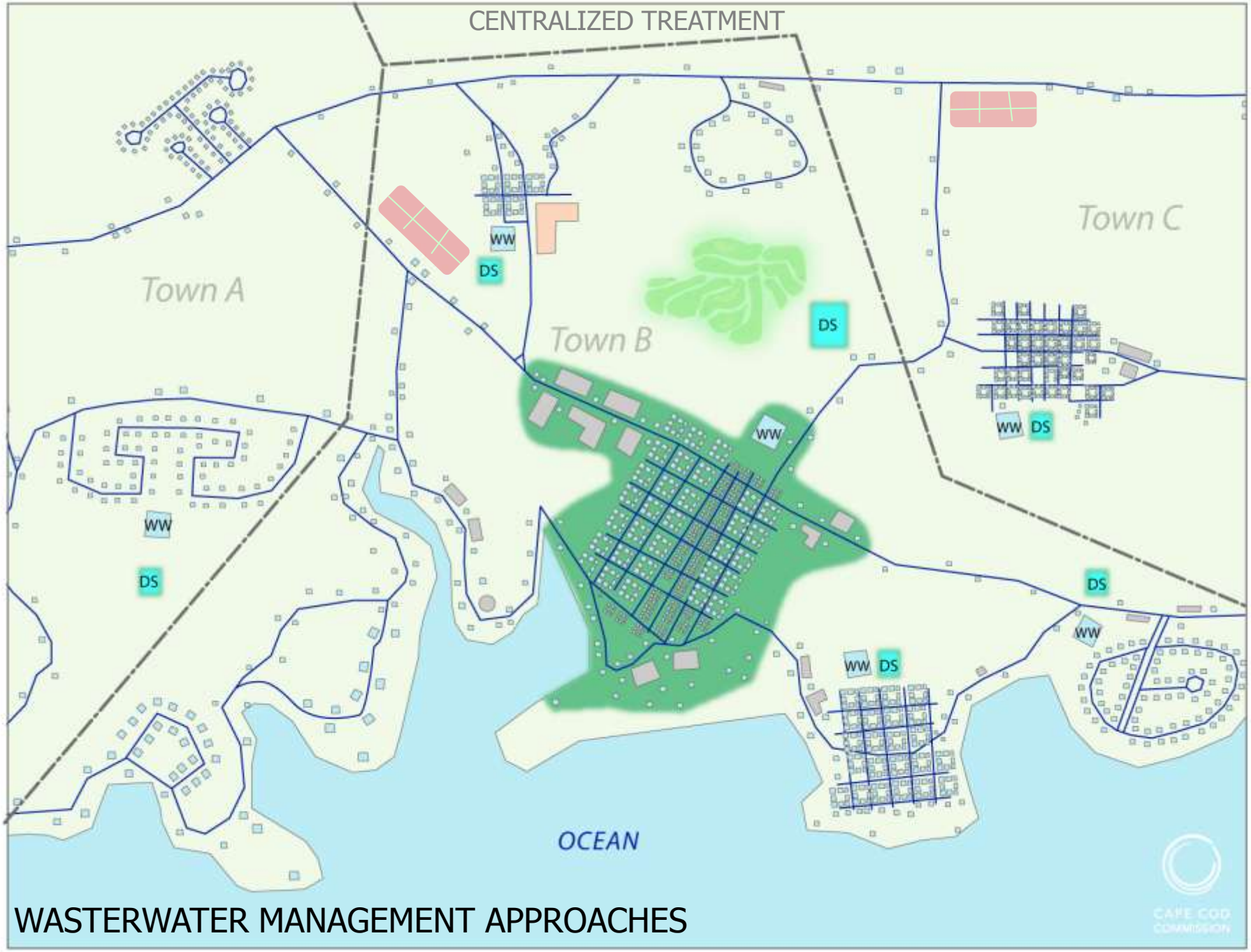


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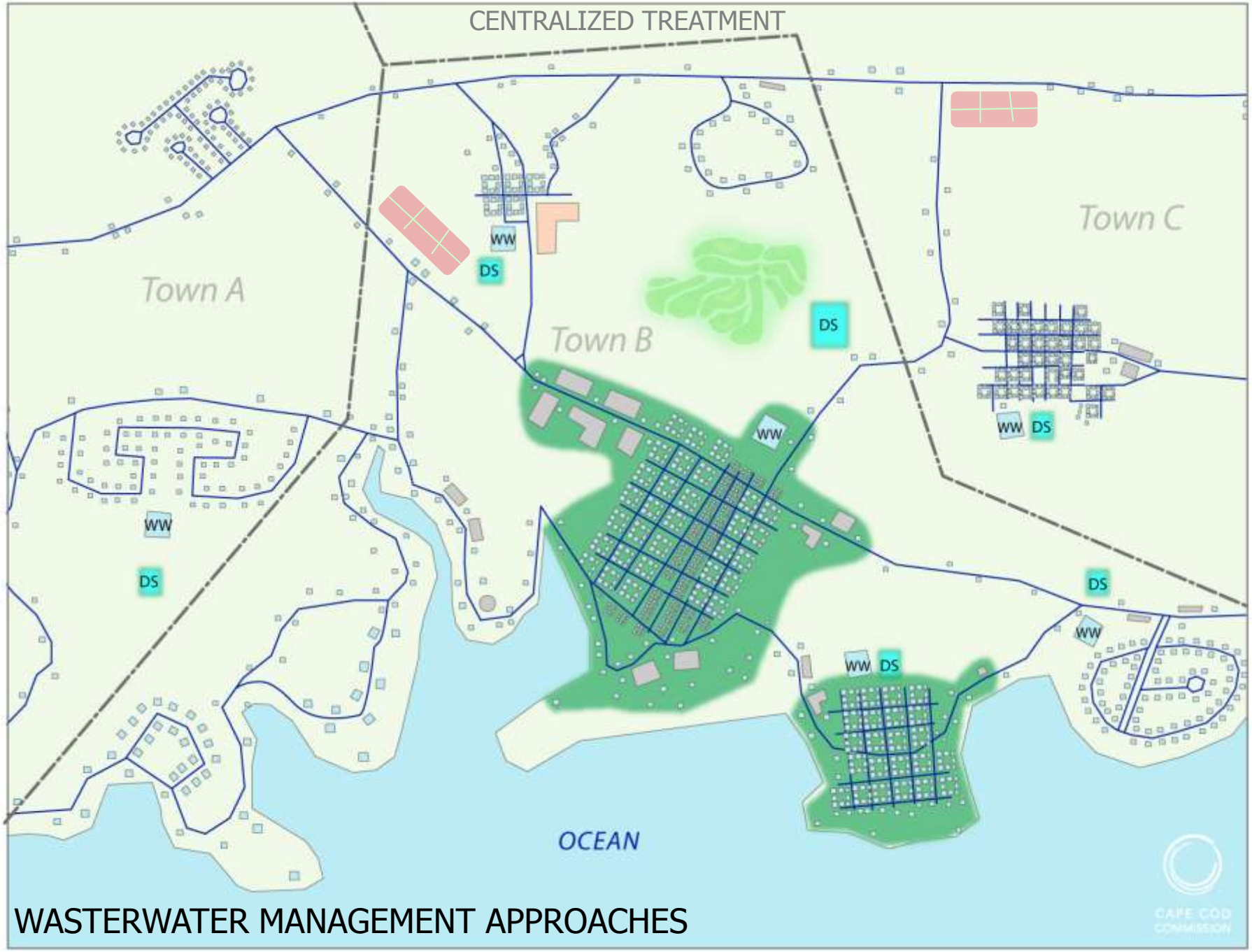
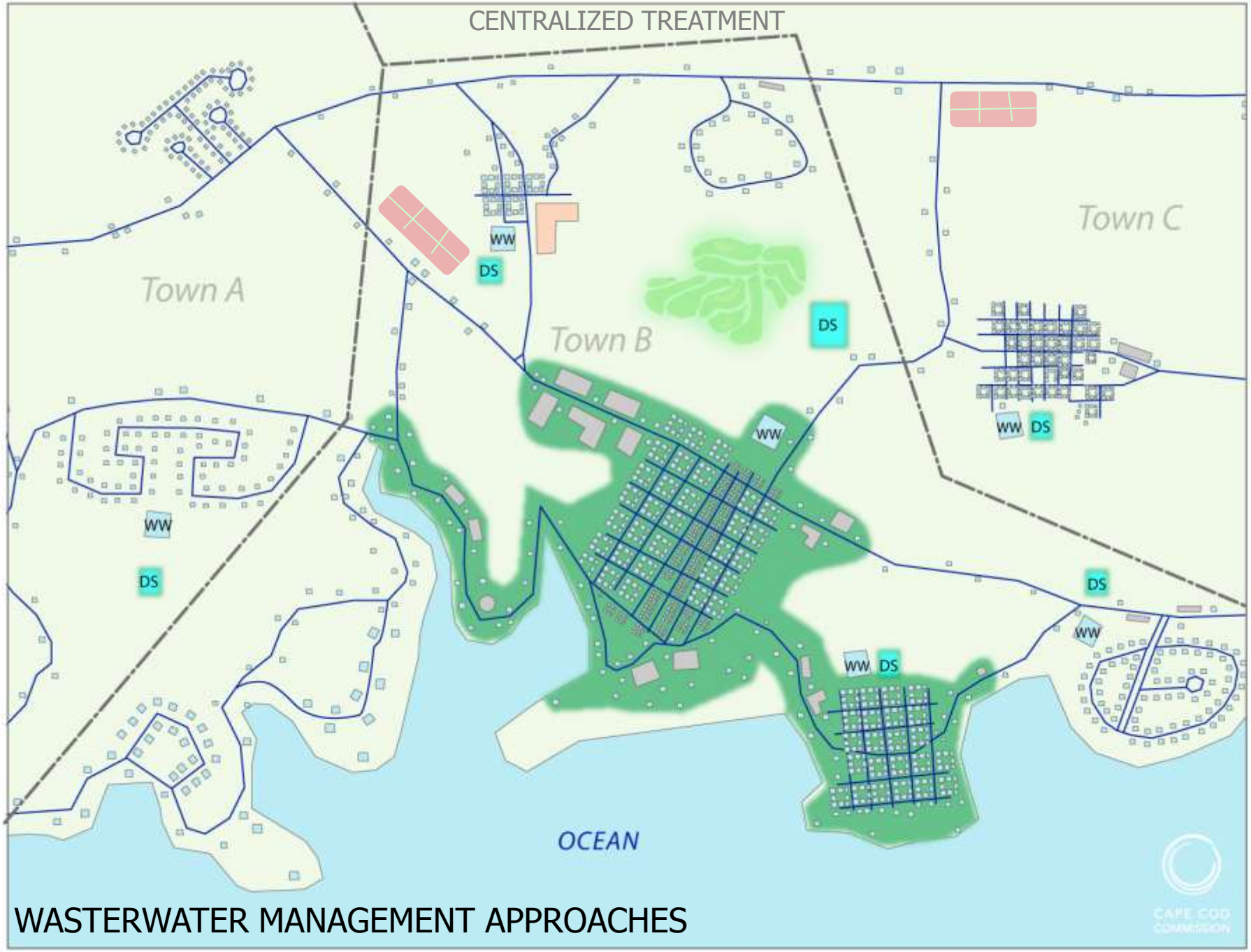
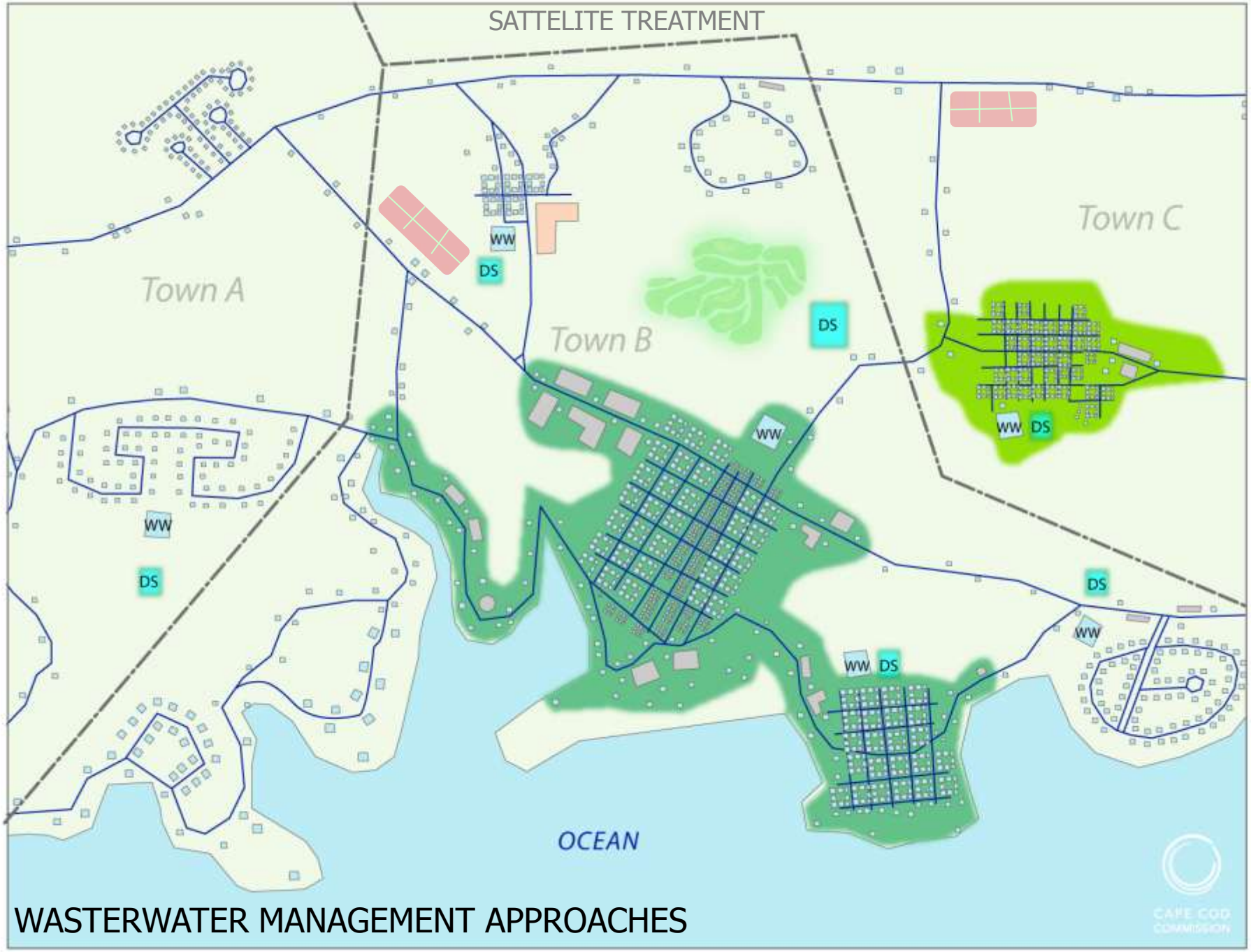


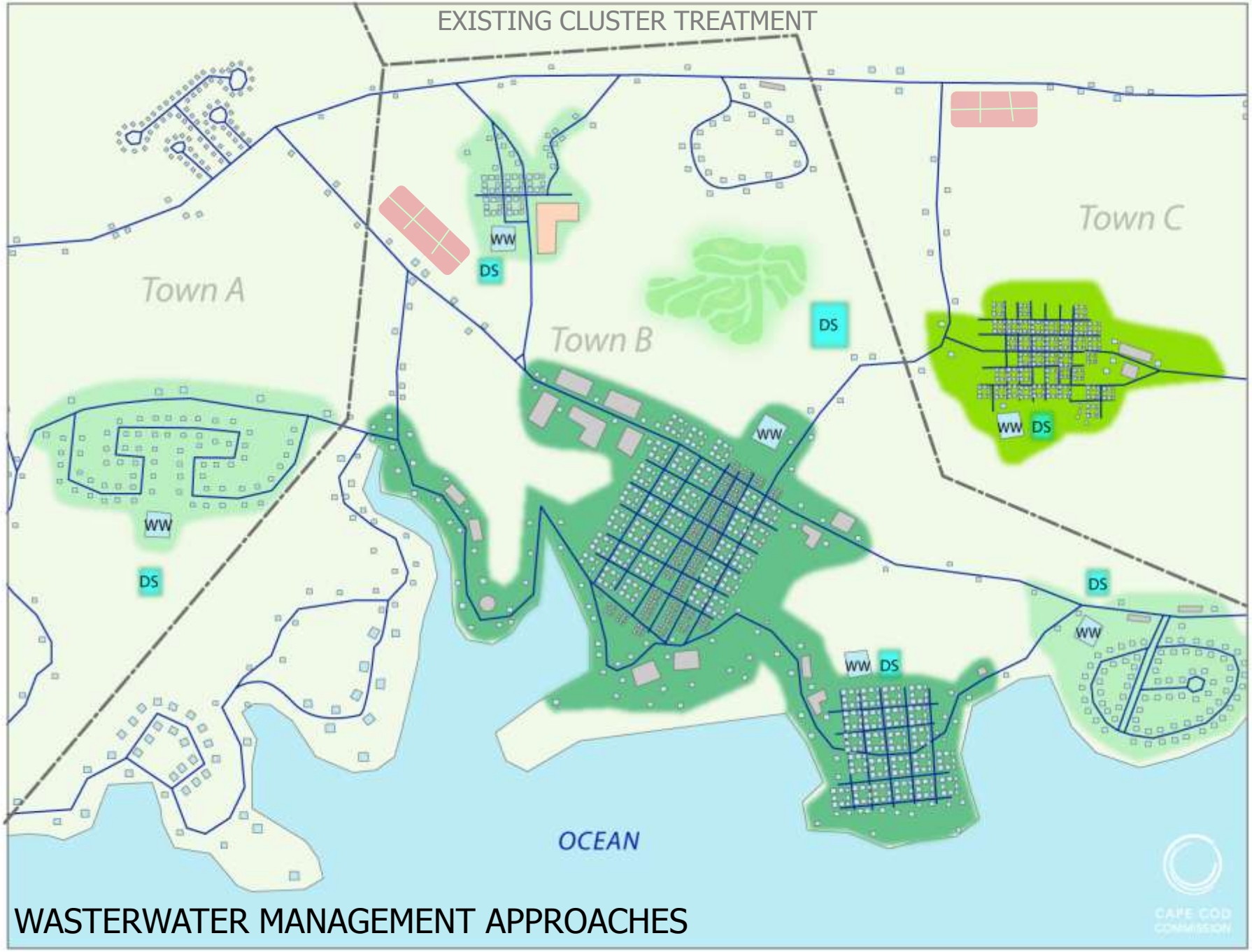

WASTERWATER MANAGEMENT APPROACHES




WASTERWATER MANAGEMENT APPROACHES




WASTERWATER MANAGEMENT APPROACHES

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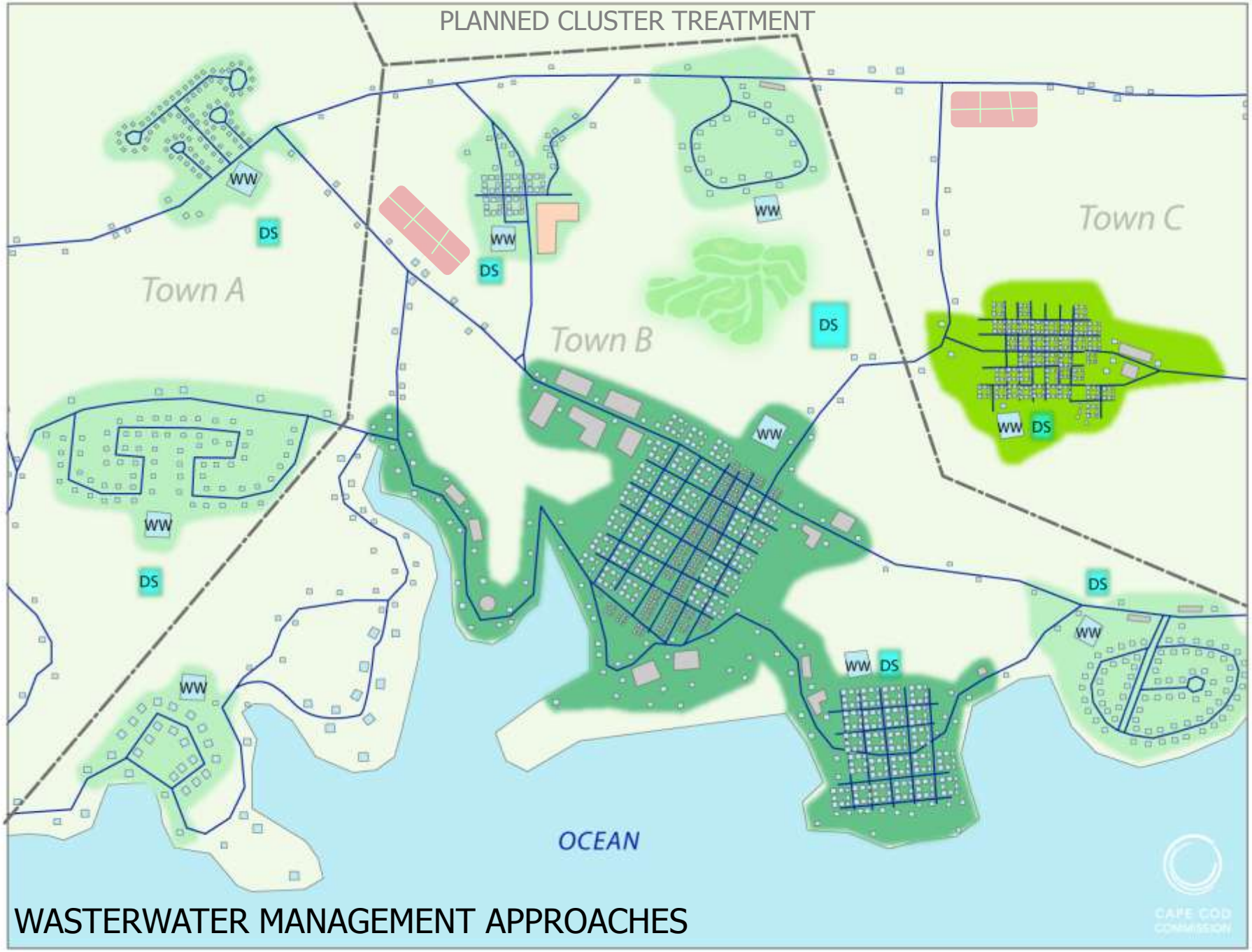
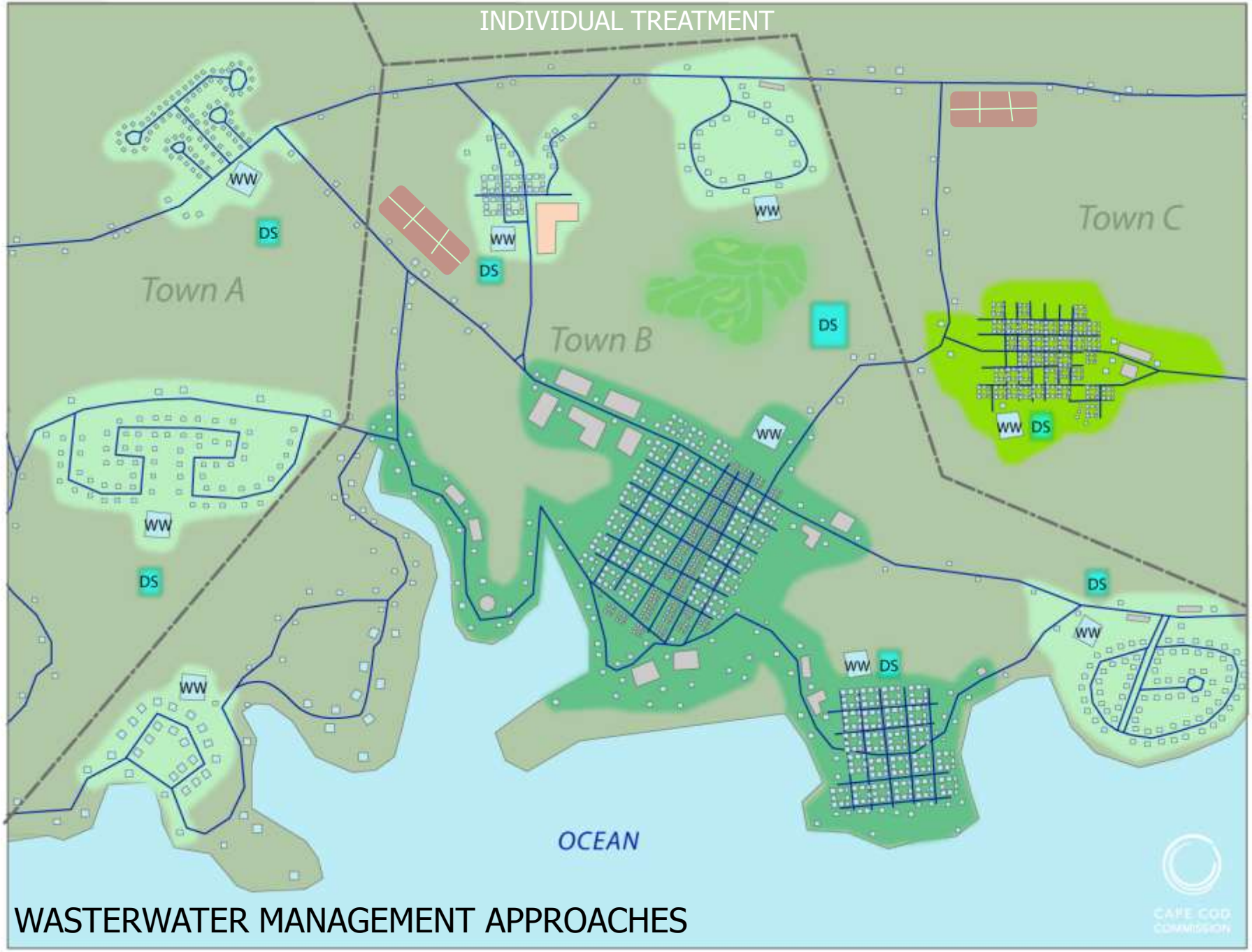



WASTERWATER MANAGEMENT APPROACHES

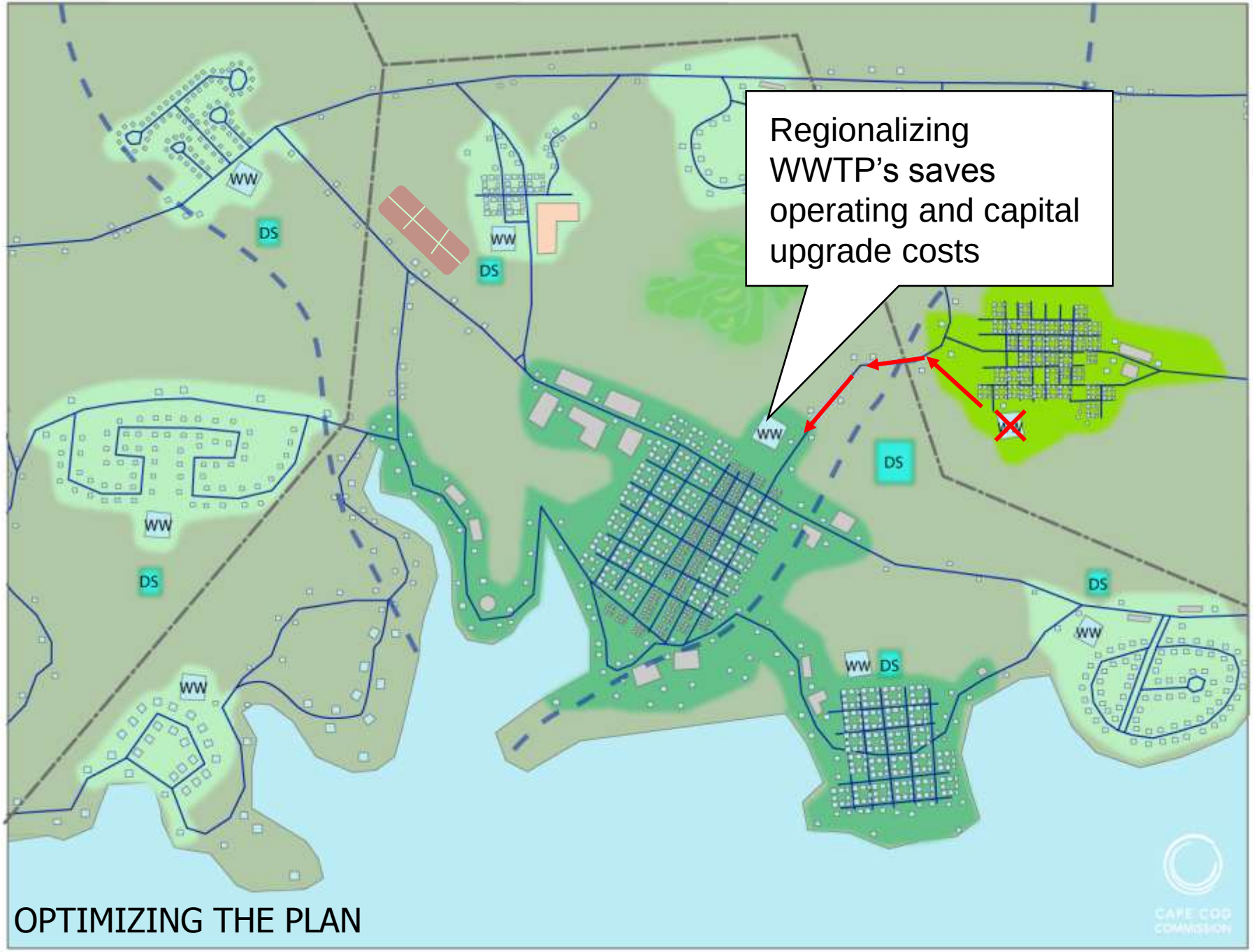



WASTERWATER MANAGEMENT APPROACHES

# OPTIMIZING THE PLAN

OPTIMIZING THE PLAN

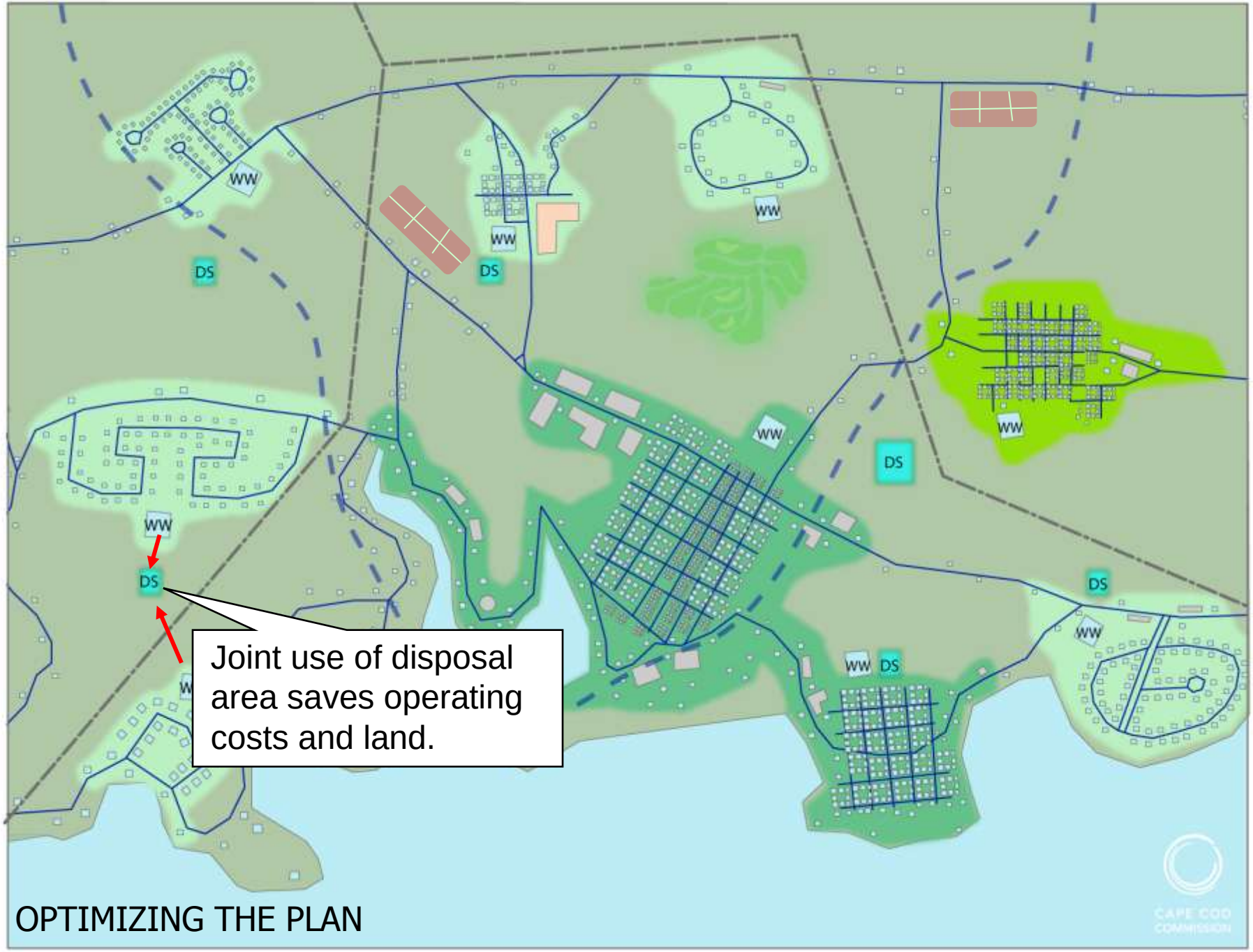
OPTIMIZING THE PLAN



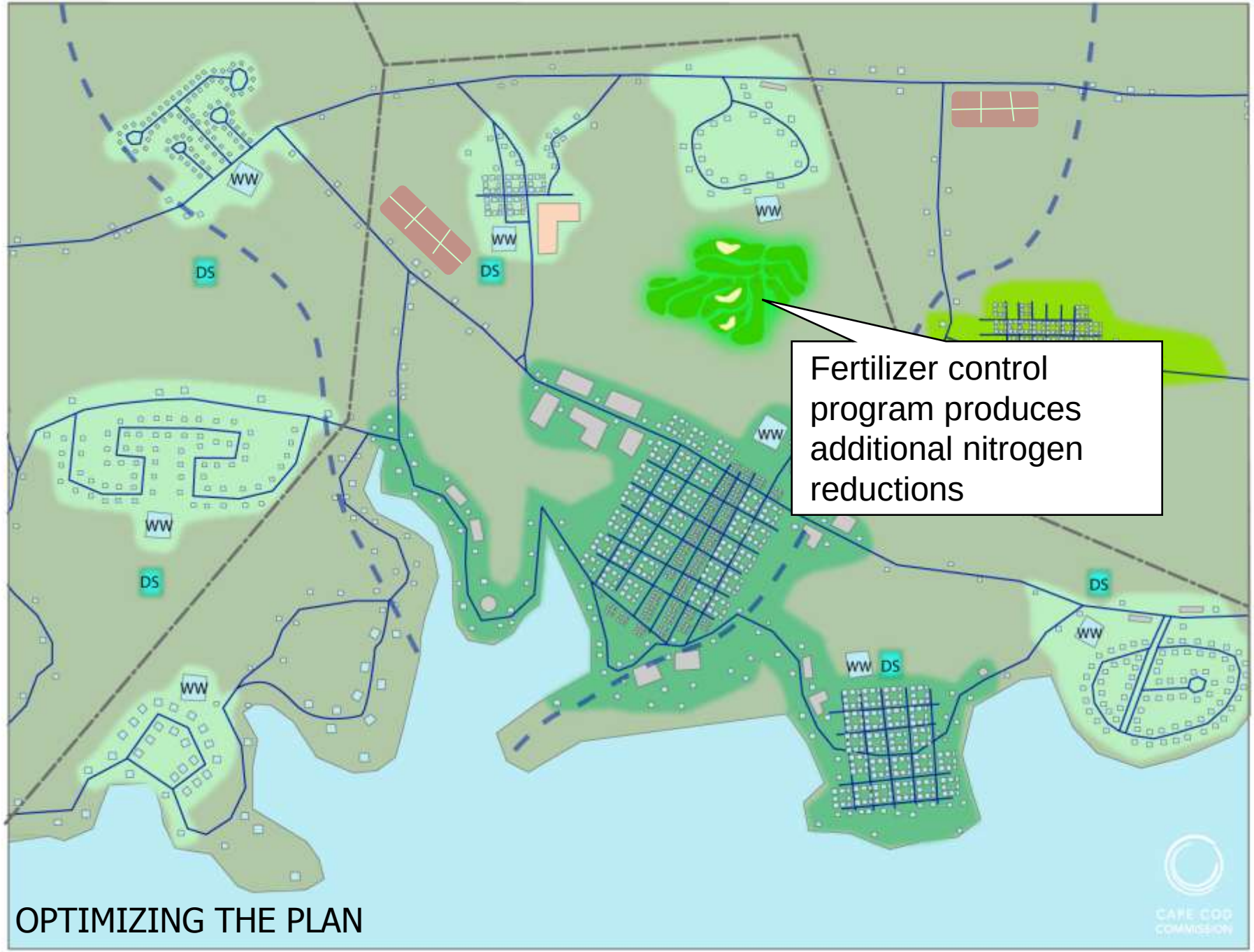

OPTIMIZING THE PLAN

OPTIMIZING THE PLAN

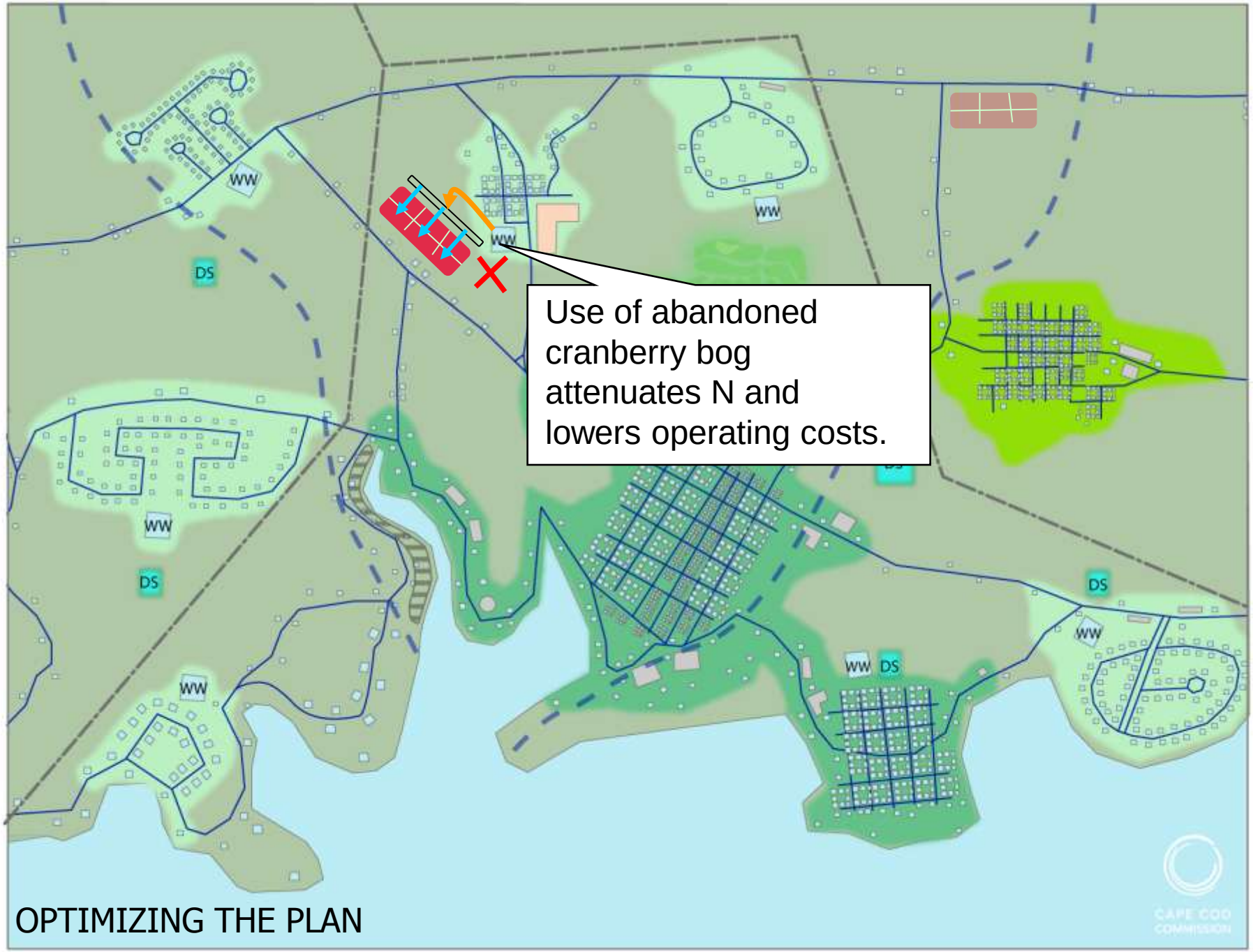
OPTIMIZING THE PLAN



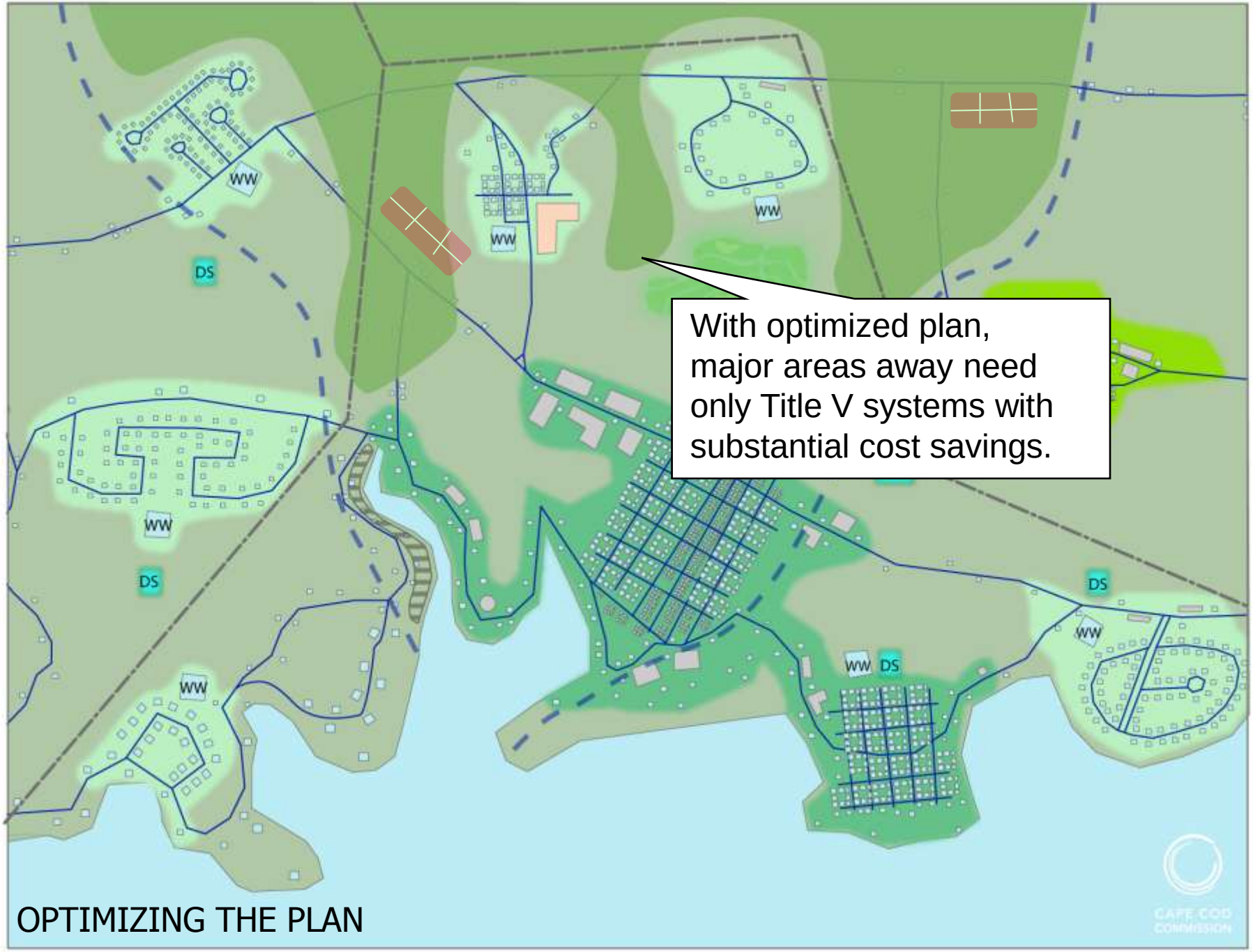

OPTIMIZING THE PLAN




# OPTIMIZING THE PLAN



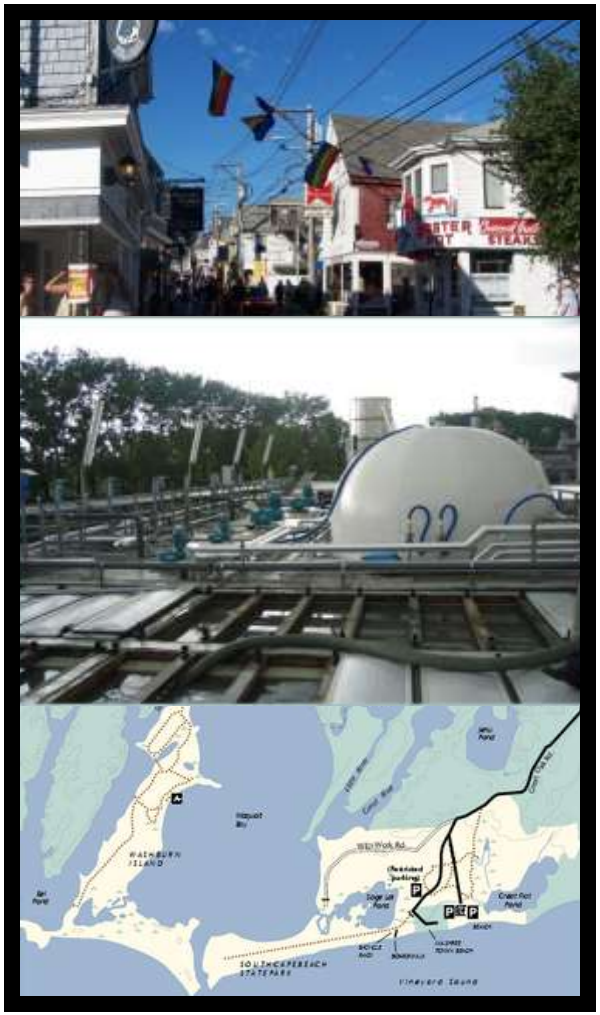

# OPTIMIZING THE PLAN




OPTIMIZING THE PLAN

# Cost Considerations in Watershed Based Planning

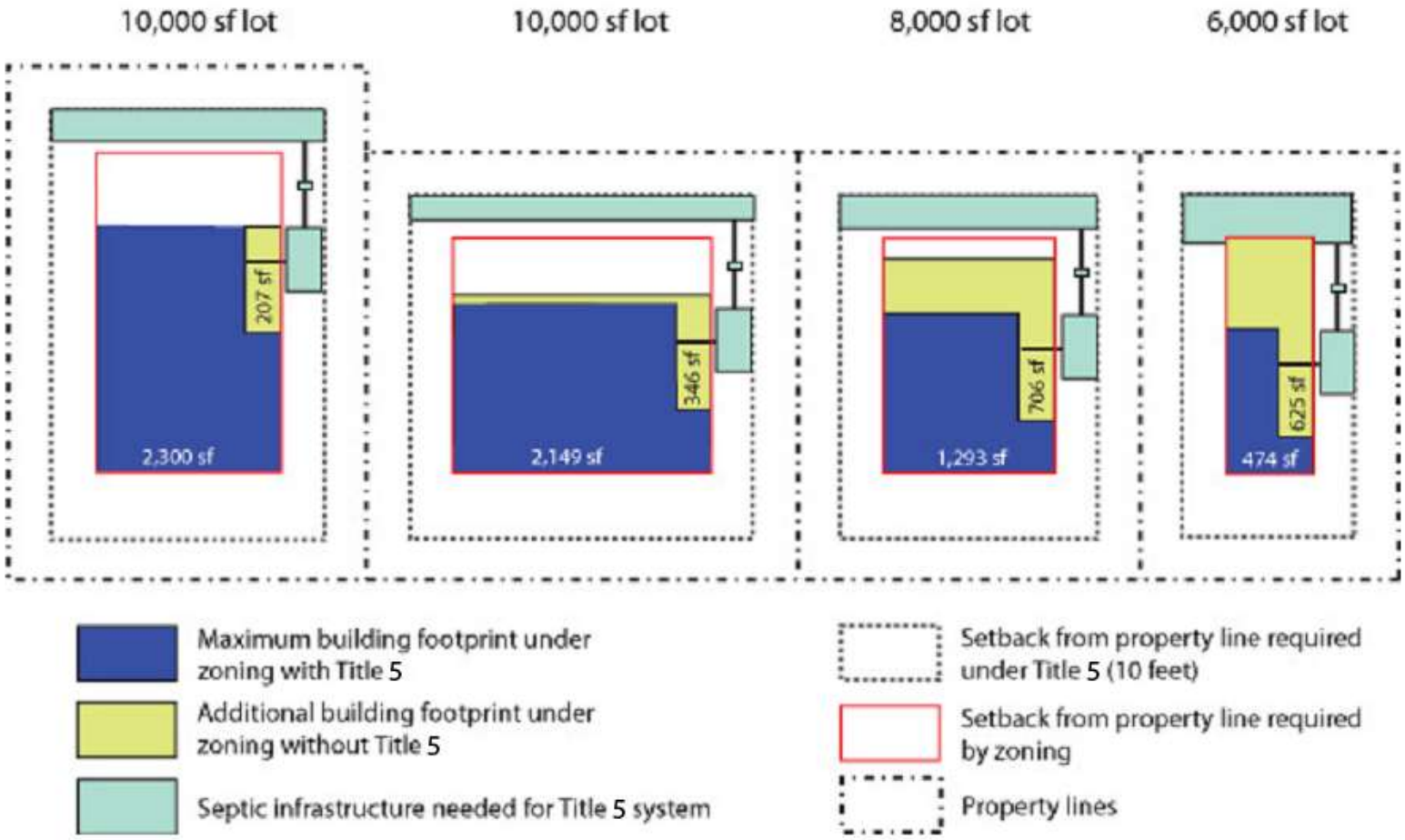
CAPE COD COMMISSION



- **Collection and Transport**
  **Density**
- **Treatment**
  **Appropriate Scale**
- **Disposal**
  **Nitrogen Sensitive Areas, Zone II's**

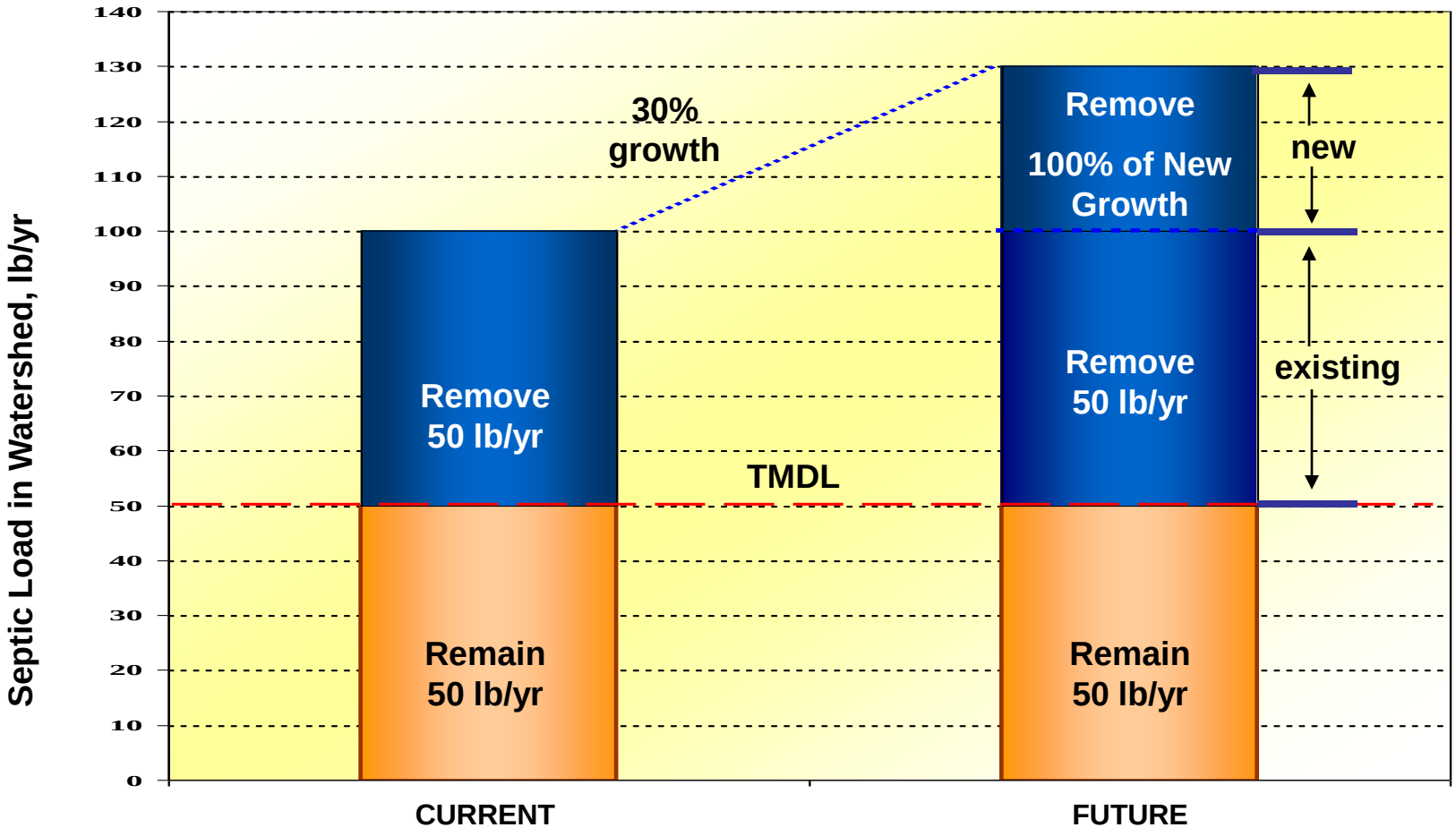
# Building Footprint With/Without Title 5

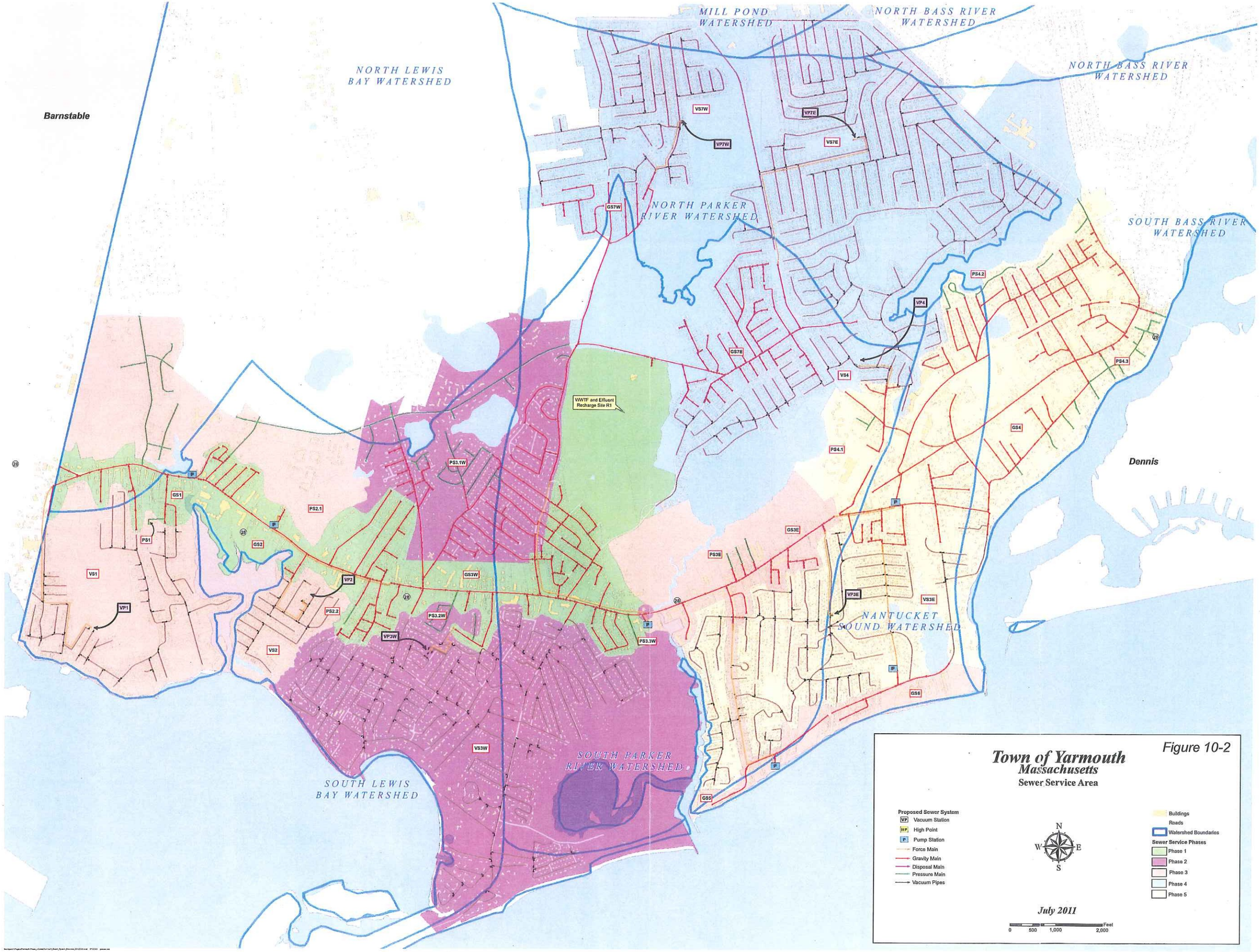
CAPE COD COMMISSION

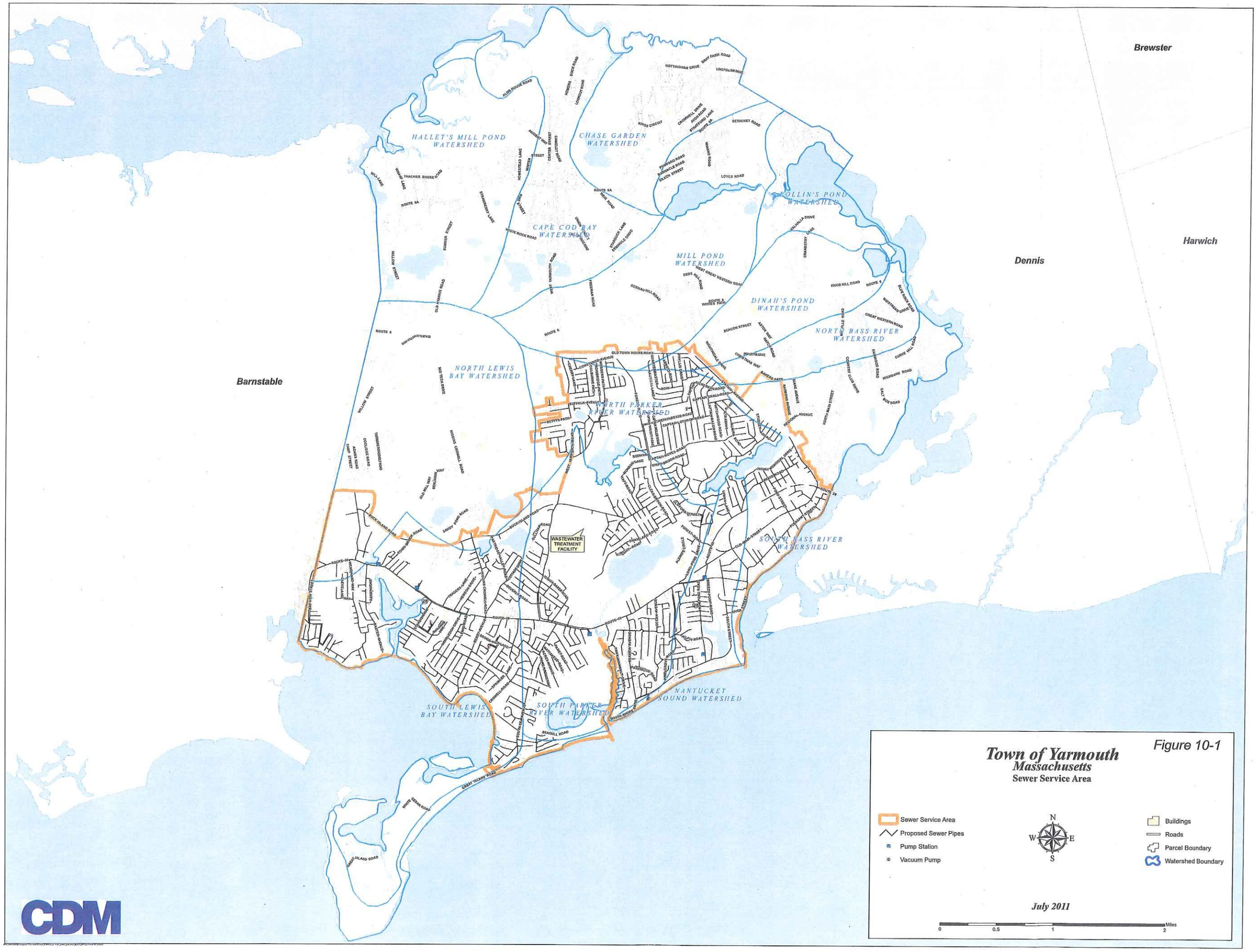



Source: Sewers and Smart Growth: Challenges, Opportunities and Strategies, March 2009, Ridley & Associates, Inc.

# Impact of Growth on N Removal




MILL POND WATERSHED
NORTH BASS RIVER WATERSHED
NORTH LEWIS BAY WATERSHED
NORTH BASS RIVER WATERSHED
Barnstable
VS7W
VP7E
VP7W
VS7E
NORTH PARKER RIVER WATERSHED
GS7W
SOUTH BASS RIVER WATERSHED
PS4.2
VP4
GS7E
VS4
PS4.3
WWTF and Effluent Recharge Site R1
GS4
PS4.1
Dennis
PS3.1W
GS1
PS2.1
PS1
GS2
GS3E
PS3E
VS1
VP2
GS3W
VP3E
VS3E
VP1
PS2.2
PS3.2W
NANTUCKET SOUND WATERSHED
VP3W
PS3.3W
VS2
GS6
VS3W
SOUTH PARKER RIVER WATERSHED
SOUTH LEWIS BAY WATERSHED
GS5
Town of Yarmouth
Massachusetts
Sewer Service Area
Figure 10-2
Proposed Sewer System
VP Vacuum Station
HP High Point
P Pump Station
Force Main
Gravity Main
Disposal Main
Pressure Main
Vacuum Pipes
N
W
E
S
Buildings
Roads
Watershed Boundaries
Sewer Service Phases
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
July 2011
0 500 1,000 2,000 Feet


Brewster
Harwich
Dennis
Barnstable
HALLET'S MILL POND WATERSHED
CHASE GARDEN WATERSHED
COLLIN'S POND WATERSHED
CAPE COD BAY WATERSHED
MILL POND WATERSHED
DINAH'S POND WATERSHED
NORTH BASS RIVER WATERSHED
NORTH LEWIS BAY WATERSHED
NORTH PARKER RIVER WATERSHED
SOUTH BASS RIVER WATERSHED
SOUTH LEWIS BAY WATERSHED
SOUTH PARKER RIVER WATERSHED
NANTUCKET SOUND WATERSHED
WASTEWATER TREATMENT FACILITY
Town of Yarmouth
Massachusetts
Sewer Service Area
Figure 10-1
Sewer Service Area
Proposed Sewer Pipes
Pump Station
Vacuum Pump
Buildings
Roads
Parcel Boundary
Watershed Boundary
N
W
E
S
July 2011
0
0.5
1
2
Miles
CDM