

# Green Infrastructure Champions Program

*This program is partially funded by the Rutgers New Jersey Agricultural Experiment Station, The Geraldine R. Dodge Foundation, NJ Sea Grant Consortium, The William Penn Foundation and is a collaboration of the Rutgers Cooperative Extension Water Resources Program and the Green Infrastructure Subcommittee of Jersey Water Works.*



**Please enter your full name  
and affiliation in the chat. This  
is how will take attendance.**



IMAGINE A BETTER NEW JERSEY



# Green Infrastructure Champion Training: Part 10

“Using Green Infrastructure to Promote  
Climate Resiliency”

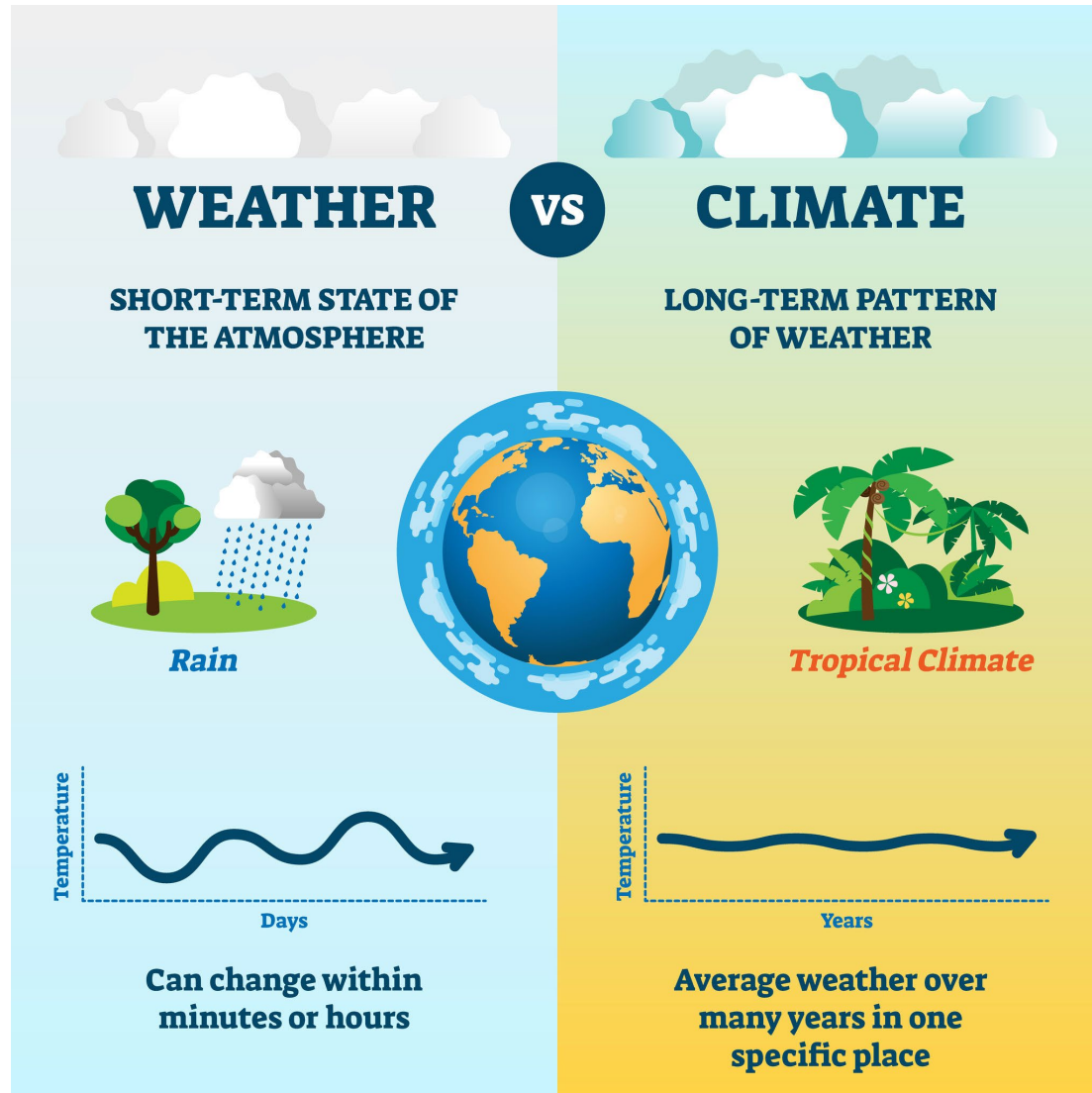
May 20, 2022  
Virtual Class

Rutgers Cooperative Extension Water Resources Program  
Cody Obropta, P.E.

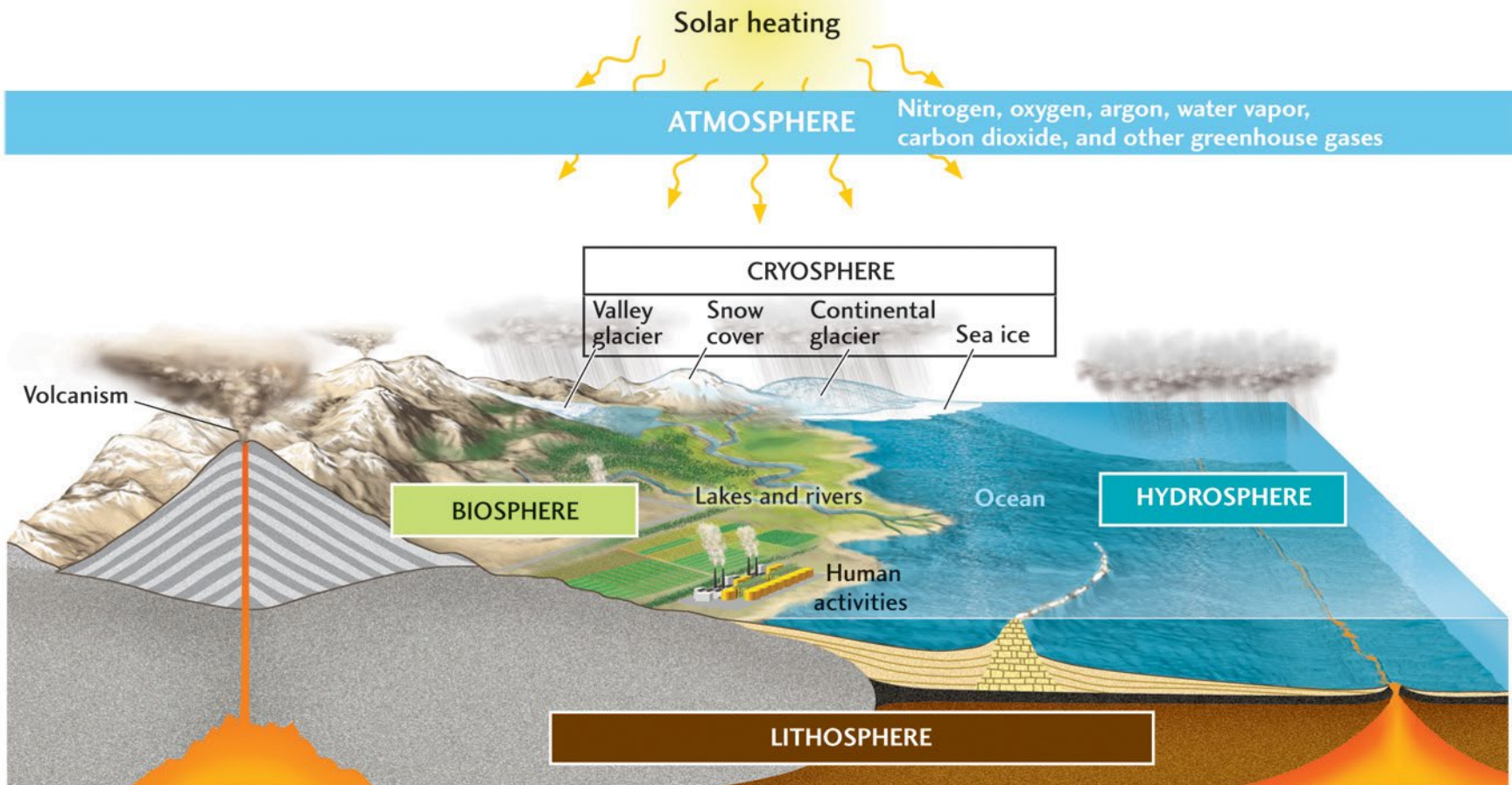


# Part I: What is Climate?

# The difference between weather and climate:



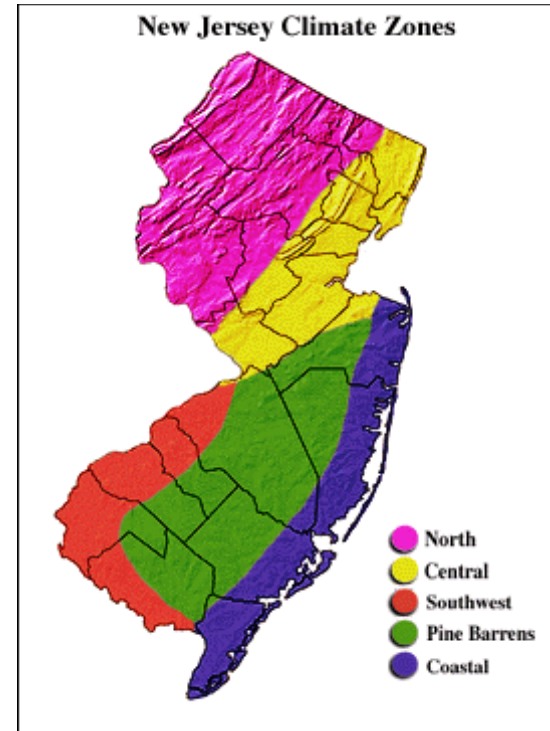
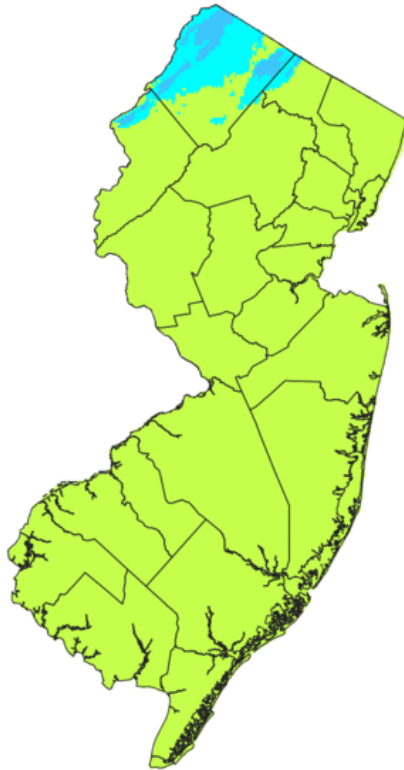
# The Earth's Climate



- The climate includes many components of the Earth's system and interactions between them.

# New Jersey's Climate

## Köppen Climate Types of New Jersey

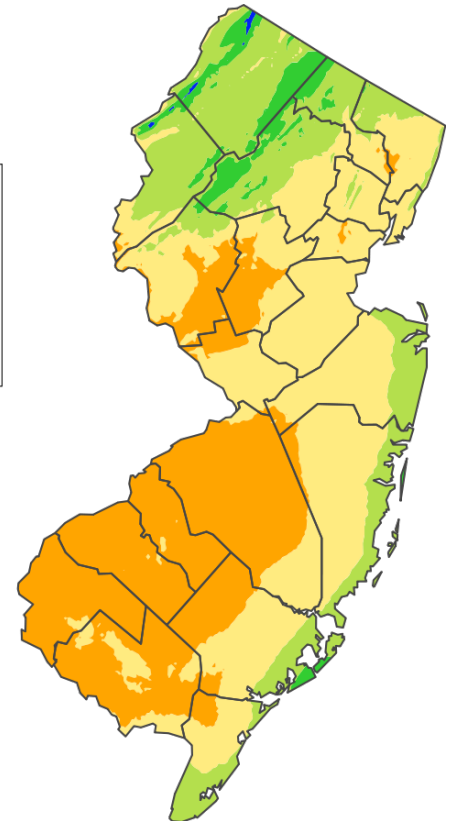
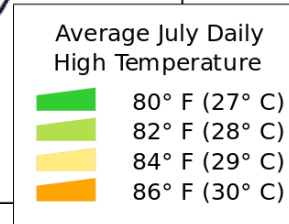
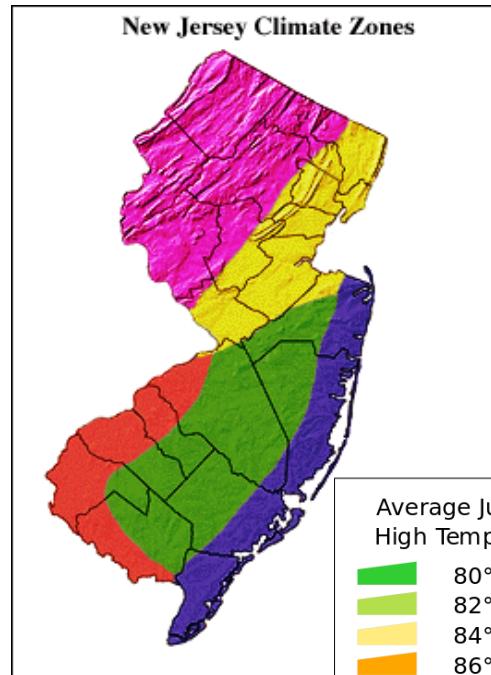
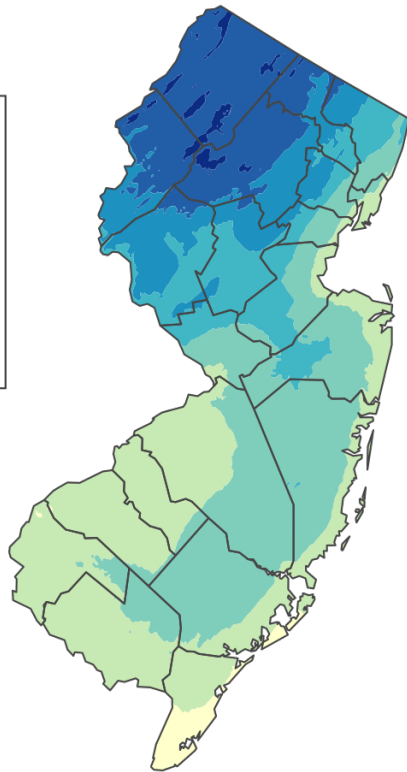
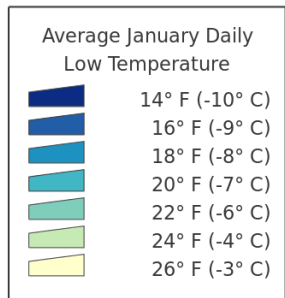


## Köppen Climate Type

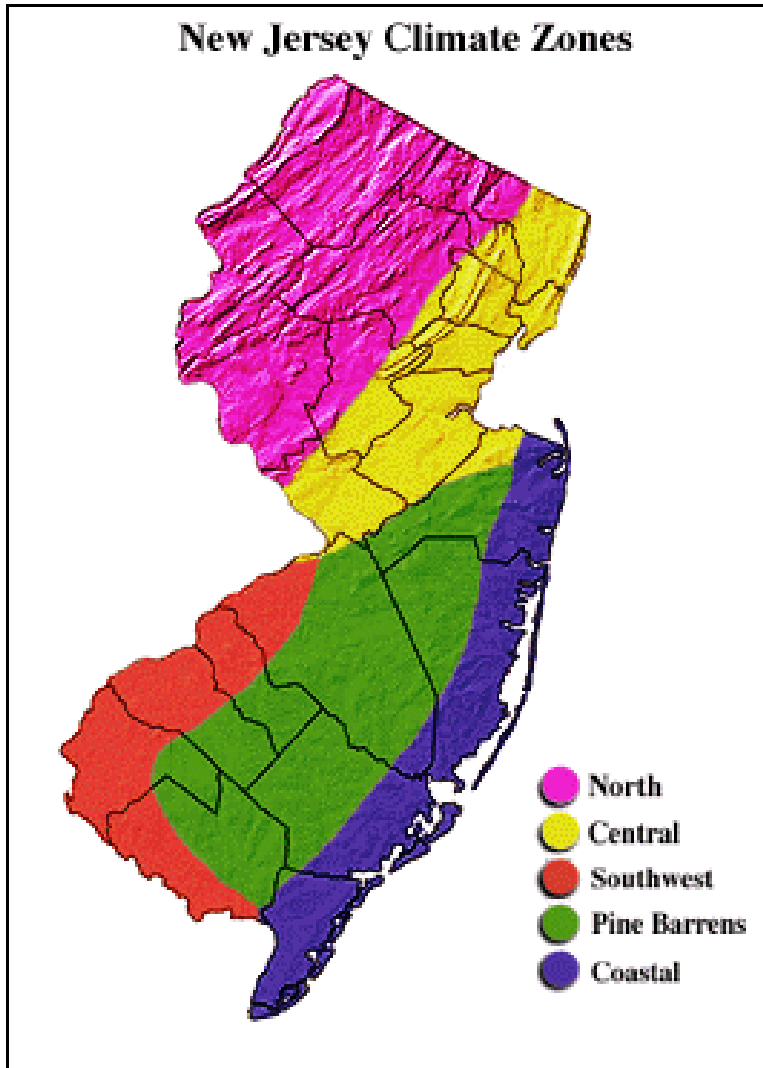
-  Cfa (Humid subtropical)
-  Dfb (Warm-summer humid continental)
-  Dfa (Hot-summer humid continental)

Data sources: 1991-2020 climate normals from PRISM Climate Group, Oregon State University, <https://prism.oregonstate.edu>; Outline map from US Census Bureau

# Average Daily Temperatures in NJ

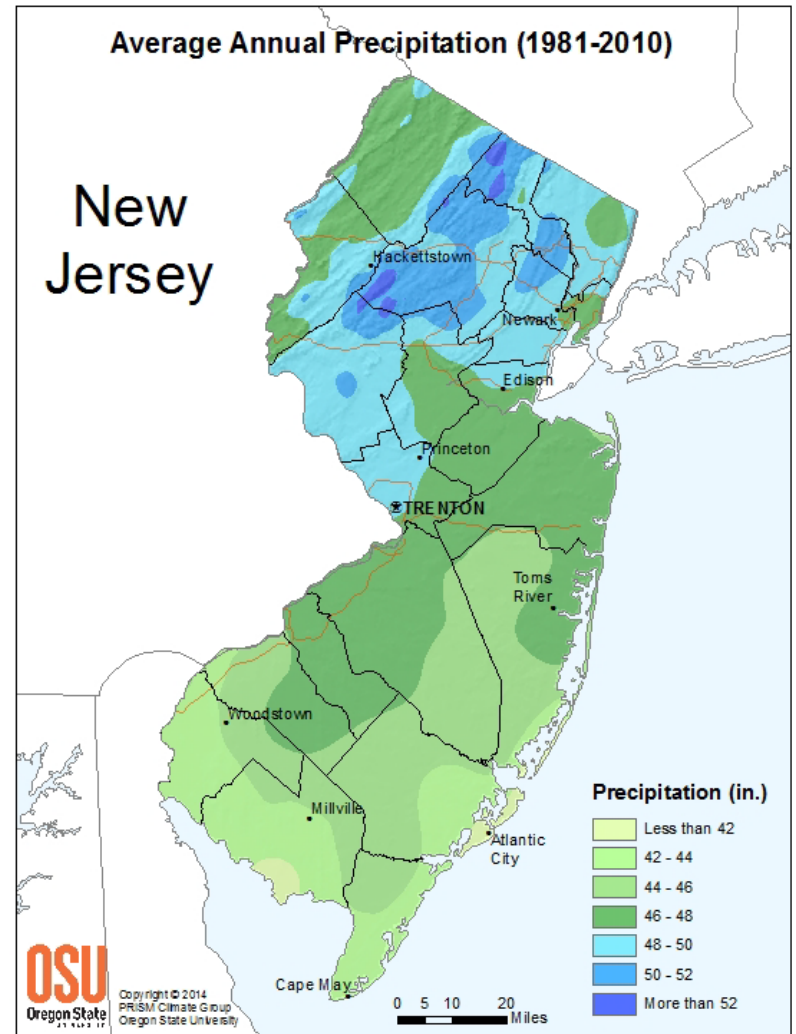
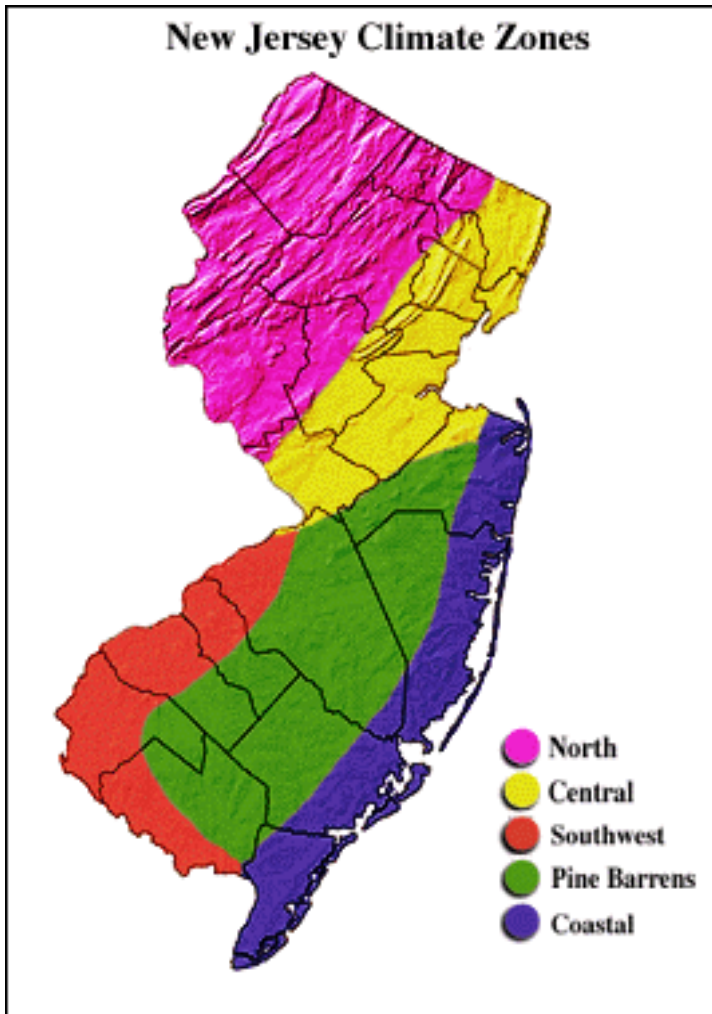


# Plant Hardiness Zone Map





# NJ Average Precipitation



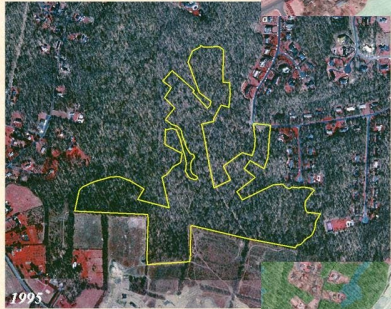
# New Jersey

## Land Use / Land Cover 1995 - 2002 Change Analysis



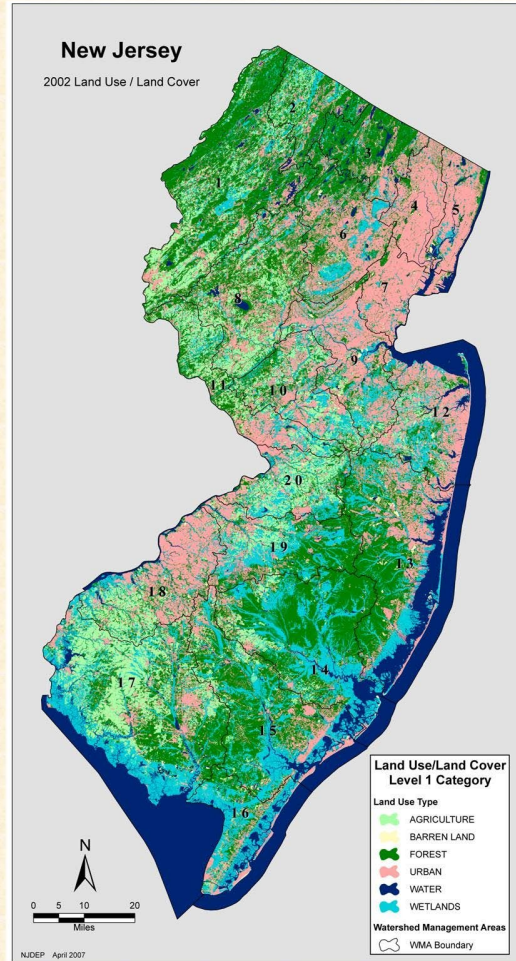
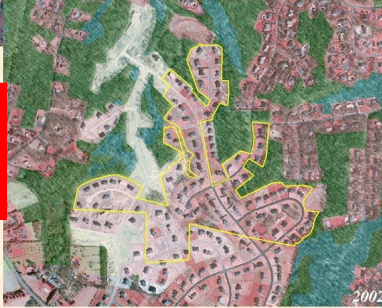
**Agriculture**

More than 21,000 acres of Agricultural Land were converted to Residential Urban Land.



**Forests**

More than 38,000 acres of Forest Land were converted to Residential Urban Land



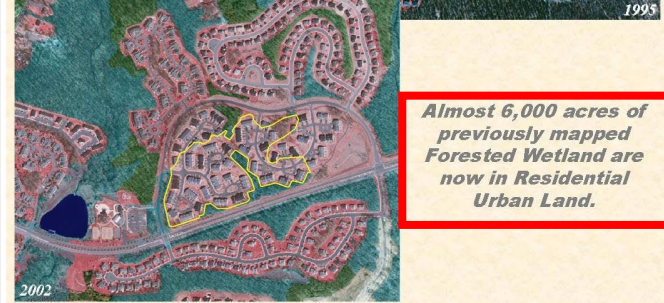
1995 - 2002 Change Analysis by Watershed Management Area  
Land Use Type - Level 1 Category (acres)

Land Use Type	WMA 1	WMA 2	WMA 3	WMA 4	WMA 5	WMA 6	WMA 7	WMA 8	WMA 9	WMA 10	WMA 11	WMA 12	WMA 13	WMA 14	WMA 15	WMA 16	WMA 17	WMA 18	WMA 19	WMA 20
Agriculture	-2,815	-2,372	37	-46	-26	688	-7	-7,364	-3,638	-6,749	-4,751	3,965	-277	-5,116	368	685	-3,276	-4,779	-2,086	-3,448
Barren Land	728	5	268	63	339	29	296	-19	-338	242	213	1,542	-268	335	289	-262	61	242	294	76
Forest	-3,497	276	-4,208	-1,921	-625	-3,817	-4,578	-2,238	-2,862	-284	278	-2,703	-6,421	-3,261	-4,917	-288	-2,182	-3,278	-4,971	-276
Urban Land	6,186	2,098	4,832	1,368	729	6,435	618	18,488	6,119	16,811	4,779	7,739	15,488	2,429	5,195	5,798	7,499	6,911	6,911	4,911
Water	-652	154	11	-15	218	64	-7	0	-1	0	38	-60	-262	281	186	186	411	158	81	538
Wetlands	66	296	-383	258	-675	688	-226	-655	-2,881	-1,678	656	-6,885	-839	289	19	835	937	-1,981	727	627



**Wetlands**

Almost 6,000 acres of previously mapped Forested Wetland are now in Residential Urban Land.



Land Use/Land Cover Level 1 Change Analysis					
2002 Statewide Land Use/Land Cover Statistics (in acres)					
Land Use Type	Revised 1995	2002	Net Change 1995-02	Net % Change 1995/97-2002	Annual Rate of Change (7 years)
Agriculture	652,334	596,804	-55,530	-8.30%	-7,933
Barren Land	57,562	61,352	3,789	6.18%	541
Forest	16,161,683	15,755,220	-41,463	-2.63%	-5,923
Urban Land	1,334,476	1,440,464	105,988	7.36%	15,141
Water	800,610	800,572	-38	0.00%	-5
Wetlands	1,022,291	1,009,544	-12,747	-1.26%	-1,821
<b>Total</b>	<b>5,483,955</b>	<b>5,483,955</b>			

Source: NJDEP Land Use/Land Cover Level 1 Data Analysis, 1995/97 - 2002

1995 Statewide Land Use/Land Cover Statistics (in acres)					
Land Use Type	1986	1995	Net Change 1986-95	Net % Change 1986-1995/97	Annual Rate of Change (9 years)
Agriculture	744,382	659,017	-85,365	-12.95%	-9,485
Barren Land	57,223	57,971	748	1.29%	83
Forest	1,641,279	1,602,578	-38,701	-2.41%	-4,300
Urban Land	1,208,553	1,342,525	133,972	9.98%	14,896
Water	285,498	290,643	5,145	1.77%	571
Wetlands	1,049,269	1,033,471	-15,798	-1.53%	-1,755
<b>Total</b>	<b>4,986,204</b>	<b>4,986,205</b>			

Source: NJDEP Land Use/Land Cover Level 1 Data Analysis, 1986 - 1995/97

Note: The Values for the 1986/97 interpretation were revised during the 2002 update. The values shown for "Water" now include lakes, ponds, reservoirs, major watercourses, enclosed tidal bays (eg. Barnegat Bay), and the tidal and non-tidal portions of the Delaware River. The "Water" values also now include any open water areas of Delaware Bay, Flamm Bay or the Atlantic Ocean out to the boundaries of the WMA. The 1986/95 "Water" values do not include any open water areas of the Delaware Bay, Flamm Bay or the Atlantic Ocean, even though the boundaries of some WMAs do extend into these water bodies.

In January 2007, the New Jersey Department of Environmental Protection released the Land Use/Land Cover 2002 Update data sets. This is the third in a series of land use/land cover layers that the NJDEP first began producing in 1981 utilizing a modified Anderson Classification System.

The first land use layer NJDEP produced was based on aerial photography captured in the spring of 1986 with a minimum mapping unit of 2.5 acres. Freshwater wetlands were mapped under the New Jersey Freshwater Wetlands Mapping Program and were incorporated into the 1986 land use data sets. The second iteration of the land use data was based on photography captured in 1995/97 with a minimum mapping unit of 1 acre. These first two mapping efforts provided NJDEP with the data to begin Land Use Change Analysis.

This latest series is based on photography captured in the spring of 2002. As with both previous layers, the 2002 data was produced by visually interpreting color infrared photography, however, the 1 foot pixel resolution of the 2002 imagery improved the ability of the interpreters to identify features. Through this process, photo interpreters examine each image, and based on their knowledge of photo signatures, classify the image into well defined land use/land cover codes as well as determining the percent impervious surface. The 68 land use classification codes are grouped into 6 - Level 1 categories to produce this land use/land cover type map.

All three land use/land cover data sets contain important land use data used in a wide variety of environmental analyses. Every effort has been made to insure that all land use data sets are as accurate as possible. However, LULC data are not intended to substitute for on the ground jurisdictional boundaries. Users of all data sets should understand the mapping process, appropriate uses and limitations of the data.

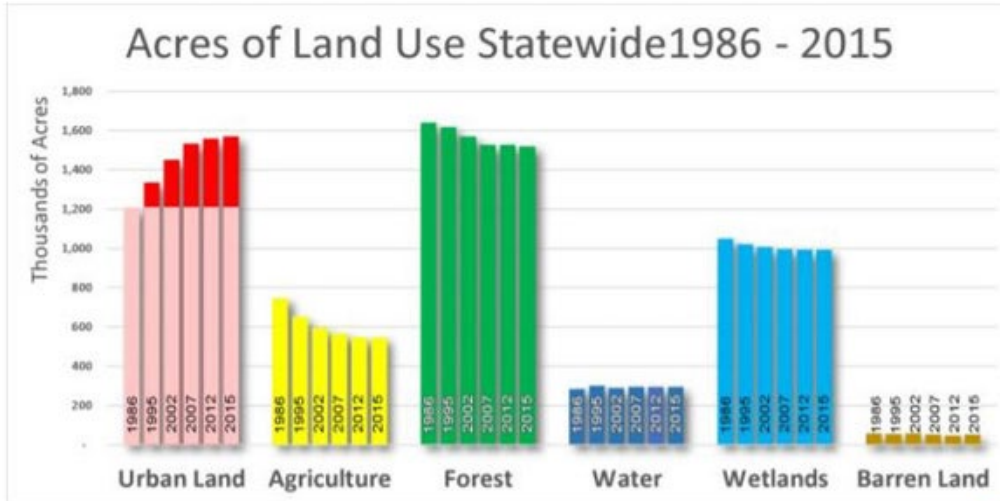
Aerial Information Systems, Inc. (AIS), Redlands, California developed the 2002 Statewide Land Use/Land Cover (LULC) and Hydrography (Hyd) data sets for the New Jersey Department of Environmental Protection (NJDEP). AIS is a provider of NJDEP in the partnership with the developer of the 1995 (1986/97) and the 1995/97 LULC data sets.

Funding for this project was provided by: The NJ Department of Transportation, The NJ Department of Environmental Protection, and through a grant from the National Geographic Society and Atlantic City Administration (NCA).

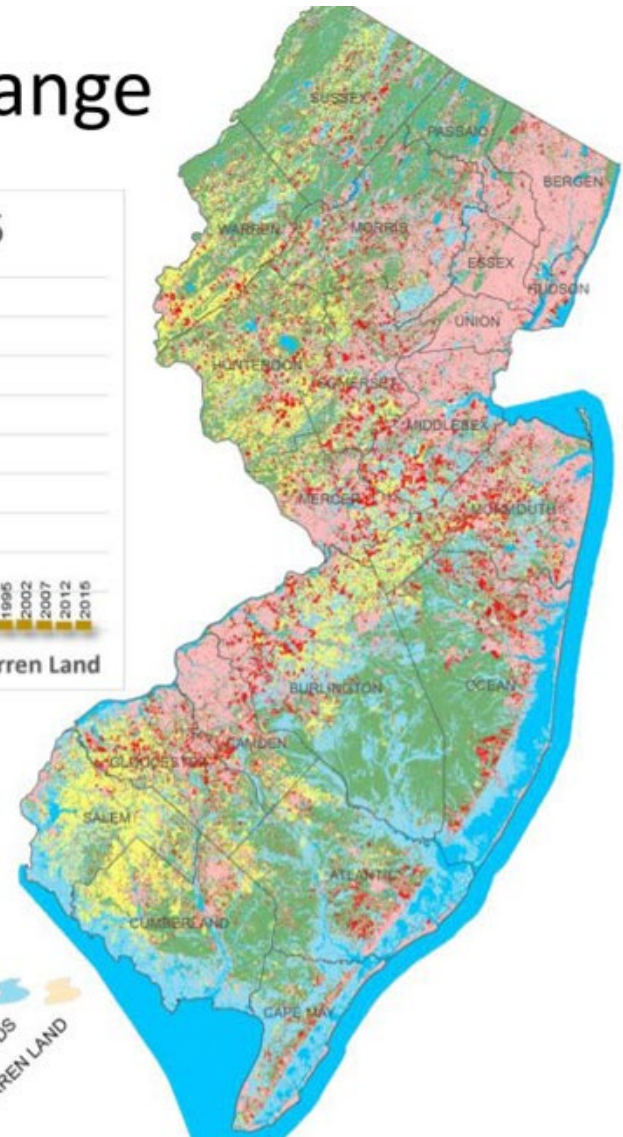
Project Team: Craig Cochran, Jo In Tyranski, Lawrence Thomson

Map Composition by Craig Cochran, OIS Specialist  
NJ Department of Environmental Protection, Office of Information Resources Management, Bureau of Geographic Information Systems, April 2007.

# Dynamic Landscape Change

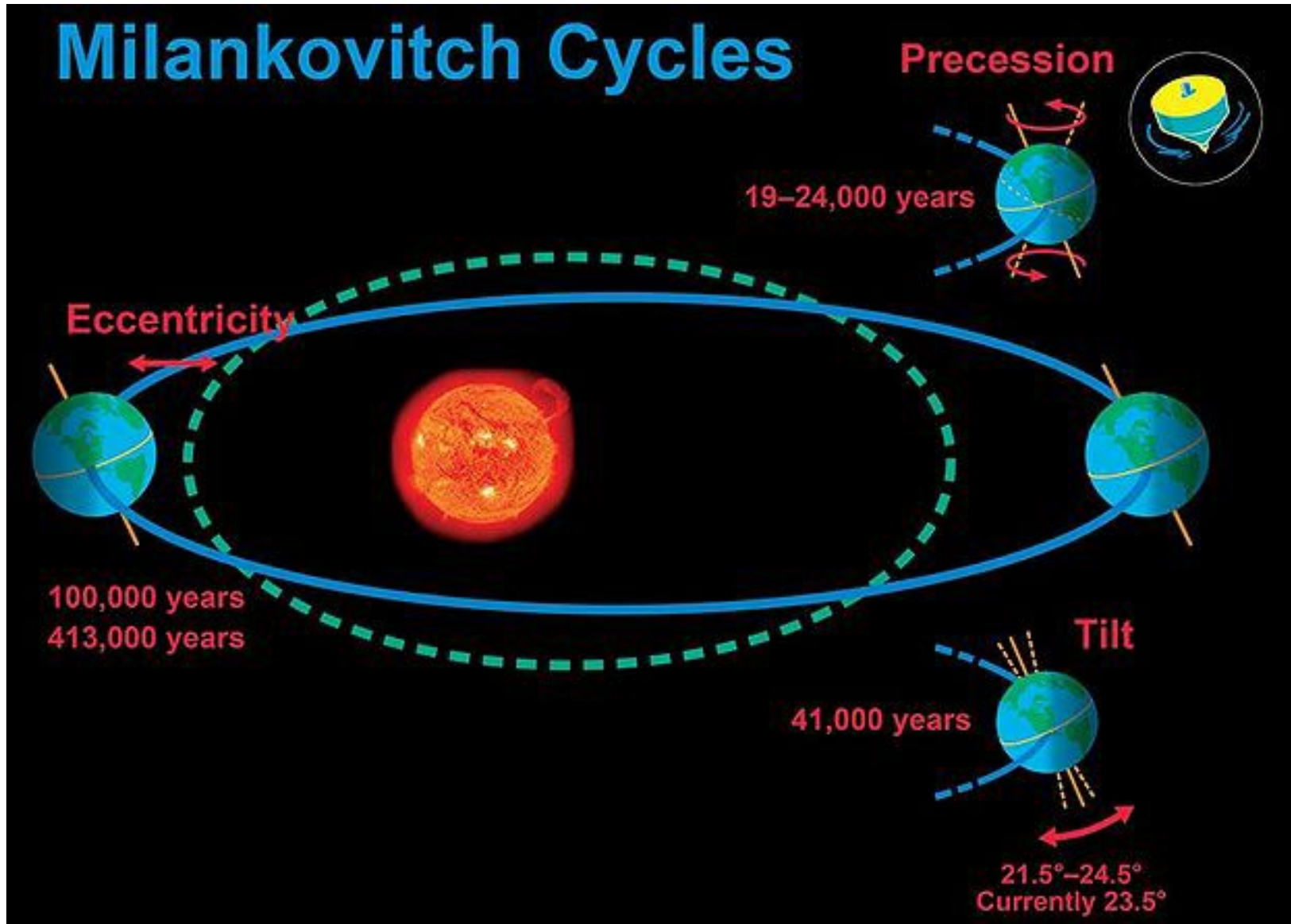


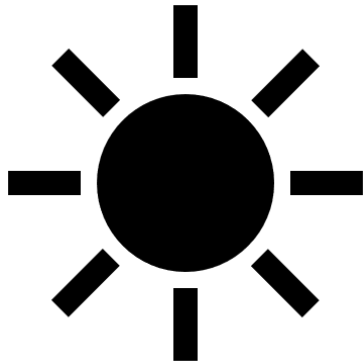
	2012-2015	1986-2015
Urban Growth	10,404 Acres	360,376 Acres
Farmland Loss	(2,087) Acres	(200,876) Acres
Forest Loss	(9,494) Acres	(122,569) Acres
Wetlands Loss	(2,295) Acres	(57,166) Acres



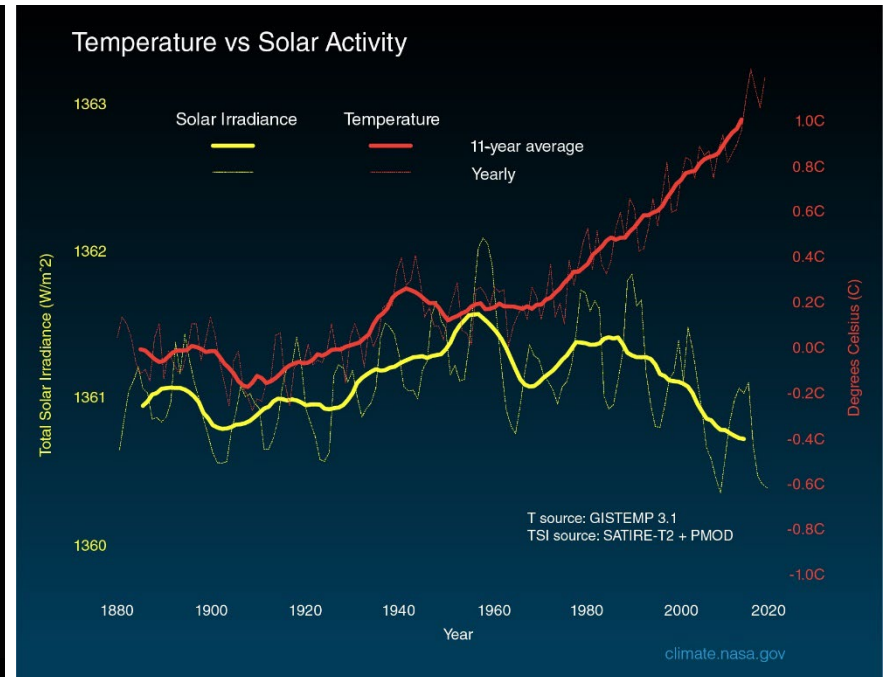
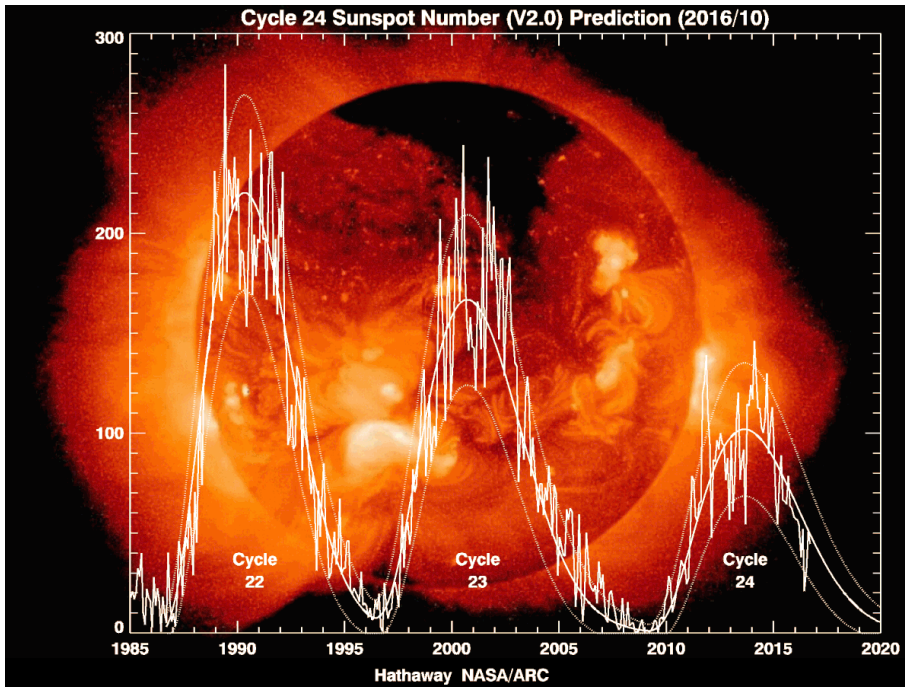
## Part II: Causes of Climate Change

# Natural Climate Change

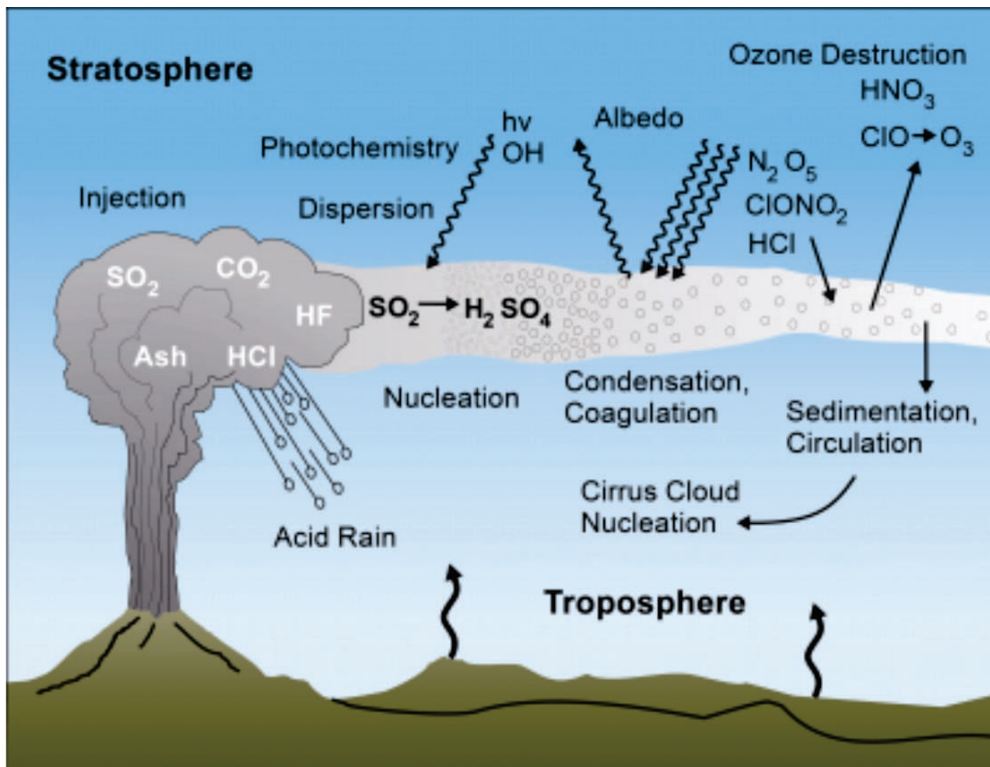




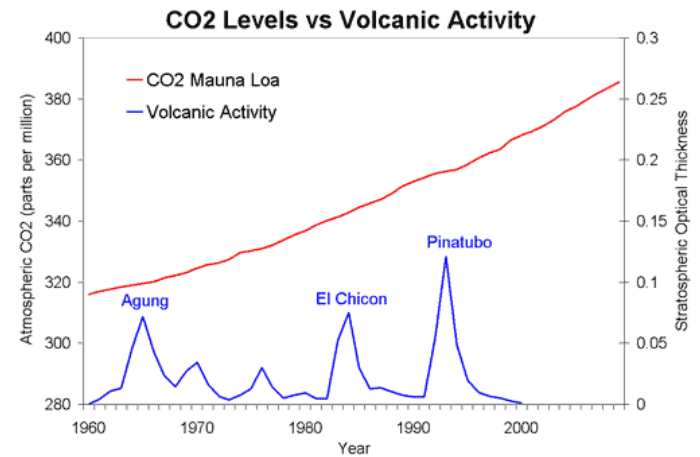
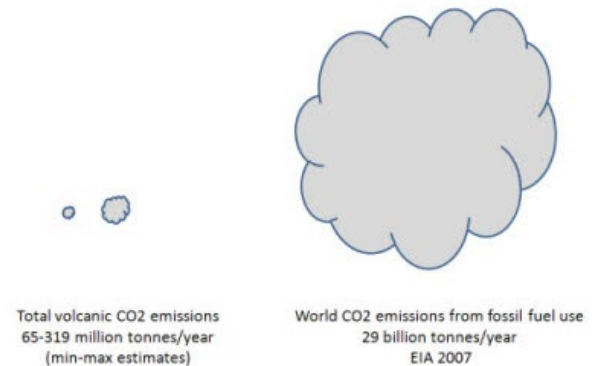
# The Sun (obviously)



# Volcanoes



This cartoon, from the USGS, illustrates the dispersal of aerosols and some of the photochemical interactions in the stratosphere. Circulation of an aerosol cloud in is eventually terminated when the particles succumb to gravity, gradually sinking to the lower atmosphere and earth's surface.



# Anthropogenic Factors

## Dictionary

Definitions from [Oxford Languages](#) · [Learn more](#)

Search for a word



an·thro·po·gen·ic

/,anTHrəpōˈjenɪk/

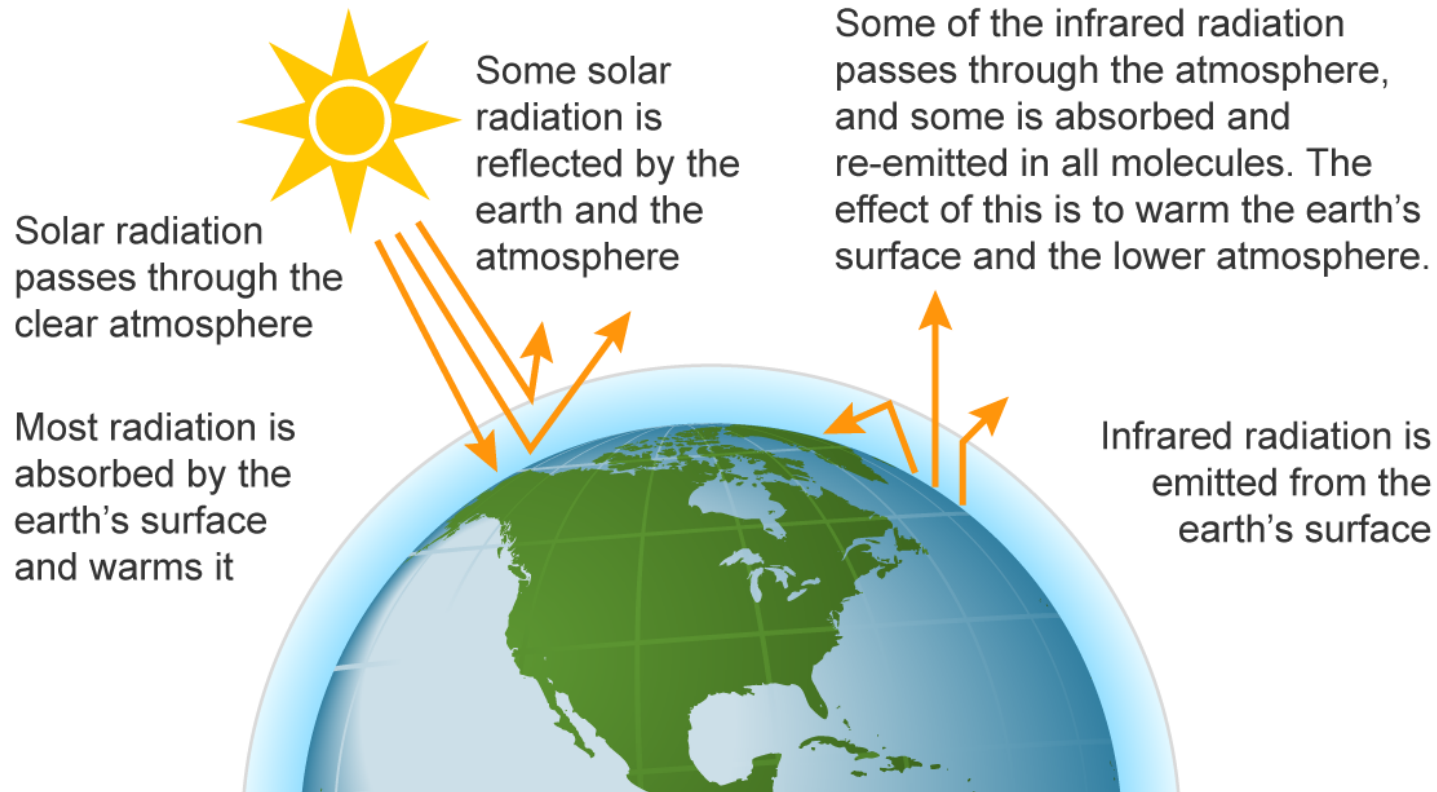
*adjective*

(chiefly of environmental pollution and pollutants) originating in human activity.  
"anthropogenic emissions of sulfur dioxide"



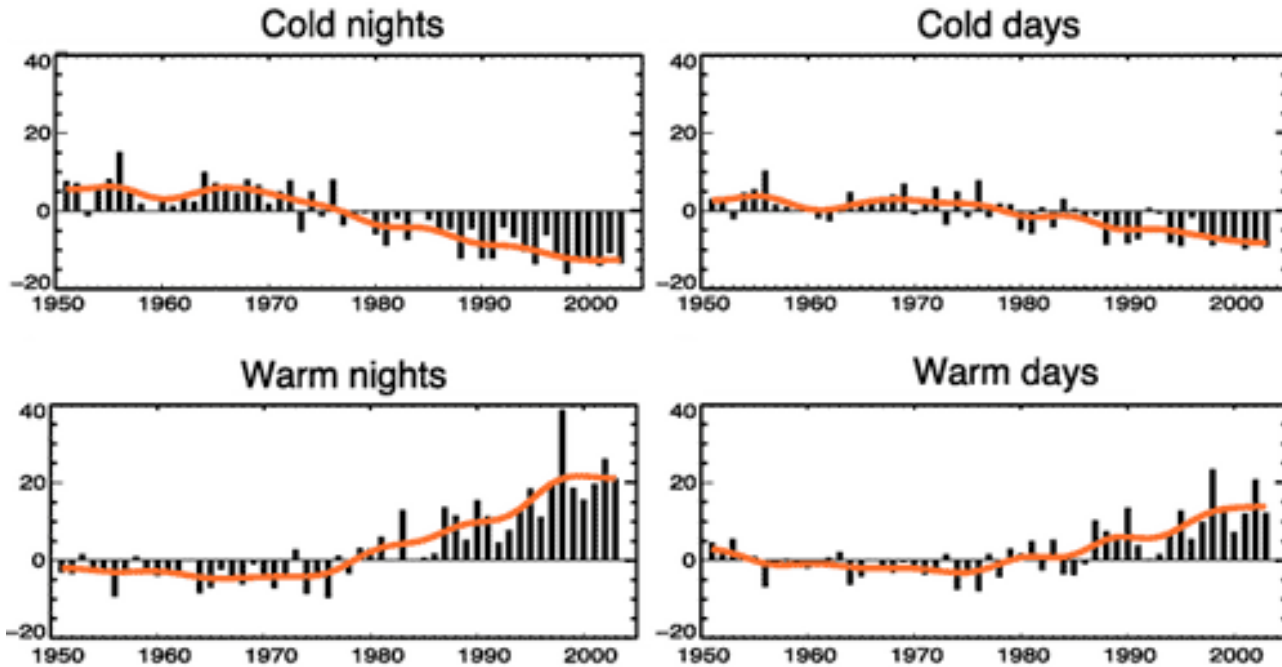
# The Greenhouse Effect

## The greenhouse effect



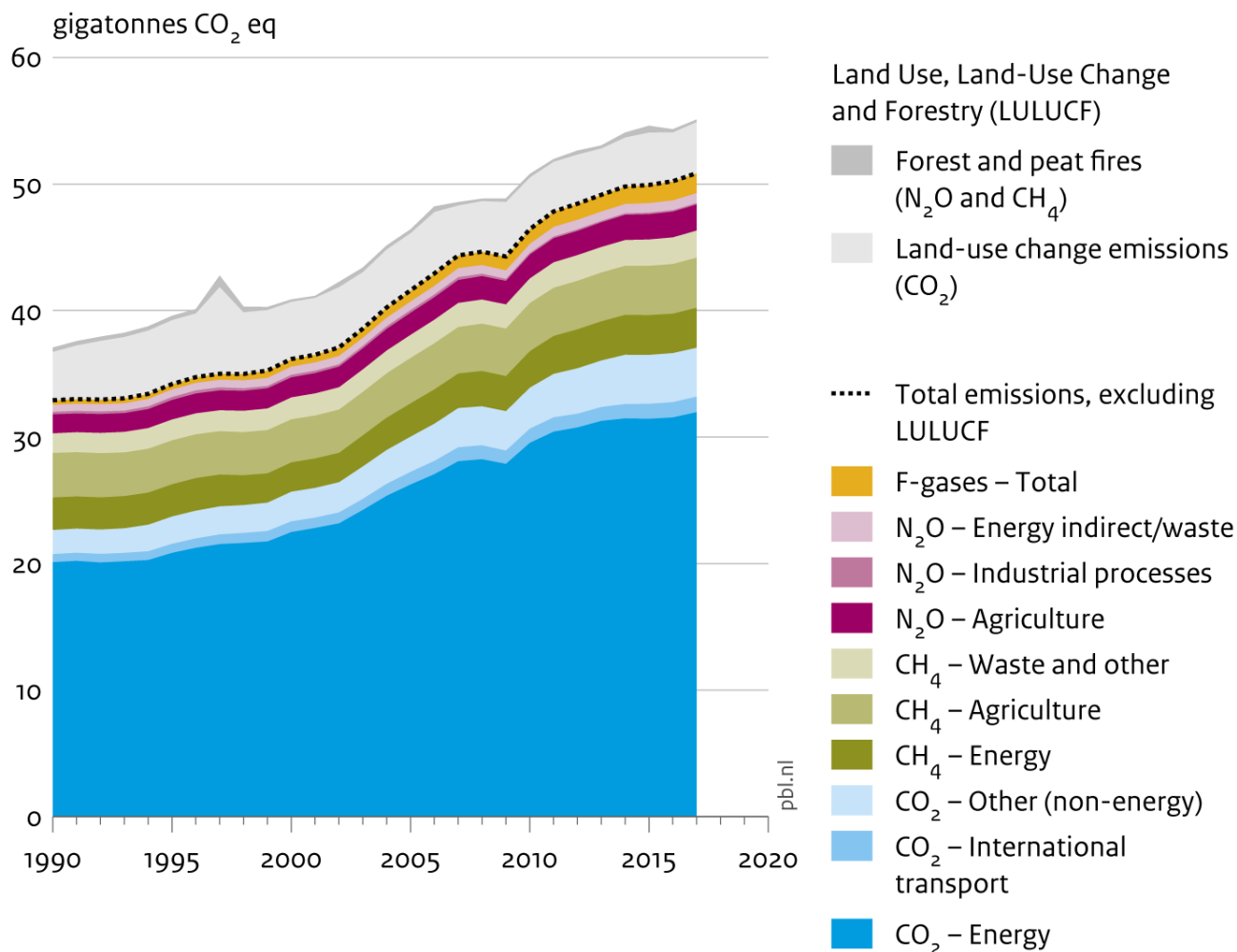
# Greenhouse Effect

## Frequency of cold and warm days and nights



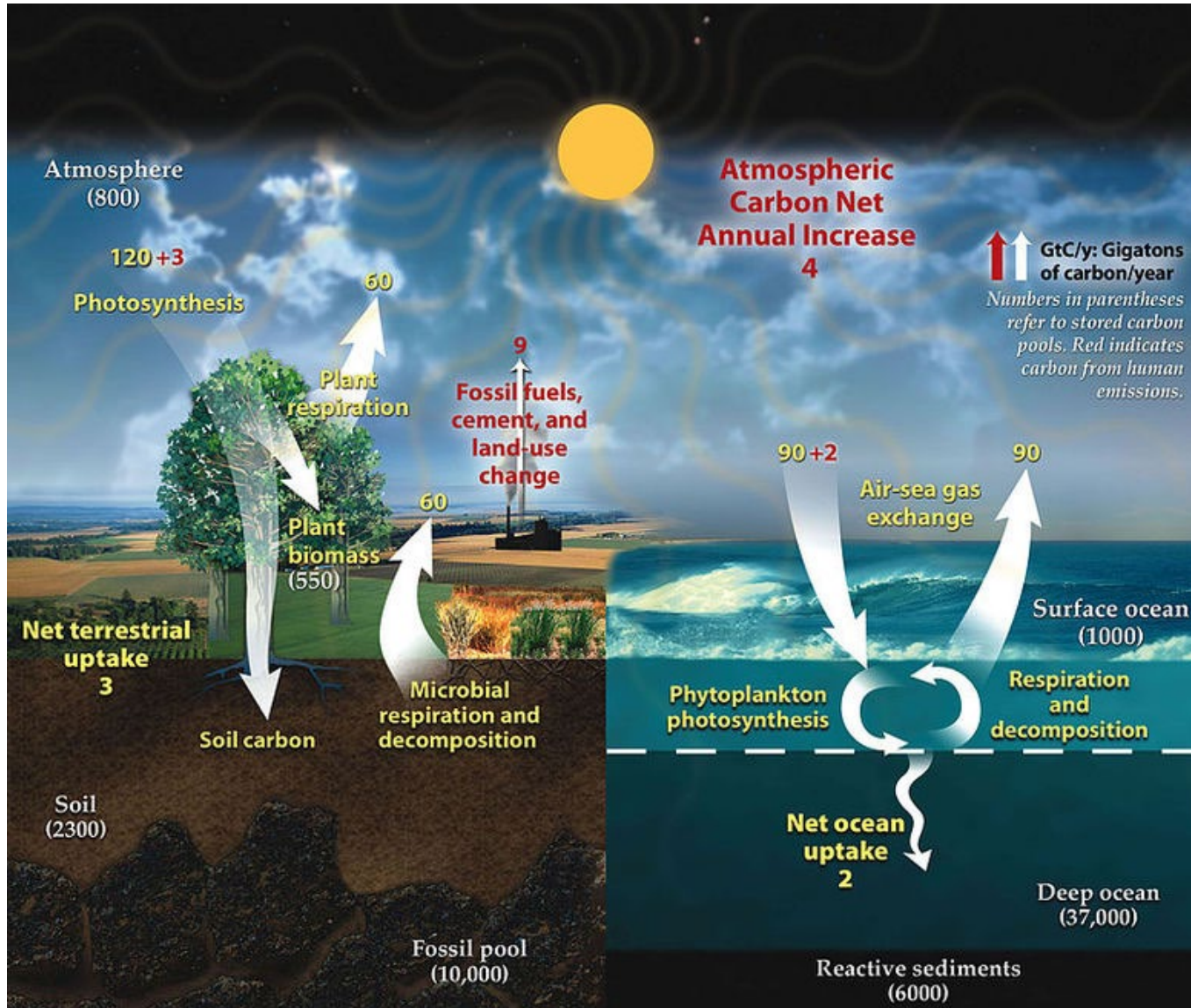
# Greenhouse Gas Emissions

## Global greenhouse gas emissions, per type of gas and source, including LULUCF

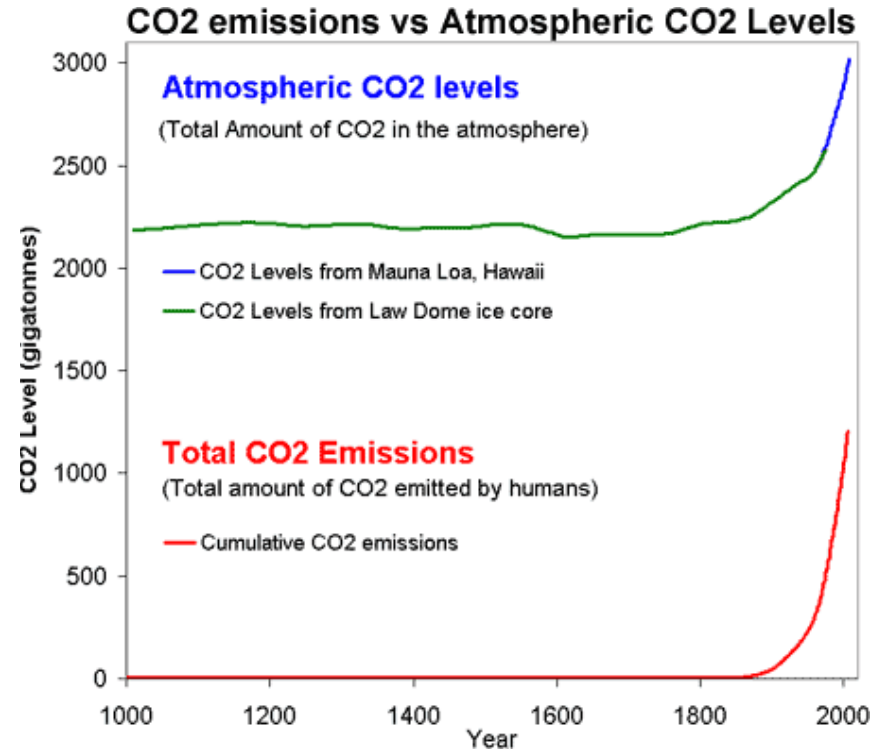
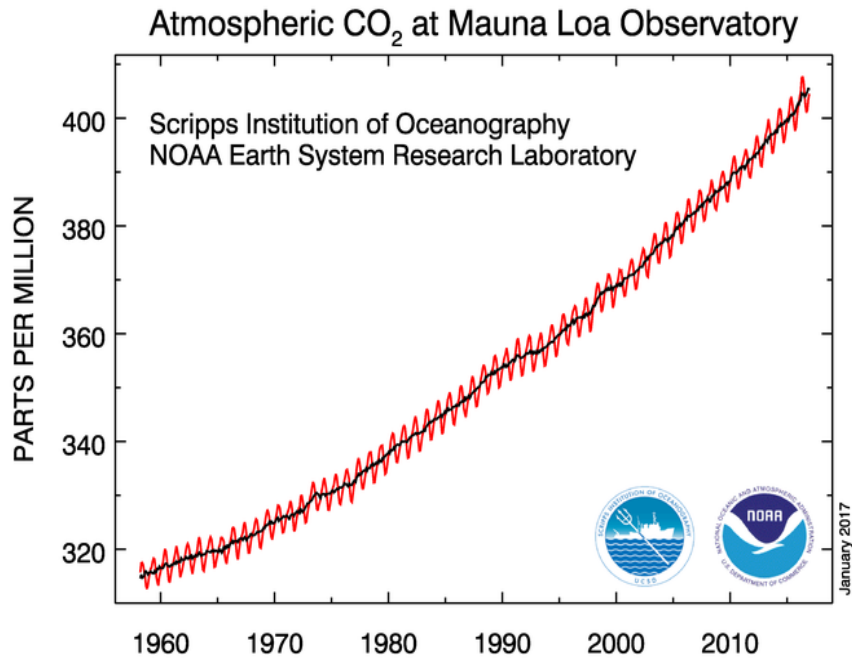


Source: EDGAR v5.0/v4.3.2 FT 2017 (EC-JRC/PBL, 2018); Houghton and Nassikas (2017)

# The Carbon Cycle



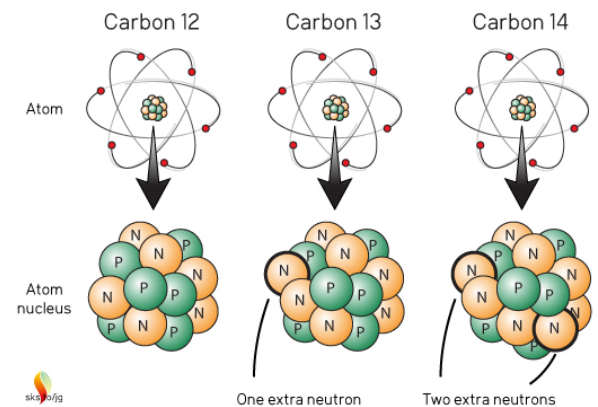
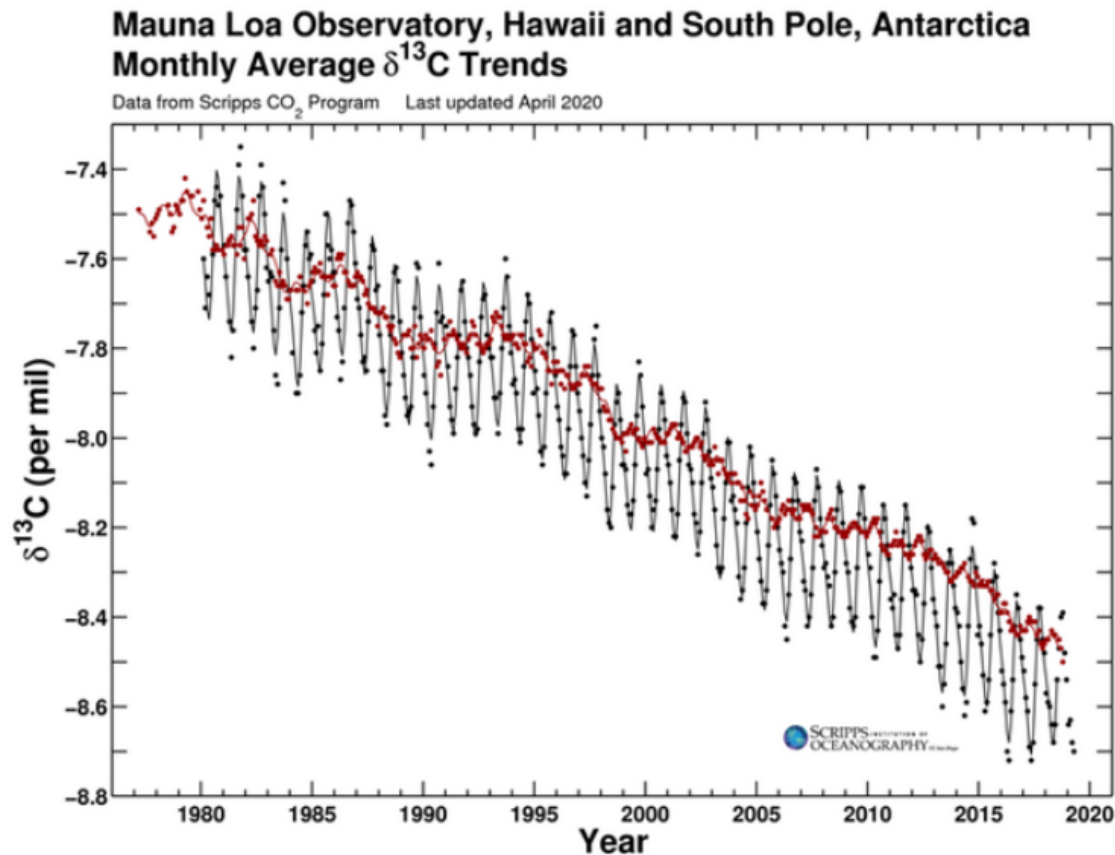
# Greenhouse Gas Emissions



# Human Footprints

## Isotope fingerprints point to human sources

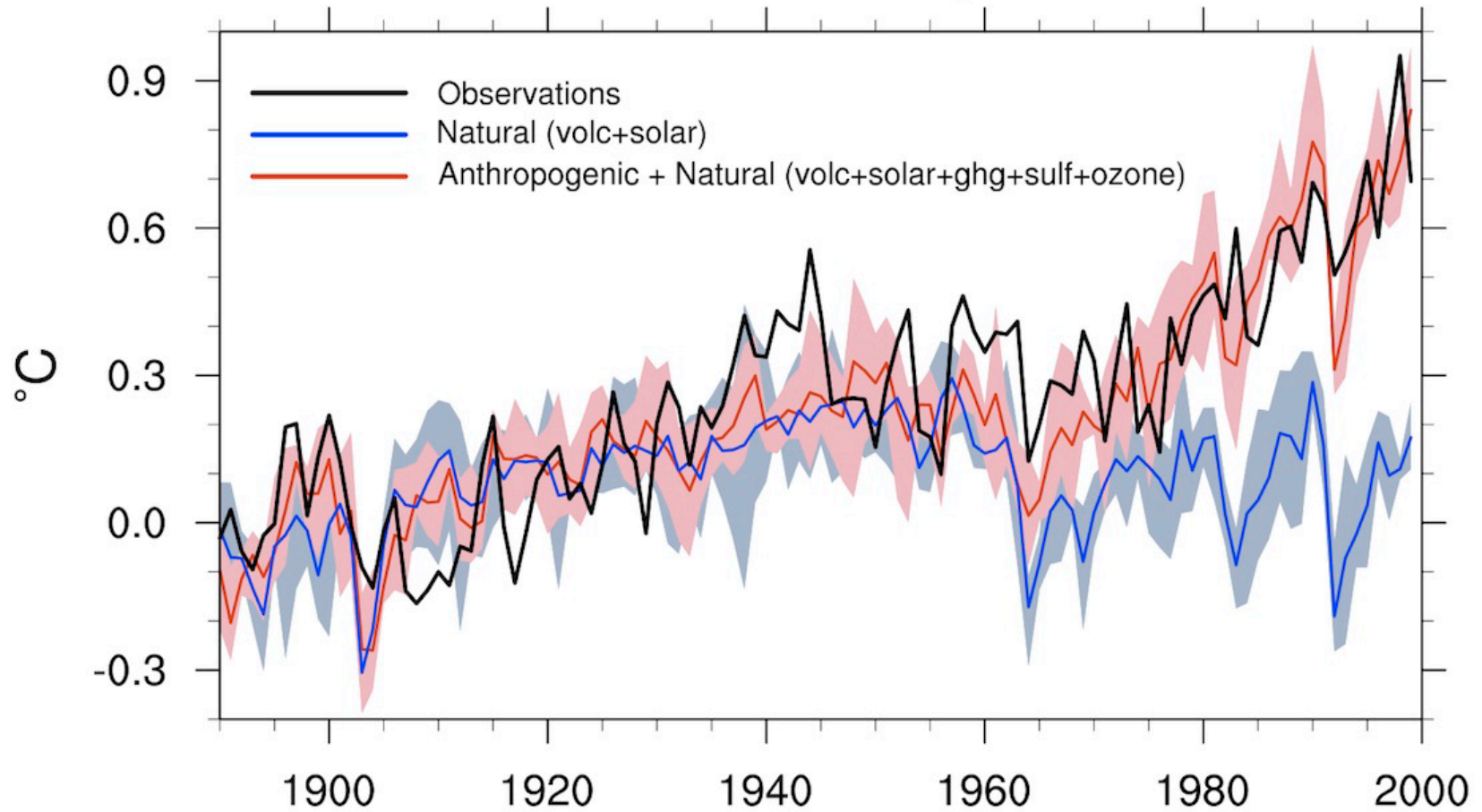
Different sources of CO<sub>2</sub> have their own unique isotopic fingerprints. CO<sub>2</sub> from the fossil fuel burning doesn't have carbon 14 (<sup>14</sup>C), and CO<sub>2</sub> from terrestrial plants has less carbon 13 (<sup>13</sup>C) than from the ocean. Since fossil fuels are derived from ancient plants, they all have less <sup>13</sup>C isotopes. Isotope data from ice cores show that since 1800, the carbon 13 in the atmosphere have decreased, which means the extra CO<sub>2</sub> in the atmosphere came from fossil fuel burning (Fig. 6).



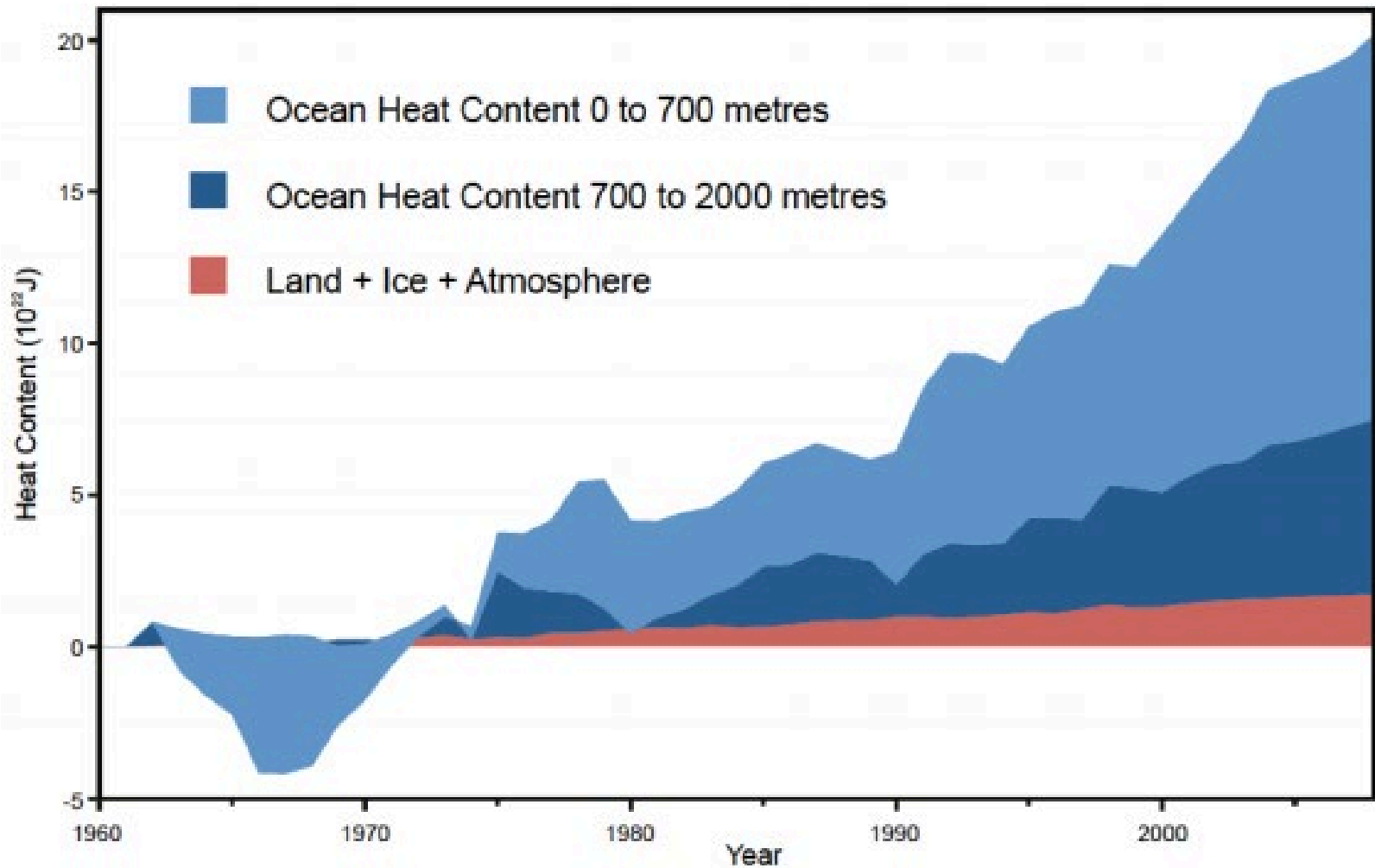
# Parallel Climate Model Ensembles

## Global Temperature Anomalies

from 1890-1919 average



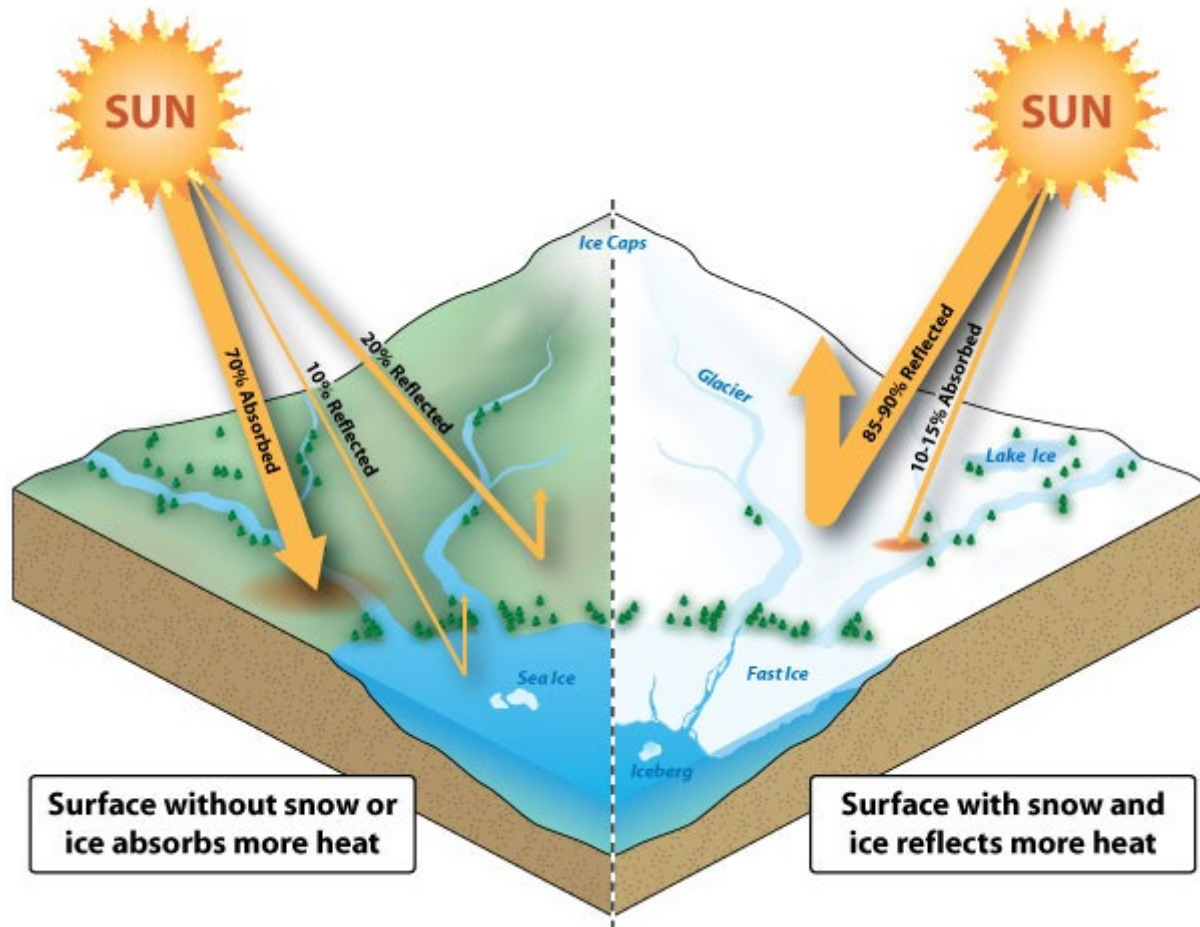
# Heat Storage



Nuccitelli et al., 2012



# Feedback Loops



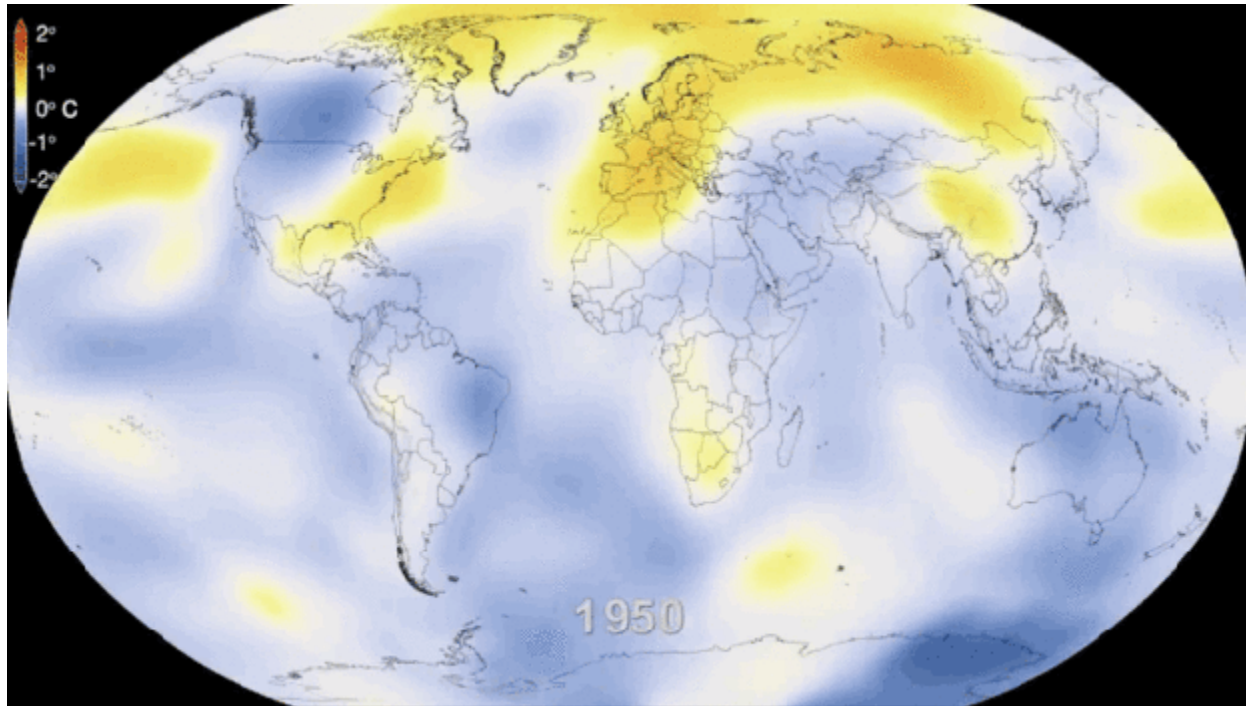
# Peruvian Terminus Retreat

(Slide from a presentation created by the brilliant David Robinson)



Courtesy of L. Thompson

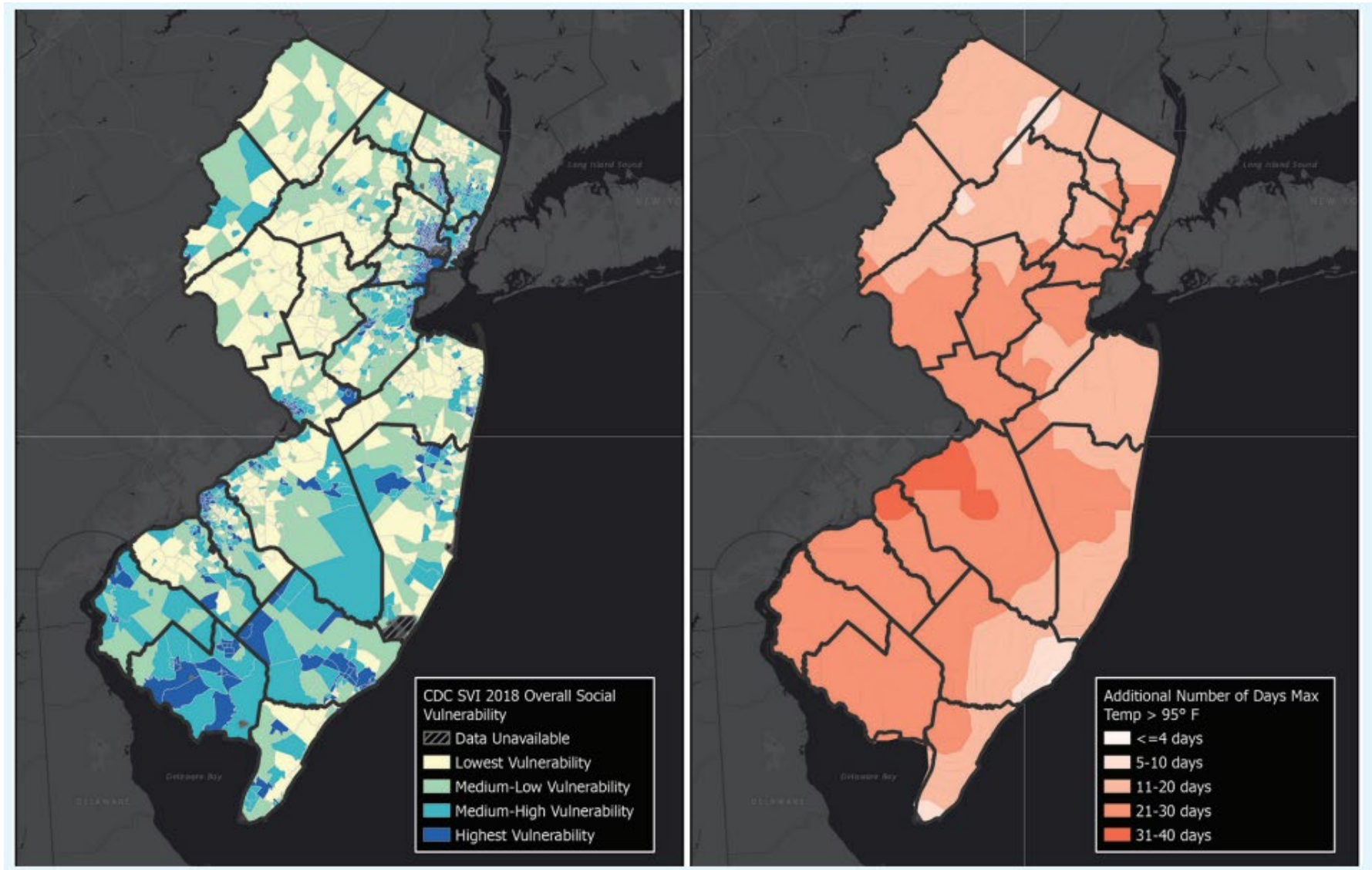
# Warming Over Time



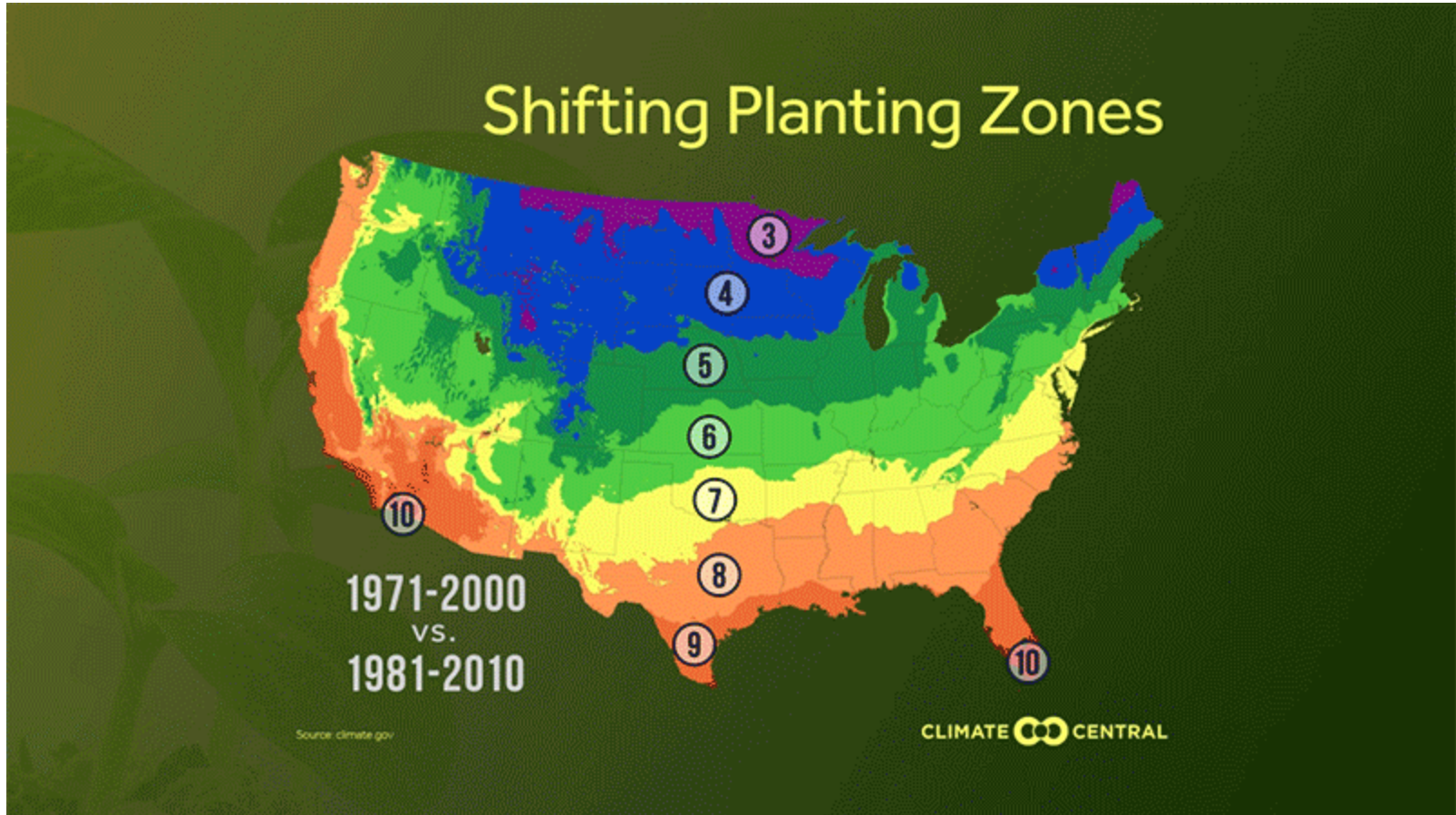
NASA Goddard Spaceflight Center

Part III:  
Climate Change in New Jersey

# Increasing Excessive Temperature Days



# Changing Hardiness Zones



# From State of the Climate – New Jersey 2021

## Temperatures are climbing

The mid-Atlantic region is one of the most rapidly warming locations in the continental U.S.

2021 was the  
**3rd warmest  
year**  
on record in NJ

Average annual temperatures  
in NJ increased nearly  
**4°F**  
since 1900, roughly  
twice the global average

CO<sub>2</sub> levels in the  
atmosphere are  
the highest in at least  
**800,000  
years**

Avg annual temperatures  
are projected to increase

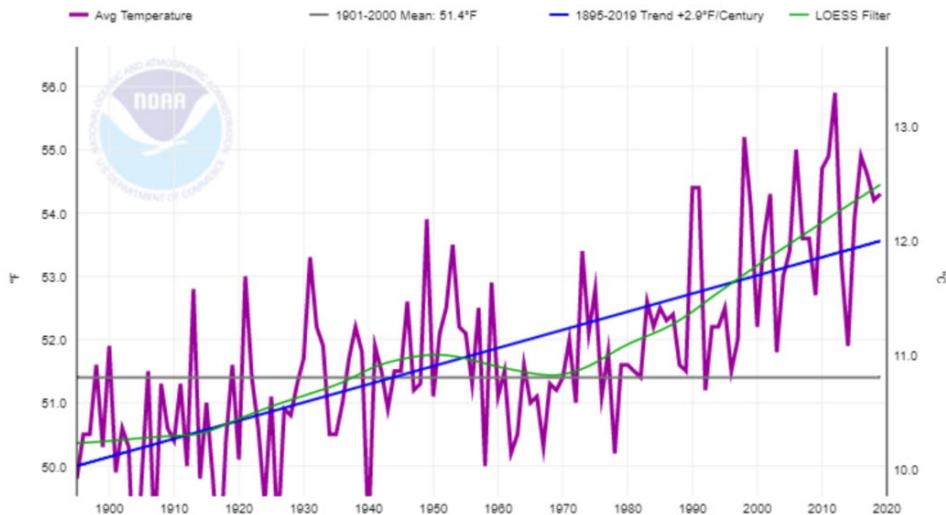
↑ **5–8 °F**

above preindustrial levels  
by 2100 in a low  
emissions scenario

↑ **8–14 °F**

by 2100 in a high  
emissions scenario

New Jersey, Average Temperature, January-December



# From State of the Climate – New Jersey 2021

## Sea-level rise is accelerating

And the trend is expected to continue well beyond the 21st century.

Sea level at Atlantic City rose about

**18 inches**

since 1911, more than double the global average

**Average annual tidal flooding days in Atlantic City**

	1950s:	<1
	2007-16:	8
projected	{ 2030:	17-75
	{ 2060:	85-315

with moderate emissions

## Tidal flooding

in Atlantic City is expected to occur at least

**240 days a year**

with moderate emissions by 2100

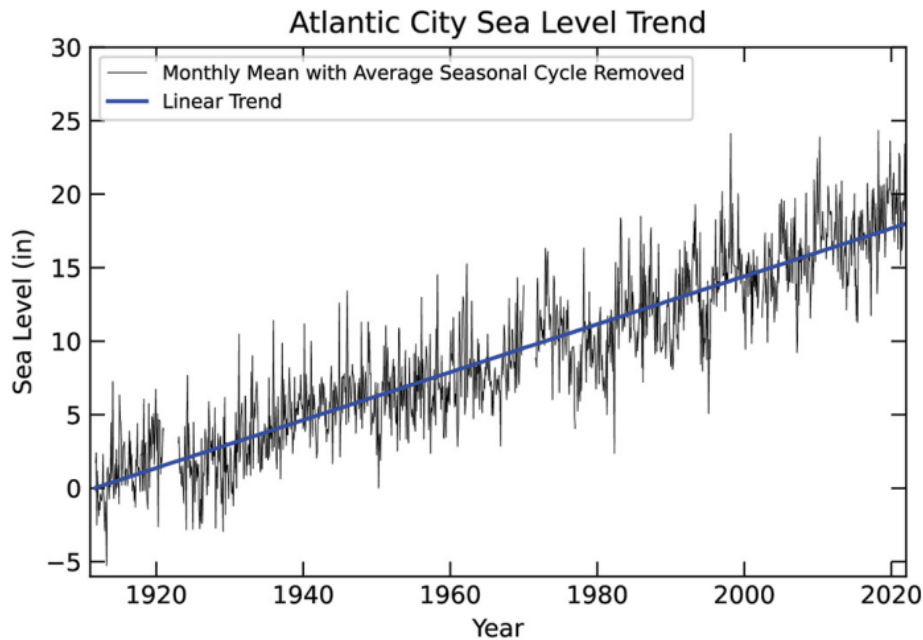
Sea level is projected to increase

**0.5–1.1 ft by 2030**

and

**0.9–2.1 ft by 2050**

relative to the year 2000





# From State of the Climate – New Jersey 2021

## Ida delivered catastrophic flooding (and a glimpse of the future)

Warming temperatures are driving greater variability in precipitation. New Jersey is wetter overall, and heavy rainfall is occurring more often.

**30 lives lost**

2nd greatest loss of life in NJ due to a natural disaster since 1900

Estimated  
**\$16–24B in damages**  
in the Northeast U.S.

**>9 inches of rain**

in about 6 hrs in Somerset and Hunterdon counties, 2x normal rainfall for whole month of September

By 2100, annual rainfall is expected to increase about

**5–8%**

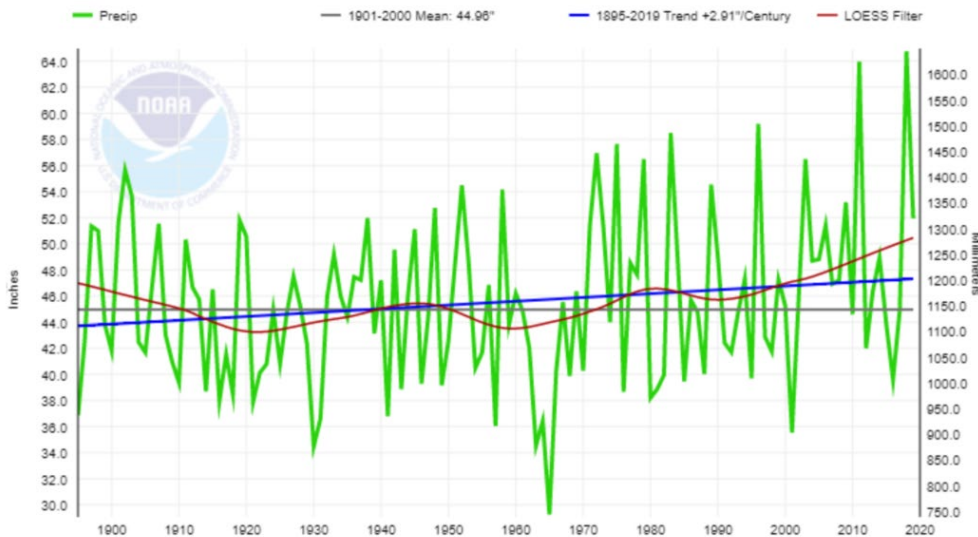
relative to 2010

Extreme 24-hour rainfall is expected to increase

**5–15%**

relative to 1950–1999

New Jersey, Precipitation, January–December



# A change in extremes?



17 September 1999

# 2 crest 21.0' (nearby Blackwells Mills: 1921-present)

## Manville



14 March 2010

# 6 crest 16.2' (1 May 2014 #7 crest 15.9')



16 April 2007

# 3 crest 19.2'

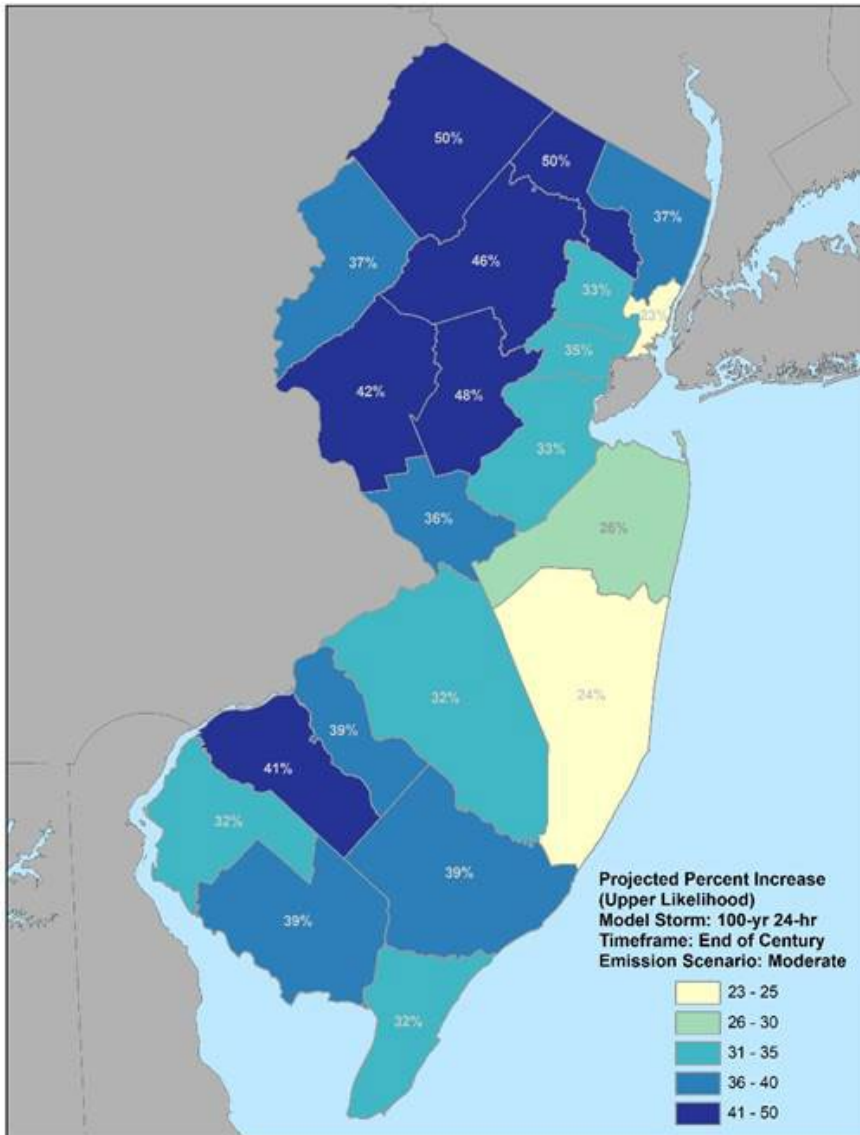


28 August 2011

# 1 crest 21.2'

(Slide from a presentation created by the brilliant David Robinson)

# Precipitation Increase

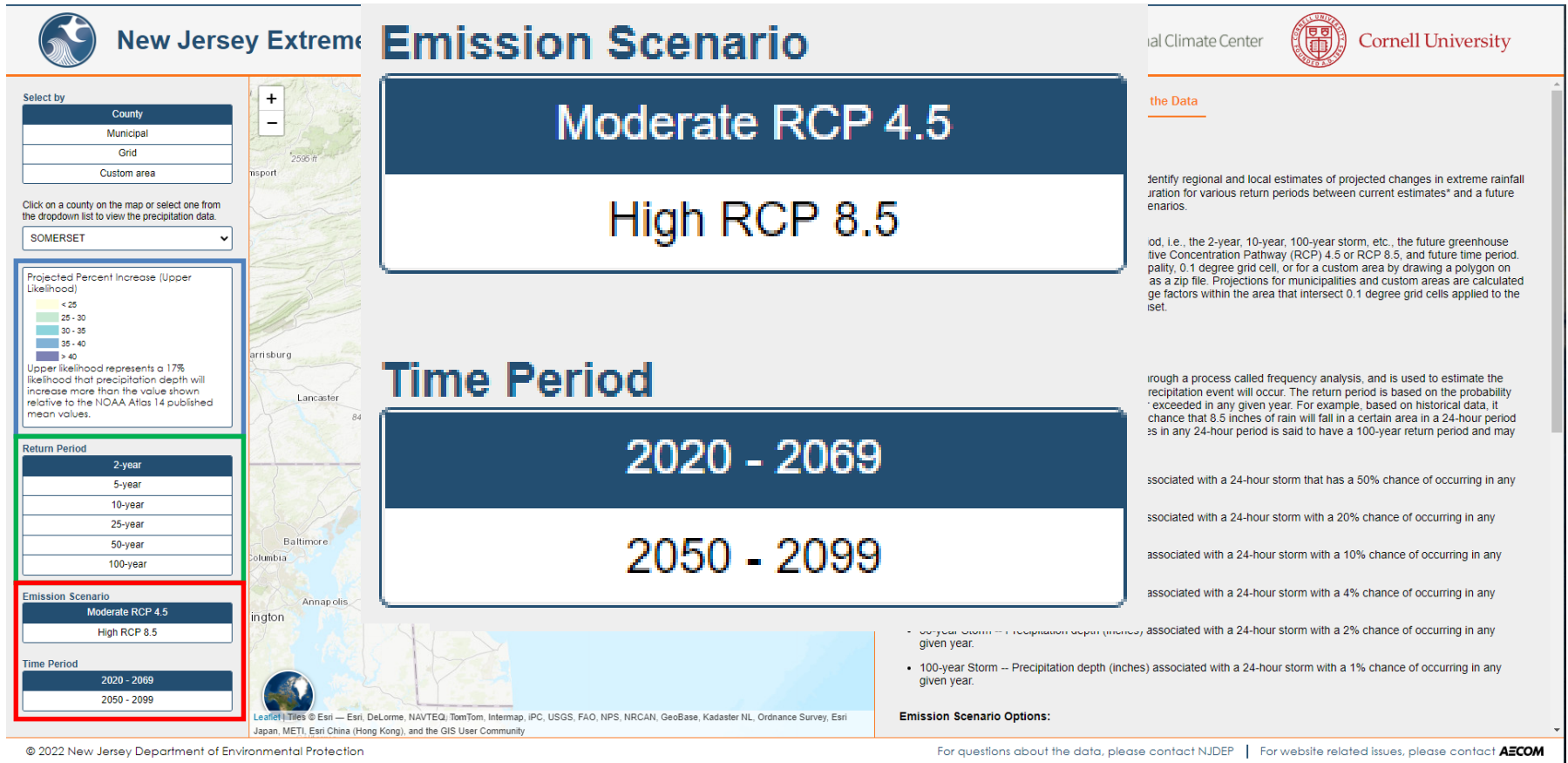


The studies show:

- **Precipitation is already 2.5% to 10% higher.** The precipitation expectations that presently guide state policy, planning and development criteria, and which rely upon data obtained through 1999, do not accurately reflect current precipitation intensity conditions. Extreme precipitation amounts are 2.5% higher now than the 1999 data suggests, and some parts of the state have seen a 10% increase above the outdated data.
- **Precipitation is likely to increase by more than 20% from the 1999 baseline by 2100,** and projected changes will be greater in the northern part of the state than in the southern and coastal areas, with projections for some northwestern counties seeing the greatest increase, some by as much as 50%.

# New Jersey Extreme Precipitation Projection Tool

<https://njprojectedprecipitationchanges.com/>



The screenshot displays the user interface of the New Jersey Extreme Precipitation Projection Tool. It features a central map of New Jersey with various controls on the left and right sides. The left sidebar includes a 'Select by' dropdown menu set to 'SOMERSET', a legend for 'Projected Percent Increase (Upper Likelihood)' with color-coded categories, a 'Return Period' dropdown menu set to '2-year', an 'Emission Scenario' dropdown menu set to 'Moderate RCP 4.5', and a 'Time Period' dropdown menu set to '2020 - 2069'. The right sidebar contains a 'the Data' section with descriptive text and a 'Emission Scenario Options' section with a list of storm types and their associated probabilities. The top of the interface includes the 'New Jersey Extreme Precipitation Projection Tool' title and logos for the 'New Jersey Department of Environmental Protection', 'Cornell University', and 'Climate Center'. The bottom of the interface contains copyright information and contact details for NJDEP and AECOM.

## New Jersey Extreme Precipitation Projection Tool

© 2022 New Jersey Department of Environmental Protection

### Emission Scenario

- Moderate RCP 4.5
- High RCP 8.5

### Time Period

- 2020 - 2069
- 2050 - 2099

### Return Period

- 2-year
- 5-year
- 10-year
- 25-year
- 50-year
- 100-year

### Projected Percent Increase (Upper Likelihood)

- < 25
- 25 - 30
- 30 - 35
- 35 - 40
- > 40

Upper likelihood represents a 17% likelihood that precipitation depth will increase more than the value shown relative to the NOAA Atlas 14 published mean values.

### the Data

Identify regional and local estimates of projected changes in extreme rainfall duration for various return periods between current estimates\* and a future scenarios.

...od, i.e., the 2-year, 10-year, 100-year storm, etc., the future greenhouse gas concentration pathway (RCP) 4.5 or RCP 8.5, and future time period. ...ally, 0.1 degree grid cell, or for a custom area by drawing a polygon on as a zip file. Projections for municipalities and custom areas are calculated as factors within the area that intersect 0.1 degree grid cells applied to the set.

...rough a process called frequency analysis, and is used to estimate the precipitation event will occur. The return period is based on the probability 'exceeded in any given year. For example, based on historical data, it chance that 8.5 inches of rain will fall in a certain area in a 24-hour period as in any 24-hour period is said to have a 100-year return period and may

...associated with a 24-hour storm that has a 50% chance of occurring in any

...associated with a 24-hour storm with a 20% chance of occurring in any

...associated with a 24-hour storm with a 10% chance of occurring in any

...associated with a 24-hour storm with a 4% chance of occurring in any

...100-year Storm -- Precipitation depth (inches) associated with a 24-hour storm with a 2% chance of occurring in any given year.

...100-year Storm -- Precipitation depth (inches) associated with a 24-hour storm with a 1% chance of occurring in any given year.


### Emission Scenario Options:

For questions about the data, please contact NJDEP | For website related issues, please contact AECOM

Duration (hrs)	Projected Depth (inches)						
	10th	17th	25th	Median	75th	83rd	90th
24	3.09	3.20	3.30	3.51	3.75	3.86	3.97

# New Jersey Future Precipitation Projection Tool

<https://www.nj.gov/dep/changes.com/>



**New Jersey**

Select by

- County
- Municipal
- Grid
- Custom area

Click on a county on the map or select one from the dropdown list to view the precipitation data.

SOMERSET

Projected Percent Increase (Upper Likelihood)

- < 25
- 25 - 30
- 30 - 35
- 35 - 40
- > 40

Upper likelihood represents a 17% likelihood that precipitation depth will increase more than the value shown relative to the NOAA Atlas 14 published mean values.

**Return Period**

- 2-year
- 5-year
- 10-year
- 25-year
- 50-year
- 100-year

**Emission Scenario**

- Moderate RCP 4.5
- High RCP 8.5

**Time Period**

- 2020 - 2069
- 2050 - 2099

## Return Period

- 2-year
- 5-year
- 10-year
- 25-year
- 50-year
- 100-year

## Emission Scenario

- Moderate RCP 4.5
- High RCP 8.5

## Time Period

- 2020 - 2069
- 2050 - 2099



Northeast Regional Climate Center



Cornell University

Precipitation Projection About the Data

Period RCP 4.5 Projection 2020-2069 - SOMERSET

Excel PDF

**Projected 24-hour Precipitation Depth**

Projected values along the line are interpolated from the seven percentile values provided below



Projected Depth (inches)							NOAA Atlas 14 Values (Inches, data through Dec. 2000)*		
10th	17th	25th	Median	75th	83rd	90th	Low CI	Mean	High CI
7.06	7.55	8.06	9.21	11.10	11.64	12.37		8.11	

precipitation data is referenced from the [Full Report](#) and [Supplemental Table](#) of the Future Precipitation Study.

Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, D., 2006. NOAA Atlas 14 Precipitation-Frequency Atlas of the United States Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, South Carolina, Tennessee, Virginia, West Virginia, Silver Spring, Maryland: National Oceanic and Atmospheric Administration. <https://hdsc.nws.noaa.gov/hdsc/pfds/docs/NA14Vol2.pdf>

For questions about the data, please contact NJDEP | For website related issues, please contact AECOM

# New Jersey Extreme Precipitation Projection Tool

<https://njprojectedprecipitationchanges.com/>

**100-yr Return Period RCP 4.5 Projection 2020-2069 - SOMERSET**

**Projected 24-hour Precipitation Depth**  
Projected values along the line are interpolated from the seven percentile values provided below

Duration (hrs)	10th	17th	25th	Median	75th	83rd	90th	NOAA Atlas 14 Values (Inches, data through Dec. 2000)*		
								Low CI	Mean	High CI
24	7.06	7.55	8.06	9.21	11.10	11.64	12.37		8.11	

*The projected precipitation data is referenced from the Full Report and Supplemental Table of the Future Precipitation Study.*

\*Bonnin, G.M., D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, D., 2006. NOAA Atlas 14 Precipitation-Frequency Atlas of the United States Volume 2 Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, Silver Spring, Maryland: National Oceanic and Atmospheric Administration. Available online: <https://hdsc.nws.noaa.gov/hdsc/pfds/docs/AT14Vol2.pdf>

Median	75th	83rd	90th
9.21	11.10	11.64	12.37

44% Higher

For questions about the data, please contact NJDEP | For website related issues, please contact AECOM

# NJ Flood Mapper

[www.njfloodmapper.org/](http://www.njfloodmapper.org/)

The screenshot displays the NJ Flood Mapper web application interface. A blue box highlights the left sidebar menu, which includes the following options: Total Water Levels Tool, Flood Hazards, Map Layers, New Jersey MyCoast, Municipal Snapshots, Basemaps, Save / Share / Print, Custom Layers, and Legend. A larger blue box highlights a central panel containing callouts for: Total Water Levels Tool, Flood Hazards, Map Layers, New Jersey MyCoast, Municipal Snapshots, Basemaps, Save / Share / Print, Custom Layers, and Legend. The main map area shows a geographical view of the New Jersey coastline with various cities and towns labeled. A 'Layer Control' panel is visible on the right side of the map, featuring 'Show Legend' and 'Remove All Layers' buttons, and a message stating 'No Layers are selected'. The top navigation bar includes a search icon, a 'Tour' button, and a 'Report A Problem' button. The bottom of the page contains a scale bar (0 to 20 miles) and a 'Powered by Esri' logo.

This is where you'll find the options to add data.



# NJ Flood Mapper

<https://www.njfloodmapper.org/>

The screenshot displays the NJ Flood Mapper web application. The interface includes a top navigation bar with 'NJ Adapt' and 'NJ Flood Mapper' labels, a search icon, and links for 'Tour' and 'Report A Problem'. A left sidebar contains navigation options like 'Home', 'Flood Hazards', 'Map Layers', and 'Legend'. The main map area shows a map of New Jersey with a green and blue overlay representing flood risk. A 'Total Water Levels Tool' overlay is active, featuring a title bar with a back arrow and a close button. Below the title, there is a button for 'Total Water Levels Tool' and a section for 'Customize the variables to produce a Total Water Level'. This section includes tabs for 'Summary View', 'Tide Gauge', 'Emissions', 'Timeframe', 'SLR Estimate', and 'Flood Event'. The 'SLR Estimate' tab is selected and highlighted with a red box. Below the tabs, the current 'Total Water Level' is set to '4 Ft.' with a '+ Add' button. A 'Sea Level Estimate Selection' section lists five options with radio buttons: 8.8 ft. (Less than a 5% Chance of Exceeding), 6.3 ft. (Less than a 17% Chance of Exceeding), 3.9 ft. (Approximately a 50% Chance of Exceeding), 2.3 ft. (At least an 83% Chance of Exceeding), and 1.5 ft. (At least a 95% Chance of Exceeding). The 3.9 ft. option is selected and highlighted with a red box. A 'High emissions' section contains a text box and a 'NJ Sea Level Rise Estimates Example' button. A 'Layer Control' panel on the right shows the 'Total Water Level (4 ft)' layer is turned 'ON' with a 100% opacity slider. The bottom of the page includes a scale bar (0 to 20 miles) and a footer with 'Powered by Esri'.

← Total Water Levels Tool

Flood Hazards

Map Layers

New Jersey MyCoast

Municipal Snapshots

Basemaps

Save / Share / Print

Custom Layers

Legend

### Total Water Levels Tool



First time users, please use the interactive tool to determine your Total Water Level

Total Water Levels Tool

Customize the variables to produce a Total Water Level

- Summary View
- Tide Gauge
- Emissions
- Timeframe
- SLR Estimate
- Flood Event

Total Water Level 4 Ft. + Add

### Sea Level Estimate Selection

- 8.8 ft. Less than a 5% Chance of Exceeding
- 6.3 ft. Less than a 17% Chance of Exceeding
- 3.9 ft. Approximately a 50% Chance of Exceeding
- 2.3 ft. At least an 83% Chance of Exceeding
- 1.5 ft. At least a 95% Chance of Exceeding

### High emissions

Select a sea level rise estimate based on the level of risk tolerance for your planning project.

NJ Sea Level Rise Estimates Example

# NJ Flood Mapper

<https://www.njfloodmapper.org/>

The screenshot displays the NJ Flood Mapper web application interface. The main map shows the New Jersey coastline with flood hazard areas highlighted in green and blue. A 'Total Water Levels Tool' dialog box is open, showing 'Emissions' selected under 'Emission Scenario Selection'. A 'Layer Control' panel is also visible on the right side of the map.

**Total Water Levels Tool**

First time users, please use the interactive tool to determine your Total Water Level

Total Water Levels Tool

Customize the variables to produce a Total Water Level

Summary View | Tide Gauge | **Emissions** | Timeframe | SLR Estimate | Flood Event

Total Water Level: 2 Ft.

**Emission Scenario Selection**

Choose an emissions scenario based on future fossil fuel use and policy decisions.

**High emissions** | Moderate Emissions | Low Emissions

- **High GHG emissions** - Corresponds to a future consistent with the strong, continued growth of fossil fuel consumption.
- **Moderate GHG emissions** - Corresponds to a future consistent with current global policies.
- **Low GHG emissions** - Corresponds to a future consistent with the global goal of limiting warming to 2°C above early industrial (1850-1900) levels.

**Layer Control**

Show Legend | Remove All Layers

Total Water Level (2 ft) Opacity: 100%

ON  OFF

0%  100%

Esri, HERE, Garmin, USGS, EPA, NPS | Esri, HERE, NPS Harrisonburg

Powered by Esri

« Total Water Levels Tool

ⓘ Flood Hazards

☰ Map Layers

🗺 New Jersey MyCoast

📁 Municipal Snapshots

🗺 Basemaps

📄 Save / Share / Print

📁 Custom Layers

☰ Legend

## Total Water Levels Tool



*First time users, please use the interactive tool to determine your Total Water Level*

Total Water Levels Tool

*Customize the variables to produce a Total Water Level*

Summary View

Tide Gauge

Emissions

Timeframe

SLR Estimate

Flood Event

Total Water Level: 2 Ft. [+ Add](#)

### Emission Scenario Selection

Choose an emissions scenario based on future fossil fuel use and policy decisions.

High emissions

Moderate Emissions

Low Emissions

- **High GHG emissions** - Corresponds to a future consistent with the strong, continued growth of fossil fuel consumption.
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- **Low GHG emissions** - Corresponds to a future consistent with the global goal of limiting warming to 2°C above early industrial (1850-1900) levels.

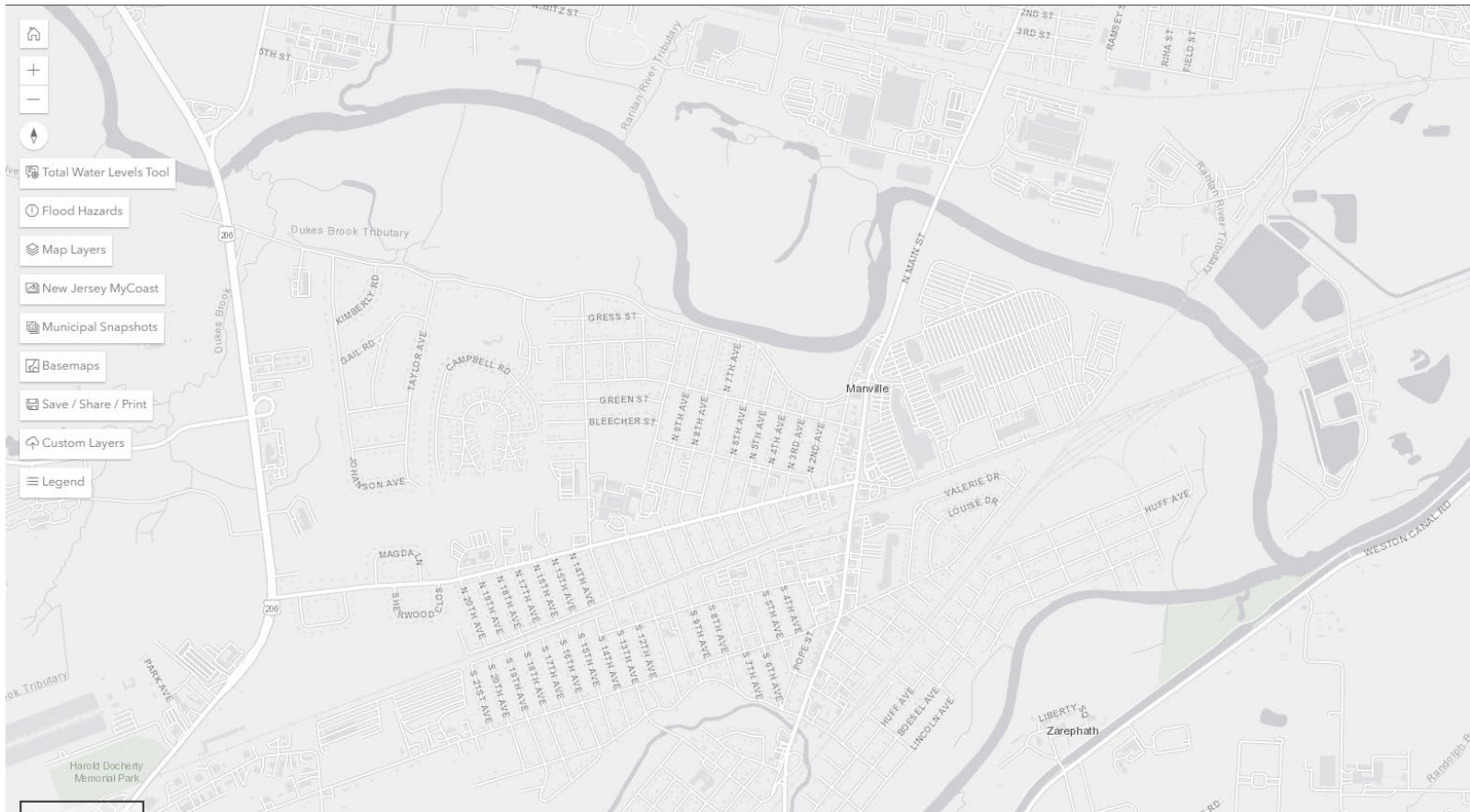
# NJ Flood Mapper

<https://www.njfloodmapper.org/>

The screenshot displays the NJ Flood Mapper web application. The interface includes a top navigation bar with 'NJ Adapt' and 'NJFloodMapper' labels, a search icon, and links for 'Tour' and 'Report A Problem'. A left sidebar contains navigation options like 'Home', 'Map Layers', and 'Save / Share / Print'. The main map area shows New Jersey with a flood event overlay in green and blue. A 'Total Water Levels Tool' dialog box is open, featuring tabs for 'Summary View', 'Tide Gauge', 'Emissions', 'Timeframe', 'SLR Estimate', and 'Flood Event' (highlighted with a red box). The 'Flood Event' tab shows a 'Total Water Level: 8 Ft.' and a 'Flood Event Height Selection' section with radio buttons for various MHHW levels (4.8 ft, 3.3 ft, 2.4 ft, 1.6 ft, and 0.0 ft) and a 'Historical Events' dropdown menu (highlighted with a red box) currently set to '[10/29/2012] Hurricane Sandy'. A 'Layer Control' panel on the right shows the 'Total Water Level (8 ft)' layer is turned 'ON' with a 100% opacity slider.

# Manville Example

<https://www.njfloormapper.org/>



Step one: Select an area of study.

You can zoom in and out using the mouse wheel.

Click and hold the left mouse button to drag the map view.

# Manville Example

<https://www.njfloodmapper.org/>

The screenshot displays the NJ Flood Mapper interface. On the left, a 'Flood Hazard Overlays' panel lists various data layers. The 'NJ Climate Adjusted Flood Elevations (CAFE)' layer is highlighted with a red box, and its '+ Details' button is also highlighted. In the top right, a 'Layer Control' panel shows the CAFE layer with a 'Show Legend' button, a 'Remove All Layers' button, and a transparency slider set to 100%. A blue text box in the center-right of the map area contains the text: 'You can adjust the transparency of the data, turn off the data, or remove the added data here.'

Step two: select data from the boxes on the left panel.

Note: hitting the + Details box gives additional information about the data.

# Manville Example

<https://www.njfloodmapper.org/>

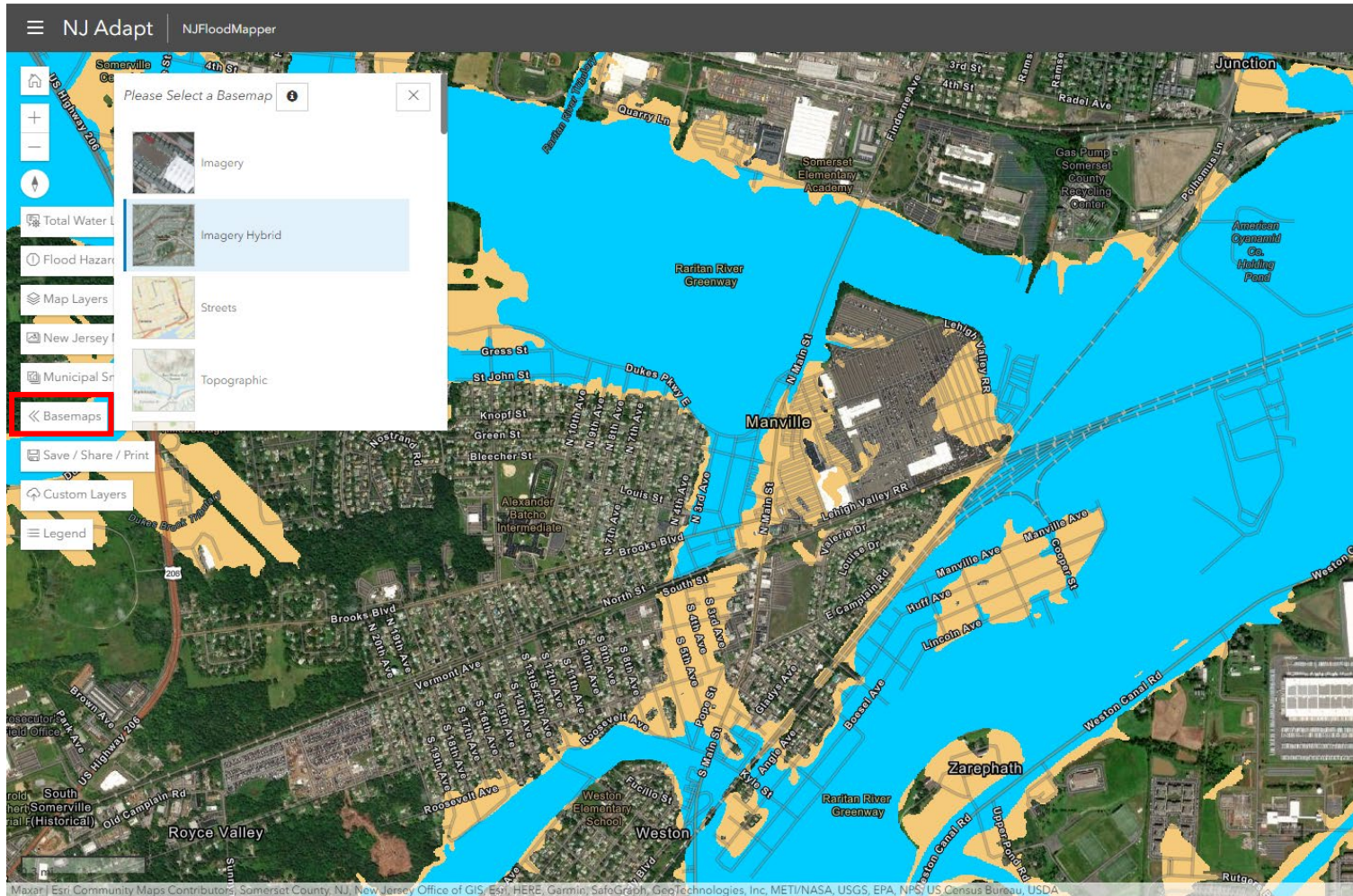


Step three: Click the Legend on the side panel to reveal the meaning of the data.



# Manville Example

<https://www.njfloodmapper.org/>



Additional feature: Adding a Basemap.

# Manville Example

<https://www.njfloodmapper.org/>

The screenshot displays the NJ Flood Mapper web application interface. The top navigation bar includes the NJ Adapt logo and the NJ Flood Mapper title. A sidebar on the left contains various map controls and layers, including 'Total Water Levels To', 'Flood Hazards', 'Map Layers', 'New Jersey MyCoast', 'Municipal Snapshots', 'Basemaps', 'Custom Layers', and 'Legend'. The main map area shows a coastal region with flood hazard overlays. A 'Save / Share / Print' dialog box is open, featuring three main buttons: 'Save / Share Current Map', 'Print Current Map', and 'Map Image'. The 'Save / Share Current Map' button is highlighted with a red box. Below these buttons is a 'Minimal View' button. The dialog also provides a 'Permalink' section with a text input field containing the URL `https://www.njfloodmapper.org/map/nTyQSmdveUZQTlc` and a note: 'Create a permanent link of your current map for sharing'. A 'Temporary Map Url' section below it shows a longer URL with map options and a note: 'Use this link if you're not ready to make your options a permanent link.' A red box highlights the 'Save / Share / Print' button in the sidebar.

Save / Share / Print

Save / Share

Save / Share Current Map Print Current Map Map Image

Minimal View

Permalink

`https://www.njfloodmapper.org/map/nTyQSmdveUZQTlc`

Create a permanent link of your current map for sharing

Temporary Map Url

`https://www.njfloodmapper.org/?options={"center":`  
`("lat":40.54708502979333,"lng":-74.57982030891735),"zoom":15,"b`

Use this link if you're not ready to make your options a permanent link.

Save / Share / Print

Sharing your data: Select the Save/Share/Print box. Selecting the first option creates a link you can share that will show your data selection/view.

# Manville Example

<https://www.njfloodmapper.org/>

printMap.php

1 / 2 - 67% +

NJ Floodmapper

Legends

**CAFE 100yr**

- NJ Climate Adjusted Flood Elevations (CAFE)
- FEMA 1% Annual Chance Flood Hazard + 3' ft
- FEMA 1% Annual Chance Flood Hazard
- Ocean/Bay/Major River Waters

If you select the “Print” option, it will download a view of the map with the data. It will also print the legend on a separate page. From there you can download as a PDF or send it to a printer.

# Part IV: Strategies for Adaptation and Mitigation

# IPCC Annual Report 6 Working Group II

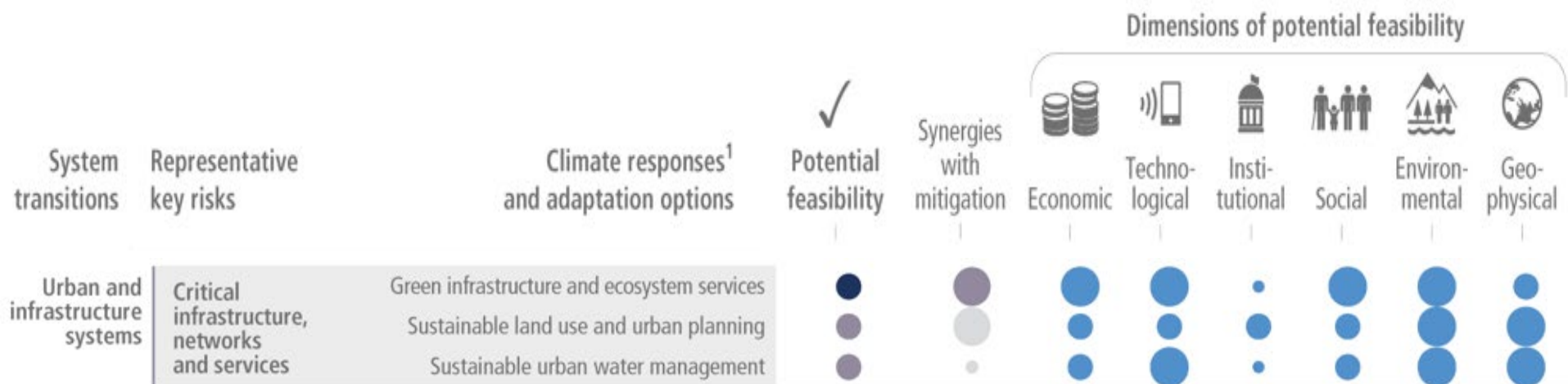
- **“Green Infrastructure” is mentioned 155 times in the report.**
- “As green infrastructure is increasingly being used for stormwater absorption in cities (McPhillips et al., 2020), rain gardens, wetlands, or engineered infiltration ponds and bioswales are the nature-based solutions most likely to promote recharge, reduce evapotranspiration, and contribute to water provisioning.” — 6.3.4.5 Riverine Flood Impact Reduction (Pg. 1137)
- “Urban green infrastructure including urban gardens, can bring benefits to social cohesion, mental health and wellbeing and reduce the health impacts of heatwaves by decreasing temperatures, thus reducing inequities in exposure to heat stress for low income, marginalized groups (Hoffman et al., 2020) — 7.4.6.6 Adopting Mitigation Policies and Technologies that have Significant Health Co-benefits (Pg. 1408)

# IPCC Annual Report 6 Working Group II

Diverse feasible climate responses and adaptation options exist to respond to Representative Key Risks of climate change, with varying synergies with mitigation

Multidimensional feasibility and synergies with mitigation of climate responses and adaptation options relevant in the near-term, at global scale and up to 1.5°C of global warming





### Feasibility level and synergies with mitigation

○ High

○ Medium

○ Low

/ Insufficient evidence

■ Dimensions of potential feasibility

### Confidence level in potential feasibility and in synergies with mitigation

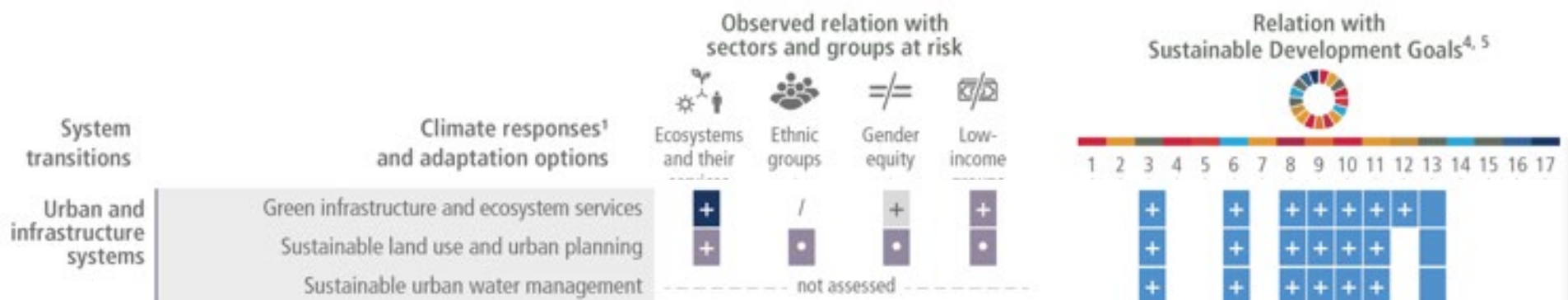
■ High

■ Medium

■ Low







### Types of relation

- + With benefits
- With dis-benefits
- Not clear or mixed
- / Insufficient evidence

### Confidence level

in type of relation with sectors and groups at risk

- High
- Medium
- Low

Related Sustainable Development Goals

- 1: No Poverty
- 2: Zero Hunger
- 3: Good Health and Well-being
- 4: Quality Education
- 5: Gender Equality
- 6: Clean Water and Sanitation
- 7: Affordable and Clean Energy
- 8: Decent Work and Economic Growth
- 9: Industry, Innovation and Infrastructure
- 10: Reducing Inequality
- 11: Sustainable Cities and Communities
- 12: Responsible Consumption and Production
- 13: Climate Action
- 14: Life Below Water
- 15: Life On Land
- 16: Peace, Justice, and Strong Institutions
- 17: Partnerships for the Goals

# IPCC Annual Report 6 Working Group III

Mitigation options have synergies with many Sustainable Development Goals, but some options can also have trade-offs. The synergies and trade-offs vary dependent on context and scale.



- Type of relations:
- Synergies
  - Trade-offs
  - Both synergies and trade-offs<sup>4</sup>
  - Blanks represent no assessment<sup>5</sup>
- Confidence level:
- High confidence
  - Medium confidence
  - Low confidence
- Related Sustainable Development Goals:
- 1 No poverty
  - 2 Zero hunger
  - 3 Good health and wellbeing
  - 4 Quality education
  - 5 Gender equality
  - 6 Clean water and sanitation
  - 7 Affordable and clean energy
  - 8 Decent work and economic growth
  - 9 Industry, innovation and infrastructure
  - 10 Reduced inequalities
  - 11 Sustainable cities and communities
  - 12 Responsible consumption and production
  - 13 Climate action
  - 14 Life below water
  - 15 Life on land
  - 16 Peace, justice and strong institutions
  - 17 Partnership for the goals

<sup>1</sup> Soil carbon management in cropland and grasslands, agroforestry, biochar

<sup>2</sup> Deforestation, loss and degradation of peatlands and coastal wetlands

<sup>3</sup> Timber, biomass, agri feedstock

<sup>4</sup> Lower of the two confidence levels has been reported

<sup>5</sup> Not assessed due to limited literature

## 2020 CLIMATE RESILIENCE SURVEY RESULTS

### Top Six Concerns regarding climate change effects as selected by participants:



1 Increasing precipitation/storms



3 Decreased water quality



5 Ocean acidification



2 Sea-level rise



4 Extreme temperatures



6 Decreased air quality

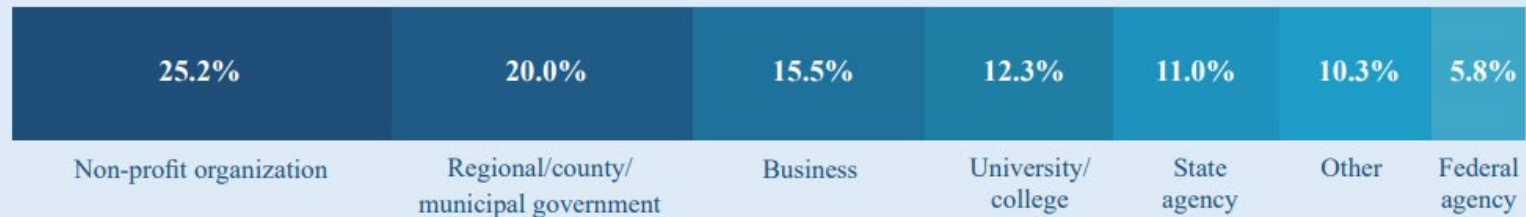
### Climate Resilience Actions favored by participants to be implemented by the state:

1. Incentivize green infrastructure/nature-based solutions
2. Preserve natural lands
3. Regulate at risk buildings/development
4. Support vulnerable populations
5. Pilot innovative solutions

### Coastal Resilience Strategies favored by participants to be implemented by the state:

1. Marsh restoration and migration
2. Living shorelines
3. Buyouts or managed retreat
4. Infrastructure projects
5. Beach and dune nourishment

### Types of Organizations that participated:



***STRATEGY 2.3:***  
**Deploy Natural and Nature-based Solutions**  
**for Resilience**

**ACTIONS**

**2.3.1** Create a homeowner assistance program to encourage use of nature-based shoreline stabilization statewide

**2.3.2** Prioritize investment in green infrastructure to augment water quality protection and stormwater management, particularly in underserved communities

**2.3.3** Deploy urban and community forestry solutions for heat mitigation, stormwater retention, beautification, and air quality benefits



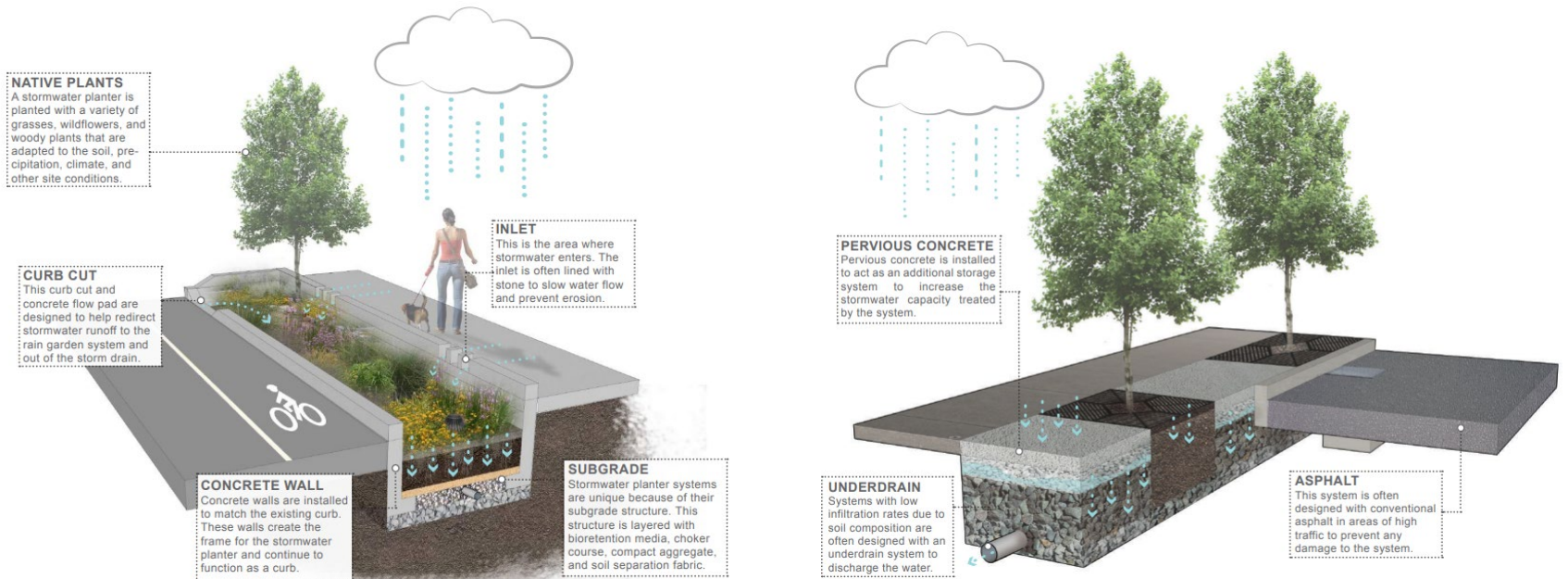
*Rain Garden*

Harnessing the power of nature through natural and nature-based solutions supports multiple resilience goals. Natural and nature-based solutions are resilience interventions that utilize natural ecological processes to reduce negative environmental impacts. Some common examples include trees

# New Jersey Global Warming Response Act 80x50 Report

Table 7.5 Carbon Sequestration Programmatic Recommendations

Actions	Entity	Timeframe	Reference
Update the Municipal Land Use Law to encourage and facilitate green infrastructure including green streets. Prioritization should be given to infrastructure that accommodates trees.	DCA	Near-term	



# New Jersey PACT

## Protecting Against Climate Threats



### Resilient Environments and Landscapes (REAL)

Modernizing environmental land use rules to respond to climate change by considering risks such as sea level rise and chronic flooding, and to facilitate climate resilience by supporting green infrastructure and renewable energy. To learn more about the Department's rulemaking efforts pursuant to the REAL initiative.



# Nature-Based Solutions

## Nature Improves Resilience to Climate Change

To learn more,  
visit [www.nwf.org/  
naturalsolutions](http://www.nwf.org/naturalsolutions)



- **CORAL REEFS** can reduce 97% of incoming wave energy, which helps reduce erosion and storm-surges.

- 1 acre of **WETLANDS** stores 1-1.5 million gallons of floodwater.

- Protecting undeveloped **FLOODPLAINS** would cost < \$160 billion, but prevent nearly \$400 billion in damages.

- Ecological **FOREST** management can protect drinking water supplies and mitigate wildfire risk.

- Over 1/2 of the nation's water supply comes from **FORESTS**.

- **URBAN AND COMMUNITY TREES** reduce over 7% of residential energy use. Urban trees and green spaces absorb stormwater and provide habitat for wildlife.



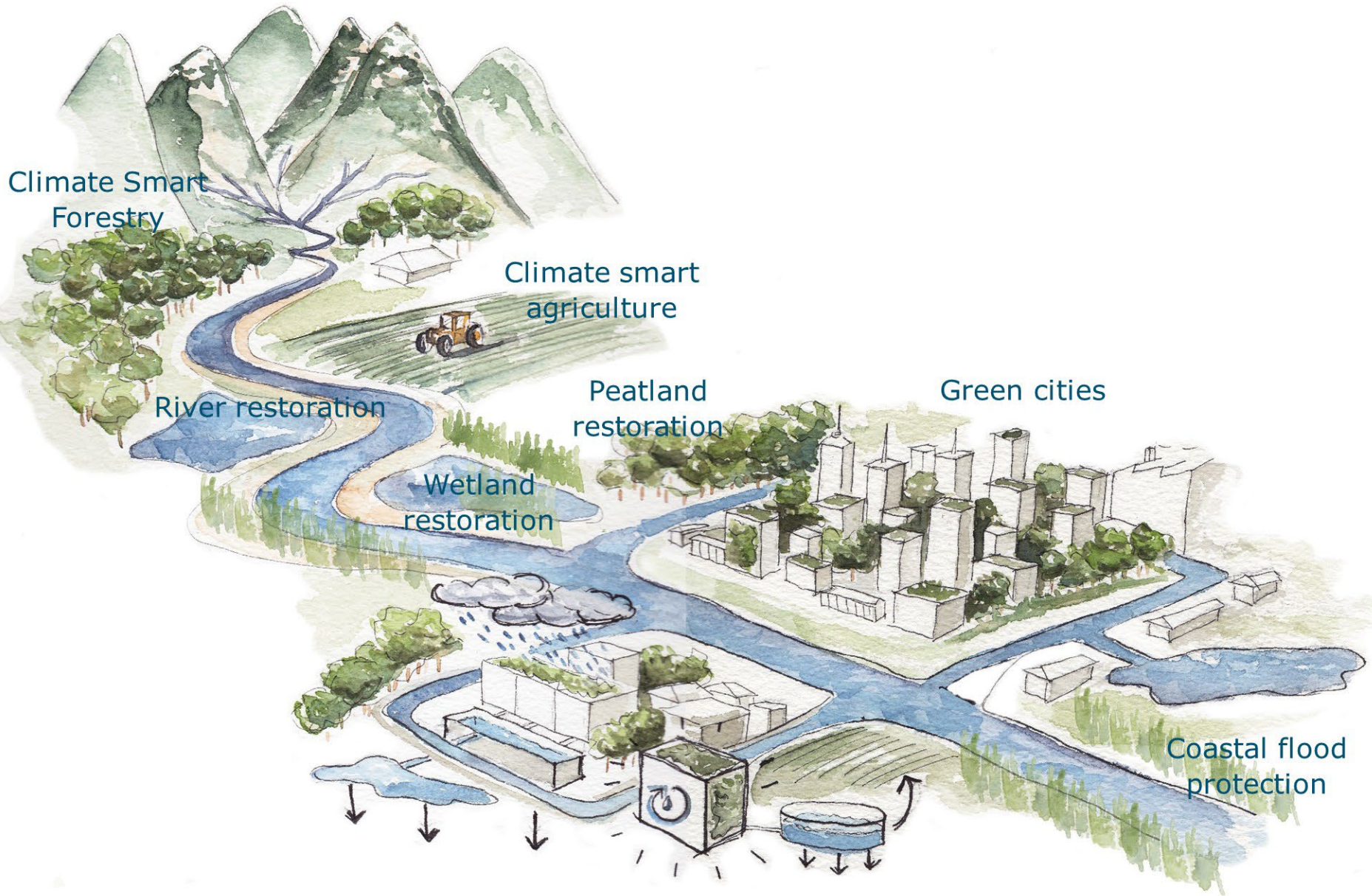
Coastal Ecosystems

Floodplains

Forests

Urban Forests

# Nature Based Climate Solutions





**RUTGERS**

New Jersey Agricultural  
Experiment Station



**So what did  
we learn?**

Climate change ...  
it's real, it's  
happening now,  
and it's affecting  
New Jersey.



# Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More frequent dry spells
- Rising sea level with increased frequency and intensity of coastal flooding





## What do we do now?

- Reduce carbon emissions
- Convert to alternative sustainable fuels (solar and wind)
- Pray
- Manage stormwater runoff more effectively using sustainable practices
- Work together – only through cooperative and collaborative partnership will we be successful

# Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More frequent dry spells
- Rising sea level with increased frequency and intensity of coastal flooding



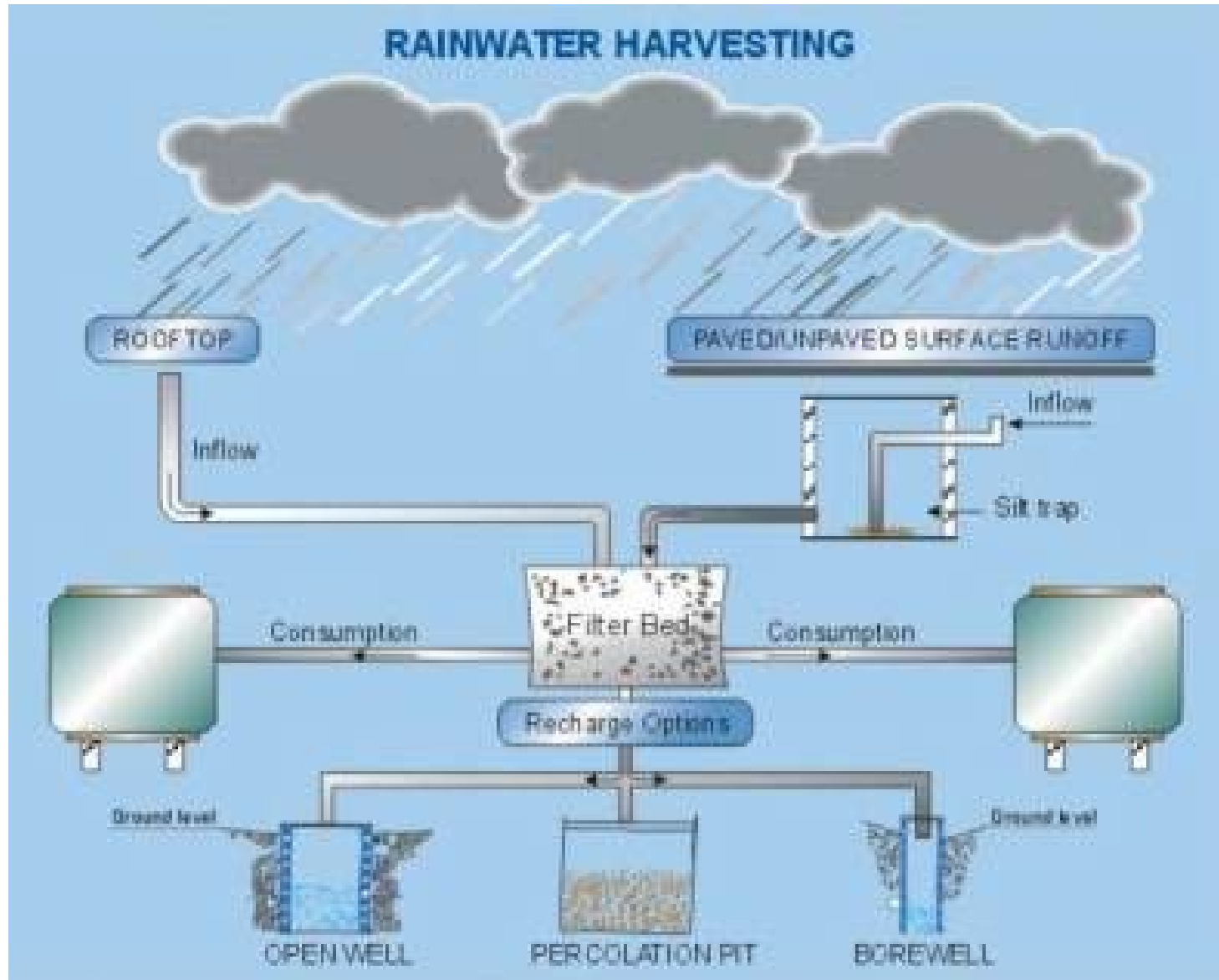


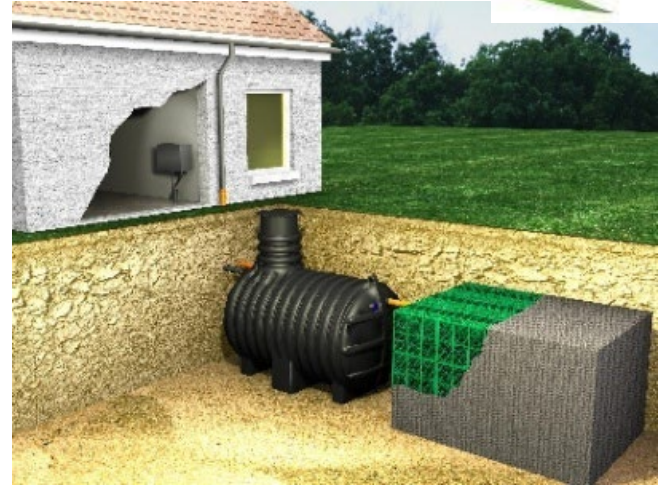
## **Rainwater Harvesting - Functions**

- Rainwater harvesting involves collecting, filtering, and storing water from roof tops and paved and unpaved areas for multiple uses.
- Harvested water can be used for nonpotable or potable purposes after testing and treatment.
- Surplus water after usage can be used for recharging groundwater.
- Systems can range in size from a simple PVC tank or cistern to a contractor designed and built tank/sump with water treatment facilities.



# Rainwater Harvesting – Components









## Sizing

- The rule of thumb is 600 gallons of water per inch of rain per thousand square feet of catchment area.
- Not all the rain that falls can actually be collected; efficiency is usually presumed to be 75% depending on system design and capacity.





## **Sizing Formula**

Here is the basic formula for calculating the potential amount that can be collected:

$$\textit{(Catchment area) x (inches of rain) x (600 gallons) x (.75)}$$

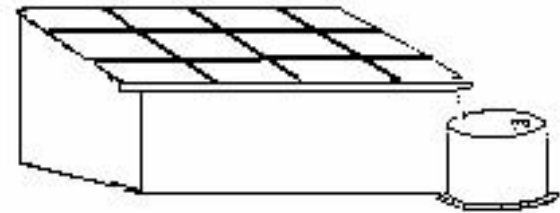
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***1,000 square feet***



## Design Example

The sample roof shown below has a catchment area that is 40 feet wide and 30 feet long. Hence, it has a 1,200 square feet roof (40 feet wide x 30 feet long). Assume that it rains 2 inches. We can now plug this information into our general formula (see equation above).



Catchment Area = 1,200 square feet

Amount of Rain = 2 inches

Gallons of water collected per inch of rain per 1,000 square feet = 600 gallons

Percent Efficiency = 75% or 0.75

*(1,200 square feet) x (2 inches of rain) x (600 gallons) x (.75)*

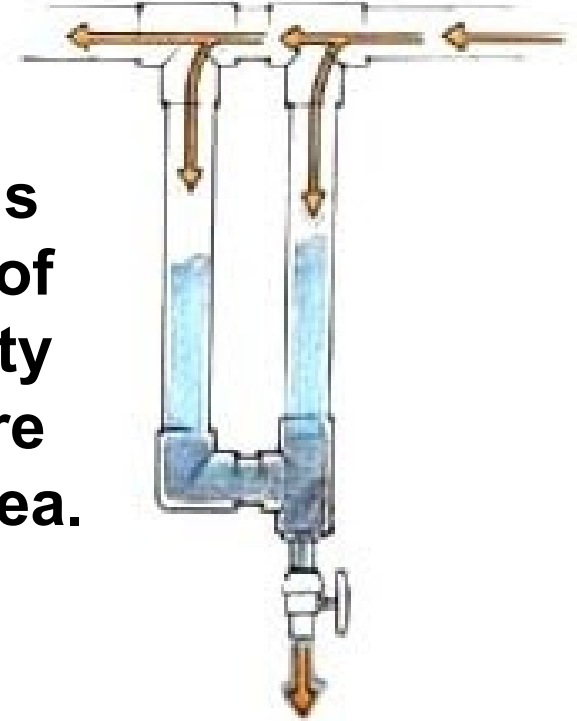
----- = 1,080 gallons

*1,000 square feet*

# First Flush Diverter or Roof Washer



**The rule of thumb is one to two gallons of roof washer capacity for every 100 square feet of catchment area.**



- **A one foot length of 6 inch diameter PVC pipe holds 1.5 gallons.**
- **A one foot length of 4 inch diameter PVC pipe holds 0.66 gallons.**



## Construction

- The most stable place to position the cistern is against a stable wall on level ground as close to the downspout as possible.
- Gravity moves water downhill. Be sure there is available space for a downward pitch in all pipes.
- The cistern on its platform is the highest point of the garden but the lowest point of the system.
- The overflow pipe should be directed toward a rain garden not toward pathways or structures.
- The overflow pipe should flow from the cistern's highest point.
- The spigot should be at the cistern's lowest point.

# Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More frequent dry spells
- Rising sea level with increased frequency and intensity of coastal flooding





**KNOWN:** The New Jersey Water Quality Design Storm is 1.25 inches of rain over two-hours and 90% of New Jersey rainfall events come in storms of less than 1.25 inches of rain.

**UNKNOWN:** If “heavy rains become more intense” due to climate change in New Jersey, how much will the New Jersey Water Quality Design Storm increase?







**The scientists just say  
it will be “more,” but  
how do we design for  
“more?”**



**What if we size our green infrastructure practices for the next higher design storm – the two-year storm (3.3 inches of rain over 24 hours)?**



<b>Parameters</b>	<b>Two-hour design storm</b>	<b>24-hour design storm</b>
Rainfall total	1.25 inches	3.3 inches
Drainage area	1,000 sq.ft.	1,000 sq.ft.
Infiltration during the storm	None	0.5 to 1.0 in/hr
Cost basis	Surface area	Surface area

# Climate Resilient Rain Garden

Drainage area = 1,000 sq.ft.

**200 sq.ft.**  
**0.0 in/hr**

WATER QUALITY STORM  
1.25" over 2-hr

\$2,000

**260 sq.ft.**  
**1.0 in/hr**

2-YR STORM  
3.3" over 24-hr

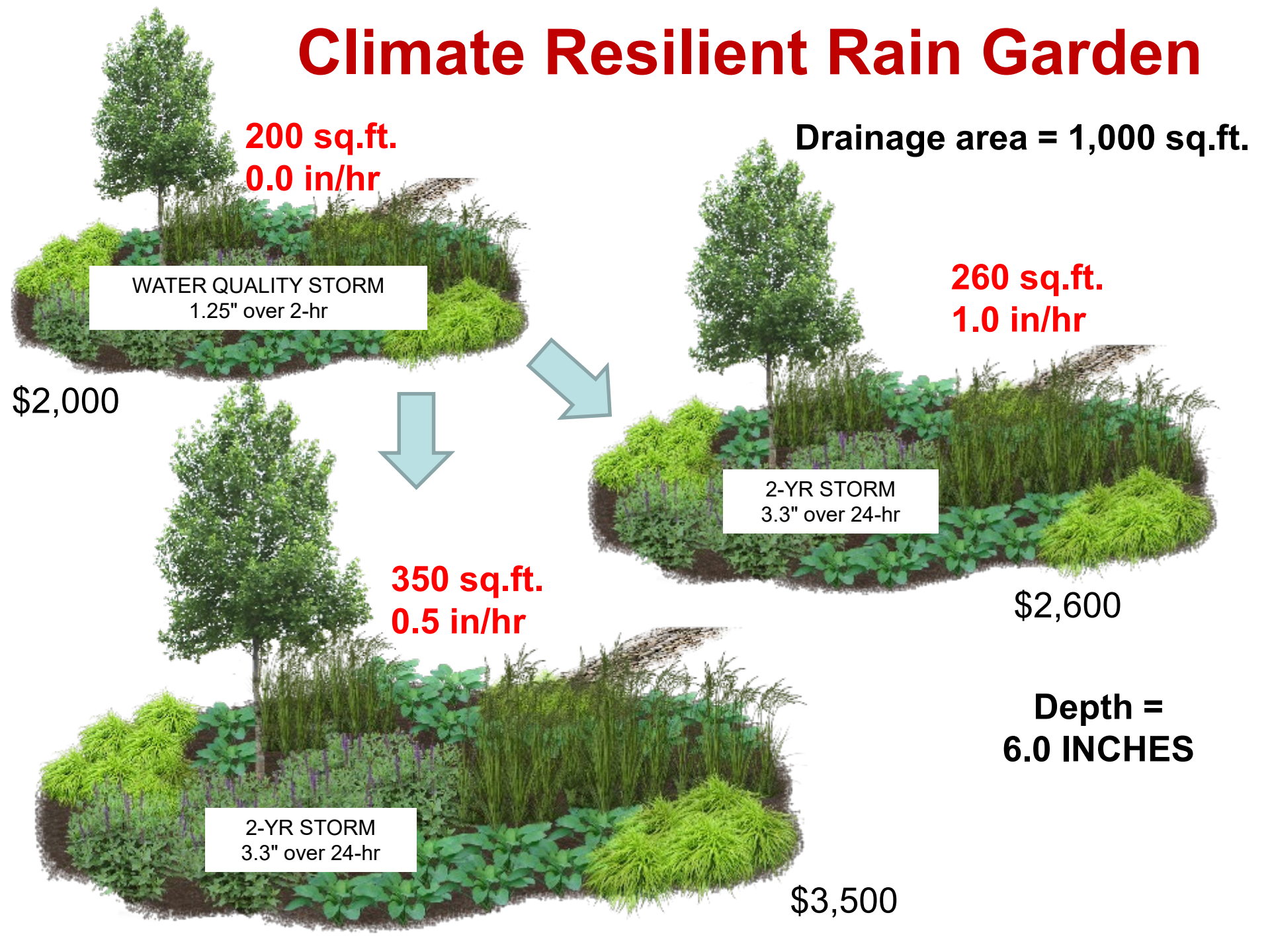
\$2,600

**350 sq.ft.**  
**0.5 in/hr**

2-YR STORM  
3.3" over 24-hr

\$3,500

Depth =  
**6.0 INCHES**



# Climate Resilient Rain Garden

**260 sq.ft.**  
**1.0 in/hr**

2-YR STORM  
3.3" over 24-hr

**Depth =**  
**6.0 INCHES**



**260 sq.ft.**  
**0.5 in/hr**

2-YR STORM  
3.3" over 24-hr

**Depth =**  
**9.0 INCHES**

**\$2,600**

# Results

Rain Garden Surface Area (sq. ft.)	Rain Garden Depth (in.)	Rain Garden Storage Volume (cu. ft.)	Rain Garden Capacity for 2-hr Rainfall (in.)	Cost (\$)
200	6	100	1.25	2,000
260	6	130	1.56	2,600
350	6	175	2.10	3,500
260	9	195	2.34	2,600



**What if we combined roadside  
rain gardens with street trees?**













Credit: Montgomery County, MD





**Can green infrastructure be used to control flooding from larger storms?**









**Bioretention is an option, but does it take up too much space?**



**Bioretention might be good for new construction  
but not for retrofitting existing development.**



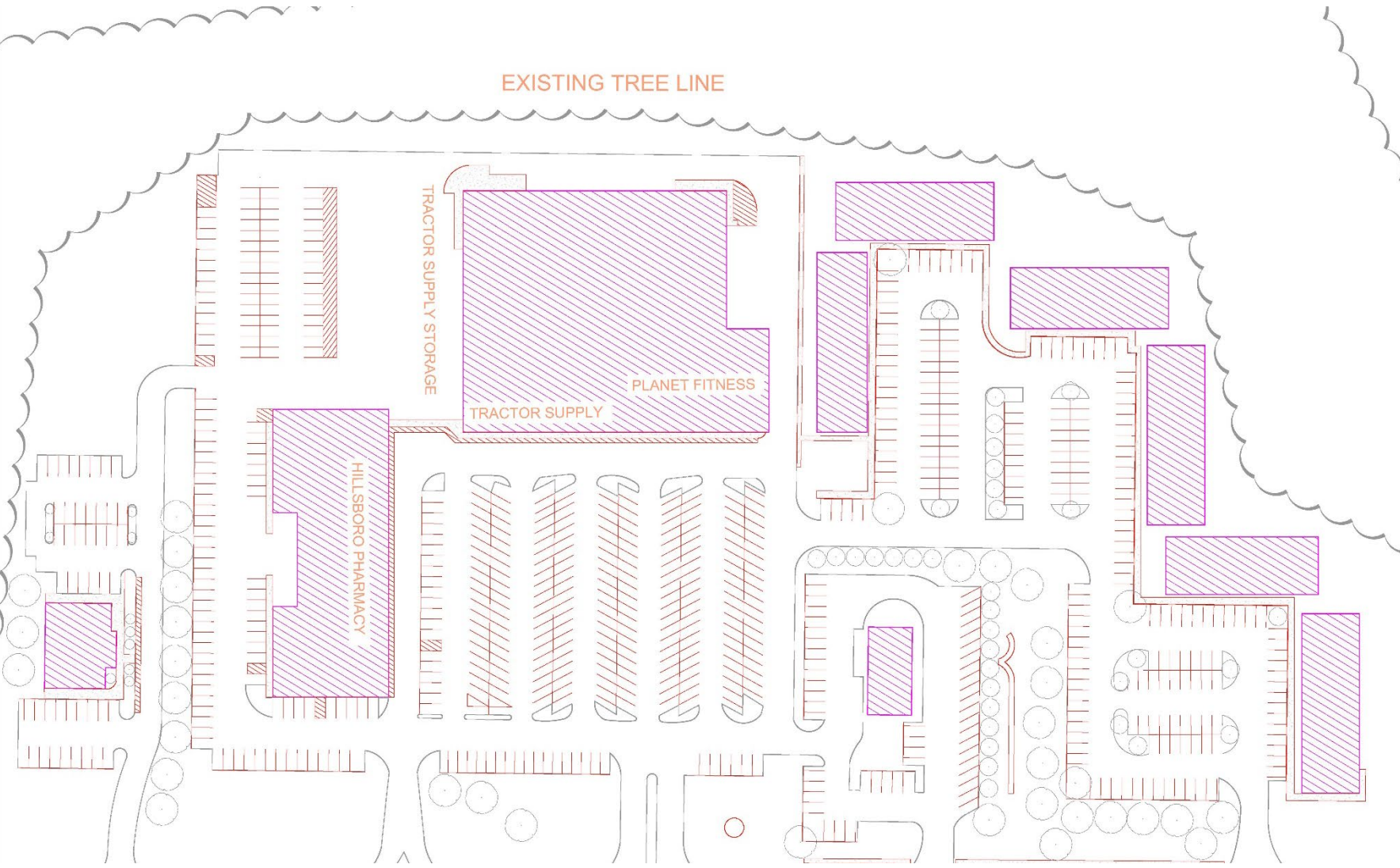
**We could increase the depth from 6 inches to 42 inches to handle the 100-year storm.**



**What if we couple  
green with gray  
infrastructure?**



**Hillsborough Plaza**  
**256 Route 206**  
**Hillsborough, New Jersey**



CHRISTOPHER C. OREFFO, P.L.L.C., P.E.  
 PROFESSIONAL ENGINEER - CIVIL/MECHANICAL/ELECTRICAL

PLAN NUMBER: \_\_\_\_\_  
 DATE: \_\_\_\_\_  
 PROJECT: \_\_\_\_\_  
 SHEET NO.: \_\_\_\_\_  
 OF \_\_\_\_\_

**HILLSBOROUGH PLAZA**  
**GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT**  
 256 US-126 HILLSBOROUGH CITY  
 SOMERSET COUNTY, NJ

**EXISTING CONDITIONS AND DEMOLITION PLAN**



**DRAFT**

# Water Quality Storm Analysis (1.25 inches)

11.6 acres

52,635 ft<sup>3</sup> or  
1.2 acre-ft

EXISTING TREE LINE

TRACTOR SUPPLY STORAGE

PLANET FITNESS

TRACTOR SUPPLY

HILLSBORO PHARMACY

ROUTE 206



EXISTING PLAN

CHRISTOPHER C. CROFFA, P.E.  
REGISTERED PROFESSIONAL ENGINEER  
STATE OF NEW JERSEY  
NO. 25000000  
DATE: 05/05/2020

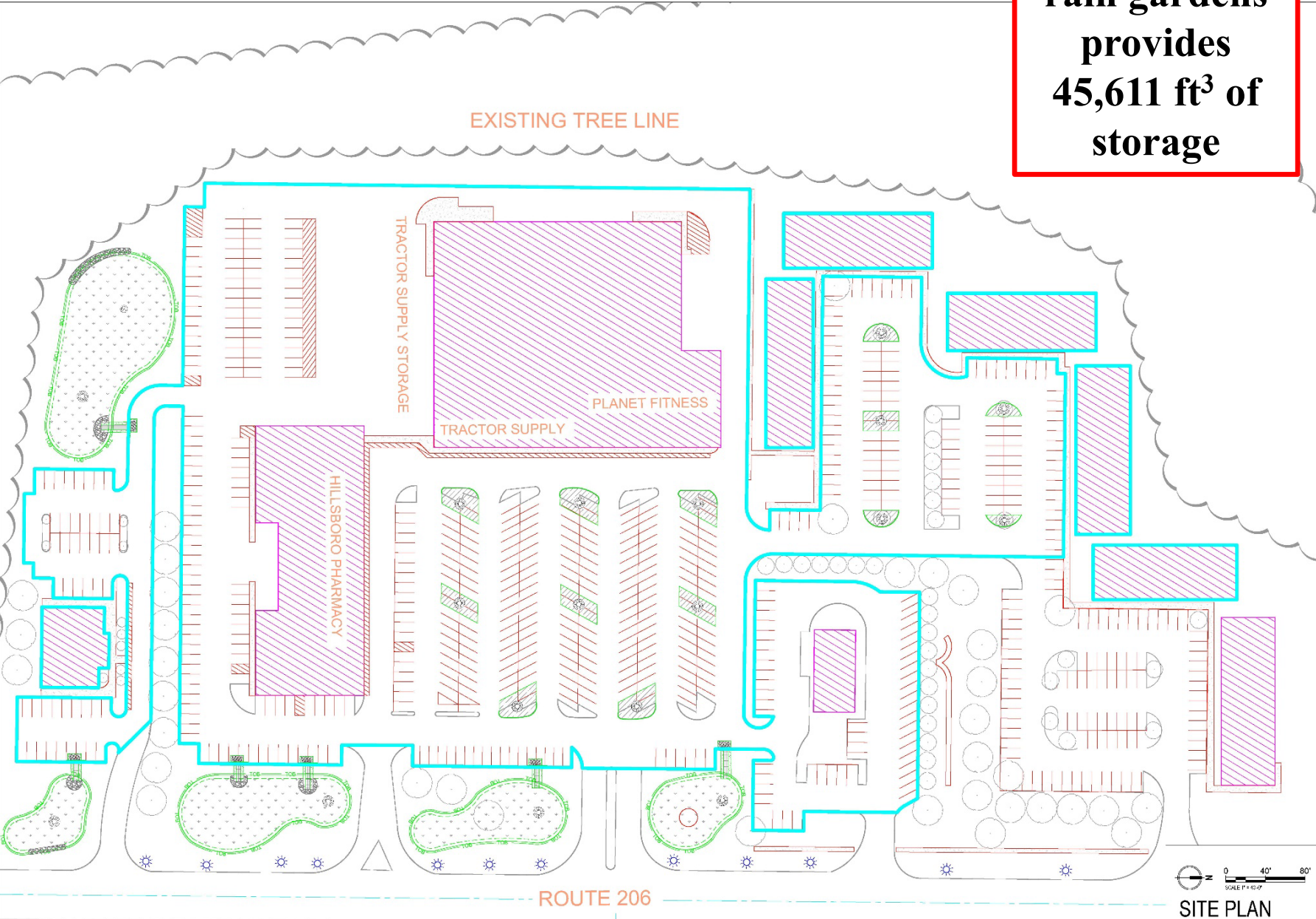
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SHEET NO. 01  
**DRAFT**

HILLSBOROUGH PLAZA  
GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
256 US-126, HILLSBOROUGH CITY  
SOMERSET COUNTY, NJ  
EXISTING CONDITIONS AND DEMOLITION PLAN



SHEET NAME  
P-1

**1.23 acres of  
rain gardens  
provides  
45,611 ft<sup>3</sup> of  
storage**



CHRISTOPHER C. OBROPTA, P.N.D., P.E.  
PROFESSIONAL ENGINEER - LANDSCAPE ARCHITECT

DATE: \_\_\_\_\_  
DRAWN BY: \_\_\_\_\_  
CHECKED BY: \_\_\_\_\_  
DATE: \_\_\_\_\_

**DRAFT**

HILLSBOROUGH PLAZA  
GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
256 US-126 HILLSBOROUGH CITY  
SOMERSET COUNTY, NJ  
PROPOSED SITE PLAN

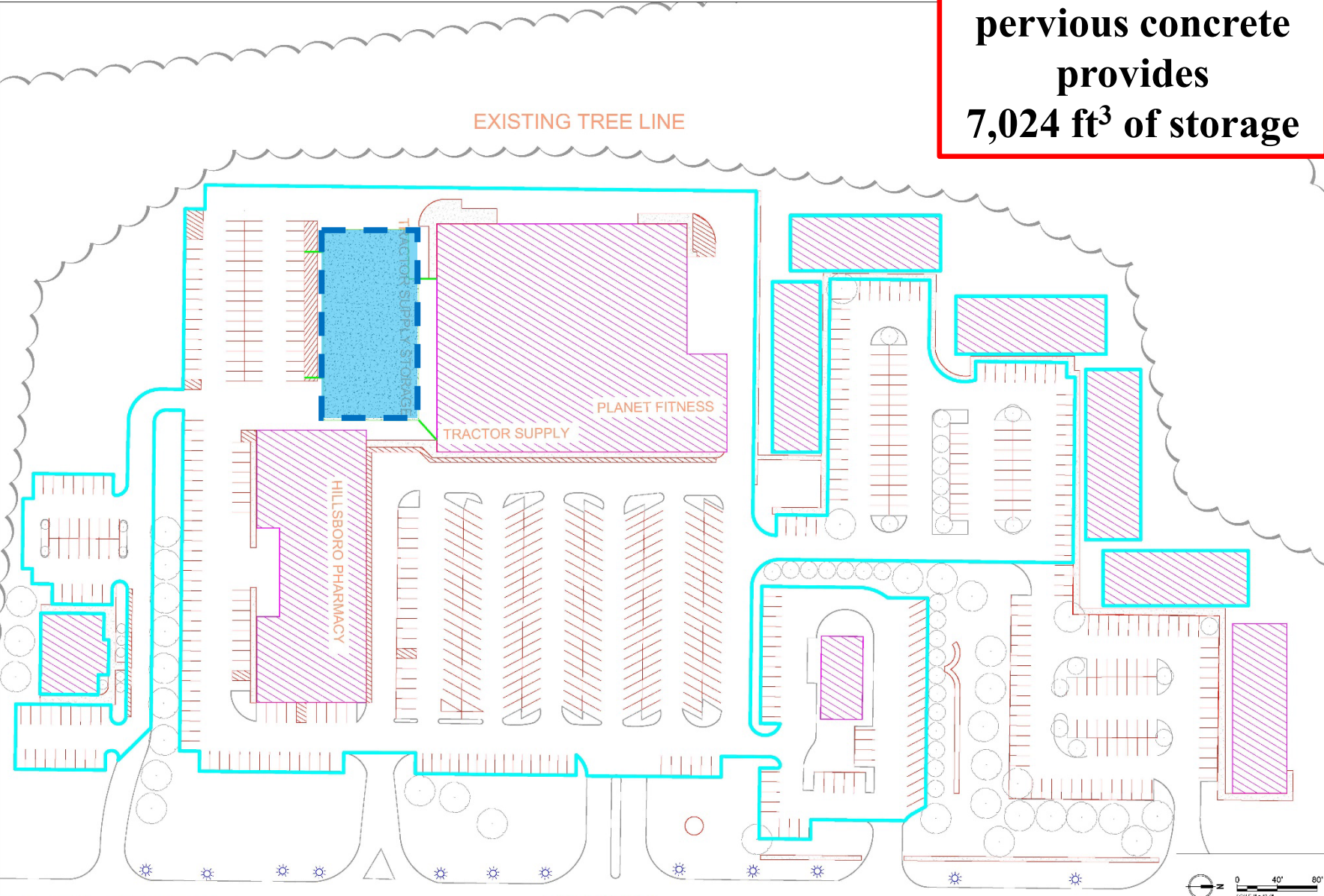


SHEET NAME  
P-2

SITE PLAN



**17,560 ft<sup>2</sup> of pervious concrete provides 7,024 ft<sup>3</sup> of storage**



**CHRISTOPHER C. OBROPTA, P.A.D., P.E.**  
 PROJECT: 2024030001 DATE: 03/20/24  
 DRAWN: JAS PREPARED: JAS CHECKED: NI  
 SCALE: 1/4" = 1'-0"

HILLSBOROUGH PLAZA  
 GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
 286 US-126, HILLSBOROUGH CITY  
 SOMERSET COUNTY, NJ  
 PROPOSED SITE PLAN

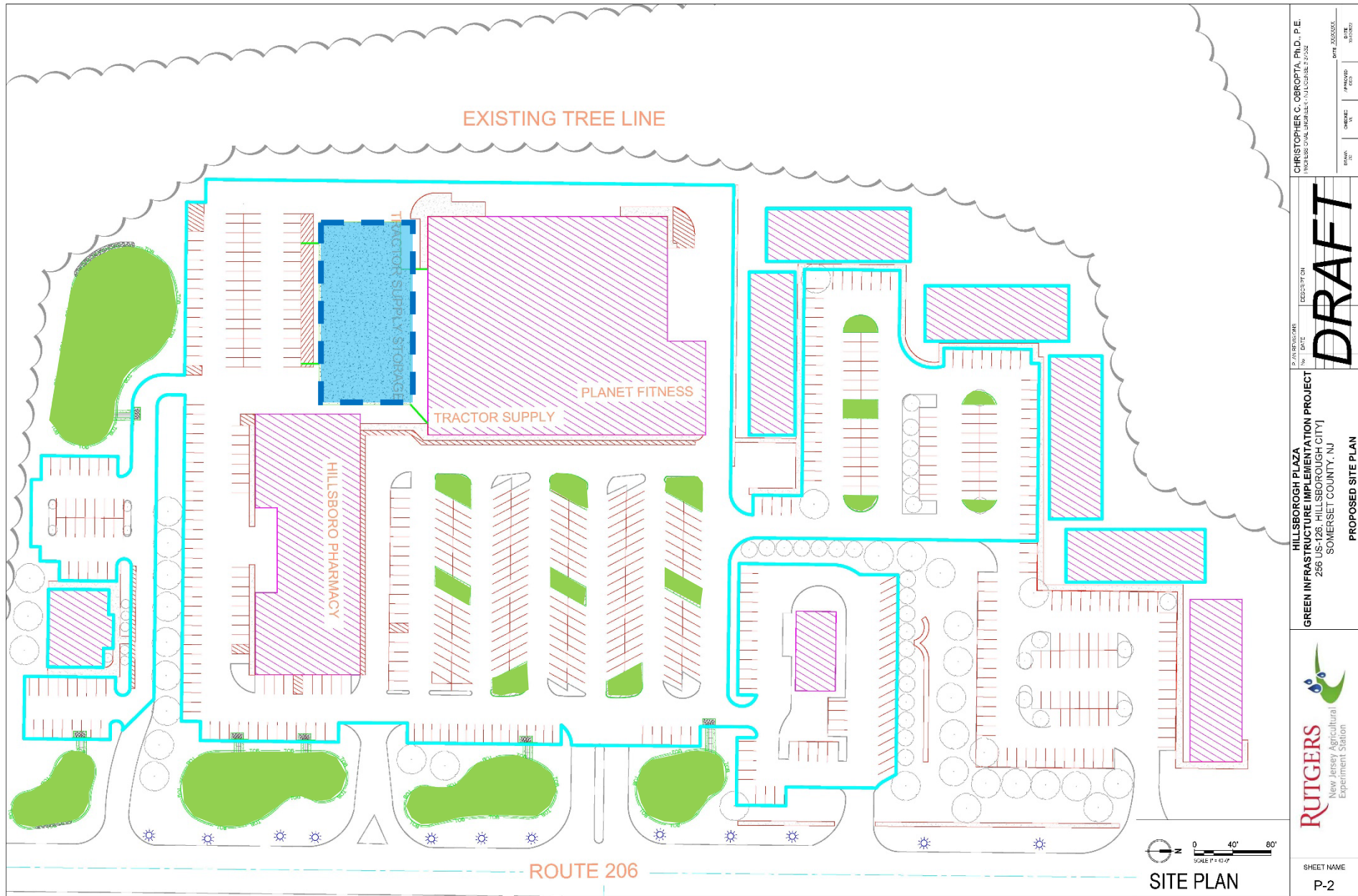
**DRAFT**

**RUTGERS**  
 New Jersey Agricultural  
 Experiment Station

SHEET NAME  
**P-2**

**SITE PLAN**

# All of the Green Infrastructure Practices



**CHRISTOPHER C. OBROPTA, PH.D., P.E.**  
 PROFESSIONAL ENGINEER, CIVIL ENGINEER, LEED AP  
 PROJECT NO. 20240006  
 SHEET NO. P-2

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HILLSBOROUGH PLAZA  
 GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
 256 US-126 HILLSBOROUGH CITY  
 SOMERSET COUNTY, NJ  
 PROPOSED SITE PLAN

---

PLAN REVISIONS  
 NO. DATE  
**DRAFT**

---

**RUTGERS**  
 New Jersey Agricultural  
 Experiment Station

---

SHEET NAME  
**P-2**

# 100-Year Storm Analysis 8.25 inches

11.6 acres

294,756 ft<sup>3</sup> or  
6.8 acre-feet

EXISTING TREE LINE

TRACTOR SUPPLY STORAGE

PLANET FITNESS

TRACTOR SUPPLY

HILLSBORO PHARMACY

ROUTE 206



EXISTING PLAN

PROFESSOR OF CIVIL ENGINEERING, P.E.  
INDEPENDENT CONSULTANT SINCE 2006

DATE: 08/20/2024  
PROJECT: HILLSBORO PLAZA  
SHEET: 01

HILLSBORO PLAZA  
GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
266 US-126 HILLSBOROUGH CITY  
SOMERSET COUNTY, NJ



SHEET NAME  
P-1

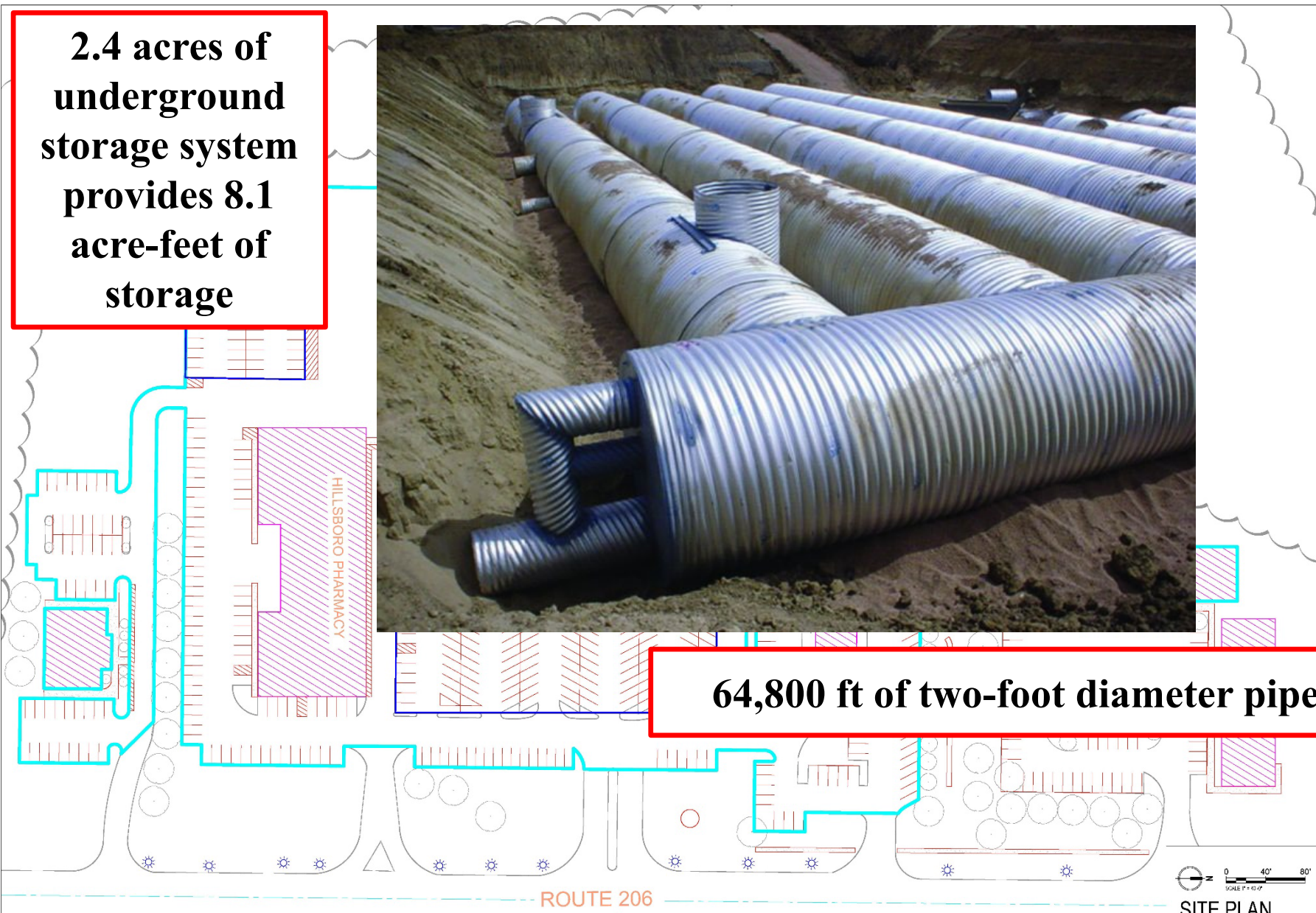
DRAFT

EXISTING CONDITIONS AND DEMOLITION PLAN

**2.4 acres of underground storage system provides 8.1 acre-feet of storage**



**64,800 ft of two-foot diameter pipe**



CHRISTOPHER C. OBROPTA, P.H.D., P.E.  
REGISTERED PROFESSIONAL ENGINEER - CIVIL ENGINEERING - LICENSE NO. 17-0202

HILLSBOROUGH PLAZA  
GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
256 US-126, HILLSBOROUGH CITY,  
SOMERSET COUNTY, NJ

PROPOSED SITE PLAN

**DRAFT**

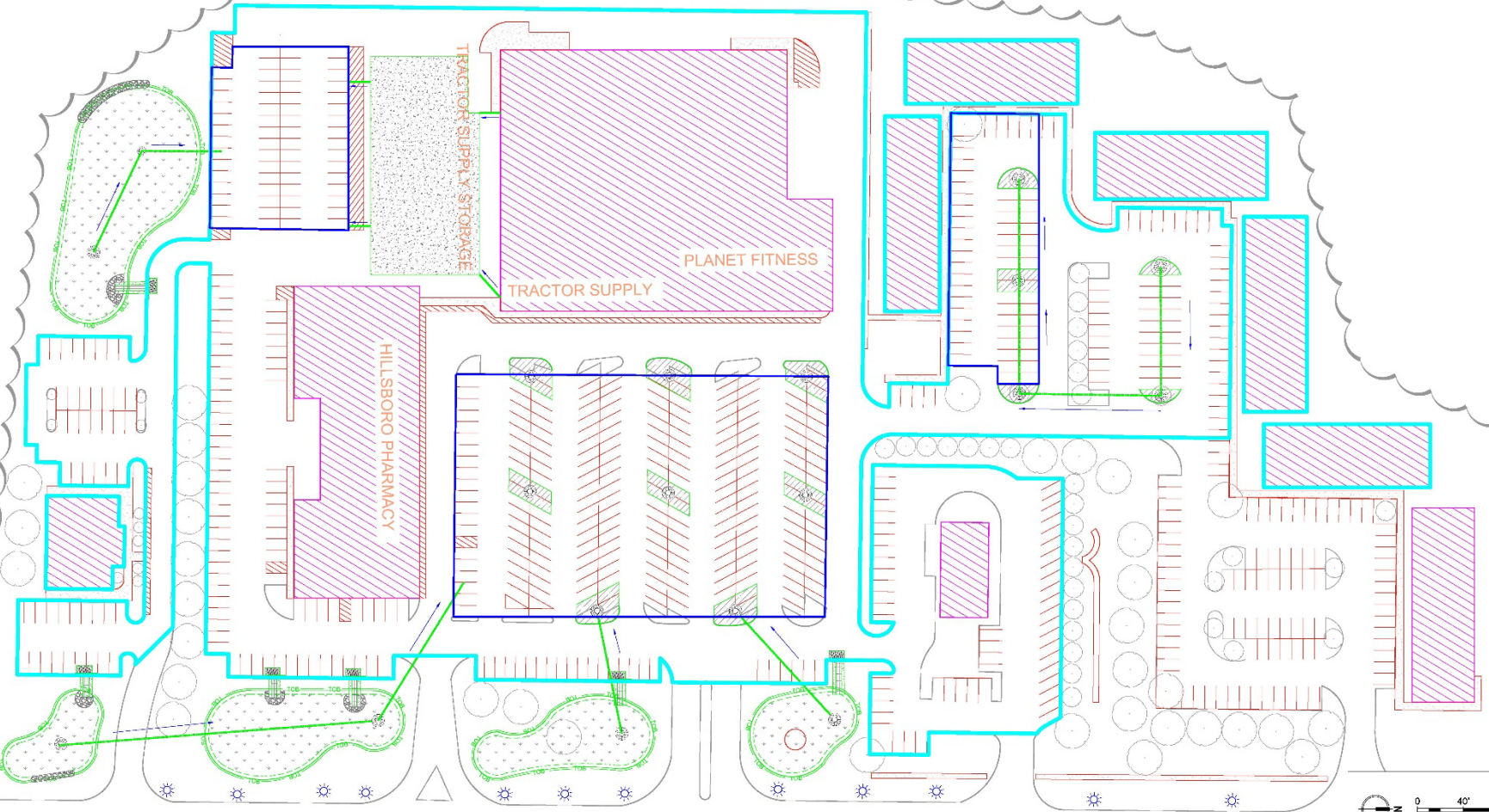
DATE: 08/11/2020  
DRAWN BY: J. B. BROWN  
CHECKED BY: J. B. BROWN  
PROJECT NO.: 17-0202

RUTGERS  
New Jersey Agricultural  
Experiment Station

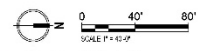
SHEET NAME: P-2

# Green and Gray Infrastructure Practices

EXISTING TREE LINE



ROUTE 206



SITE PLAN

CHRISTOPHER C. OBROTA, P.D., P.E.  
 PROFESSIONAL ENGINEER  
 1000 EASTERN AVENUE, SUITE 200  
 HILLSBOROUGH, NJ 08064  
 PHONE: 908.833.1111  
 FAX: 908.833.1112  
 WWW: CCOBROTA.COM

HILLSBOROUGH PLAZA  
 GREEN INFRASTRUCTURE IMPLEMENTATION PROJECT  
 266 US-126 HILLSBOROUGH CITY  
 SOMERSET COUNTY, NJ  
 PROPOSED SITE PLAN

REVISIONS  
 NO. DATE  
 DESCRIPTION



SHEET NAME  
 P-2

**DRAFT**

## Remaining Questions

1. Is it possible to route all the stormwater runoff for the 1.25-inch storm to the green infrastructure practices?
2. Is it possible to bypass the larger storms to the underground storage system?
3. How long do we hold the larger storms before we can safely release the stormwater?
4. If we over-design the system, can we get stormwater flows from nearby areas to this location for storage?
5. How many developed areas must get this treatment to reduce flooding downstream?
6. What is the cost?

# Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More frequent dry spells
- Rising sea level with increased frequency and intensity of coastal flooding



# **NEW JERSEY BACK BAYS COASTAL STORM RISK MANAGEMENT INTERIM FEASIBILITY STUDY AND ENVIRONMENTAL SCOPING DOCUMENT**

**1 March 2019**



**U.S. Army Corps  
of Engineers  
Philadelphia District**



**NJDEP**

## **Examples of Measures Under Consideration**

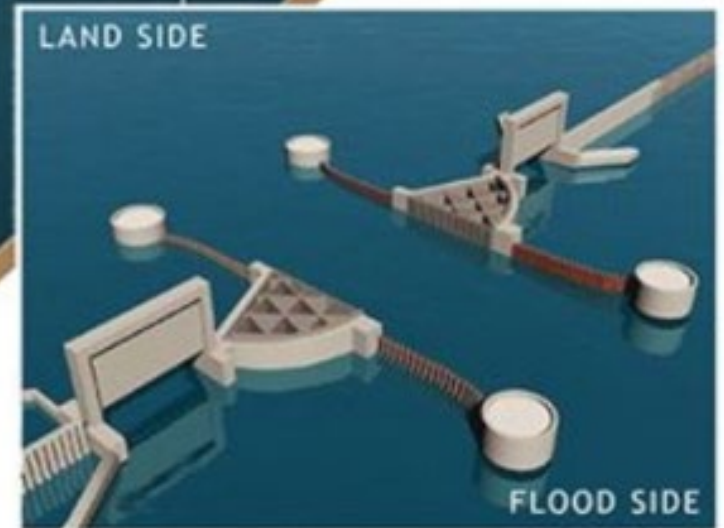
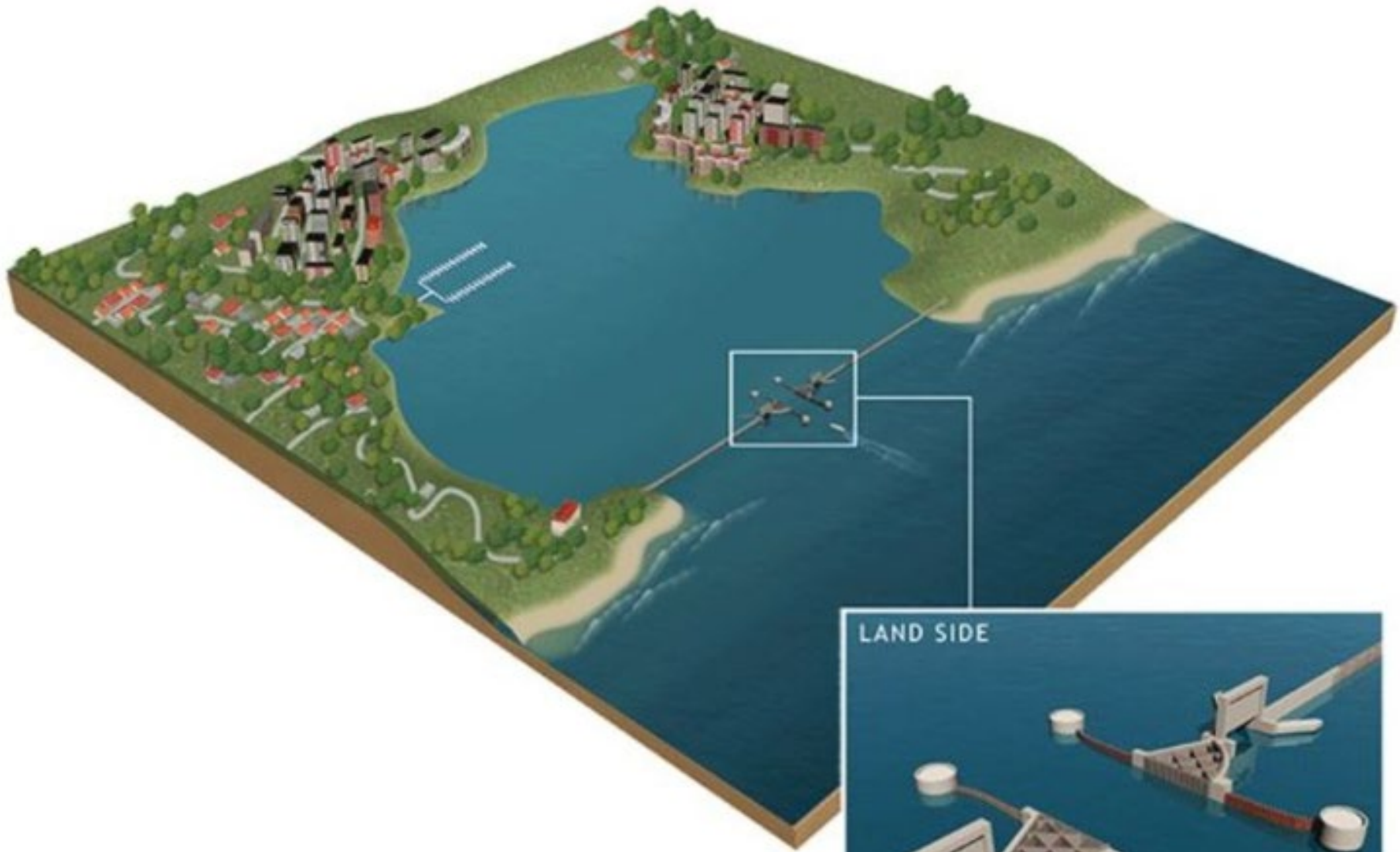


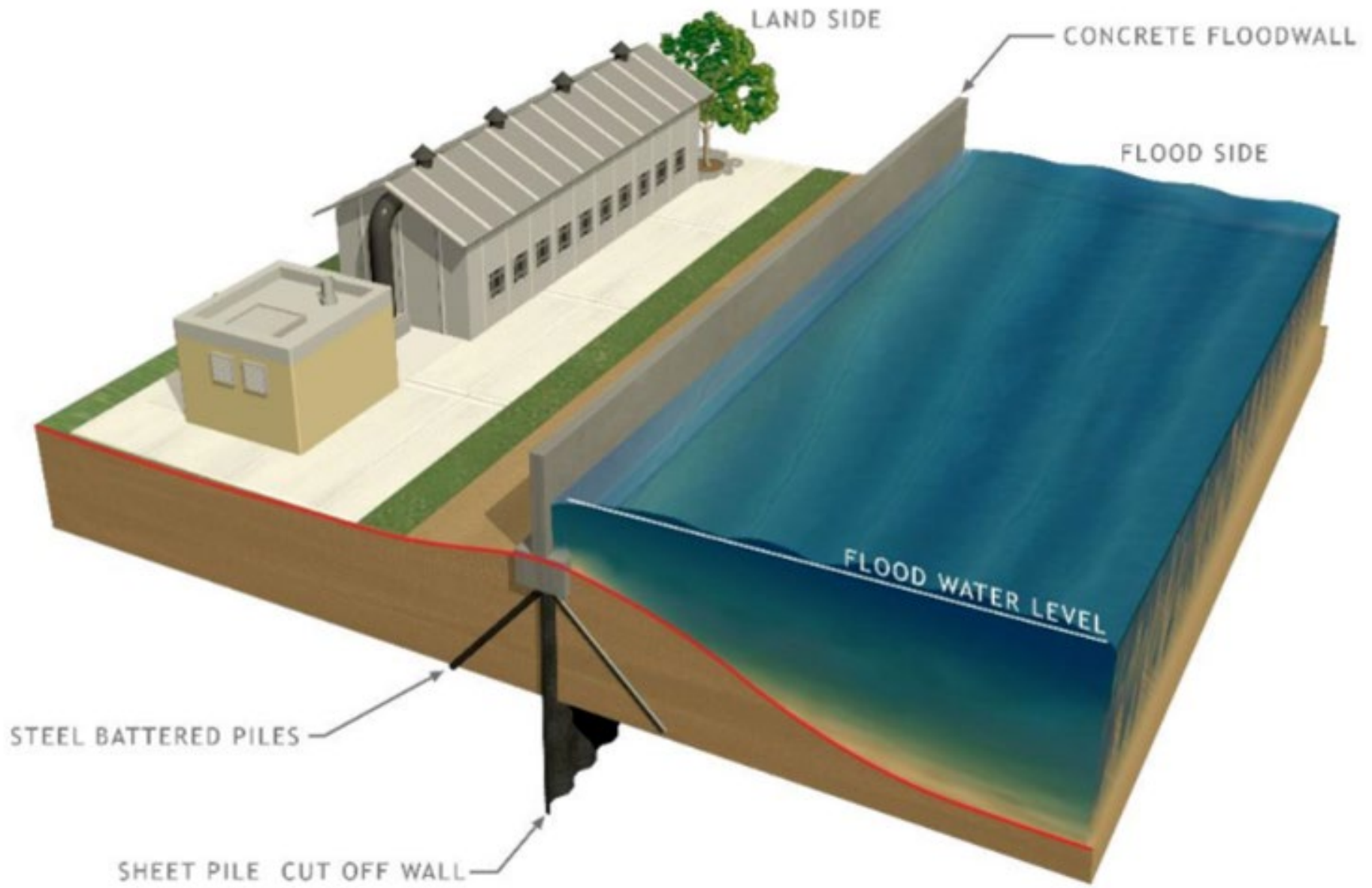
# Structural Measures

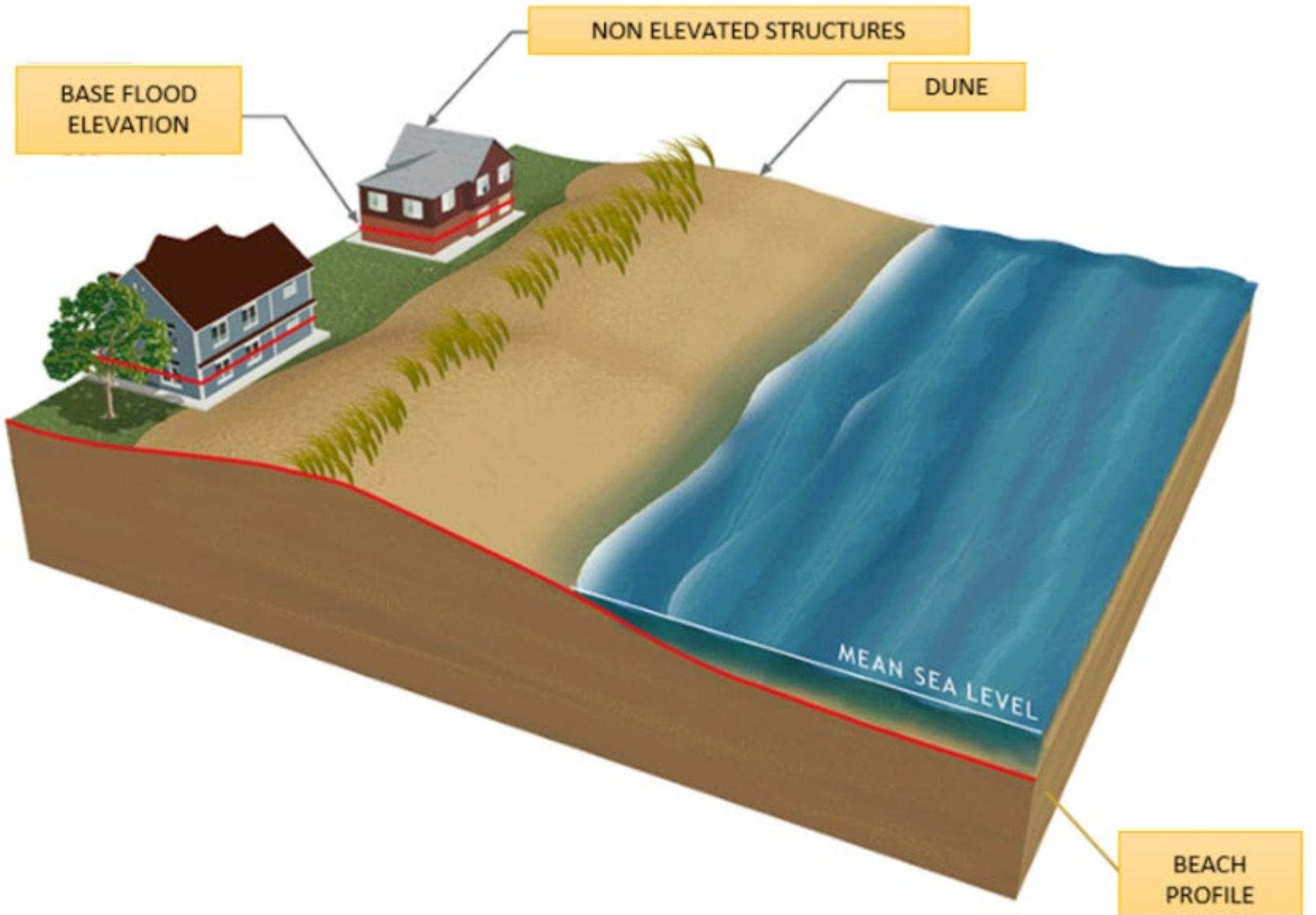
- Inlet Storm Surge Barriers
- Interior Bay Closures
- Raised Roads and Rails
- Levees
- Floodwalls (Permanent)
- Deployable Floodwalls
- Crown Walls
- Beach Restoration/Groins/Breakwaters
- Bulkheads
- Seawalls
- Revetments
- Stormwater System Drainage Improvements

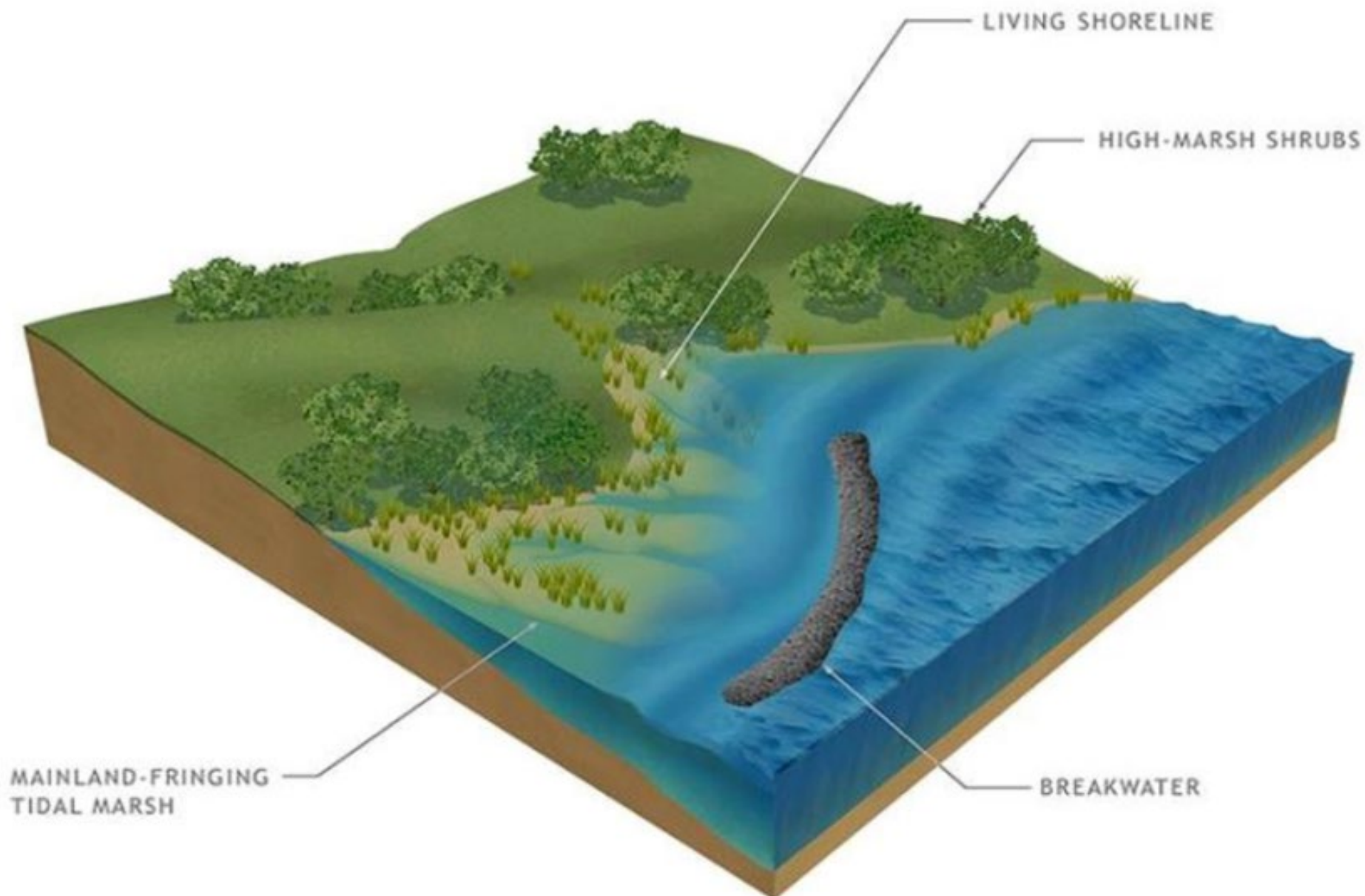
# Natural and Nature-Based Features

- Living Shorelines
- Reefs
- Wetland Restoration
- Submerged Aquatic Vegetation (SAV) Restoration
- **Green Stormwater Management**









LIVING SHORELINE

HIGH-MARSH SHRUBS

MAINLAND-FRINGING  
TIDAL MARSH

BREAKWATER









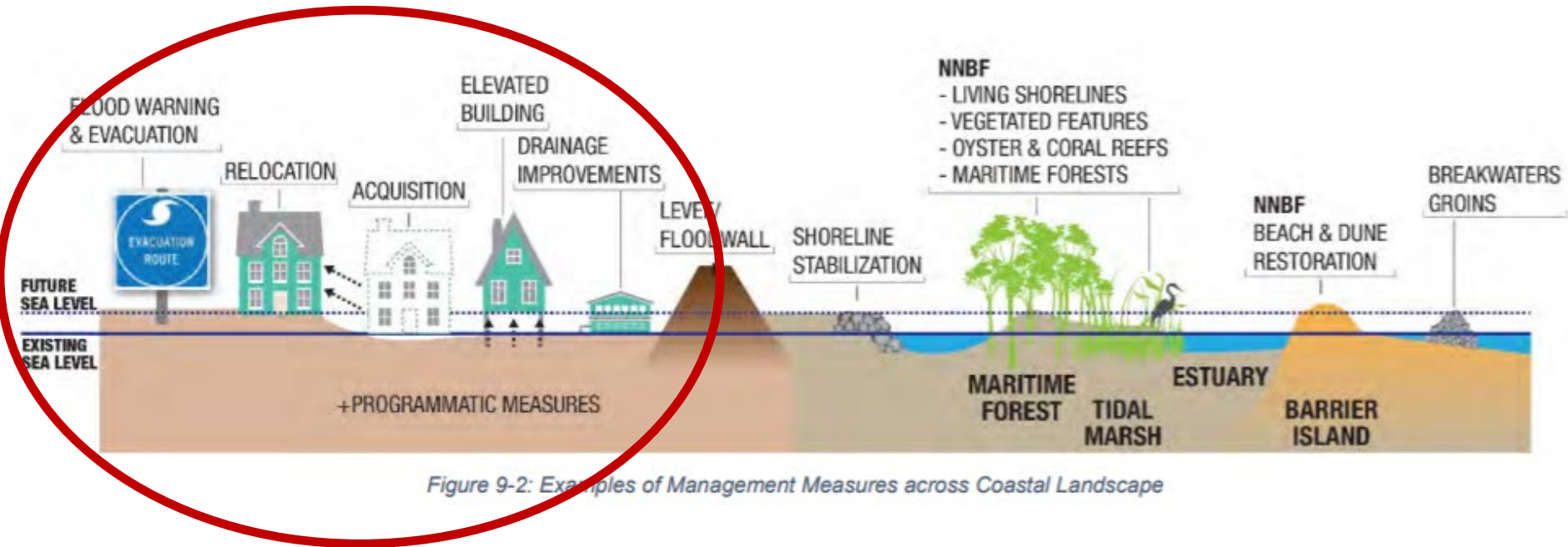
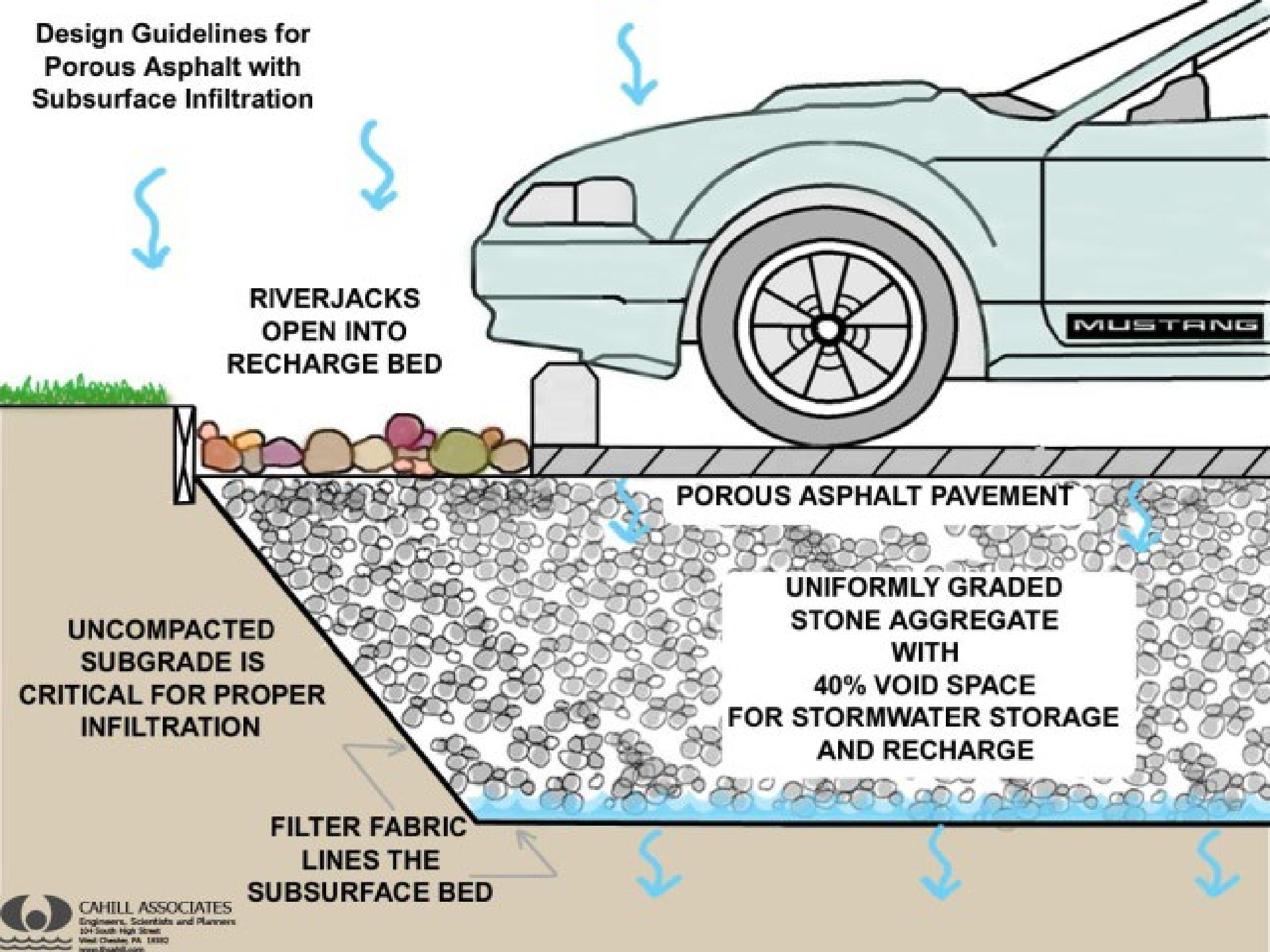


Figure 9-2: Examples of Management Measures across Coastal Landscape

# Design Guidelines for Porous Asphalt with Subsurface Infiltration



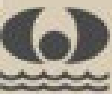
**RIVERJACKS  
OPEN INTO  
RECHARGE BED**

**POROUS ASPHALT PAVEMENT**

**UNIFORMLY GRADED  
STONE AGGREGATE  
WITH  
40% VOID SPACE  
FOR STORMWATER STORAGE  
AND RECHARGE**

**UNCOMPACTED  
SUBGRADE IS  
CRITICAL FOR PROPER  
INFILTRATION**

**FILTER FABRIC  
LINES THE  
SUBSURFACE BED**



# Together we can do it!



# Thanks, Cody!



# WE ARE DONE! Congratulations!

Christopher C. Obropta, Ph.D., P.E.  
Extension Specialist in Water Resources

Rutgers Cooperative Extension

[obropta@envsci.rutgers.edu](mailto:obropta@envsci.rutgers.edu)

[www.water.rutgers.edu](http://www.water.rutgers.edu)