# CLIMATE CHANGE PROJECTIONS FOR WASHINGTON, DC

KATE JOHNSON

DEPARTMENT OF ENERGY & ENVIRONMENT

# Agenda

1. Climate Adaptation Planning Background
2. Is the Climate Changing?
3. Planning for the Future
4. Planning Scenarios & Next Steps

Part One

# CLIMATE ADAPTATION PLANNING BACKGROUND

# Citywide Climate Adaptation Plan

DEPARTMENT OF ENERGY & ENVIRONMENT

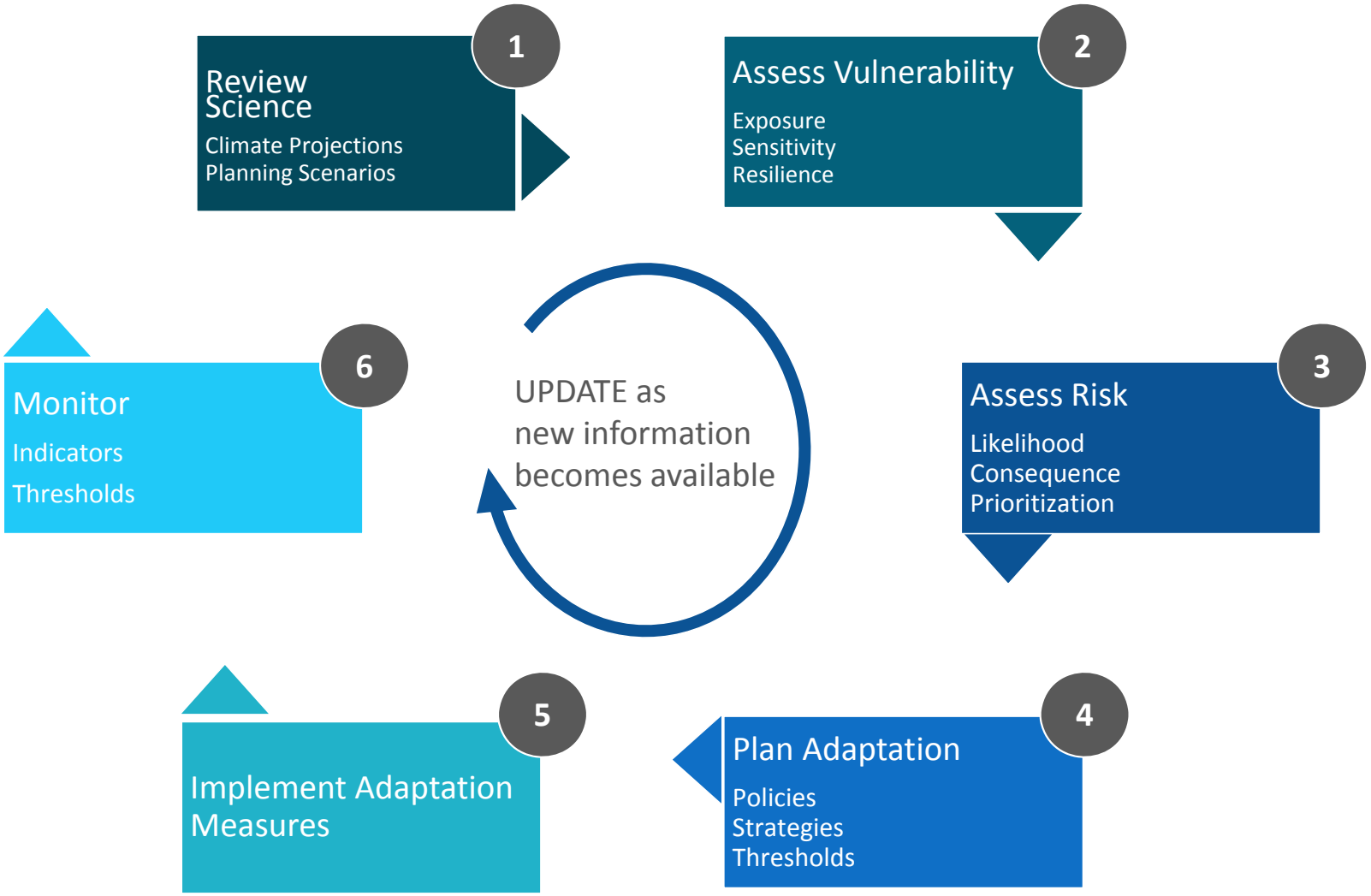
## Three-part Analysis to:

1. **Analyze Climate Impacts:** extreme weather, heat waves, sea level rise, flooding

2. **Assess Risks & Vulnerabilities:** public buildings, energy, transportation, water, health facilities

3. **Identify & Prioritize Solutions:** policy changes & projects

# Climate Adaptation Planning Framework




Adapted from City of San Francisco, *Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco*

# Project Team

In 2014, DDOE awarded a grant to develop the plan and provide technical expertise to:

AREA Research

Perkins+Will

Kleinfelder

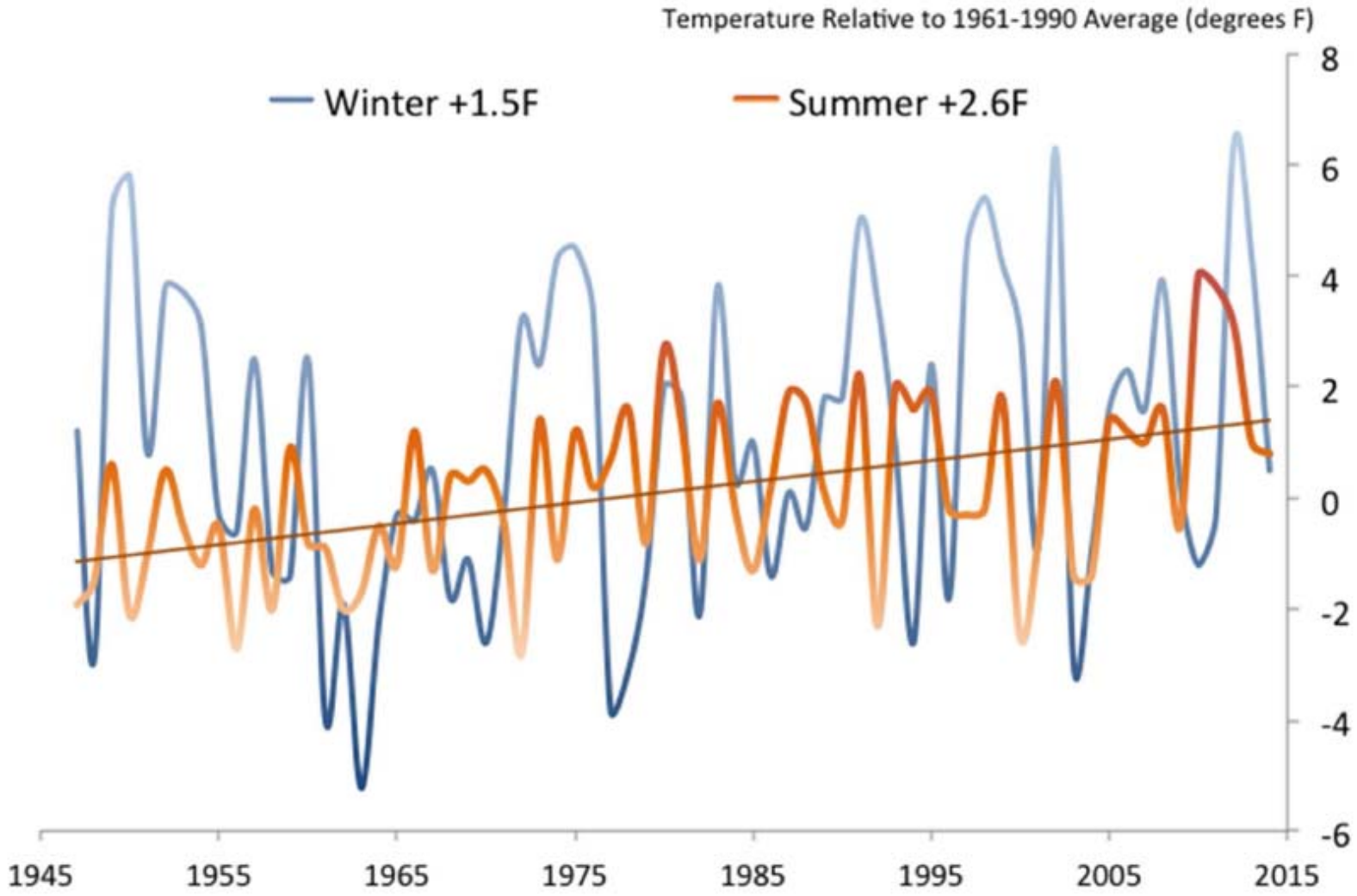
ATMOS Research

Part Two

# IS THE CLIMATE CHANGING?

DEPARTMENT OF ENERGY & ENVIRONMENT

# DC is Warming

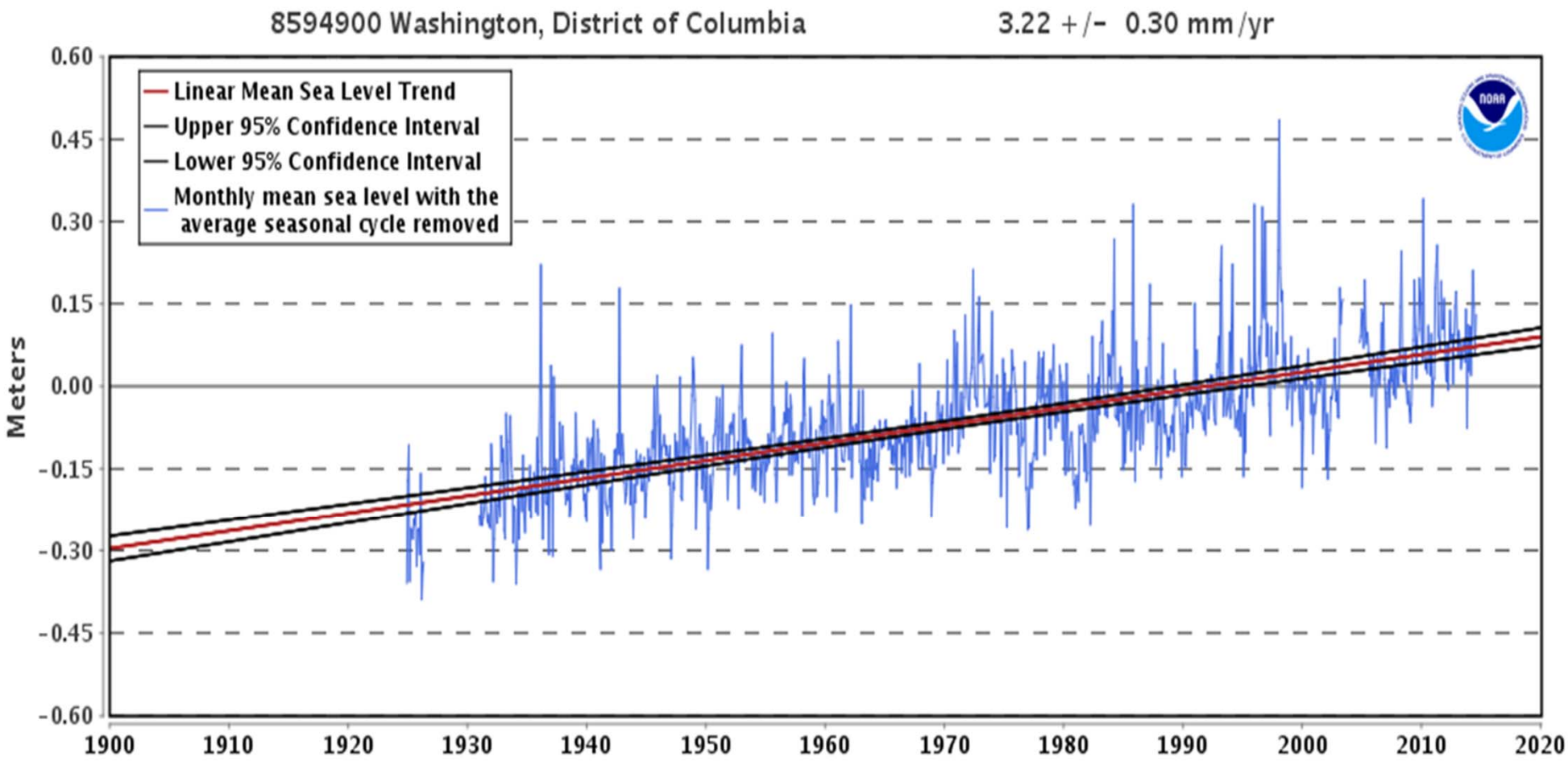



National Airport

## Both DC winters and summers are getting warmer

DEPARTMENT OF ENERGY & ENVIRONMENT

# Local Sea Level is Rising




Source: NOAA gauge 8594900 in Washington Channel

**Local sea level has risen 11” since 1924.**

# Flooding is More Frequent

As a result of sea level rise, **“nuisance flooding”** days have increased by **373%** since the 1950s.

Source: NOAA

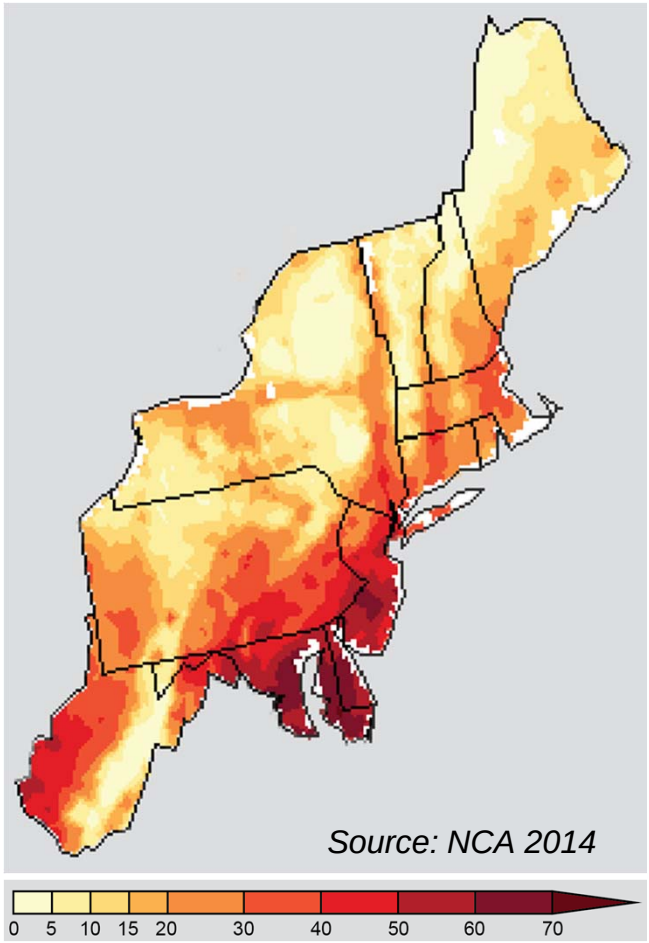
Part Three

# PLANNING FOR THE FUTURE

# How Will Climate Change Affect DC?

DEPARTMENT OF ENERGY & ENVIRONMENT

## Temperature



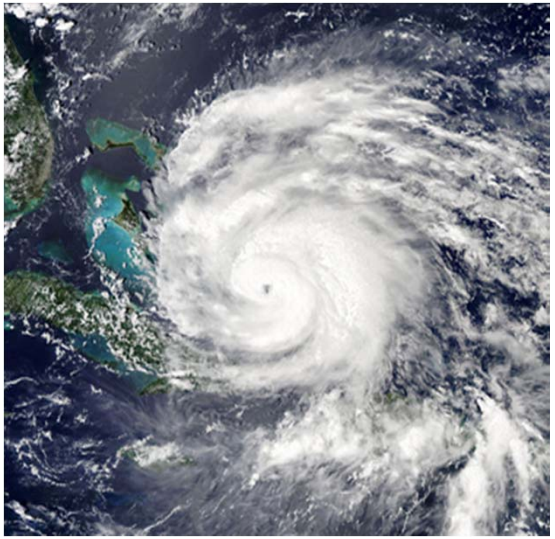

Number of days > 90°F

## Precipitation

## Sea Level Rise

## Extreme Weather

## Storm Surge



**Timescales: 2020s, 2050s, 2080s**

# Key Findings

***Temperature:*** Temperatures are expected to increase in future years. This temperature increase will impact both the annual average temperature and summer temperatures, resulting in more dangerously hot days and longer and more frequent heat waves.

***Precipitation:*** The frequency and intensity of extreme precipitation events are expected to increase in future years.

***Sea Level Rise*****:** Local sea level has risen 11" since 1924 and is projected to increase by an additional 0.2 ft. by 2020, 1.4 ft. by 2050 and by 3.4 ft. by 2080. Rising sea levels will exacerbate coastal flooding caused by storm surge.

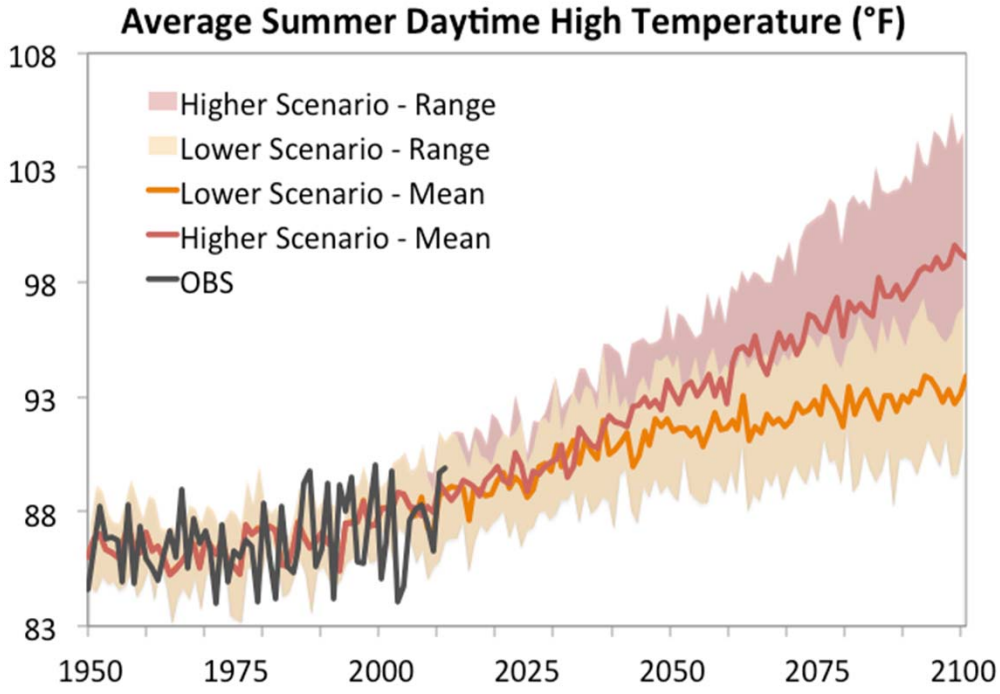
# Temperature

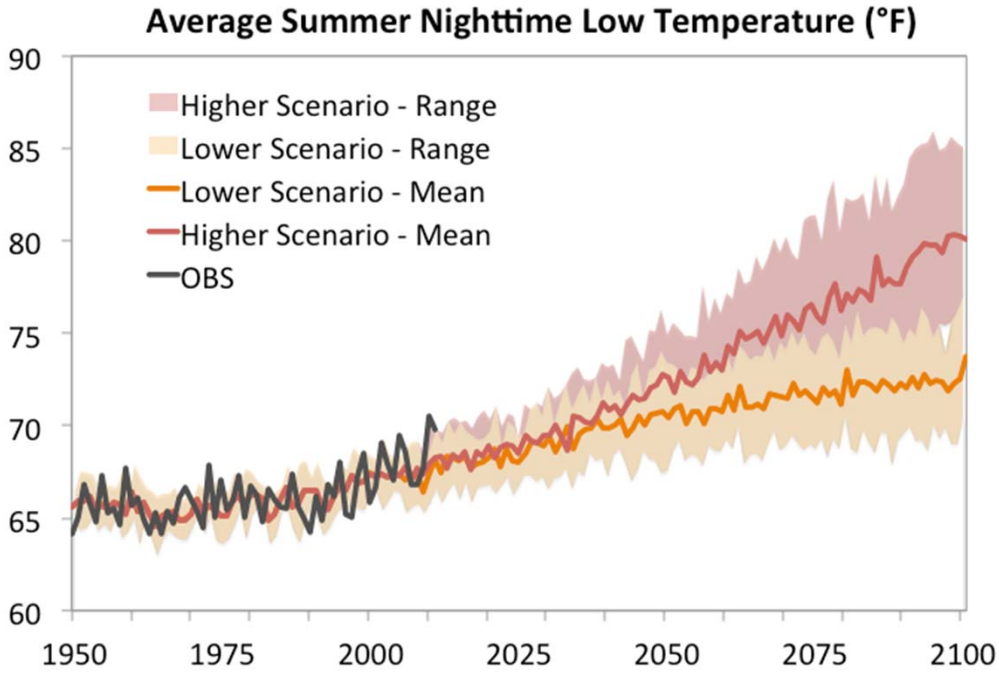
Average and seasonal temperatures in the District are expected to increase.

Charts show historical and projected summer daytime high and nighttime low temperatures under higher (red) and lower (orange) emissions scenarios.

Lower nighttime temperatures help provide relief from hot days. As minimum nighttime temperatures increase, there is higher likelihood of heat-related illnesses.

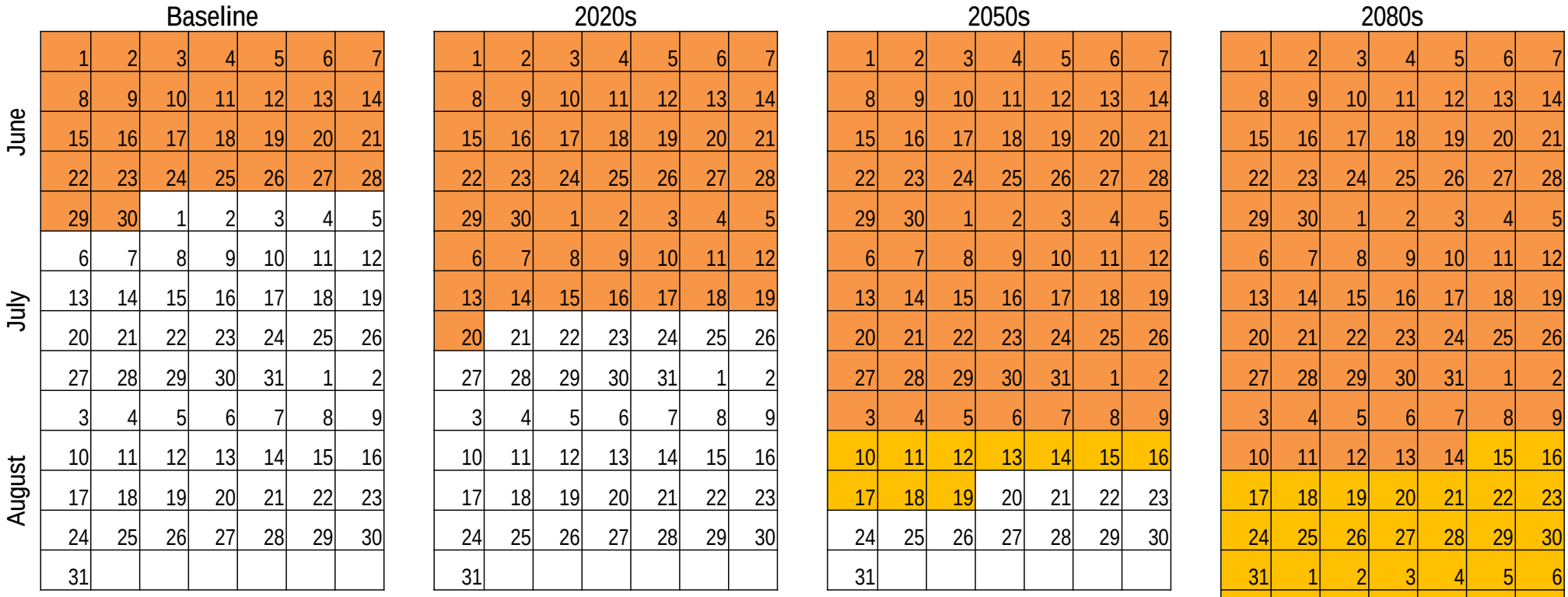
Under the high scenario (red), average high and low temps are projected to increase by **10°** by the 2080s.



# Extreme Heat Events
# Days over 95°F Heat Index

DEPARTMENT OF ENERGY & ENVIRONMENT




| Baseline | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

| 2020s | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

| 2050s | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

| 2080s | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |

| 30 | 50 | 70-80 | 75-105 |
|---|---|---|---|
| days | days | days | days |

Days above 95°F Heat Index (low emission scenario)

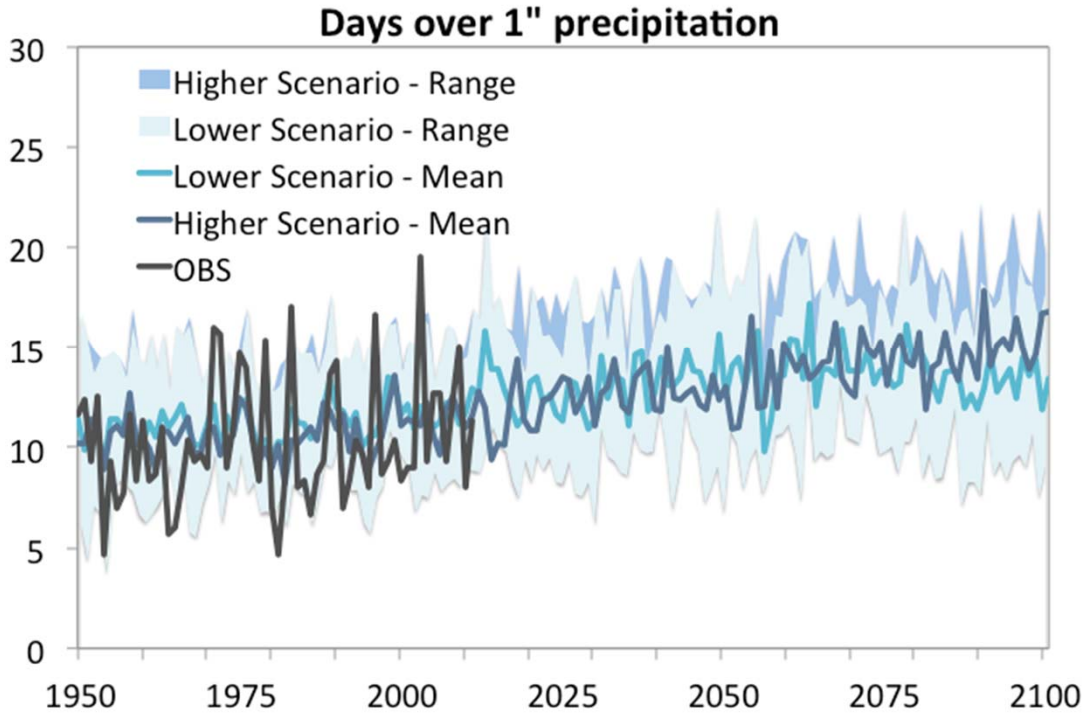
Days above 95°F Heat Index (high emission scenario)

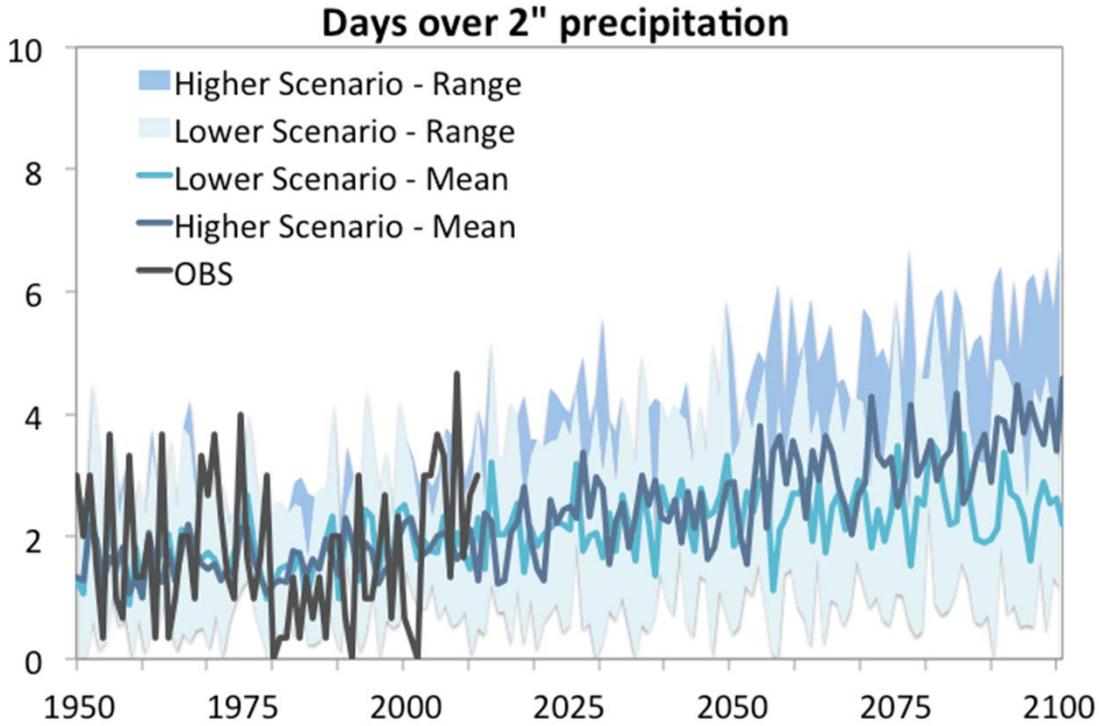
## Precipitation Projections for DC

Observed trends in measures of extreme precipitation are expected to continue to increase.

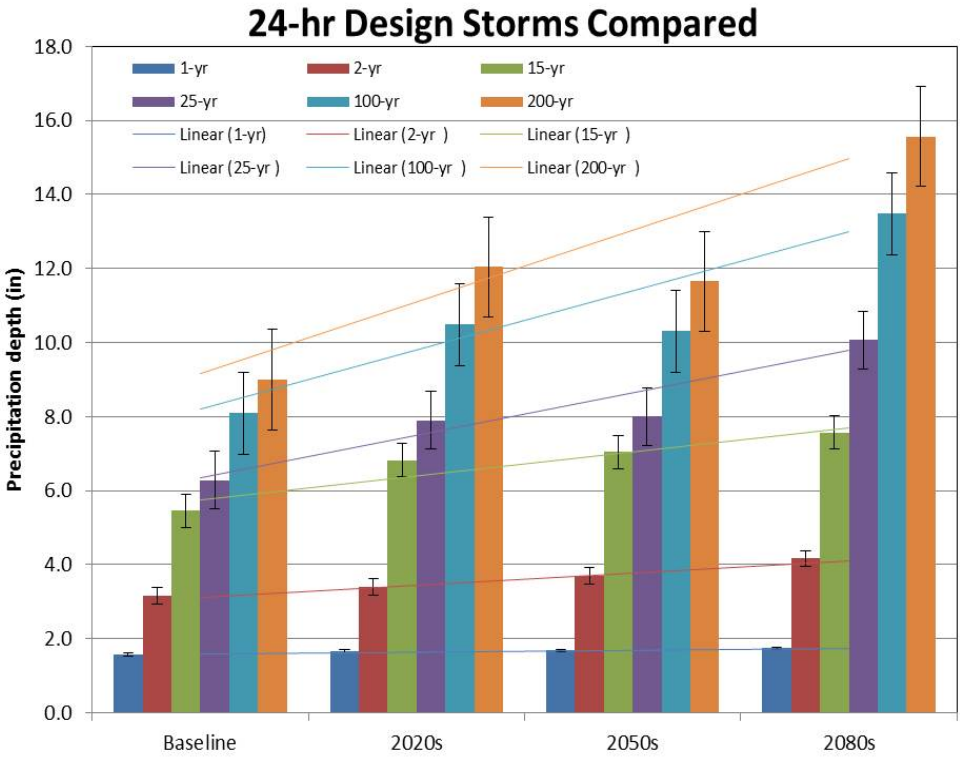
Charts show the number of days per year with more than 1” (top) and 2” (bottom) of precipitation in 24h.

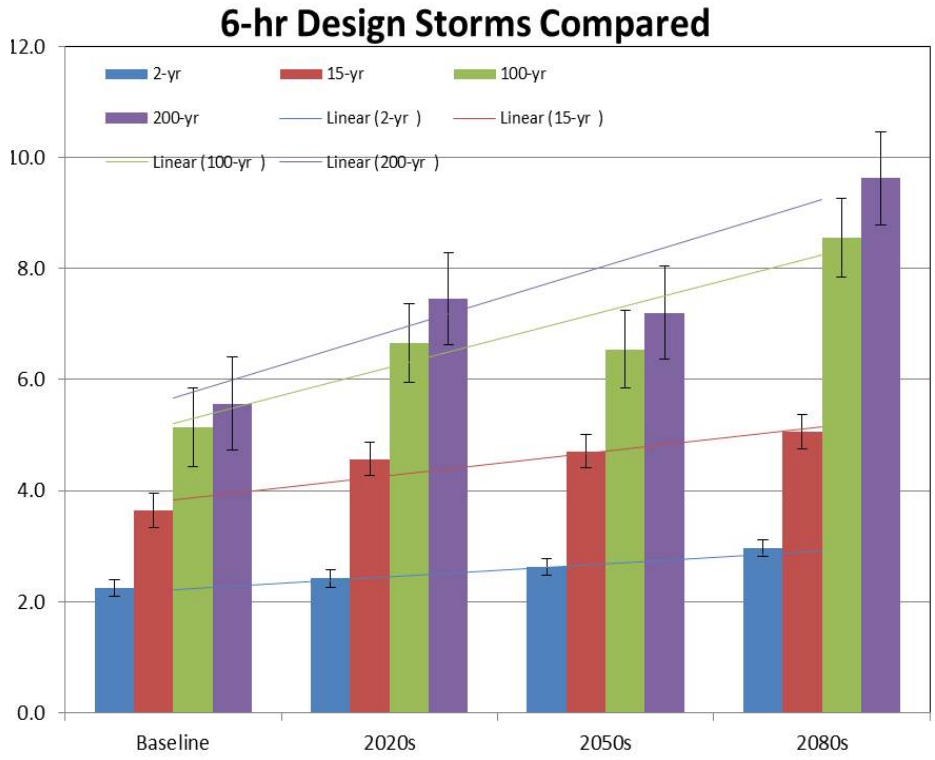
By the 2080s the number of days per year with more than 2” of rain are expected to more than double from 2 days to 4.5 days under the higher scenario.



# Design Storms Compared




Bar charts compare 24-hour and 6-hour design storms for each of the planning horizons. Trend lines show increase in rainfall volumes over time.

# Sea Level Rise

DEPARTMENT OF ENERGY & ENVIRONMENT

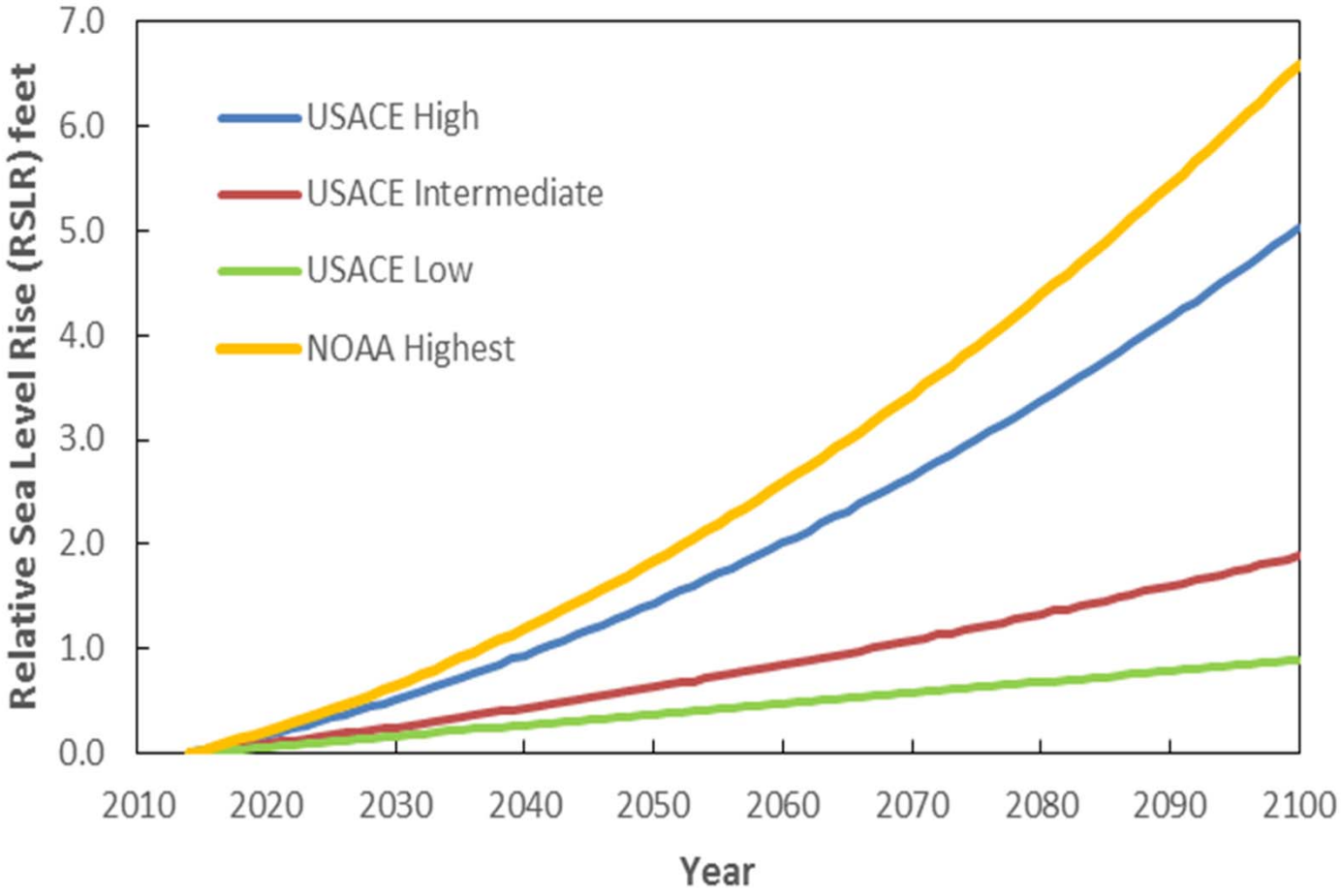
**Sea Level Rise Scenarios**

**High** – sea level rise projections due to polar and glacial ice loss, and ocean warming

**Intermediate** – sea level rise projections due to ocean warming only

**Low** – sea level rise projections based on linear extrapolation of historical rates

Source: U.S. Army Corps of Engineers (USACE)



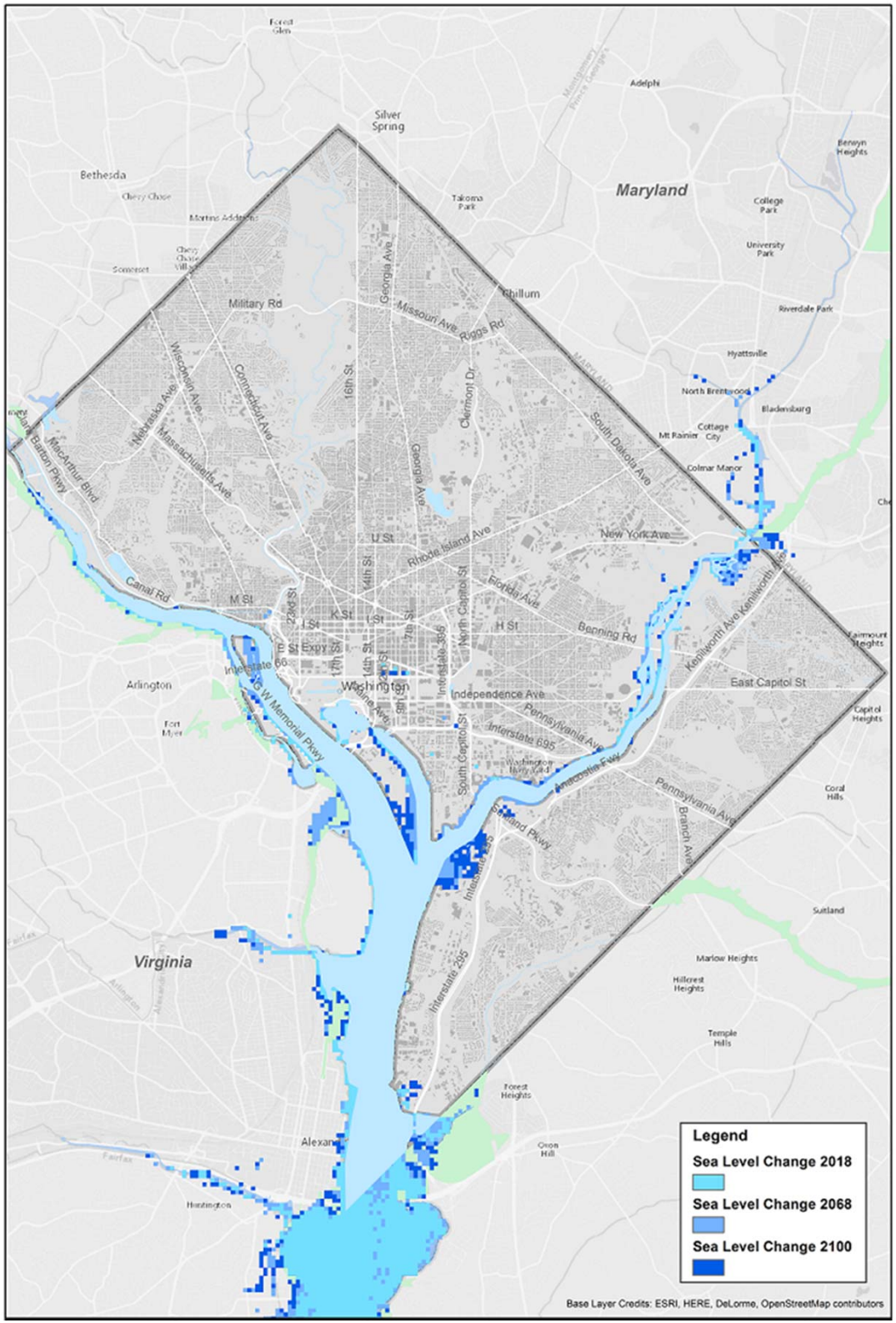

Local sea level is expected to increase by **0.2 ft.** by 2020, **1.4 ft**. by 2050 and by **3.4 ft**. by 2080 from 2014 levels according to the U.S. Army Corp of Engineer's "high"" scenario.

## Mapping Sea Level Rise

Relative sea level rise (RSLR) inundation mapping in Washington, DC.

Map shows USACE “High” scenario, for years 2018, 2068, and 2100.

Source: USACE North Atlantic Coast Comprehensive Study map overlaid on GIS map base created by Kleinfelder, 2015.



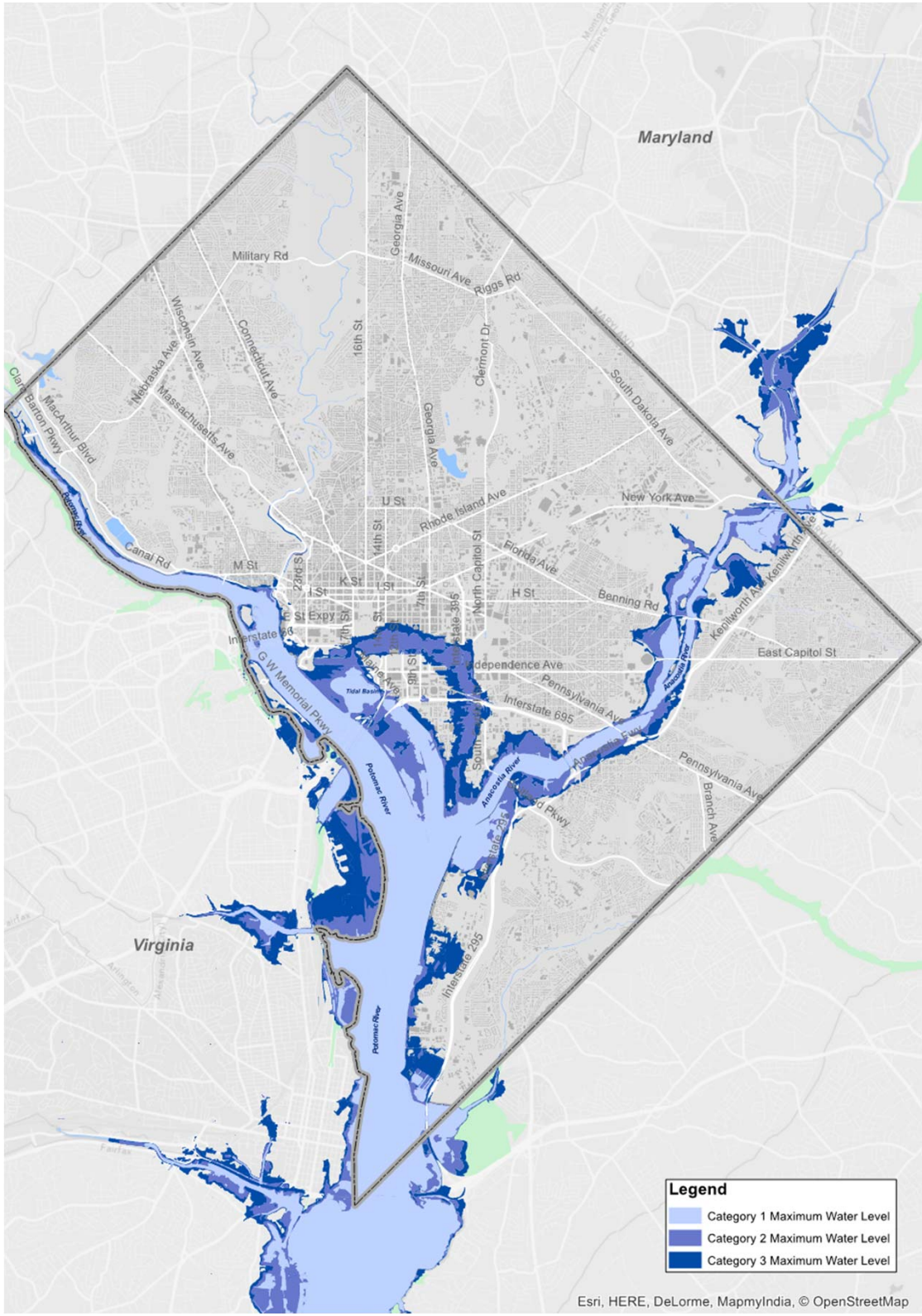
# Storm Surge

Storm surge is wind-driven coastal flooding caused by hurricanes and nor'easters.

Storm surge flooding will be exacerbated in the future by climate change due to sea level rise and storm intensification.

Maps shows the extent of storm surge flooding resulting from present day Category 1, 2, and 3 storms.

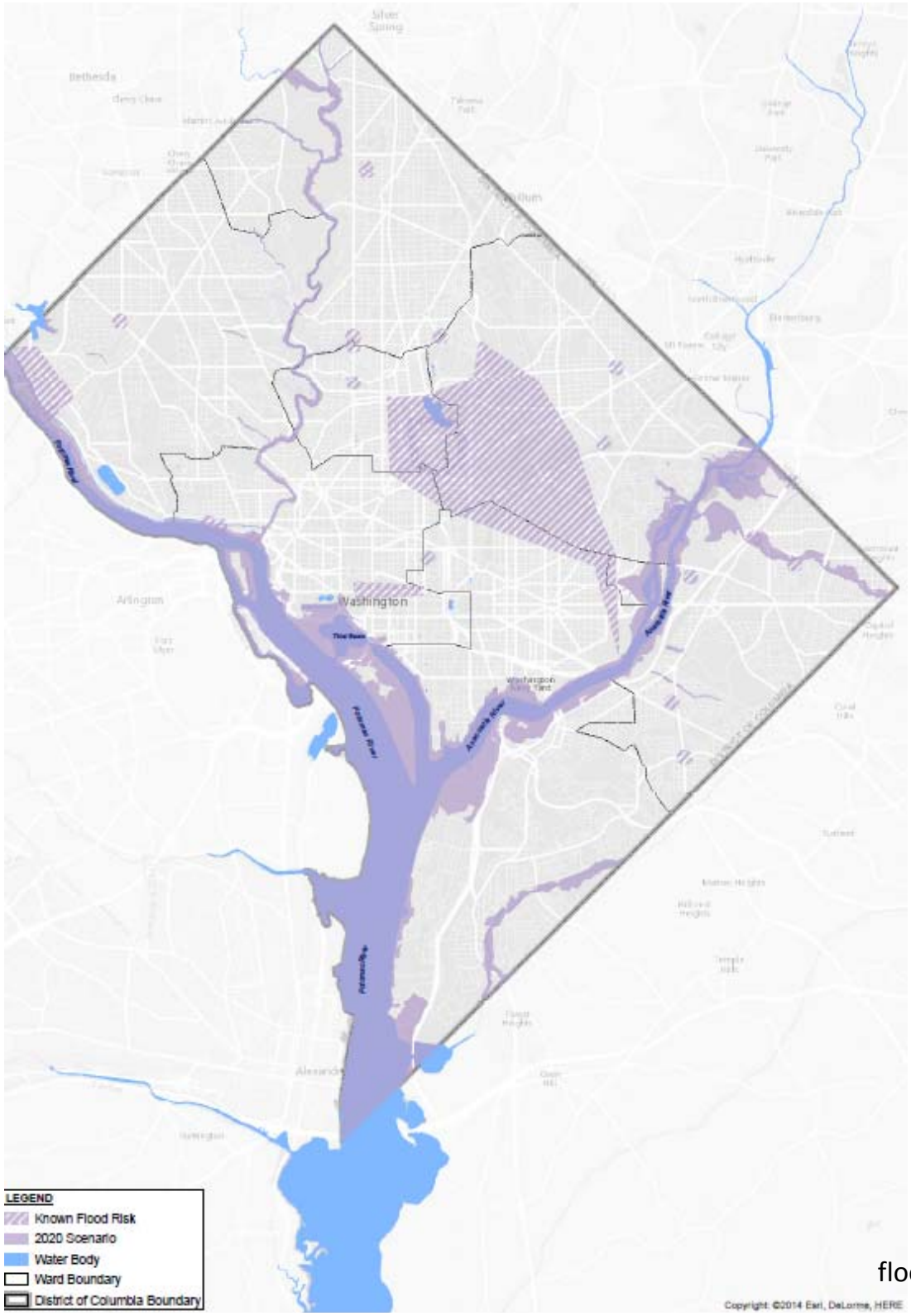
Source: USACE North Atlantic Coast Comprehensive Study map using the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) numerical modeloverlaid on GIS map base created by Kleinfelder, 2015.



Part Four

# PLANNING SCENARIOS & NEXT STEPS

# Planning Scenarios

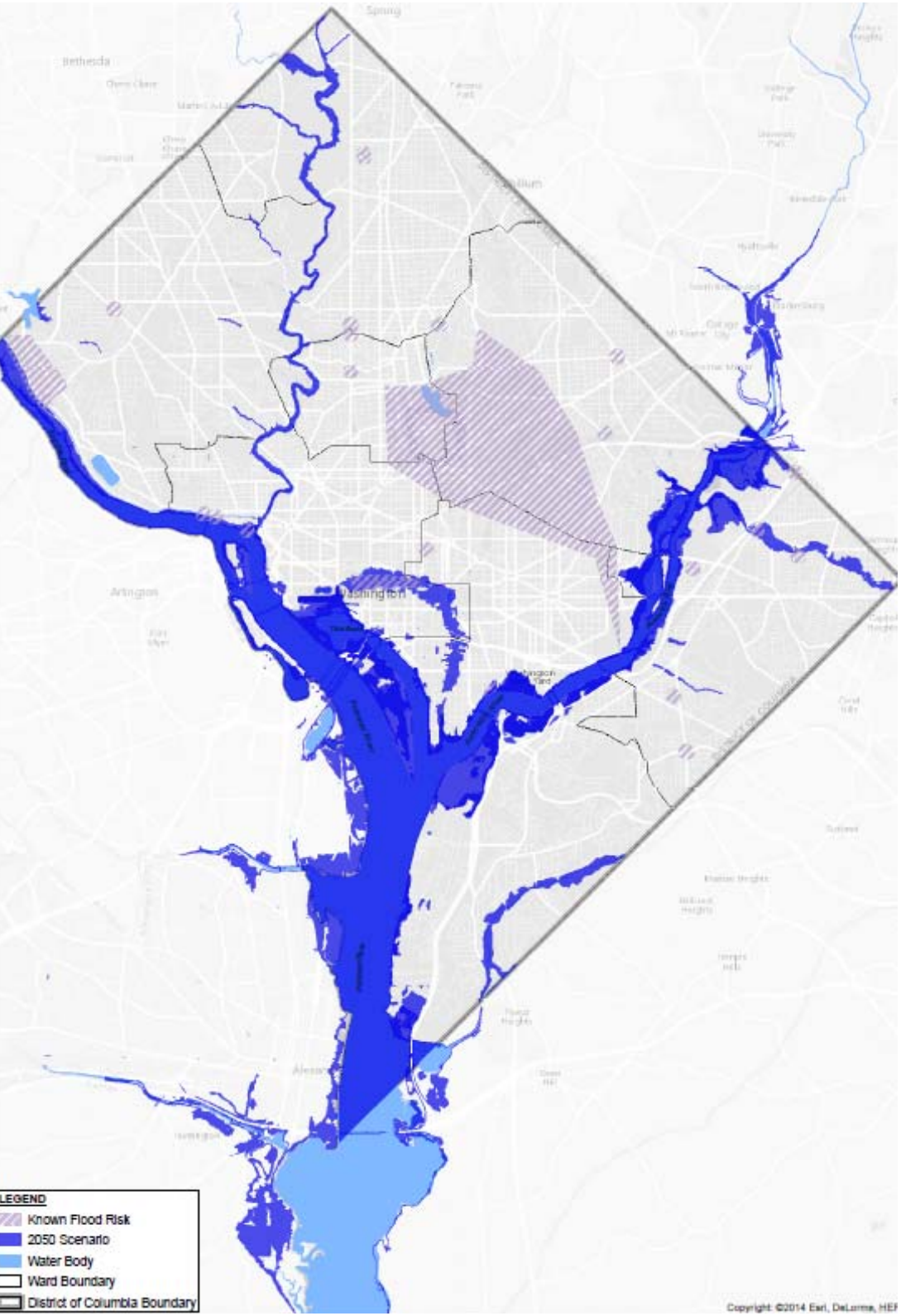



## 2020 Scenario

***Sea Level Rise & Storm surge***
100-year flood = base flood elevation

***Heat***
Increase of daytime maximum by 2.5 - 3°F

2020 Scenario for flooding areas. (Source: NACCS map and historic flooding as identified by stakeholders GIS map base, Kleinfelder, 2015)




# Planning Scenarios

## 2050 Scenario

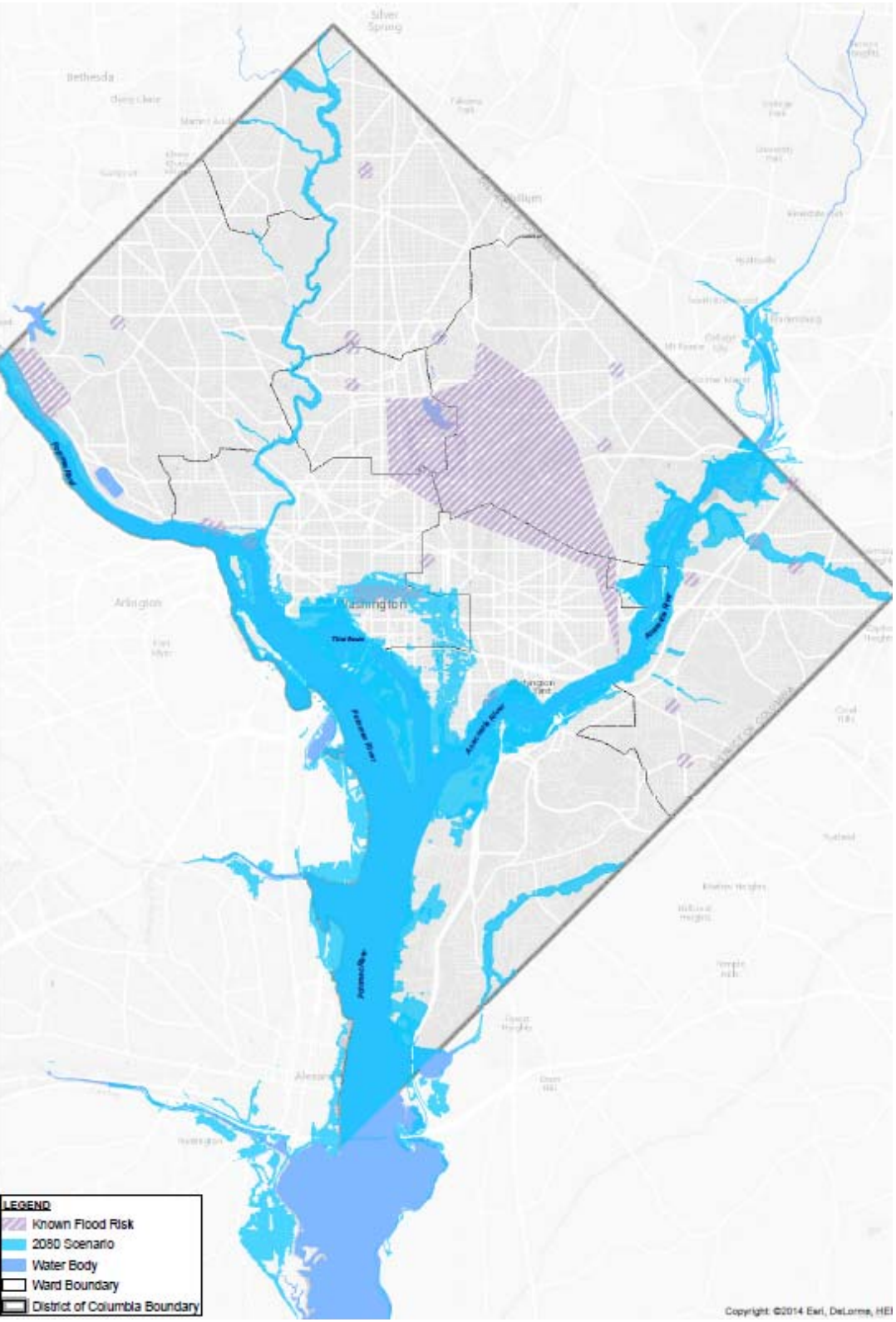
***Sea Level Rise & Storm Surge***
Currently 100-year flood + 3 feet

***Precipitation***
(High scenario)
7.1 inches for the 15-year – 24-hour storm

(Low scenario)
6.5 inches for the 100-year 6-hour storm

***Heat***
Increase of daytime maximum by 5 - 7$^{o}$F
Possible heat wave of 8 - 9.5 days

2050 Scenario for flooding areas. (Source: NACCS map and historic flooding as identified by stakeholders GIS map base,




# Planning Scenarios

## 2080 Scenario

***Sea Level Rise & Storm Surge***
Current 500-year flood (equivalent to current 100-year flood + 4 feet)

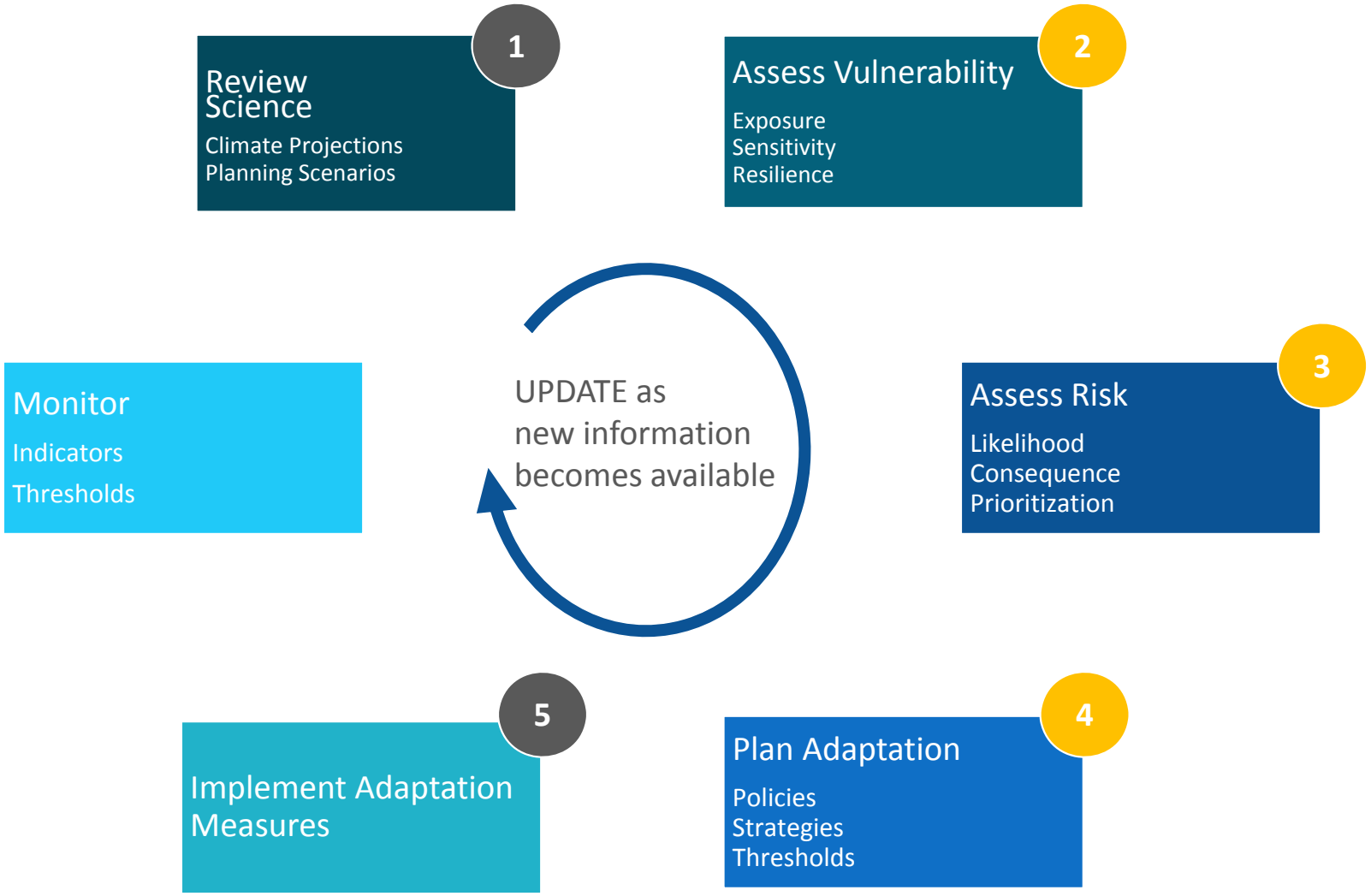
***Precipitation***
(High scenario)
8 inches for the 15-year – 24-hour storm

(Low scenario)
9 inches for the 100-year 6 hour storm

***Heat***
Increase of daytime maximum by 6 - 10$^{o}$F
Possible heat wave of 9.5 - 12 days

2080 Scenario for flooding areas (Source: NACCS map and historic flooding as identified by stakeholders GIS map base, Kleinfelder, 2015)

# Next Steps




Now that we have reviewed the science, we can use the planning scenarios to assess the vulnerability and risks that climate change poses to DC and identify policies and strategies to prepare.

DEPARTMENT OF ENERGY & ENVIRONMENT

# Kate Johnson

**katherine.johnson@dc.gov**
**202-299-3355**

**Email**: katherine.johnson@dc.gov