TECHNICAL MEMORANDUM

JonesEdmunds

TO: City of Atlantic Beach

FROM: Jarrod Hirneise, PE; Karen Liang, PE, CFM; Justin Gregory, PE; Brett Cunningham, PE

DATE: May 3, 2019

SUBJECT: Sea Level Task Authorization #09 – Vulnerability Assessment Support – Task 3
Jones Edmunds Project No. 95239-057-19

5/3/2019 Justin H. Gregory, PE
Florida PE No. 69831

(Relating to the results of the rainfall-induced flood analysis presented in this Technical Memorandum)

1 INTRODUCTION

The City of Atlantic Beach selected Jones Edmunds and Applied Technology & Management, Inc. (ATM) to perform an analysis of future flood risk under projected sea-level rise scenarios to support the City's Vulnerability Assessment. As part of Task 1 of this project, the City asked Jones Edmunds to review sea-level rise projections and recommend future sea-level rise values for the 25-, 50-, and 100-year planning horizons. As part of Task 2 of this project, the City asked ATM to use the recommended sea-level rise projections from Task 1 to evaluate the future flood risk from coastal storm surge and map the 100-year flood risk for the 25-, 50-, and 100-year future conditions. For Task 3 the City asked Jones Edmunds to use the recommended sea-level rise projections to evaluate the future rainfall-induced flood risk for three return period storms for the 25-, 50-, and 100-year future conditions. This task also included mapping the future rainfall-induced flood risk for each of the future conditions scenarios and mapping the 100-year return period combined storm surge and rainfall-induced flood risk for each of the planning horizons. This Technical Memorandum summarizes Task 3.

2 FUTURE CONDTIONS STORMWATER MODELING APPROACH

Jones Edmunds developed 2044, 2069, and 2119 drainage conditions models for the 10-, 25-, and 100-year/24-hour return period storm events to see what future drainage conditions within the City may be and to determine how rainfall-induced flooding may be impacted by sea-level rise and new development within the City. To develop these models, Jones Edmunds adjusted hydrologic and hydraulic parameters in the Interconnected Pond Routing (ICPR) Version 4 models that were developed during the City's 2018 Stormwater Master Plan update to reflect projected increases in impervious area from future development, increased boundary conditions and node initial conditions from rising sea levels, and reduced soil storage from rising sea levels. The following sections summarize how each of these changes was considered.

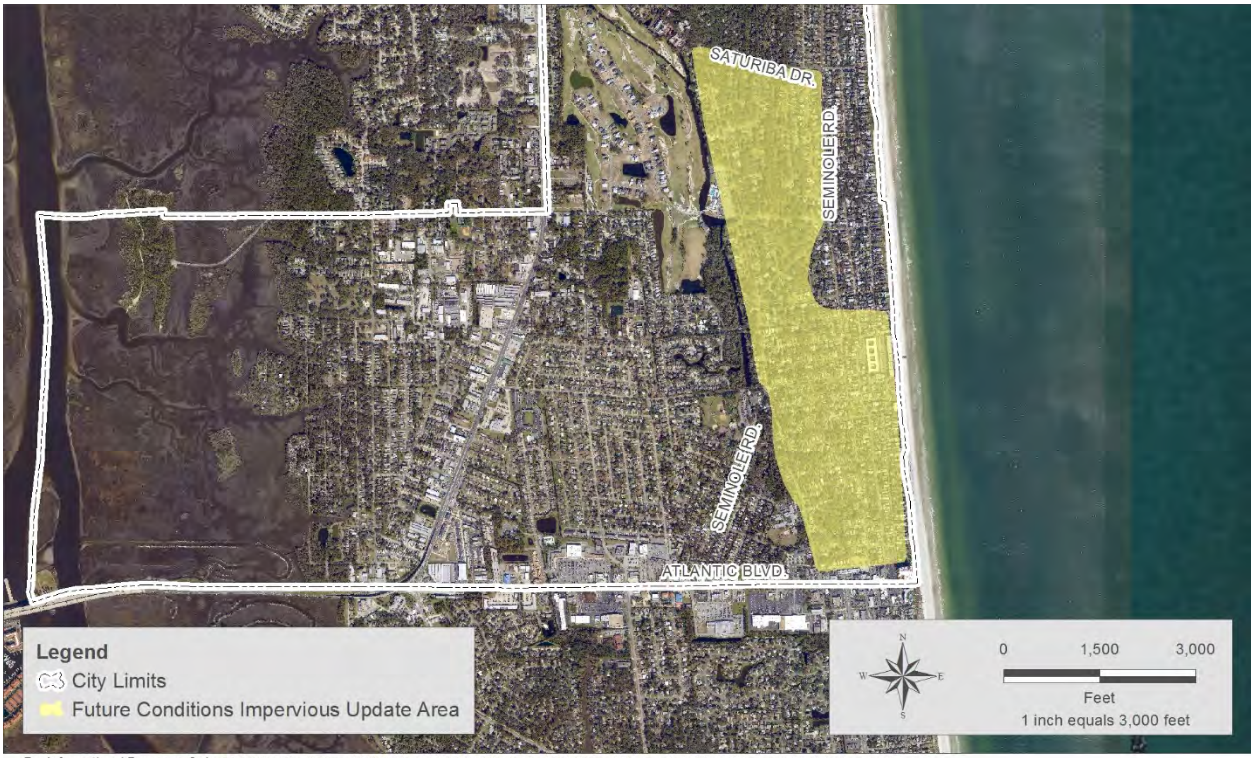
2.1 FUTURE IMPERVIOUS AREA UPDATES

Jones Edmunds used the rates of future development that were developed for the City's 2018 Stormwater Master Plan update to estimate the impervious area in the City in 2044, 2069, and 2119. The estimated future impervious values were applied to the modeled stormwater drainage basins so that modeled runoff accurately reflects future conditions.

Basin curve numbers (CNs) were updated to reflect hydrologic conditions resulting from projected future increases in impervious area for the 2044, 2069, and 2119 conditions in the residential area shown in Figure 1. According to City staff, this area has experienced increases in imperviousness on residential parcels that the City expects will continue. Many of the parcels in this area currently have less impervious surface coverage than the maximum allowable limit of 45 percent. For the future conditions modeling completed during the 2018 Stormwater Master Plan update, we assumed that 40 percent of the residential parcels that currently have less than 45 percent impervious surface coverage would be built-out to 45 percent by 2030 and that 45 percent of the remaining 60 percent of the parcels would be built-out to 45 percent by 2045. This assumption was made based on City staff's understanding of the redevelopment rates in this area when the Stormwater Master Plan update modeling was completed.

For the future conditions modeling completed in this task, we assumed that the 2044 hydrologic conditions would be the same as the 2045 conditions used during the Stormwater Master Plan update. For the 2069 and 2119 scenarios we assumed that 45 percent of the remaining parcels below the 45 percent limit would continue to be built-out between 2045 and 2069 and between 2069 and 2119. Using these assumptions, 67 percent of the parcels would be built-out in 2044, 82 percent of the parcels would be built-out in 2069, and 90 percent of the parcels would be built-out in 2119. The new impervious area was applied to the basins spatially for each scenario so that it was correctly assigned based on the number of parcels available for redevelopment in each basin.

Figure 1 Future Conditions Impervious Update Area



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2.2 Boundary Condition Updates from Sea-Level Rise

Jones Edmunds used the intermediate-high values from the National Oceanic and Atmospheric Administration (NOAA) 2017 sea-level rise projections recommended in Task 1 to update the tidal boundary conditions for the future drainage condition models. Tidal boundary conditions in the 2018 Stormwater Master Plan update model were set at elevation 2.0 feet NAVD88 based on mean higher high tide data from Florida Department of Environmental Protection's (FDEPs) Bar Pilots Dock St. Johns River tide station (ID 872-0218) and from FDEPs Pablo Creek tide station (ID 872-0267).

Based on the intermediate-high values from the NOAA 2017 sea-level rise projections, we increased the tidal boundary conditions and model node initial stages where necessary according to the projected increases in sea level in 2044, 2069, and 2119 for the future conditions scenarios. Table 1 summarizes the updated boundary condition elevations and projected sea-level rise increases.

Table 1 Summary of Boundary Condition Updates

Scenario	Projected Sea Level Rise (feet)	Tidal Boundary Stage* (feet NAVD88)
2044	1.06	3.06
2069	2.65	4.65
2119	6.75	8.75

*Predicted future mean higher high water level

2.3 Changes in Runoff Due to Reduction in Soil Storage

Jones Edmunds adjusted basin Natural Resources Conservation Service (NRCS) CN parameters to reflect hydrologic conditions with decreased soil storage from higher groundwater tables created by rising sea levels. We expect that surficial groundwater levels will be higher because of consistently higher tides. This increase in groundwater levels will reduce the amount of soil storage available for rainfall to infiltrate and will increase the volume of runoff during storm events. The decrease in soil storage will be more marked in areas directly adjacent to the coastline and will be reduced further inland.

We assumed that locations directly connected to the boundary condition will experience groundwater table increases equivalent to the increases in boundary conditions from sea-level rise in Section 2.2. We also assumed that the increase in groundwater table elevation will decrease at a linear rate and that the increases would become negligible and be 0 at 1 mile inland from the boundary condition, which included Sherman's Creek and Hopkins Creek. These assumptions were based on our engineering judgement. A detailed groundwater model would be required to understand the spatial effects of sea-level rise on groundwater table elevations but is not included in the scope and budget of this project.

We calculated the increase in groundwater table elevation throughout the watershed based on this linear relationship. We used the increase in groundwater table elevation and soil parameters from the University of Florida's Institute of Food and Agricultural Sciences (UF IFAS) Florida Soil Characterization Data Retrieval System database to calculate the soil storage reduction that would occur and the resulting total soil storage available for runoff infiltration under the sea-level rise scenarios. We then used Technical Release 55 (TR-55) CN relationships to calculate the resulting open land CNs that would result from the reduced soil storage capacity. Finally, we recalculated weighted CNs that accounted for impervious areas for all model basins. The average CN increased from 81 in the Existing Conditions Model to 90 in the 2044 Conditions Model, 97 in the 2069 Conditions Model, and 99 in the 2119 conditions model.

3 FLOOD RISK MAPPING

3.1 Rainfall-Induced Inundation Mapping

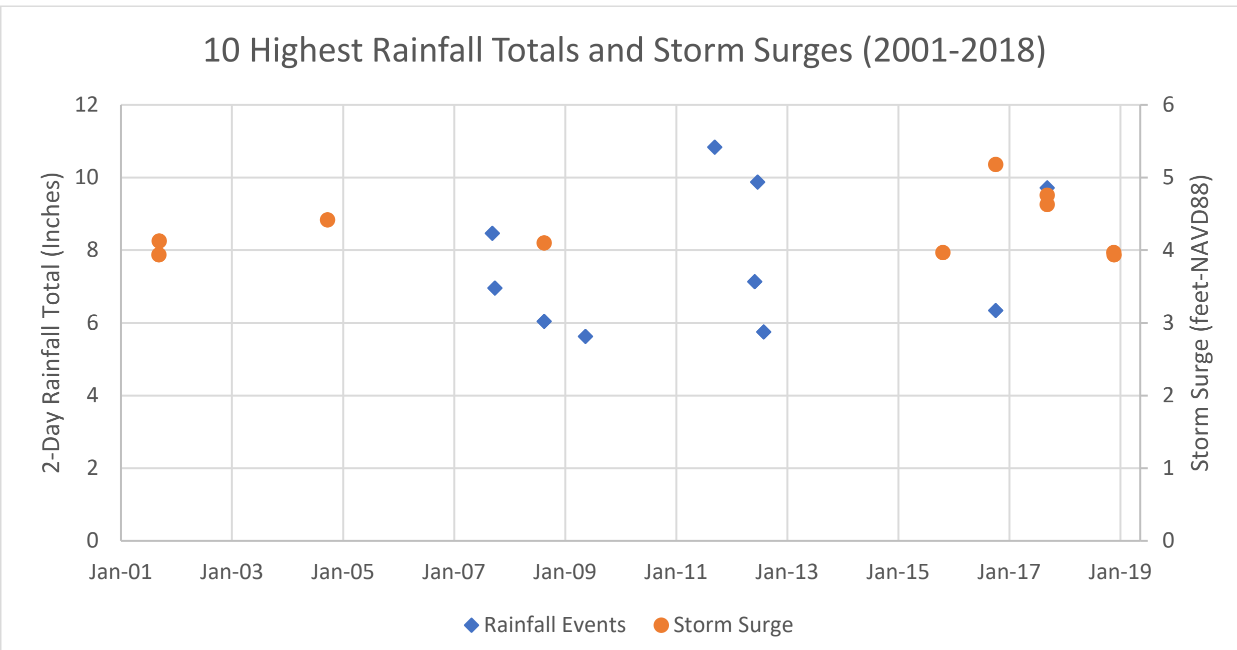
Node peak stage results from the future drainage conditions models were used to map the predicted rainfall-induced flood risk in the City in 2044, 2069, and 2119 for the 10-, 25-, and 100-year return period 24-hour rainfall events. The results were mapped using the 5-foot-by-5-foot digital elevation model (DEM) generated from the 2007 City of Jacksonville Light Detection and Ranging (LiDAR) data. The DEM did not account for grading changes that have occurred since the LiDAR was collected, including the grading changes at the Atlantic Beach Country Club. Polygons were plotted where the node peak stages were greater than the DEM elevation. Gaps and holes in the polygons greater than 2,500 square feet were filled and polygons less than 2,500 square feet were deleted. Figures 1, 2, and 3 show results of the rainfall-induced inundation mapping completed for the 10-, 25-, and 100-year return period 24-hour storms.

3.2 COMBINED RAINFALL AND COASTAL INUNDATION MAPS

Jones Edmunds combined the future storm surge flood risk maps that were produced by ATM for Task 2 and the rainfall-induced inundation maps for the 100-year return period storm produced by Jones Edmunds. Figure 5 compares ATM's storm surge flood extents for 2044, 2069, and 2119. Figure 6, 7, and 8 show the combination of rainfall-induced inundation and surge-and-wave-induced flooding for 2044, 2069, and 2119. Where there was overlap between the flood risk mapping, we selected the higher inundation estimate from the two mapping sources. These maps provide the City with a spatial estimate of future flood risk that can be used in the City's vulnerability assessment. Figure 9 is a comparison of the inundation extent of the 2044, 2069, and 2119 conditions.

Rainfall-induced flood risk and coastal surge flood risk are usually evaluated relatively independently because the two forms of flood risk are neither fully dependent or fully independent. Therefore, traditional statistical approaches are not applicable. The standard workaround to the problem is to evaluate the two relatively independently and then take the higher of the combined identified risk at each location.

Figure 2 Occurrence of 10 highest rainfall totals and storm surges in Atlantic Beach between 2001 and 2018.



4 REFERENCES

NOAA. 2017. *NOAA Technical Report NOS CO-OPS 083, National Oceanic and Atmospheric Administration, Global and Regional Sea Level Rise Scenarios For The United States* (NOAA et al. 2017). Available at https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf.

US Army Corps of Engineers (USACE). 2017. *Sea-Level Change Curve Calculator, Version 2017.55.* Revised July 18, 2017. Available at: http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html.

Figure 3

City of Atlantic Beach Rainfall Based Inundation - 10-Year/24-Hour

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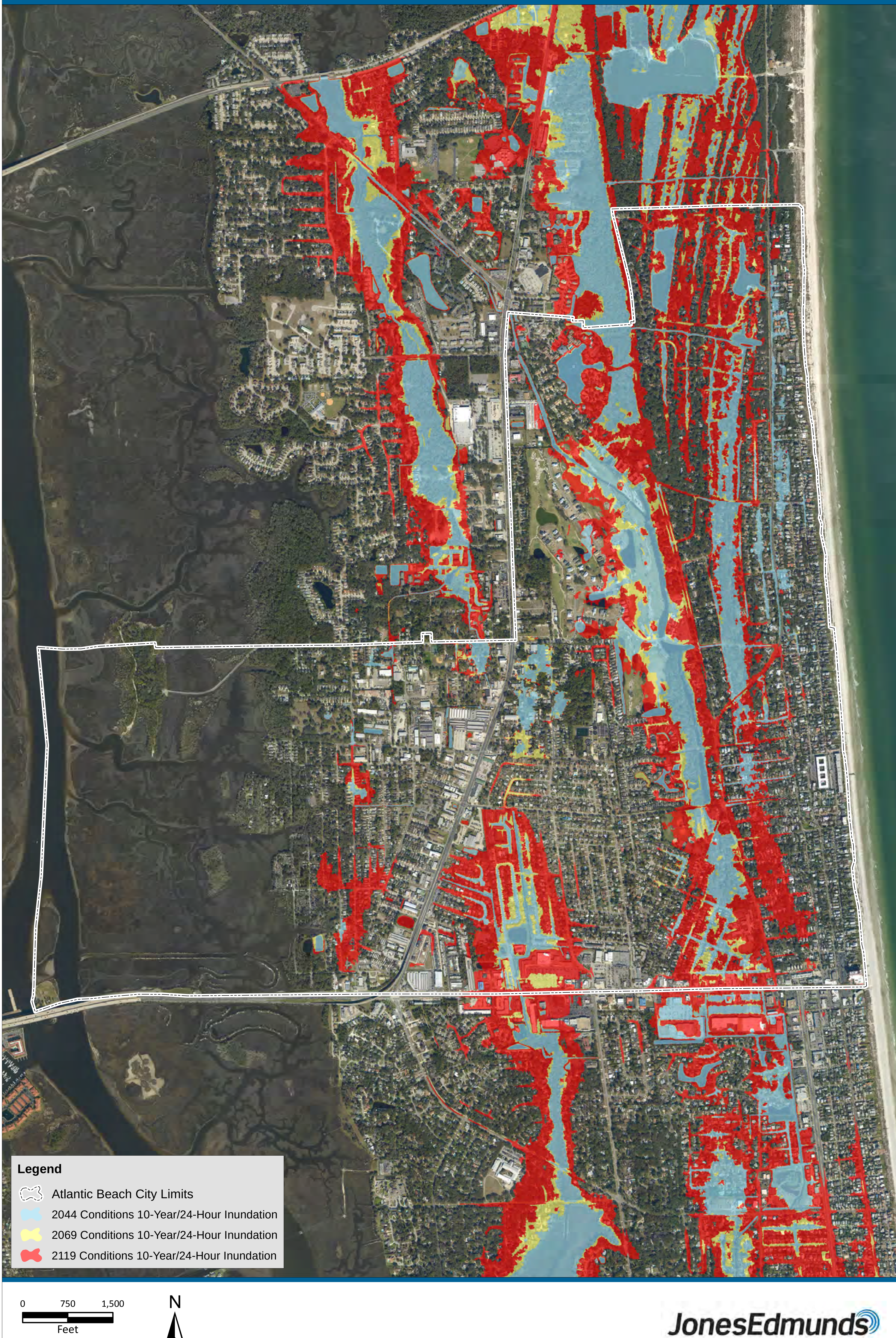

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Figure 4

City of Atlantic Beach Rainfall Based Inundation - 25-Year/24-Hour

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Figure 5

City of Atlantic Beach Rainfall Based Inundation - 100-Year/24-Hour

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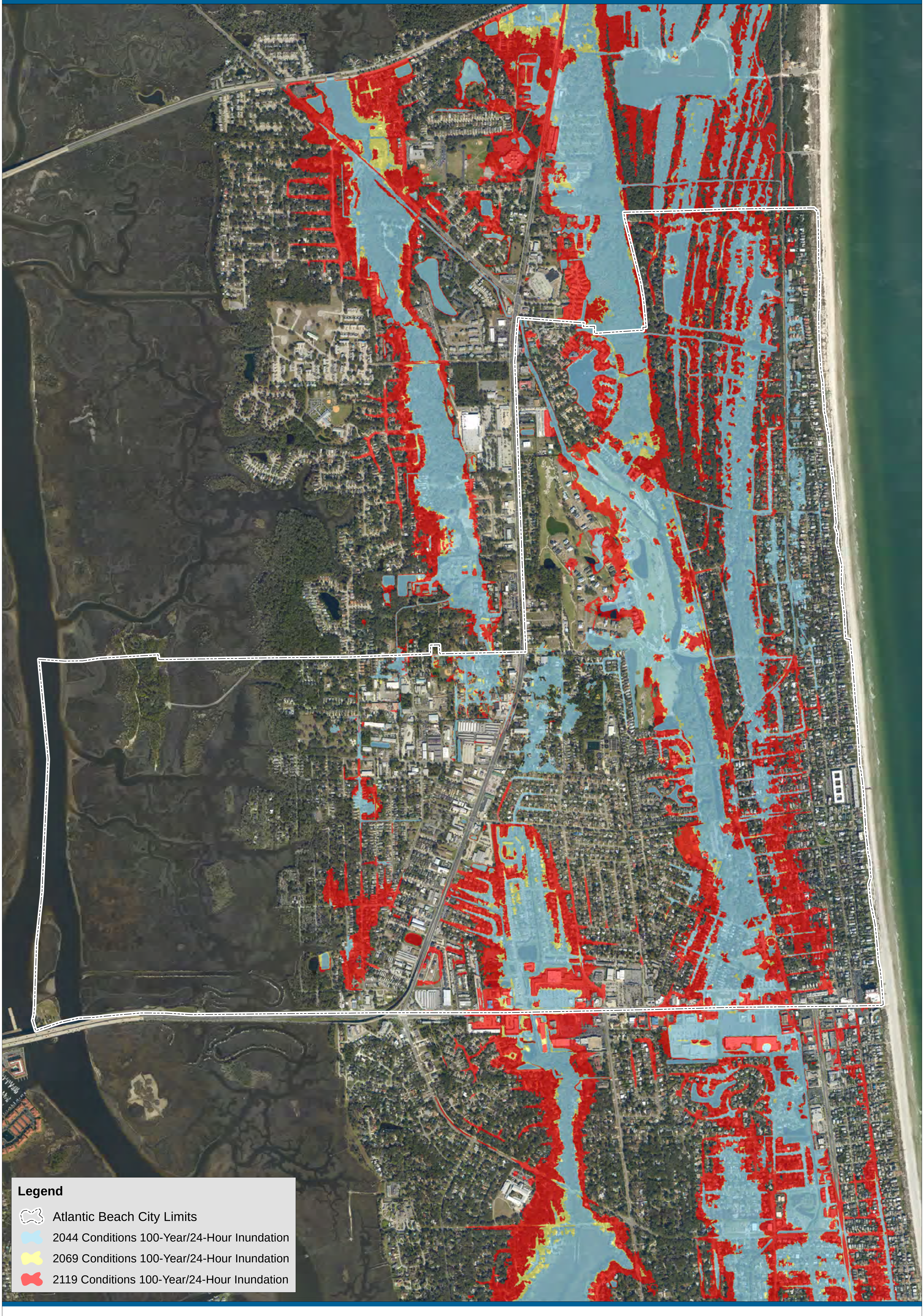

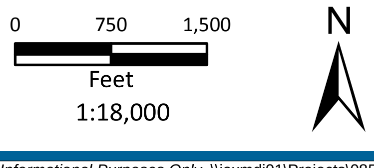

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Figure 6

City of Atlantic Beach Surge Based Inundation - 100-Year

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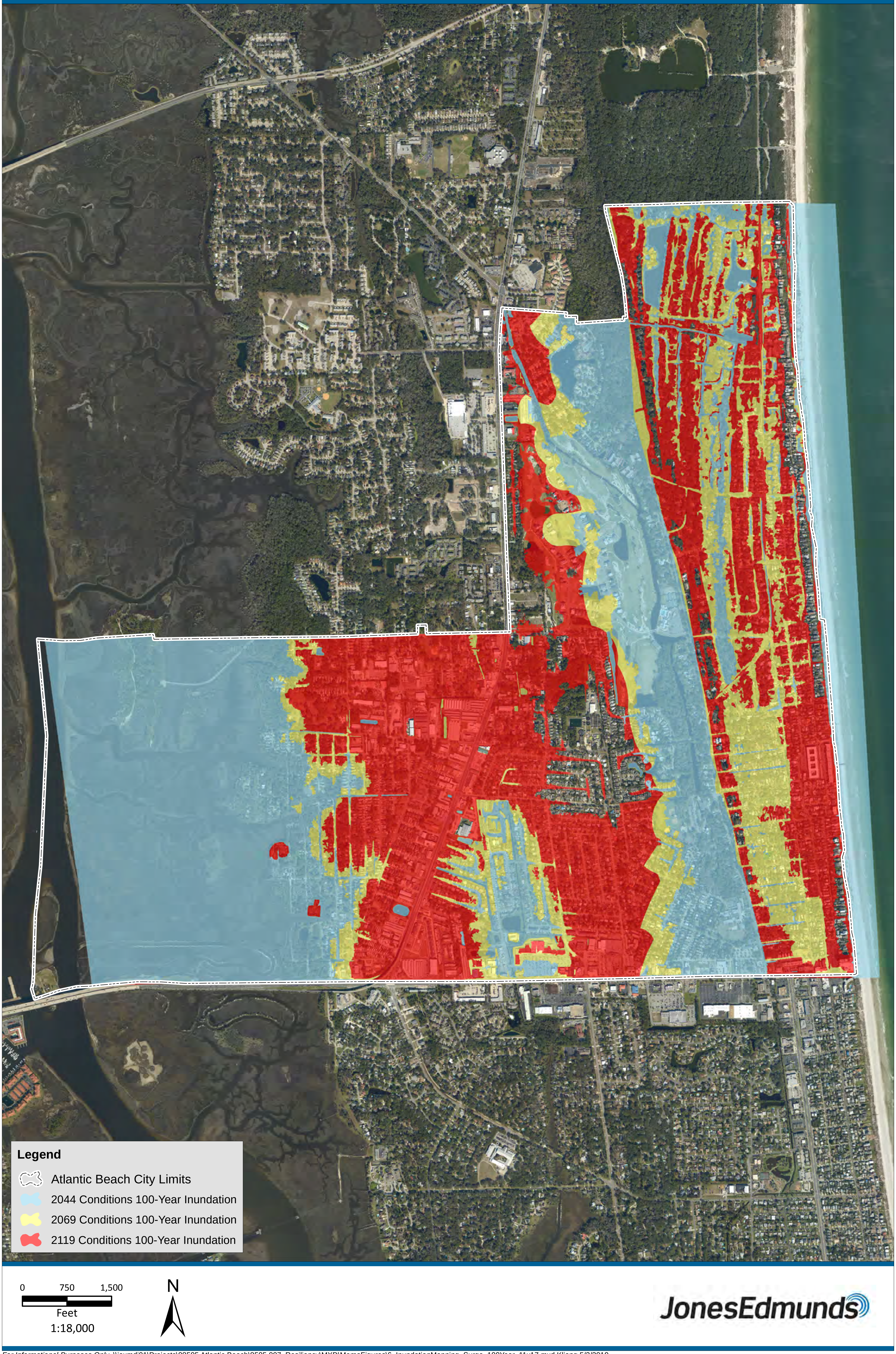

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Figure 7

City of Atlantic Beach Rainfall vs. Surge Inundation - 2044 Conditions 100-Year Inundation

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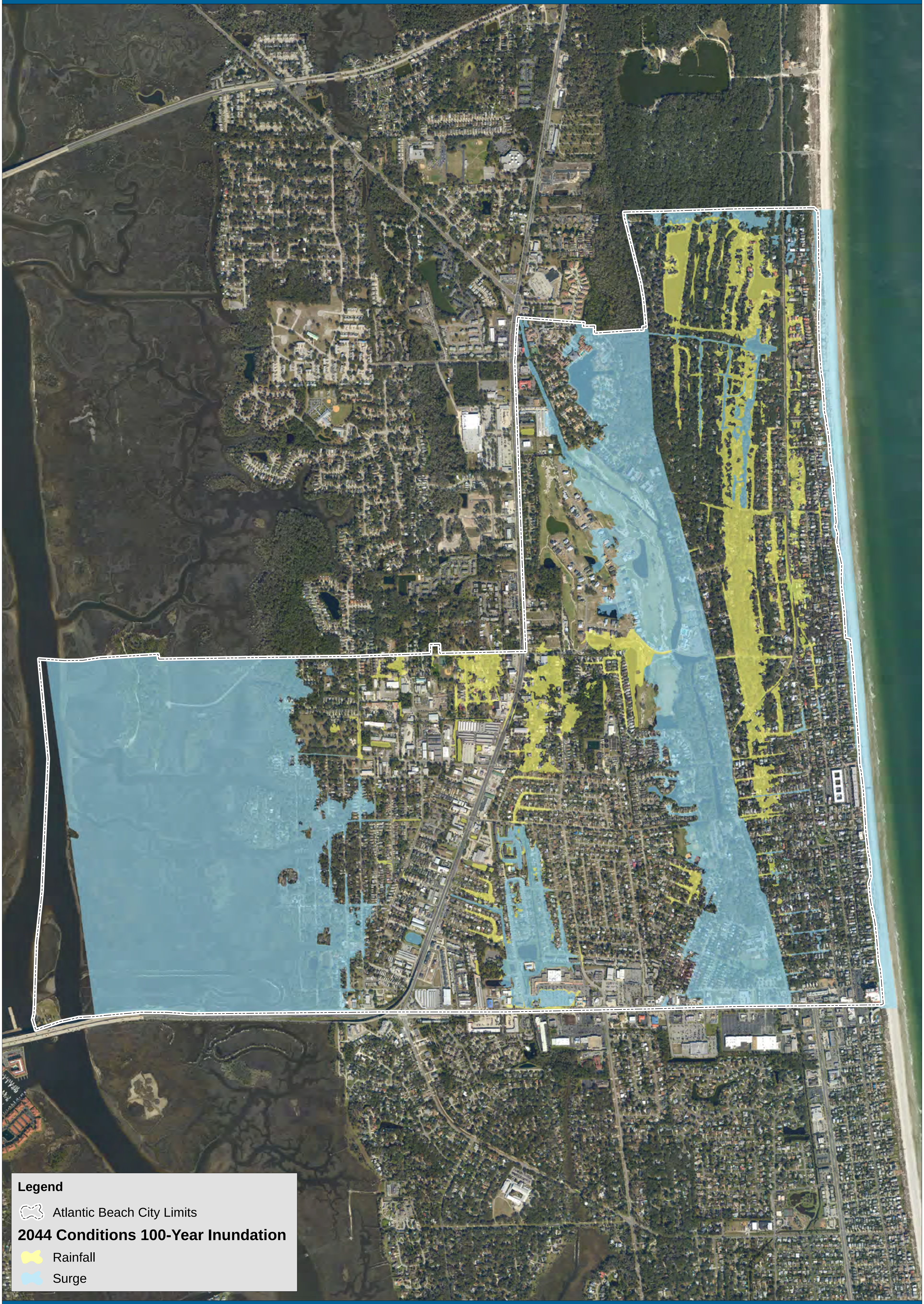

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Figure 8

City of Atlantic Beach Rainfall vs. Surge Inundation - 2069 Conditions 100-Year Inundation

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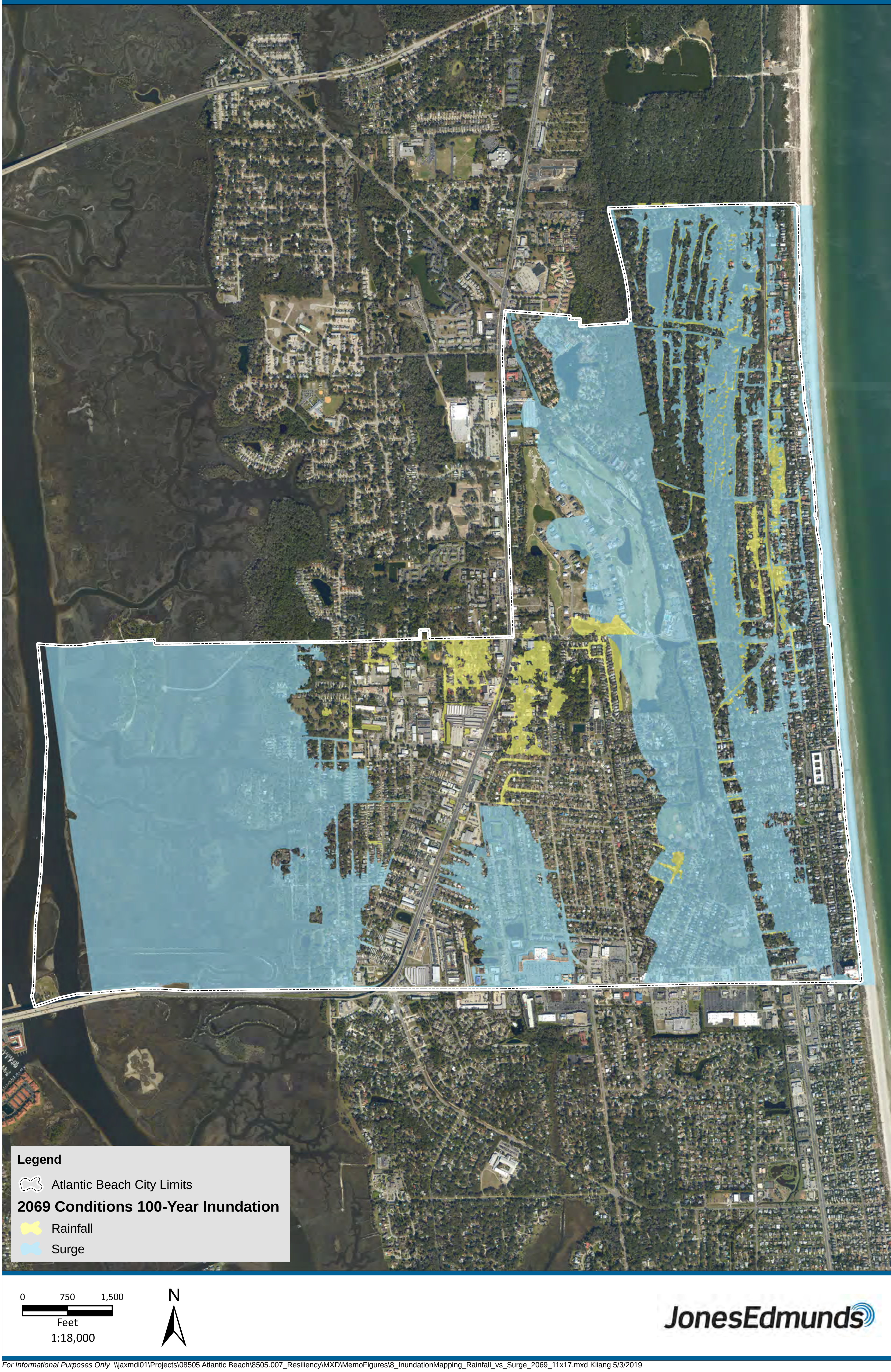

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Figure 9

City of Atlantic Beach Rainfall vs. Surge Inundation - 2119 Conditions 100-Year Inundation

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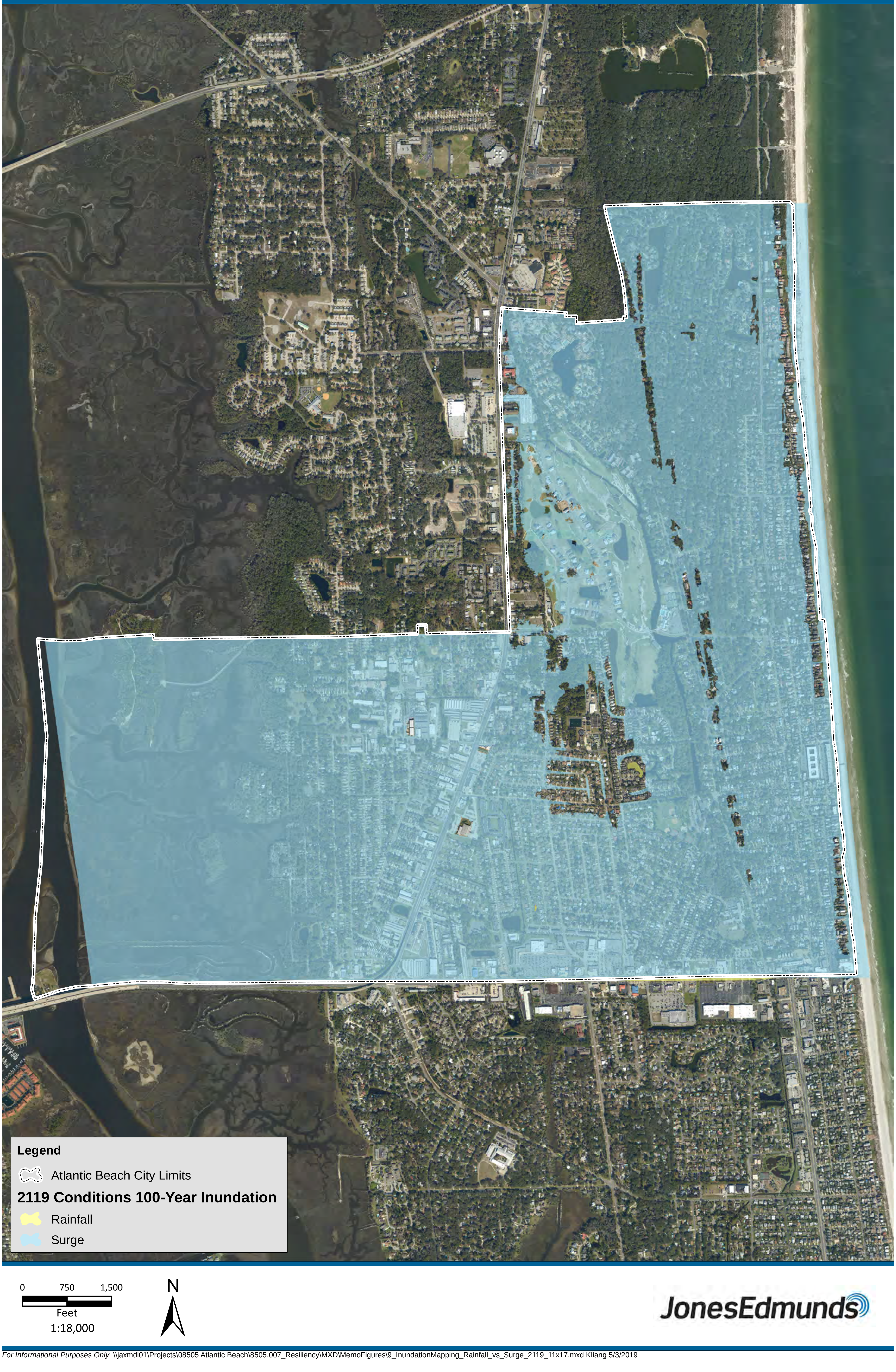

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