1. Introduction

1.1 Background

The current design road elevation (DRE) target for the City of Miami Beach (hereafter, the "City") is for the crown of the road to be at or above 3.7 feet (ft) NAVD (North American Vertical Datum of 1988). This DRE guidance was set in 2013 (referred to below at DRE13) based on the following assumptions and data inputs:

- DRE13 = (Highest Measured "King Tide") + (Sea Level Rise projected in 30 years) + (Base Clearance), as outlined below:
- For DRE13, the City estimated that the highest king tide[2] was 1.7 ft NAVD
- For DRE13, the City calculated sea level rise (SLR) of 1.0 ft, based on a 30-year planning horizon, with the U.S. Army Corps of Engineers 2015 High SLR curve included in the 2015 Unified Sea Level Rise Projection adopted by the Southeast Florida Regional Climate Compact.[3]
- For DRE13, the City referred to Florida Department of Transportation (FDOT) guidance of at least 1 ft for minimum base clearance above high water to the crown of the road.[4]

The resulting DRE13 guidance is road elevations should be set at 3.7 ft NAVD, as illustrated on Figure 1.

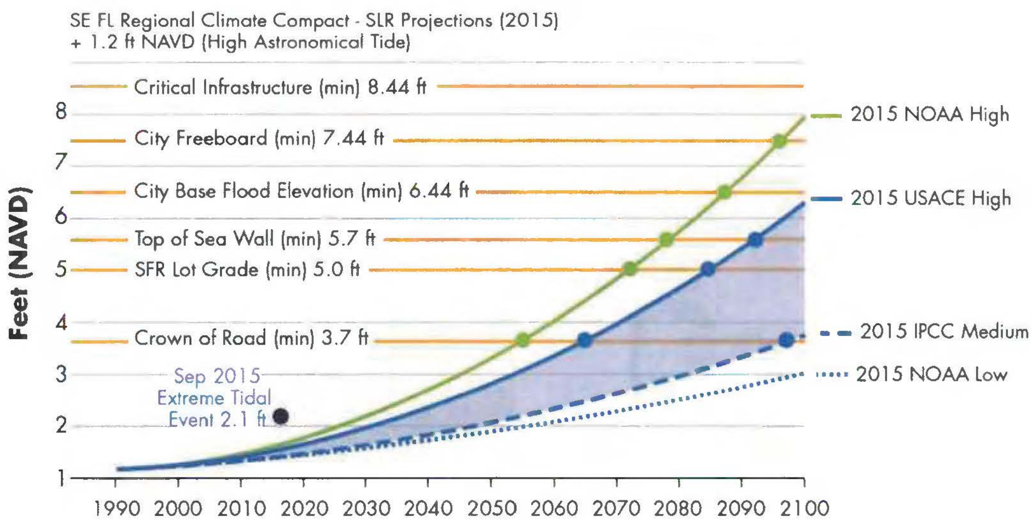

Figure 1. Current Design Road Elevation Basis for Crown of Road in Miami Beach, and Other Key Infrastructure Elevation Metrics

These elevation standards were established in 2013.

[2] The term "King Tide" used previously by the City was not technically accurate. Tidal water surface elevations are based on lunar cycles, referred to as "astronomical tide." It does not include any variations in water surface elevations that result from wind strength and direction, which can vary from increases in water level to significant increases associated with tropical storms, generally referred to as "storm surge." King tides technically only refer to the highest astronomical tides, when lunar high tides are at their greatest (typically in September through October), independent of any wind-driven water level increase. The City's previous 1.7 ft king tide includes some wind-driven increase in water elevations, as explained herein.

[3] Southeast Florida Regional Climate Change Compact. 2015. Sea Level Rise Work Group. *Unified Sea Level Rise Projection for Southeast Florida*. August 12.

[4] Florida Department of Transportation. 2019. *STRUCTURES DESIGN GUIDELINES*. January. https://www.fdot.gov/structures/structuresmanual/currentrelease/structuresmanual.shtm

1.2 Purpose and Outline

This section outlines recommendations for updated DREs, referred to hereafter as DRE2020+[5], based on updated analysis and/or data for:

- Frequency of high-water surface elevations (WSEs), irrespective of whether high WSEs are driven by astronomical tide or wind-driven water level increases
- SLR projections
- Clearance requirements are based on protecting road strength vs. minimizing road flooding at either the edge of road/edge of pavement (EOP) or crown of road

The updated recommendations in this section are not based on a single target DRE. Instead, DRE recommendations vary based on road type:

- Emergency access roads
- Commercial
- Residential[6]

Rather than specifying a one-size-fits-all DRE guidance, this approach balances the cost of road raising with the criticality of the roads in question and/or number of residents/businesses served.

The DRE guidelines outlined herein should be viewed as target road elevations. The target road elevations are considered guidelines that can be adjusted downward if warranted by local harmonization constraints between road edge and adjacent drainage infrastructure, sidewalks, and building finished floor elevations. However, Jacobs recommends that if lower elevations are adopted that the approximate level of service (LOS) provided (current and project frequency of flooding) be reviewed before a variance is allowed.

The elevations presented herein presume road construction in 2020. Attachment A presents tabular recommendations for road elevations assuming road construction in subsequent years, based on the SLR curves discussed below and in Attachment B.

Road surface elevation recommendations specified herein relate only to flooding from rising sea levels related to tide and/or storm surge. It does not address frequency of flooding and LOS recommendations related to rainfall runoff and associated drainage infrastructure.

2. Methodology and Updates to Key Input Variables

2.1 Three Components of Road Elevation Guidance

As previously stated, the recommended DRE approach includes three different factors, resulting in different DRE values for each of three road categories. The three factors are:

1) LOS – essentially the frequency of flooding that would be allowed at the end of planning horizon for road service life, assumed to be 30 years.
2) SLR between project implementation and the end of the 30-year planning horizon.
3) Controlling elevation on road section: EOP or bottom of road base. For a given road, two types of calculations should be conducted based on different locations along the road section. The higher of the two elevations that are calculated should be controlling:

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5 The "DRE2020+" acronym is meant to convey that it applies to projects implemented in either 2020, or has a sliding scale that allows for upward increases in the DRE for projects implemented after 2020 (thus, the "+" sign).

6 These three categories are meant to be generic for ease of communication. They are assumed to apply to the following road classifications used by the City: emergency roads include "Principal Arterial" and "Major Collector" roads; commercial roads include "Minor Arterial" and "Minor Collector" roads; and residential roads include "Local" roads.

a) Calculate the minimum road elevation at the EOP. Using the EOP allows for flooding in the gutter pan of the road during high sea level conditions (high tide or wind-driven surge events)

b) Calculate minimum road elevation based on bottom of the road base. The thickness of the road base would then determine the elevation of the EOP. Road slope would then determine the crown elevation. The thickness of the road depends on road construction materials.

Figure 2 outlines the decision-making process to arrive at a DRE for a given type of road.

The basis for the numerical values for each parameter is detailed in section 3.2 to 3.4.

2.2 Level of Service – Historical Frequency of High-Water Levels

As previously stated, the recommended approach includes three different target LOS for frequency of flooding, such as 50-percent chance (flooding approximately once every 2 years), 20-percent chance (flooding approximately once every 5 years), and 10-percent chance (flooding once every 10 years). Those frequencies are determined based on analysis of historical water surface elevation data.

Table 1 and Figure 3 show an analysis of the long-term records available at NOAA's Virginia Key tide gage station adjacent to Miami Beach, which summarizes the probability of a given water surface elevation.[7] Table 1 is based on all high water elevation data, irrespective of whether data are from tidal variations (astronomical tides due to lunar cycles) or from wind and surge. For example, Table 1 shows that a maximum water surface elevation of 3.0 ft NAVD has a 10-percent chance of occurring any given year.

Table 1. Probability of High-Water Surface Elevations in Miami Beach[a]

Annual Probability	Return Period (yr)[b]	Extreme Water Surface Elevation (ft NAVD)
200%	0.5	1.4
100%	1	1.5
20%	5	2.3
10%	10	3.0
4%	25	4.2
2%	50	5.6
1%	100[c]	7.1

[a] Based on extreme value analysis, Virginia Key (1994 to 2018 record length = 25.5 years). Includes all water surface elevation data, tidal and wind/surge related.

[b] The term "return period" is more commonly used, and is interchangeable with probability. For example, at 5-year storm is equal to 100/5 or 20%. However, the term "return period" is discouraged because it can lead to incorrect interpretations that a 5-year storm, for instance, will only occur once in 5 years, when in fact it means that it has a 20% chance of occurring in any given year on average.

[c] It is typically required that the data length be at least three times the largest return period sought, 100/3 = 33.3 yr. Therefore, the results for the 100-year event has more uncertainty associated with its estimation and should be used with caution.

[7] NOAA. Tides & Currents. https://tidesandcurrents.noaa.gov/datums.html?id=8723214

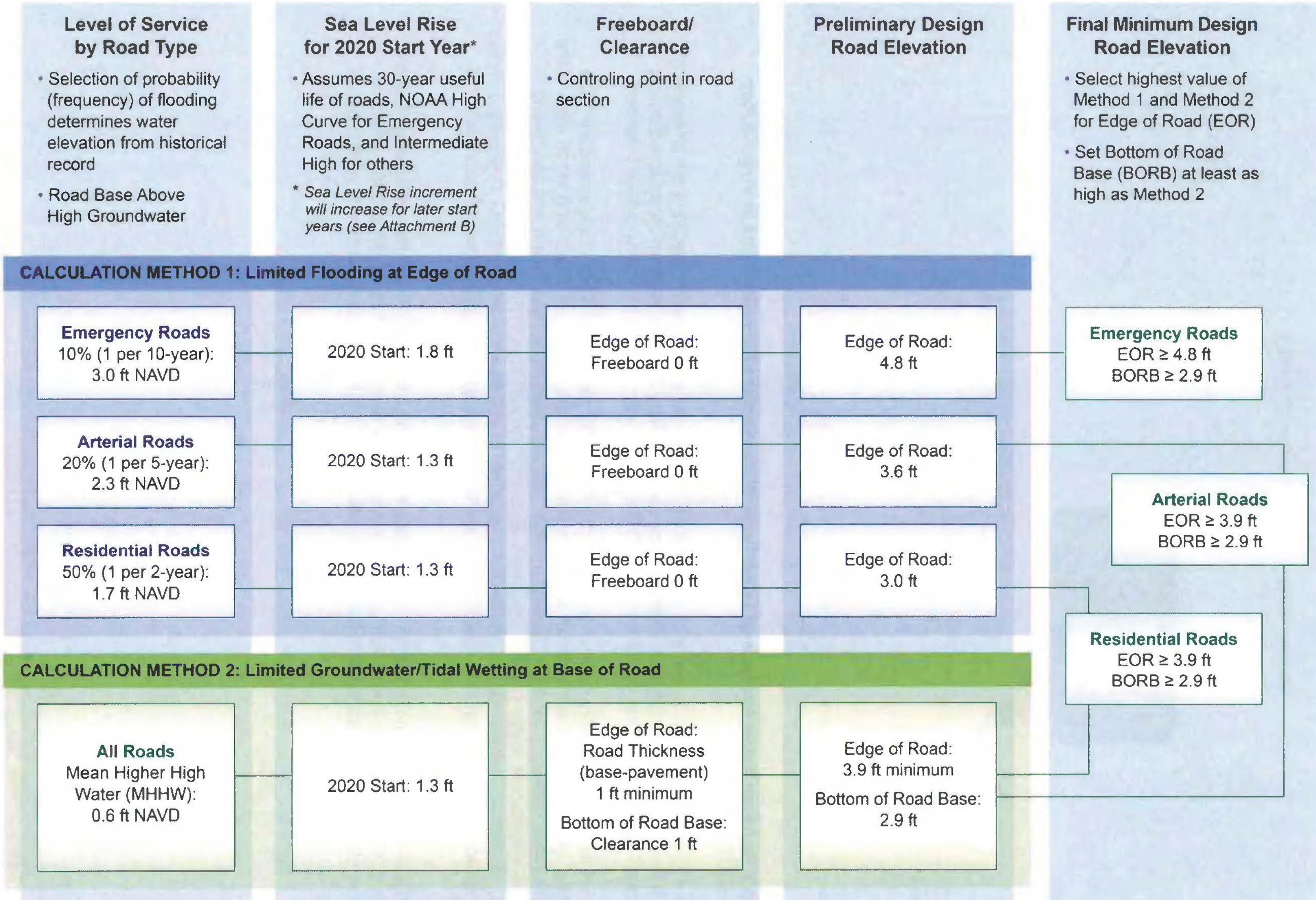


Figure 2. Decision Making Process for Design Road Elevations

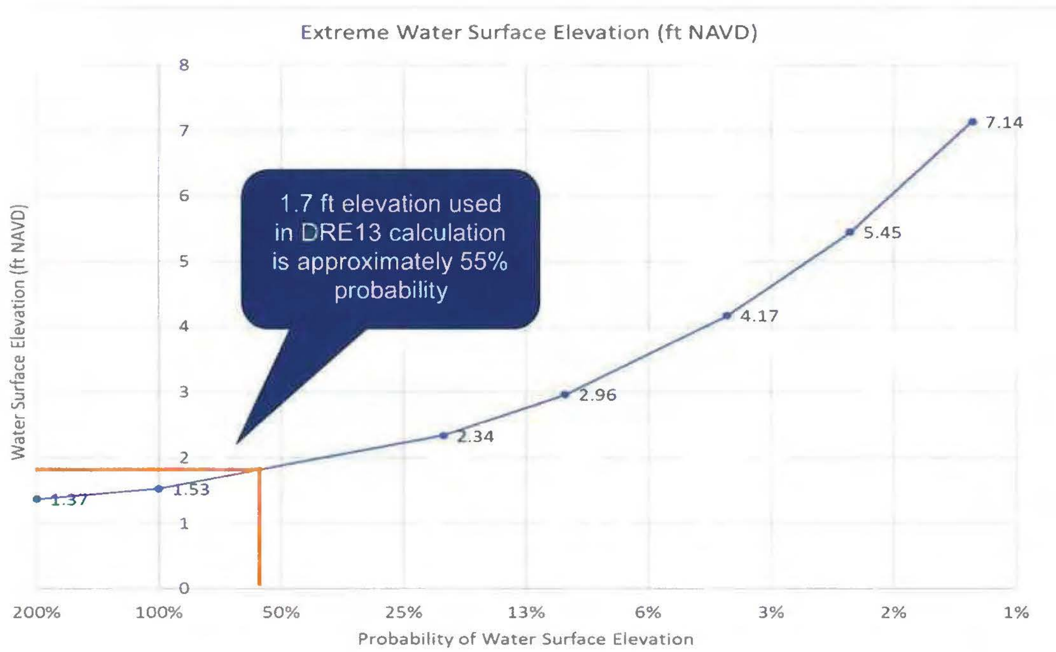


Figure 3. Extreme Value Analysis of Long-Term Water Surface Elevation Data at Virginia Key (1994–2018)

Figure 4 shows the maximum water surface elevation observed each year for the 25 years of record at Virginia Key. The highest recorded water surface elevation was 3.84 ft NAVD, which occurred during Hurricane Irma in 2017. That elevation of 3.84 ft NAVD has a probability of approximately 5 percent.

Note that the City incorrectly referred to the 1.7 ft NAVD WSE used in the DRE13 determination as a "king tide". A king tide is the maximum astronomical tide that occurs when the sun and moon align in the fall. This water elevation can be increased by local weather, leading to wind-driven and barometric pressure increases in water surface elevations. Similarly, the previous WSE used by the City was 1.7 ft NAVD, which has approximately a 55-percent probability in any given year (see Table 1). Figure 3 shows this graphically. The highest king tide predicted by NOAA during the 25-year period of record is 1.1 ft NAVD.

The NOAA tide station data indicates that the mean higher high water (MHHW) for the Virginia Key tide gage is 0.20 ft NAVD.[8] However, that value was based on a tidal epoch from 1983 to 2001, which is outdated given SLR. An update MHHW was calculated as 0.6 ft NAVD, as described in Attachment C.

[8] NOAA. Tides & Currents. https://tidesandcurrents.noaa.gov/datums.html?id=8723214

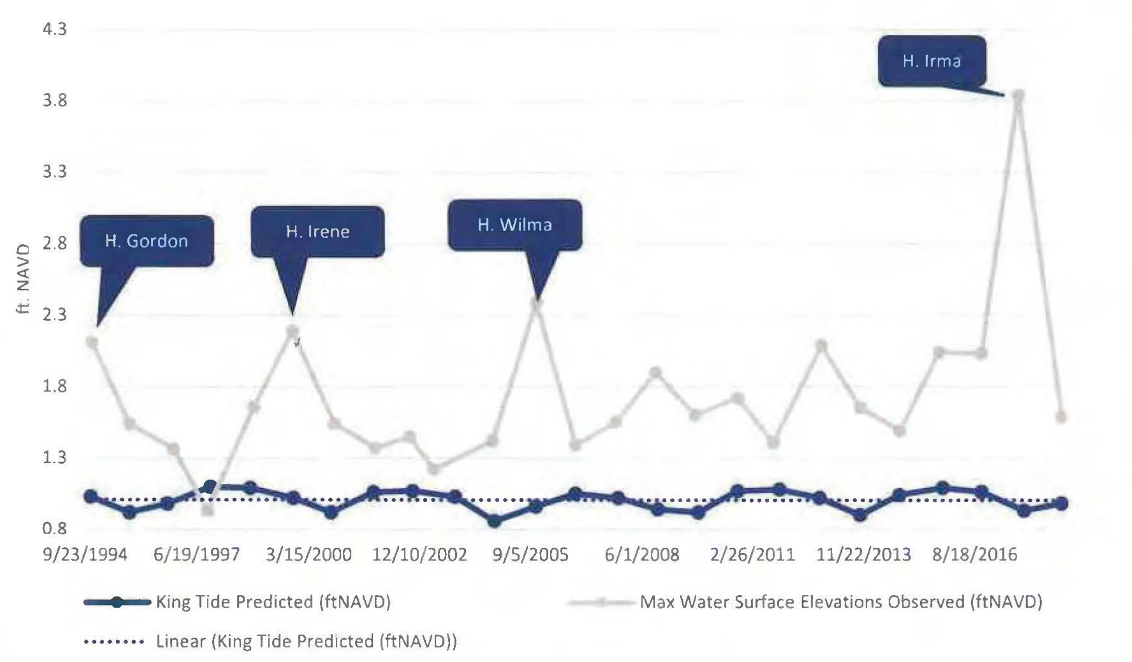


Figure 4. Annual Maximum Water Surface Elevation and Predicted King Tides (Highest Astronomical Tide) Each Year at Virginia Key (1994–2018)

The LOS for roads in Miami Beach is a choice the City needs to make based on a balance of risk versus cost. A higher LOS equates to a lower probability of flooding and a higher road elevation. The higher the road elevation, the higher the cost both in road construction and in harmonization. Table 2 provides Jacobs' recommendations on LOS to provide for the three categories of road and the corresponding probabilities of flooding and water surface elevations.

Table 2. LOS Recommendations by Road Type

Historical water surface elevations for each assumed probability of flooding target

Road Type	Level of Service – Probability of Flooding in a Given Year	Water Surface Elevation for Given LOS
Residential Roads	50% chance (2-year storm)	1.7 ft NAVD
Commercial Roads	20% chance (5-year storm)	2.3 ft NAVD
Emergency Roads	10% chance (10-year storm)	3.0 ft NAVD

Note: All water surface elevations reflect current historical estimates for a given probability of flooding (LOS).

2.3 Sea Level Rise – Projection Curve Selection and Planning Design Horizon

The previous design road elevation guidance for the City was based on the most current approved set of SLR projection curves that were adopted in region, the 2015 Unified Sea Level Rise Projection adopted by the Southeast Florida Regional Climate Compact (SEFLCC).[9] More recent sea level rise projections were published by NOAA in 2017.[10] These NOAA 2017 projections are used in this guidance document. However, the framework presented herein can be readily updated when new projections are available from SEFLCC, as is expected in December 2019.

[9] Southeast Florida Regional Climate Change Compact. 2015. Sea Level Rise Work Group. *Unified Sea Level Rise Projection for Southeast Florida*. August 12.

[10] NOAA. 2017. *GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES*. NOAA Technical Report NOS CO-OPS 083. January.

Figure 5 and Table 3 summarize SLR projections available from NOAA 2017. Figure 5 shows all five curves available from NOAA 2017, which are relative to 2000 baseline. Table 3 has converted the top four curves to a tabular format and adjusted the start year baseline to 2020.

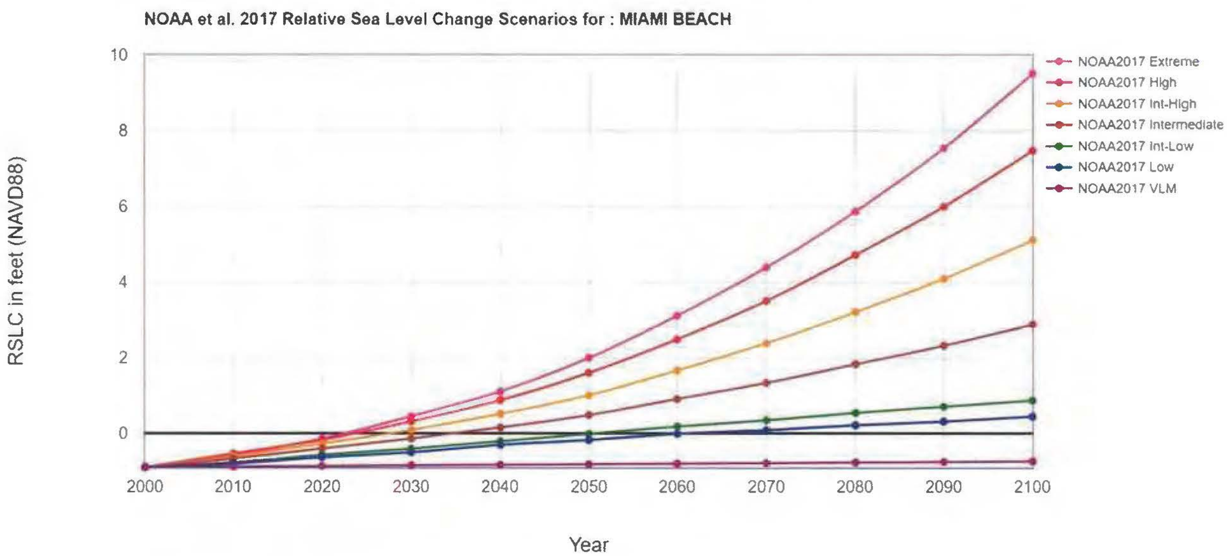


Figure 5. NOAA 2017 Relative Sea Level Rise Projections for Miami Beach

Table 3. Relative Sea Level Rise Projections for Miami Beach

		SLR Increment from 2020 NOAA (2017) Curve			
Year	Road Useful Life	Intermediate	Intermediate-High	High	Extreme
2020	0	0	0	0	0
2030	10	0.3	0.4	0.5	0.6
2035	15	0.4	0.6	0.8	0.9
2040	20	0.6	0.8	1.1	1.3
2045	25	0.7	1.0	1.4	1.7
2050	30	0.9	1.3	1.8	2.1

Source: NOAA. 2017. *GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES*. NOAA Technical Report NOS CO-OPS 083. January.

All numbers have been rounded to nearest 0.1 ft.

Deciding which SLR projection to use for setting road design elevations includes two key considerations:

- Determining the useful life of the road
- Deciding which SLR projection curve to use

The useful life of a road is between 20 and 30 years, depending a range of factors including materials, traffic loads, and wet/dry cycles. This includes the entire road section, not just the top pavement layer, which generally has a shorter useful life of approximately 15 years. Jacobs agrees with earlier City assumption that the SLR for road elevation calculations can be based on a 30-year useful life of the road.

Jacobs recommends adopting the Intermediate-High Curve with a 30-year useful life of roads for less critical commercial and residential roads and adopting the High Curve for critical emergency access roads. This is consistent with the framework presented by the SEFLCC where higher SLR projection curves are recommended for more critical infrastructure. Therefore, for a residential or commercial road built in 2020, a rise of 1.3 ft should be considered and for an emergency access road built in 2020 a rise of 1.8 ft should be considered.

The choice of SLR curve to use should recognize that there is uncertainty in the climate science that is the source of the projections, just as there is uncertainty in all master planning projections of population and economic growth. Attachment B summarizes probabilities associated with the different SLR projection curves, as well as recent scientific literature providing evidence of acceleration in measured rates of SLR both in Florida and in global mean sea level.

2.4 Summary of Design Road Elevation at Edge of Road (Method 1) and Bottom of Road Base (Method 2)

As previously indicated, two different road elevation constraints should be evaluated for any given road to determine the final design road elevation:

- The road elevation at the EOP that allows for limited flooding, based on LOS and SLR specified by road type
- The road elevation at the bottom of the road base that prevents wetting of the bottom of the road section resulting from high groundwater (from high tide with SLR)

Of these two methods, the one resulting in the highest elevation should be used. Table 4 summarizes the two methods of calculating design road elevations for all categories of roads. Based on the assumptions given in Table 4, Method 2 should be used for all roads except emergency roads. Therefore, the DRE for roads built in 2020 should be 3.9 ft NAVD for residential or commercial roads and 4.8 ft for emergency roads, unless harmonization constraints prevent using those targets.

It should be noted that Method 2 lists an assumption of a clearance of 1 ft from groundwater elevation at high tide, given by MHHW, to the bottom of the road base. However, at the beginning of the 30-year life of a road, there actually is a greater clearance including the allowance for SLR. For example, for residential roads that clearance is 1.3 + 1 = 2.3 ft. It should also be noted that Method 2 assumes a road thickness of 1 ft for the base and pavement layers.

As presented in Attachment A, DREs should increase for roads built after 2020 reflecting the increasing rate of SLR, as shown on Figure 5.

Figure 6 illustrates the calculation of the minimum elevation for the bottom of road base (Method 2), which applies to all road types.

Figure 7 illustrates the calculation for minimum elevation of the EOPs with Method 1, which applies to emergency roads because Method 1 produces a higher elevation than Method 2.

Figures 8 and 9 illustrate the calculation for commercial and residential roads, respectively, of minimum elevation of the EOP with both Methods 1 and 2. These figures show that Method 2 should be selected because it results in a higher elevation at the EOP of 3.9 ft (assuming a 2020 project start and a minimum road base of 1 ft).

Table 4. Summary of Design Road Elevation Methods for Roads Built in 2020
All elevations are in NAVD88.

	Method 1 – Limited Flooding at Edge of Road[a]			Method 2 – Limited Tidal Wetting of Road Base[a]
Applicability	Residential Roads	Commercial Roads	Critical Access Roads	
Level of Service	Minimum Standard to Avoid Flooding from 50% Chance Tide + Surge Event (2-yr), with SLR for 30 Years	Minimum Standard to Avoid Flooding from 20% Chance Tide + Surge Event (5-yr), with SLR for 30 Years	Minimum Standard to Avoid Flooding from 10% Chance Tide + Surge Event (10-yr), with SLR for 30 Years	All Roads, Road Base + Road Thickness
Current Probability of Flooding	50%	20%	10%	MHHW
Baseline Water Surface Elevation	1.7 ft	2.3 ft	3.0 ft	0.6 ft
Sea Level Rise	1.3 ft	1.3 ft	1.8 ft	1.3 ft
SLR Rationale	30 years, NOAA 2017 Intermediate-High Curve	30 years, NOAA 2017 Intermediate-High Curve	30 years, NOAA 2017 High Curve	30 years, NOAA 2017 Intermediate-High Curve
Road and Base Thickness (varies)	N/A	N/A	N/A	1.0 ft[b]
Road Base Clearance Above SHGWT (freeboard)	N/A	N/A	N/A	1.0 ft
Min. Road Elev. (edge of pavement)	**3.0 ft[c]**	**3.6 ft**	**4.7 ft**	**3.9 ft[b]**

[a] The higher design road elevation calculated by the two methods should be selected.

[b] Where road design thickness is greater than 12 inches (1.0 ft) inclusive of base material and pavement (base and wear course), the difference in additional thickness should be added to the minimum road elevation.

[c] Road elevations less than 3.5 ft using Method 1 will be influenced by Method 2 as the limiting factor.

Note:

A 1-ft freeboard above the seasonal high groundwater elevation is highly recommended for all road base materials, although the effects on hardened base materials will be minimal compared to conventional base materials.

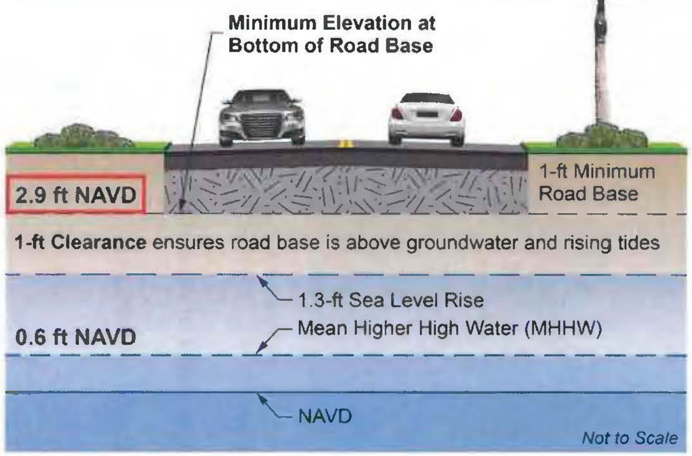
The SLR projection factored into the minimum road elevation will provide some freeboard for the early years of the pavement system, which will diminish over time as the water levels increase.

NOAA = National Oceanic and Atmospheric Administration

SHGWT = seasonal high groundwater table

ALL ROADS: MINIMUM ELEVATION AT BOTTOM OF ROAD BASE

Calculation Method 2: *Limited Groundwater/ Tidal Wetting at Base of Road*

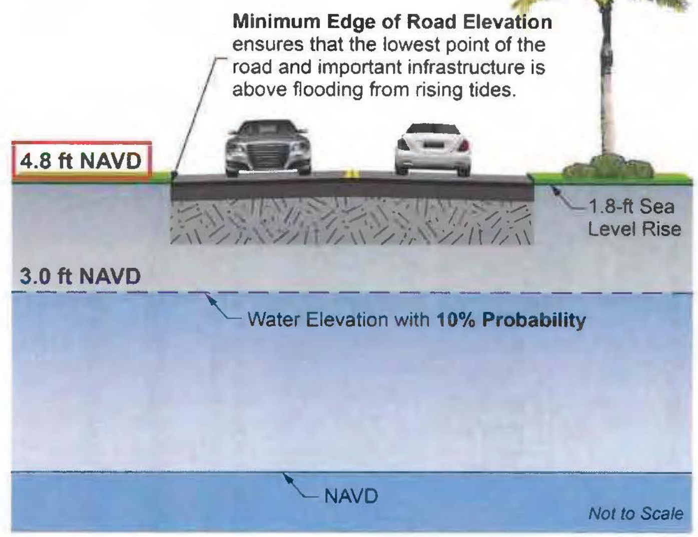


Method 2 is used to set Minimum Elevation of the Bottom of Road Base: 2.5 ft NAVD for projects built in 2020.

Figure 6. Minimum Bottom of Road Base Elevation

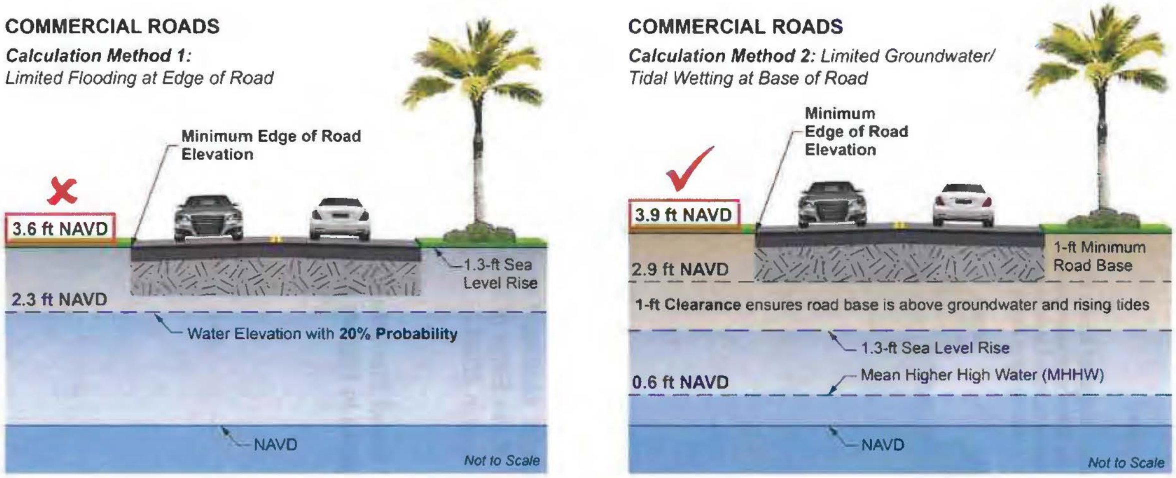
EMERGENCY ROADS

Calculation Method 1:
Limited Flooding at Edge of Road



For Emergency Roads, Method 1 results in higher Minimum Elevation at the Edge of Road for projects built in 2020.

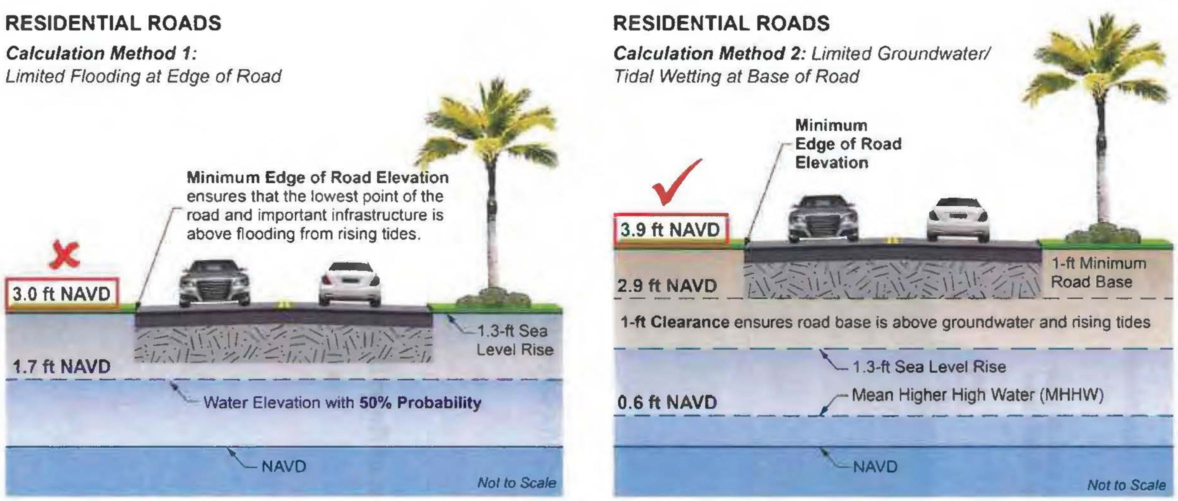
Figure 7. Minimum Edge of Road Elevation for Emergency Roads is Set by Method 1, as it results in Higher Elevation than Method 2



For Commercial Roads, Method 2 results in higher Minimum Elevation at the Edge of Road, assuming projects with 1-ft road thickness and built in 2020.

Figure 8. Comparison for Commercial Roads of Minimum Edge of Road Elevation Calculation by Both Methods 1 and 2

Method 2 results in higher elevation than Method 1 and should be selected.



For Residential Roads, Method 2 results in higher Minimum Elevation at the Edge of Road, assuming projects with 1-ft road thickness and built in 2020.

Figure 9. Comparison for Residential Roads of Minimum Edge of Road Elevation Calculation by Both Methods 1 and 2

Method 2 results in higher elevation than Method 1 and should be selected.

2.5 Road Miles Potentially Requiring Road Raising

Table 5 includes a summary of the road miles potentially requiring road raising given the minimum elevations recommended in Table 4. Figure 10 shows the probabilities of the flood elevations with 1.3 ft of SLR.

Table 5. Road Miles Below Minimum Design Road Elevation by Road Classification

Road Classification	Road Type for Elevation Target	Road Minimum Elevation	Miles Below Minimum Elevation	Total Miles in Category	Percentage Below Minimum Elevation
Principal Arterial	Emergency	4.8 ft NAVD	15.4	27.6	56%
Minor Arterial	Commercial	3.9 ft NAVD	12.0	14.2	84%
Major Collector	Emergency	4.8 ft NAVD	19.3	22.2	87%
Minor Collector	Commercial	3.9 ft NAVD	7.7	9.2	84%
Local	Residential	3.9 ft NAVD	77.7	113.6	68%
Total for All Roads	**All Types**	**varies**	**132.1**	**186.8**	**71%**

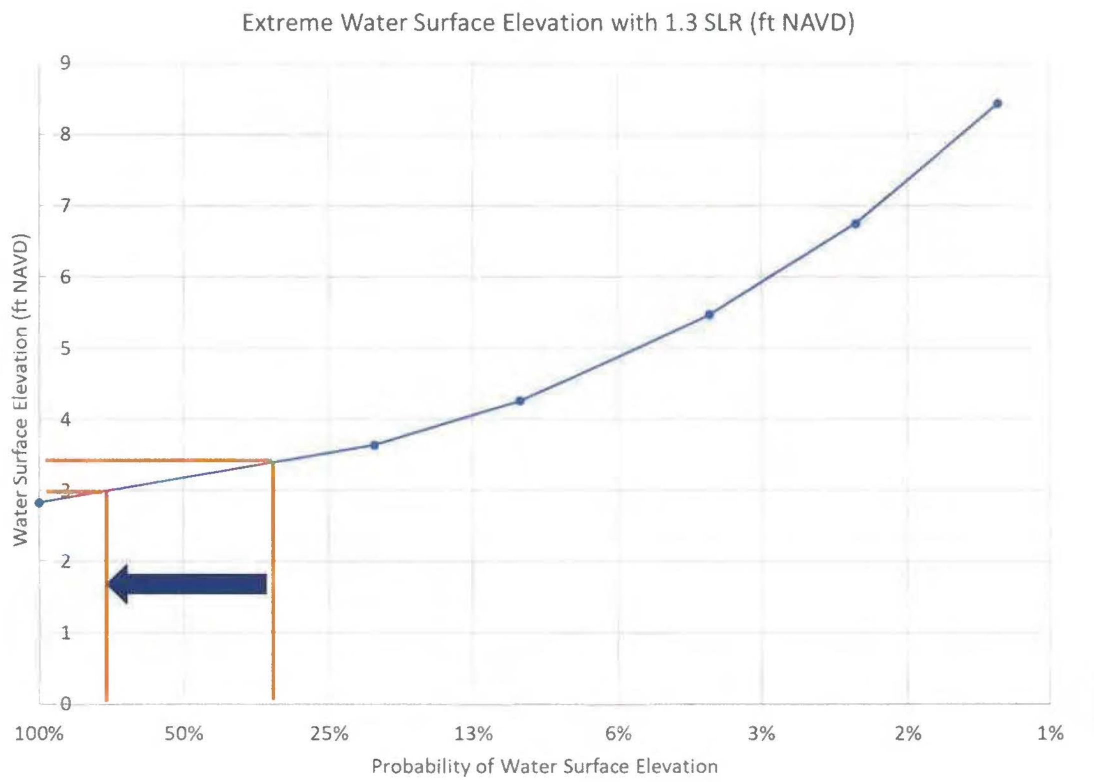


Figure 10. Water Surface Elevations vs. Probability, with Addition of 1.3 ft of SLR
Can be used to estimate decrease in LOS (increase in probability of flooding) for lower minimum design road elevation.

Attachment A
Impacts of Later Project Start Date on Design Road Elevation Recommendations

Attachment A. Impacts of Later Project Start Date on Design Road Elevation Recommendations

All City road projects are anticipated to follow this policy once adopted. The policy is expected to be administered by the Public Works department who will issue final approval for road elevation, prior to issuance of the final construction permits. Any hardship requests (variances) must be submitted in writing to Public Works for review.

The proposed minimum road elevations are based on conditions and future projections as of the date of this memorandum, and future road elevation projects may require a revised set of criteria to meet the objectives of this policy. Therefore, any new road project should consider the anticipated construction date of the roadway and select the appropriate minimum elevations associated with that time horizon. This will promote improved road performance over its service life with the awareness that future flood and groundwater conditions are expected to be higher. Table 2 provides guidance for future road projects in 5-year increments.

Minimum Road Elevations for Future Road Projects

All elevations shown are proposed edge of pavement minimum road surface elevations in ft NAVD88.

		2020	2025	2030	2035	2040
1	Emergency Roads	4.8	5.2	5.7	6.2	6.7
2	Commercial Roads	3.6[a]	3.9	4.2	4.6	5.0
3	Residential Roads	3.0[a]	3.3[a]	3.7[a]	4.0	4.4
4	Method 2 – Road Base protection from SHGWT	3.9	4.2	4.6	4.9	5.3

[a] For elevations below 3.9 ft, the minimum road elevation may be determined based on the groundwater elevation and minimum base clearance. See above road elevation criteria for more info.

Notes:

SLR projections are based on NOAA 2017 Intermediate High for application on commercial and residential roads and Method 2.

Emergency roads are based on NOAA 2017 High SLR projections.

Attachment B
Sea Level Rise Projections and Recent Trends in Measured SLR

Attachment B. Sea Level Rise Projections and Recent Trends in Measured SLR

As with all climate projections, it is useful to quantify the uncertainty to the degree possible and then evaluate what level of risk is appropriate given the criticality of infrastructure. Fortunately, for sea level rise (SLR) projections, the NOAA 2017 report that is the source of the projections used herein included a probability associated with each curve.[11] The probability is expressed in terms of the likelihood that a given SLR projection curve will be exceeded (that is, the likelihood that the projection is too low). The probability is further qualified based on the assumed greenhouse gas emission scenarios that are assumed, which are referred to as Representative Concentration Pathways (RCPs). RCP8.5 represents the highest emission scenario, which is consistent with recent observed data on emissions and a "do nothing" assumption that all global emissions will continue to increase at a rate consistent with current economic and population growth.

Table 4 the NOAA 2017 report summarizes the probability of exceeding each of the six global mean sea level (GMSL) rise scenarios. The NOAA 2017 report describes this table as follows:

> "The six GMSL rise scenarios are also shown (Table 4) relative to the probability of exceedance in 2100 as assessed by the RCP-based probabilistic projections of Kopp et al. (2014). ***Note that the GMSL rise scenarios assume that the rate of ice-sheet mass loss increases with a constant acceleration; however, this might not be the case (DeConto and Pollard, 2016), so it is, for example, possible to be on the Intermediate scenario early in the century but the High or Extreme scenario late in the century***."

The second sentence (italics added) provides an important caveat on selection of a given curve. Recent advancements in climate science, as published in the latest Intergovernmental Panel on Climate Change (IPCC) reports and elsewhere have all pointed to increases in SLR projections with each successive refinement of SLR projections.

Table 4. Probability of exceeding GMSL (median value) scenarios in 2100 based upon Kopp et al. (2014).

GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

B.1 Recent Trends in SLR in Florida and in Global Mean Sea Level

SLR has been well-documented for many years with authoritative data analysis for long periods of sea level data, as described by Church and White.[12] Church and White use data from 1880 to 2009 and find not only considerable global SLR (approximately 210 millimeters [mm]) during that period but also statistically significant acceleration in the most recent period analyzed. Since its publication in 2011,

[11] NOAA. 2017. *GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES.* NOAA Technical Report NOS CO-OPS 083. January.

[12] Church, J. A. and N.J. White. 2011. "Sea-Level Rise from the Late 19th to the Early 21st Century". *Surveys In Geophysics* 32:585–602. September.

additional research has been conducted confirming an acceleration on SLR. This research is consolidated and reported in the most recent IPCC report on oceans and cryosphere where GMSL is found to be rising, with acceleration in recent decades because of increasing rates of ice loss from the Greenland and Antarctic ice sheets, as well as continued glacier mass loss and ocean thermal expansion.[13] The report indicates that, globally, the recent rate of increase in sea level is approximately 2.5 times the rate that was observed in the 1901 to 1990 period:

"Total GMSL rise for 1902–2015 is 0.16 m (likely range 0.12–0.21 m). The rate of GMSL rise for 2006–2015 of 3.6 mm yr–1 (3.1–4.1 mm yr–1, very likely range), is unprecedented over the last century (high confidence), and about 2.5 times the rate for 1901–1990 of 1.4 mm yr–1 (0.8– 2.0 mm yr–1, very likely range)." (IPCC, 2019). The report attributes the acceleration mostly to the sum of ice sheet and glacier contributions over the period 2006–2015, exceeding the effect of thermal expansion of ocean water. Figure A-1 below illustrates the approximation of different rates of rise historically.

One of the most recent papers on SLR acceleration[14] includes Dr. Gary Mitchume from University of South Florida who has conducted local research on sea levels across coastal Florida. In his research, he has concluded that the global SLR projections can be used as a basis and reference for the SLR in Florida.[15] Figure B-1 shows the historic analysis of global SLR.

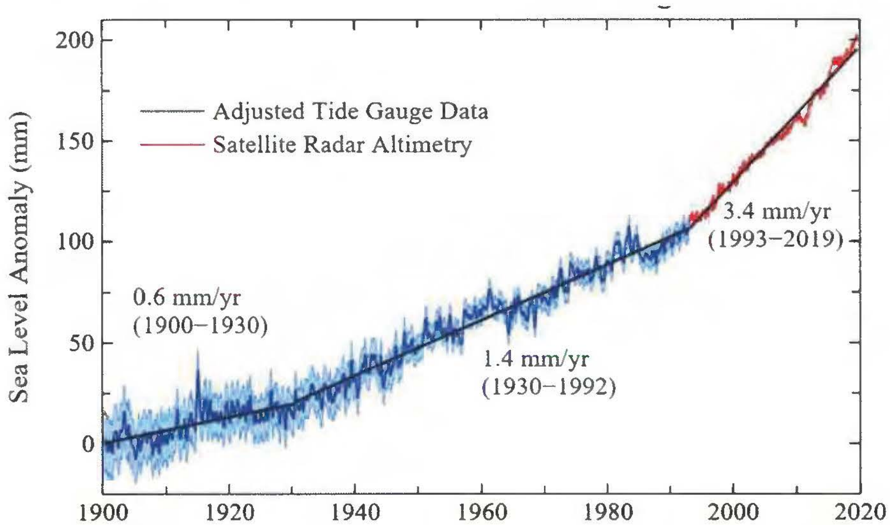


Figure B-1. Global Mean Sea Level Change from 1900 to 2020
Source: *http://www.columbia.edu/~mhs119/SeaLevel*

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[13] Intergovernmental Panel on Climate Change. 2019. *The Ocean and Cryosphere in a Changing Climate*. September 24. https://report.ipcc.ch/srocc/pdf/SROCC_FinalDraft_FullReport.pdf

[14] R. S. Nerema,1, B. D. Beckleyb, J. T. Fasulloc, B. D. Hamlingtond, D. Mastersa, and G. T. Mitchume (2018). Climate-change–driven accelerated sea-level rise detected in the altimeter era. Proceedings of the National Academies of Science PNAS February 27, 2018 115 (9) 2022-2025; first published February 12, 2018.

[15] Mitchum, G., Dutton, A., Chambers, D. P., & Wdowinski, S. (2017). Sea Level Rise. Florida's Climate: Changes, Variations, & Impacts. Retrieved from http://purl.flvc.org/fsu/fd/FSU_libsubv1_scholarship_submission_1515511935_d1ea45d2

Attachment C
Calculation of Updated
Mean Higher High Water (MHHW)

Attachment C. Calculation of Updated Mean Higher High Water (MHHW)

C.1 Background

The nearest active tide gauge operated by National Oceanic and Atmospheric Administration (NOAA) to the City of Miami Beach is Station # 8723214 Virginia Key, Biscayne Bay, Florida, where the available measured data of water level date back to January 28, 1994. Table C-1 lists the published tidal datums at the station for the previous tidal epoch (1960 through 1978) and the present tidal epoch (1983 through 2001). As shown in Table C-1, there has been an increase in the datum elevation in the order of 0.2 ft across the board, assuming that the vertical elevation of the Station Datum, which is the absolute zero of the measuring tide gauge, remains unchanged.

Table C-1. Published Tidal Datums, Virginia Key Station, FL
Source: https://tidesandcurrents.noaa.gov/datums.html?id=8723214

Datum	Elevations (ft Station Datum)		
	Previous Tidal Epoch (1960–1978)	Presents Tidal Epoch (1983–2001)	Difference (Present - Previous, in ft)
MHHW	12.19	12.36	0.17
MHW	12.12	12.30	0.18
MSL	11.05	12.30	0.20
MLW	10.02	10.27	0.25
MLLW	9.89	10.14	0.25
NAVD88	NA	12.15	
Tidal Datum Analysis Periods	02/01/1994–09/30/1997	01/01/1998–12/31/2013	
	12/01/1997–12/31/1999	02/01/2015–01/31/2016	
		04/01/2016–03/31/2017	

Thus, it is conceivable that this documented rise in MHHW may continue into the post-2001 period and it is essential that this rise in MHHW that is not captured in the present tidal epoch be accounted for.

C.2 Purpose

The purpose of the assessment is to estimate the rise in MHHW from 2001 through the present that may be captured in the measured water level data by conducting harmonic analysis of the measured time series to filter out the non-tidal components and calculating the resulting MHHW of the filtered time series that contains astronomical tide signals only.

C.3 Methodology

After recasting the filtered time series in ft NAVD, the following two methods were employed to calculate the updated MHHW, which serve as a check against each other. The two methods are outlined below.

1) First method: 5-year bands

a) Divide the available post-2001 data into 5-year bands (that is, 2001–2005, 2006–2010, 2011–2015, and 2016–2020).

b) Select the mid-year measurement (referenced to the Station Datum) to do the harmonic analysis to generate the associated tidal constituents (that is, for year 2003, 2008, 2013, and 2018 using a tide utility available in the MIKE 21 Toolbox.[16]

c) Use each set of derived tidal constituents in (b) to reconstitute predicted tides for the period 2002 –2020.

d) Calculate the MHHW for each data set of (c)

e) Use the published Station Datum – NAVD relationship in the tidal datum table for 1983–2001 (see Table C-1) to convert to ft NAVD. Note that National Geodetic Survey will replace the North American Datum of 1983 (NAD 83) and the North America Vertical Datum of 1988 (NAVD 88) with a new geometric reference frame and geopotential datum in 2022.[17]

f) Plot the variation of MHHW in (e) with time as shown in the Figure C-1, which shows an approximately linearly increasing trend to reach a value of 0.6 ft NAVD in 2018 (that is, a rise of 0.4 ft compared to that for the tidal epoch 1983–2001 [0.2 ft NAVD]).

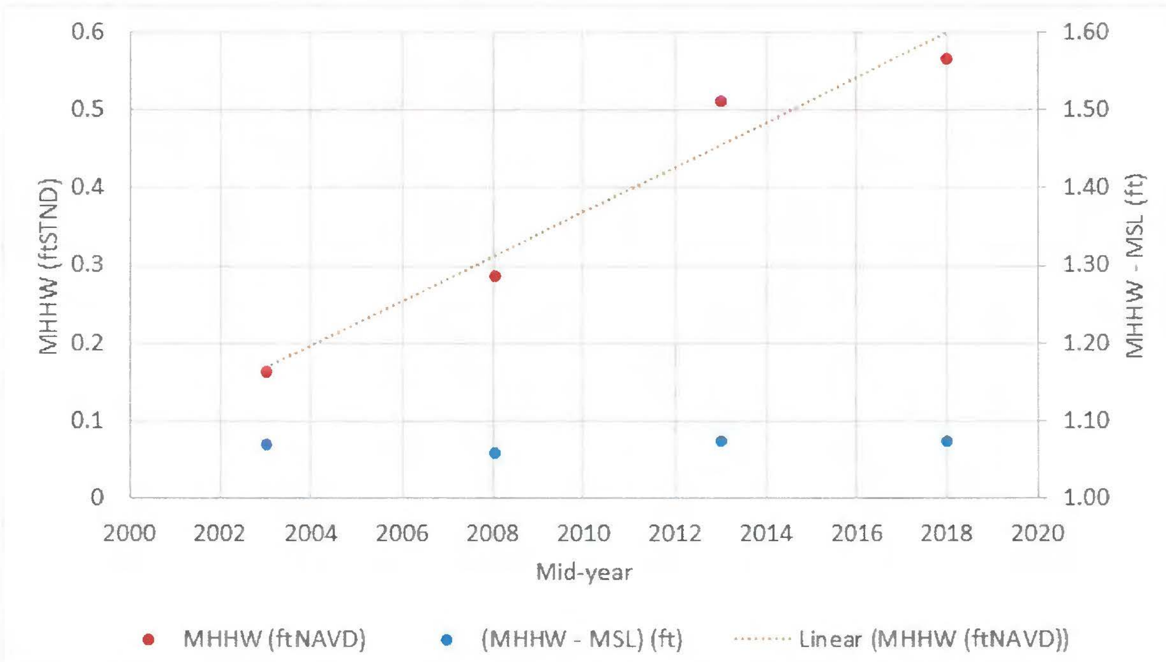

Figure C-1. Variation of MHHW over time, First Method

2) Second Method: Annual MHHW

a) For each complete year of data (2002–2018, referenced to the Station Datum), calculate the predicted tides for the year using the same tide utility above.

b) Calculate MHHW for each annual tide series.

c) Use the published Station Datum – NAVD relationship in the tidal datum table for 1983–2001 (see Table C-1) to convert to ft NAVD.

[16] MIKE Powered by DHI. 2019. *MIKE Toolbox User Manual*. https://www.mikepoweredbydhi.com/mike-2019

[17] https://www.ngs.noaa.gov/datums/newdatums/index.shtml

d) Plot the variation of MHHW in (c) with time as shown in the Figure C-2, which shows an approximately linearly increasing trend to reach a value of 0.6 ft NAVD in 2018 (that is, a rise of 0.4 ft compared to that for the tidal epoch 1983–2001 [0.2 ft NAVD]).

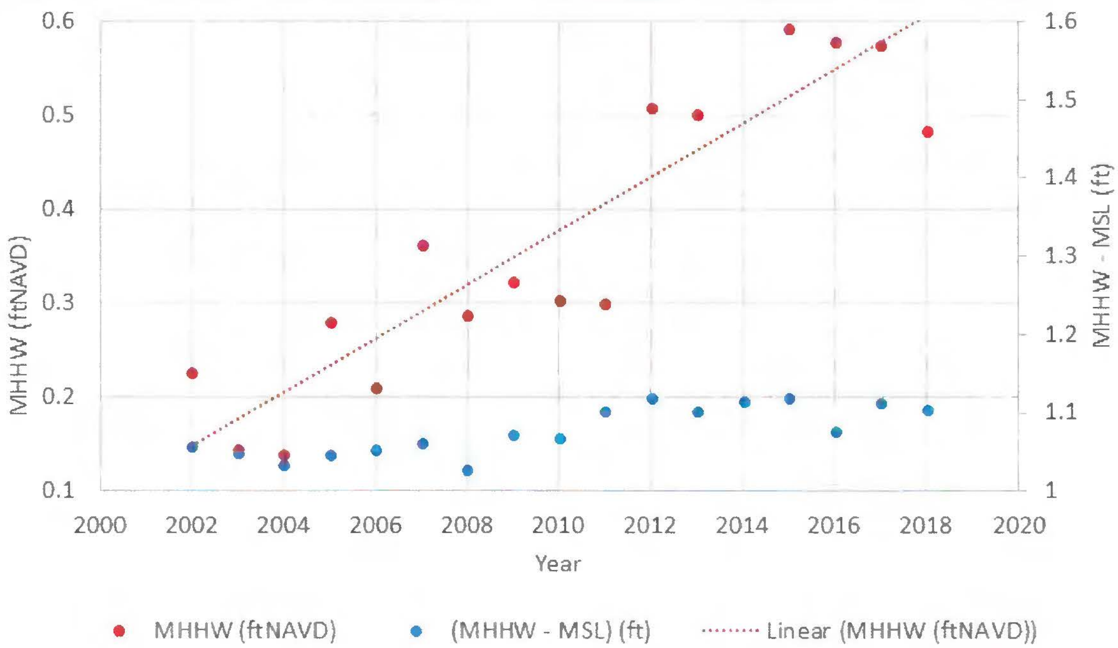

Figure C-2. Variation of MHHW over time, Second Method

C.4 Results and Recommendation

Both methods yield the same MHHW of 0.6 ft NAVD in 2018. Figures C-1 and C-2 also show the respective time variation in the excursion of MHHW above mean sea level (MSL), which shows minor variation over time when compared to those seen in the MHHW curve. This may suggest that the MSL is rising in step over the same time span as is the trend evident from Table C-1 (that is, the increase in MHHW may be a reflection of sea level rise [SLR] and therefore potentially embedded in the SLR analysis conducted independently).

Therefore, Jacobs recommends that an MHHW of 0.6 ft NAVD be adopted and to use 2019/2020 as the start year to calculate the SLR projections.

Appendix B
Road Hardening and Typical Sections

JACOBS

Memorandum

3150 SW 38th Avenue, Suite 700
Miami, FL 33146
T 305.441.1846
F 305. 443.8856
www.jacobs.com

Subject	**Proposed Road Hardening Strategy**
Project Name	City of Miami Beach Integrated Water Management, WO-1, Task 2, Proposed Road Hardening Strategy
Attention	City of Miami Beach
From	Jacobs
Date	October 18, 2019

1. Background

According to the Urban Land Institute's Advisory Services Panel Report for the City of Miami Beach (hereafter, the "City"), Miami Beach's low elevation "is one of its key vulnerabilities" and "over 20 percent of the properties in Miami Beach lie below 3.7 feet [ft] NAVD, with 93 percent within the FEMA-designated Special Flood Hazard Area".[1]

The following typical cross-section of Miami Beach illustrates the City's low ground elevation, providing typical ground elevations (in feet NAVD) for different sections of the City. These typical ground elevations are in some cases only a few feet above the Mean Sea Level of -0.90 ft NAVD for Biscayne Bay, recorded at the National Oceanographic and Atmospheric Administration (NOAA) Virginia Key tidal datum station.

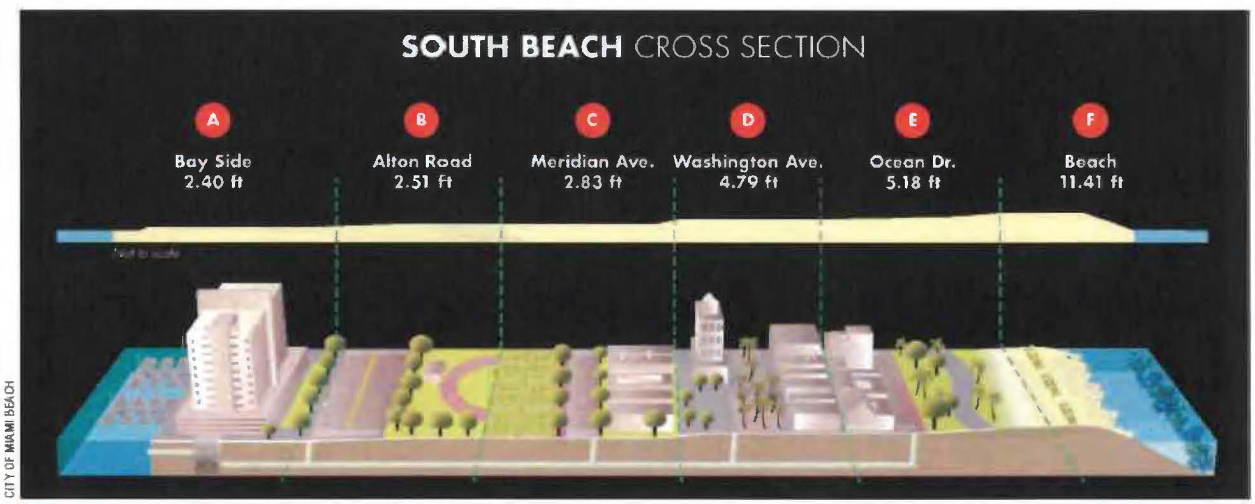

Figure 1. Miami Beach Cross Section
Source: Stormwater Management and Climate Adaptation Review *(ULI, 2018)*

[1] Urban Land Institute (ULI). 2018. *Stormwater Management and Climate Adaptation Review.* A ULI Advisory Services Panel Report for Miami Beach, Florida. April.

The City's groundwater includes a freshwater zone surrounded by a saltwater zone, which is shown in the following illustration from the ULI report. This freshwater or non-saline zone of groundwater, described as a "freshwater bowl" in the ULI report, is continually being recharged with rainwater that seeps into the ground by gravity. The top of this non-saline groundwater zone fluctuates throughout the year at a level higher than the coinciding tide level and is generally highest during the wet/rainy season from May through October, when rainwater recharge is greatest.

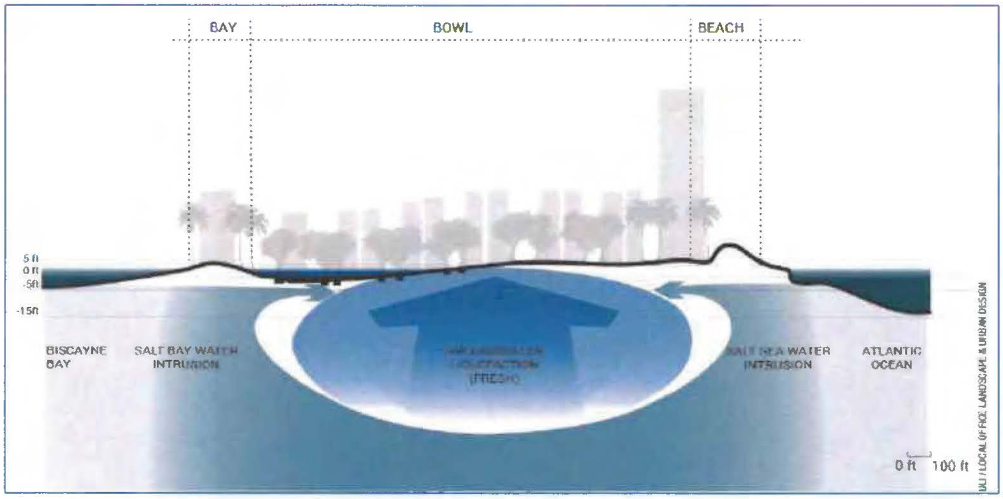

Figure 2. Miami Beach Freshwater Lens
Source: Stormwater Management and Climate Adaptation Review *(ULI, 2018)*

As shown in the results of the City's groundwater monitoring, as well as the boring logs for the Florida Department of Transportation's (FDOT's) Alton Road and Collins Ave. improvement projects, groundwater levels throughout the year fluctuate within only a few feet of the ground surface in many areas of the City. The monitoring results show that as tide levels increase, so do groundwater levels throughout the City. Given the direct influence that tide elevation has on the City's groundwater levels (because of the City's underlying highly permeable/transmissive geologic formations), it is anticipated that as ocean levels continue to rise, the City's groundwater table will also rise at the same rate, bringing the groundwater table even closer to the existing ground surface. This will result in a general decrease in the bearing capacity of the City's surficial soil over time, as it becomes increasingly saturated by a rising groundwater table. This will have a detrimental effect on the durability and strength of roadways as the soil directly beneath them weakens because of increasingly saturated conditions.

2. Recommended Design and Construction Standards for Non-Permeable Asphalt Paved Roadways

The following is a list of recommended design and construction standards for new and reconstructed public roads within the City. These recommendations are intended to minimize pavement distress and structural failure of the City's roads before the end of their design life, caused by over-saturation of their base and subgrade layers resulting from rising groundwater levels. Adopting these road hardening/ resiliency standards may result in an increase in the initial cost of some roadway projects. However, the increased long-term durability and service life of these roads, in future higher groundwater and tidal conditions, will result in a potential decrease in the life-cycle cost of these roads because there will be longer intervals between the required maintenance, rehabilitation, and/or replacement of their pavement systems. These proposed standards address the design and construction of the typical layers of a hot mix asphalt paved road, which are shown in Figure 3, which was derived from Figure 2.1 of the FDOT

FLEXIBLE PAVEMENT DESIGN MANUAL (FPDM).[2] These proposed standards are also recommended for incorporation into the City's Public Works Manual.

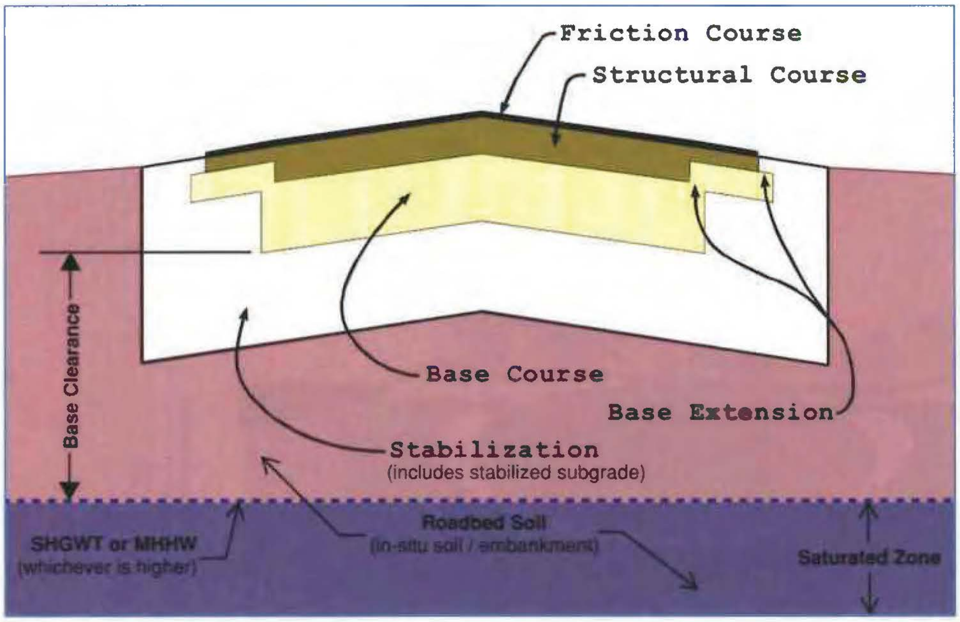

Figure 3. Typical Asphalt Paved Roadway Section
Adapted from FDOT FLEXIBLE PAVEMENT DESIGN MANUAL *(January 2018)*

1) The pavement system for asphalt paved roadways shall be designed in accordance with the requirements and procedures of the latest edition of the FDOT FPDM. The calculation of the required structural number for the roadway pavement system shall be based on the following design variables:
    a) Accumulated traffic loading of roadway during its design life (ESAL value)
    b) Resilient Modulus (M_R) of the roadway subgrade
    c) Minimum Reliability (%R) factor of 90
2) The roadway embankment, stabilized subgrade, base layer, asphalt structural course, and asphalt friction course shall meet the material and construction requirements of the latest edition of the FDOT Standard Specifications for Road and Bridge Construction.
3) As shown in Figure 3, base clearance shall be the vertical distance between the bottom of the roadway base layer and the estimated seasonal high groundwater table (SHGWT) elevation at the road location or the mean higher-high water (MHHW) elevation from the NOAA tidal datum station closest to the road, whichever is higher. The SHGWT and MHHW elevations used for base clearance determinations shall be the SHGWT and MHHW elevations expected at the end of the roadway's design life, factoring in sea level rise (SLR). The degree of SLR used to estimate the SHGWT/MHHW elevation at the end of the roadway's design life shall be based on the City's adopted SLR projection for roadway projects. When the base clearance is less than 3 ft, a reduced M_R shall be used for the pavement structural calculations, as required in the FDOT FPDM. Roads shall be designed to provide a minimum base clearance above the site-specific SHGWT/MHHW elevation of 1 ft or greater.
4) The base layer of all roadway pavement systems shall be supported by a layer of Type B Stabilized Subgrade, with a minimum limerock bearing ratio of 40, per Section 160 of the FDOT standard specifications. The stabilized subgrade layer shall have a minimum thickness of 12 inches, compacted to 98 percent of its maximum dry density per ASTM D1557.

[2] FDOT. 2019. *FLEXIBLE PAVEMENT DESIGN MANUAL*. OFFICE OF DESIGN, PAVEMENT MANAGEMENT SECTION. January

5) The base course for all asphalt paved roads shall be asphalt base, Type B-12.5 (aka, black base), per Section 234 of the latest edition of the FDOT Standard Specifications.

6) Roadway excavation and embankment construction, including requirements for the removal of unsuitable soil, and the placement and compaction of roadway fill materials, shall be in accordance with the City's requirements and the geotechnical report recommendations for the roadway project as well as FDOT's latest standards, which include Section 120 of the FDOT Standard Specifications and Index 120-001 of the FDOT Standard Plans. All fill material placed and compacted beneath the roadway shall be compacted to 98 percent of its maximum dry density per ASTM 1557.

3. Additional Information and Other Considerations Concerning Roadways/Pavement

3.1 Comparison of Strength and Required Layer Thickness of FDOT Standard Roadway Base Materials

The difference between the required thickness for an asphalt base versus a typical granular base for a given structural number is shown in Table 5.6 of the FDOT FPDM. The difference in relative strength (layer coefficient) of asphalt base versus a typical granular base is shown in Table 5.4 of the FDOT FPDM.

3.2 Uses for Geocells

The City should consider the use of geocells to stabilize grassed shoulders/buffer strips along roads where vehicles frequently park to prevent rutting and over-compaction of soil in grassed areas caused by vehicles, which leads to a loss in the permeability and stormwater storage capacity of the soil.

Geocells should also be considered as part of permeable pavement systems for parking lots, whether they are filled with soil for a grassed system or filled with gravel.

3.3 Permeable Pavement Options

At appropriate locations, the City should consider using permeable pavement for sidewalks, shared-use paths, bike lanes, low-volume dedicated use lanes, on-street parking lanes, roadway shoulders, low-traffic-volume residential roads or alleyways as well as parking lots to minimize runoff generated within roadway basins and the resultant stormwater flows to the storm sewer systems. Permeable pavement should be located in areas that are conducive to routine cleaning/ maintenance and should not be located in areas that regularly receive runoff with a heavy silt/sediment load, which can cause clogging and reduce the permeability rate of the pavement. A University of Florida report published in April 2019 provides an overview of typical permeable pavement systems as well as design, construction and maintenance considerations for permeable pavement systems.[3] Figure 4 shows some examples of permeable pavements, which include from left to right: permeable pavers, porous asphalt, pervious (porous) concrete, concrete grid pavers, and plastic reinforcing grids (geocells).

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[3] University of Florida. 2019. *Permeable Pavement Systems: Technical Considerations*. April. https://edis.ifas.ufl.edu/pdffiles/AE/AE53000.pdf

Figure 4. Common Types of Permeable Pavement
Source: Permeable Pavement Systems: Technical Considerations.
https://edis.ifas.ufl.edu/pdffiles/AE/AE53000.pdf

Figure 5 shows a typical cross-section of a permeable pavement system for common pavement materials.

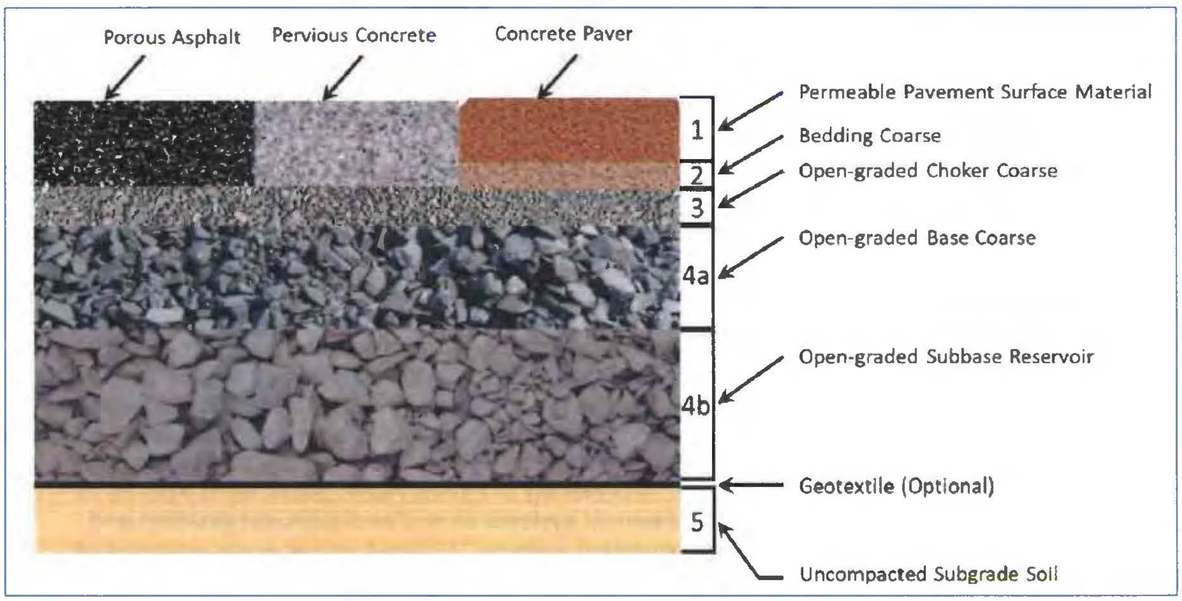


Figure 5. Typical Permeable Pavement Cross-Section for Common Pavement Types
Source: Permeable Pavement Systems: Technical Considerations.
https://edis.ifas.ufl.edu/pdffiles/AE/AE53000.pdf

Because permeable pavement systems are designed to be supported by bound and/or unbound permeable bases, FDOT standard asphalt base will not be compatible with permeable pavements because standard asphalt base is impermeable. However, FDOT standard aggregates may be used where unbound base materials are required for permeable pavement systems. Likewise, FDOT standard bound permeable bases, such as asphalt-treated permeable base and cement-treated permeable base, may be used where bound base materials are required. In addition, FDOT standard Draincrete may be used where bound base materials are required.

FDOT does not have published standards for the design and construction of complete permeable pavement systems. However, the District of Columbia Department of Transportation (DDOT), California Department of Transportation, Connecticut Department of Energy and Environmental Protection, San Diego County Public Works Department, Pinellas County Public Works Department, Sarasota County, West Palm Beach, New York City, Chicago, New Orleans, and other governmental agencies across the U.S. have authorized the use of various types of permeable pavement systems within their jurisdictions and published standards, specifications, and/or guidance documents pertaining to the selection, design, construction and maintenance of permeable pavement systems. In addition, the Federal Highway Administration, the U.S. Environmental Protection Agency, American Society Of Civil Engineers, the University of Florida, and the University of Central Florida have published guidance documents and research papers about permeable pavement systems.

Table 1 provides guidance on selecting the appropriate permeable pavement system for both vehicular use (alleys and roadways) and pedestrian use (sidewalks, trails, covered soil volume/area for plants) for a given type of roadway or walkway (dot indicates that pavement system is appropriate for the roadway/walkway application).

Table 1. Permeable Pavement System

Source: Section 33.14.4.1 of DDOT's Green Infrastructure Standards[4]

Type / Application	Alley	Roadway*	Sidewalk	Covered Soil Volume for Plants	Trail
Porous Asphalt	•	•			•
Pervious Concrete	•	•	•	•	•
Permeable Interlocking Unit Pavers	•	•	•	•	
Other Unit Pavers **				•	
Porous Rubber Paving			•	•	•
Porous Bound aggregate			•	•	
Plastic Grid Pavers	•			•	

* Appropriate for low volume roadways & dedicated parking lanes; Not currently allowed for collectors, arterials, and freeways.

** Spaced to allow infiltration

In addition, Section 33.14.46 of DDOT's *Green Infrastructure Standards* lists the following limitations when considering the use of permeable pavement.

- Bottom of permeable pavement system must be at least 2 ft above the seasonally high water table. [Note this is likely a water quality consideration, not a structural one.]
- Permeable pavements with infiltration are not allowed in Hot Spots, as defined in the District Department of Energy and Environment Guidebook.
- Permeable pavement requires more frequent maintenance if installed in areas where sand and sediment accumulate is expected, such as near the beach. It is important to minimize the build-up of sand and other fine soil particles on permeable pavements so that their infiltration rate is not reduced (and in some cases irreversibly reduced) by clogging. Studies have shown that routine washing and vacuuming of permeable pavements can help to minimize their clogging over time.

[4] District of Columbia Department of Transportation. *GREEN INFRASTRUCTURE STANDARDS*. 2014. https://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/2014-Final%20DDOT%20Green%20Infrastructure%20Standards.pdf

Appendix C
Tidal Flood Adaptation Projects
(Road Raising Project Summary)

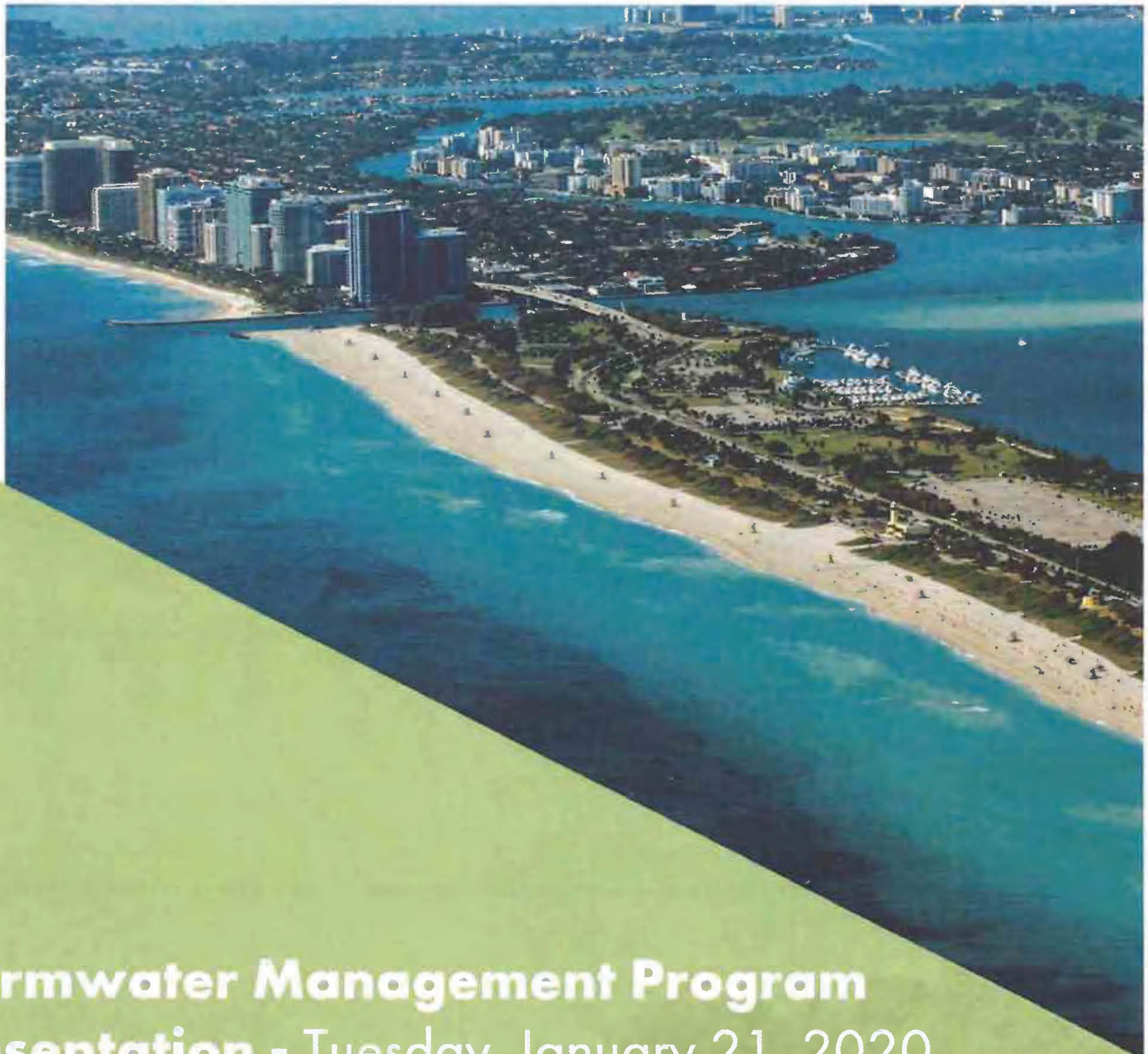
ID	TFAP	Neighborhood
1	10th St	Flamingo/Lummus
2	195 Off Ramp	Bayshore
3	5th St	Flamingo/Lummus, South Pointe
4	5th St N	Flamingo/Lummus, South Pointe
5	69th St	North Shore
6	6th St	Flamingo/Lummus, South Pointe
7	6th St	Flamingo/Lummus, South Pointe
8	Alton Rd 1	West Ave Bay, Rd Flamingo/Lummus, City Center, Bayshore
9	Alton Rd 1	West Ave Bay, Rd Flamingo/Lummus, City Center, Bayshore
10	Alton Rd 2	West Ave Bay, Rd Flamingo/Lummus, City Center, Bayshore
11	Alton Rd 2 W	West Ave Bay, Rd Flamingo/Lummus, City Center, Bayshore
12	Alton Rd 4	South Pointe
13	Alton Rd 6	Bayshore
14	Alton Rd 8	Flamingo/Lummus
15	Bay Dr	Normandy Isles
16	Biarritz Dr	Normandy Isles
17	Bonita Dr	North Shore
18	Byron Ave	North Shore
19	Calais Dr	Normandy Isles
20	Carlyle Ave	North Shore
21	Chase Ave	Bayshore
22	Collins Ave 1	Oceanfront
23	Collins Ave 2	City Center Neighborhood, Oceanfront
24	Collins Ave 3	Oceanfront
25	Collins Ave 4	Oceanfront
26	Crespi Blvd	Biscayne Point
27	Delaware Ave	La Gorce
28	Ed Sullivan Dr	Nautilus Neighborhood
29	Garden Ave	Bayshore
30	La Gorce Cir	La Gorce
31	Marseille Dr	Normandy Isles
32	Meridian Ave	Flamingo/Lummus
33	Michigan Ave 1	Nautilus Neighborhood
34	Michigan Ave 2	Flamingo/Lummus
35	Mitchell St	Normandy Shores
36	Mount Sinai Hospital Pr 1	Nautilus Neighborhood
37	Mount Sinai Hospital Pr 2	Nautilus Neighborhood
38	N Bay Rd 1	La Gorce
39	N Bay Rd 2	Nautilus Neighborhood
40	N Bay Rd 3	La Gorce
41	N Bay Rd 4	La Gorce
42	N Bay Rd 5	La Gorce
43	N Bay Rd 6	La Gorce
44	N Bay Rd 7 5a	Nautilus Neighborhood
45	N Bay Rd 7 5b	Nautilus Neighborhood
46	N Bay Rd 7 5c	Nautilus Neighborhood
47	N Shore Dr 1	Normandy Shores
48	N Shore Dr 2	Normandy Shores
49	Penn Ave	Flamingo/Lummus
50	Prairie Ave	Bayshore
51	Raymond St	Biscayne Point
52	Royal Palm Ave 1	Bayshore
53	Royal Palm Ave 2	Bayshore
54	Royal Palm Ave 3	Nautilus Neighborhood
55	Rue Granville 1	Normandy Isles
56	Rue Granville 2	Normandy Isles
57	Rue Versailles	Normandy Isles
58	S Shore Dr	Normandy Shores
59	Tatum Waterway Dr	North Shore
60	Trouville Esplanade	Normandy Isles
61	Vardon St	Normandy Shores
62	W 29th St	Bayshore
63	W 44th St	Nautilus Neighborhood
64	W Laguna Dr	La Gorce

N W E S

City of Miami Beach
Tidal Flood Adaptation Projects

0 0.5 1 Mile

Appendix D
Public Meeting Summary



Stormwater Management Program Presentation - Tuesday, January 21, 2020

Public Outreach Report

MIAMIBEACH
RISING
ABOVE

Table of Contents

Community Outreach

STORMWATER MANAGEMENT PROGRAM

HOME · CITY HALL · PUBLIC WORKS · OPERATIONS DIVISION · ANNUAL WATER QUALITY REPORT · STORMWATER MANAGEMENT PROGRAM

On Tuesday, January 21, 2020, Jacobs Engineering conducted a public meeting alongside the City of Miami Beach to present tasks 2-3 of their multi-task work order: the road elevation policy and projects prioritization matrix. The meeting provided the following:

- More information about how the recommended road elevation policy will help reduce flooding caused by sea level rise and high tides;
- Insight to the criteria that Jacobs is using to evaluate and prioritize future projects;
- An opportunity for the public to provide feedback before the final recommendations are delivered.

Download the meeting presentation: Jacobs Engineering Tasks 2-3

Review the boards and renderings: Jacobs Engineering Display Boards

Click HERE to watch the recording of the meeting.

For more information please contact:
Liz Bello-Matthews | Public Information Officer | lizbello-matthews@miamibeachfl.gov

What's Next For The City's Stormwater Management Program?

Tonight, January 21| 5:45 PM

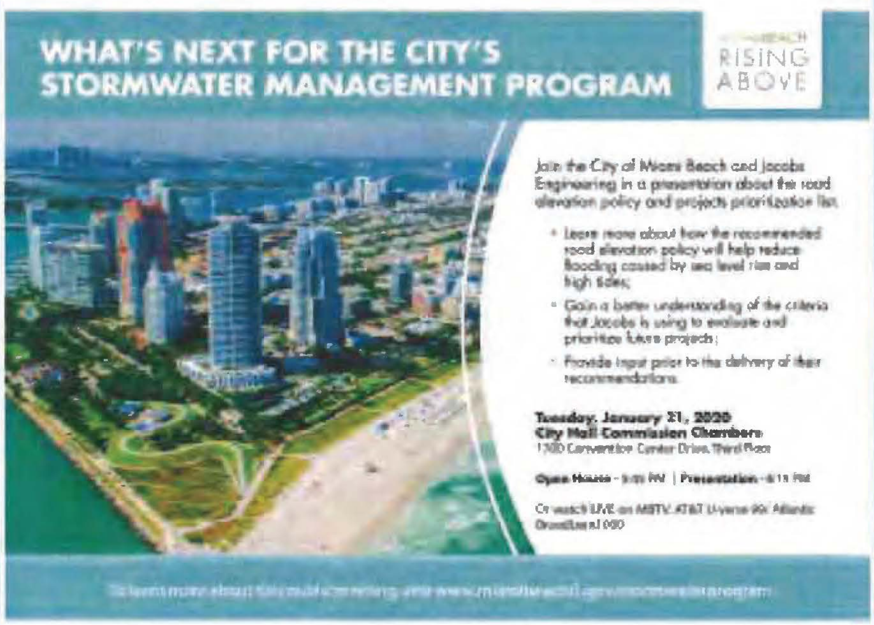
Join the City of Miami Beach and Jacobs Engineering in a presentation about the road elevation policy and projects prioritization list:

- Learn more about how the recommended road elevation policy will help reduce flooding caused by sea level rise and high tides.
- Gain a better understanding of the criteria that Jacobs is using to evaluate and prioritize future projects.
- Provide input prior to the delivery of their recommendations.

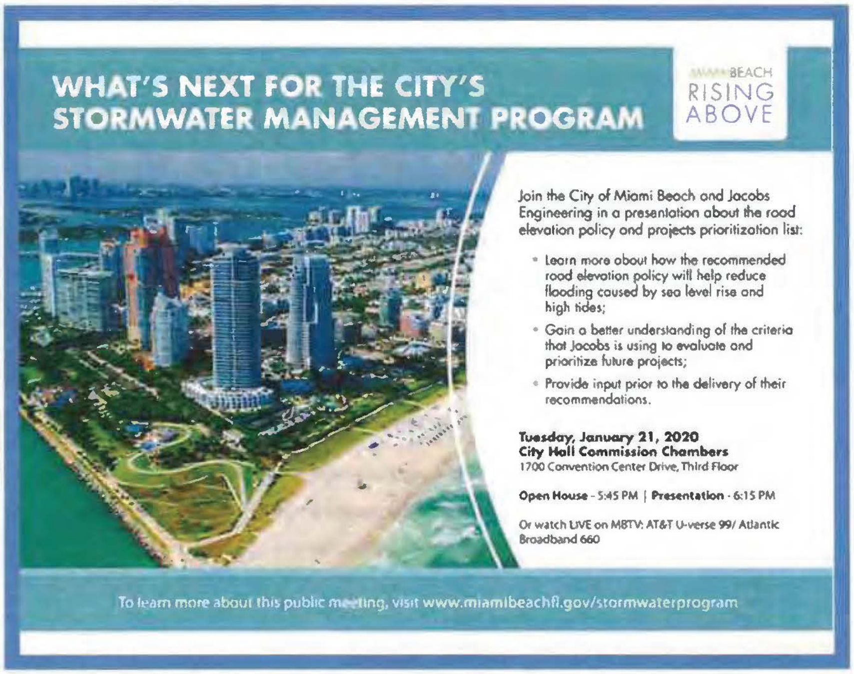
Tuesday, January 21, 2020
City Hall Commission Chambers
1700 Convention Center Drive, Third Floor

Open House – 5:45 PM | Presentation – 6:15 PM

Or watch LIVE on MBTV: AT&T U-verse 99/ Atlantic Broadband 660



E-blast sent on 1/21/2020 - "Learn What's Next For The City's Stormwater Management Program? - Tonight, 1/21"



E-blast sent on 1/3/2020 - "You are Invited"
E-blast sent on 1/13/2020 - "You are Invited"
E-blast sent on 1/20/2020 - "See you Tomorrow"

E-blast sent on 1/22/2020 - "Thank you for joining us!"

City of Miami Beach @MiamiBeachNews · 21 ene.

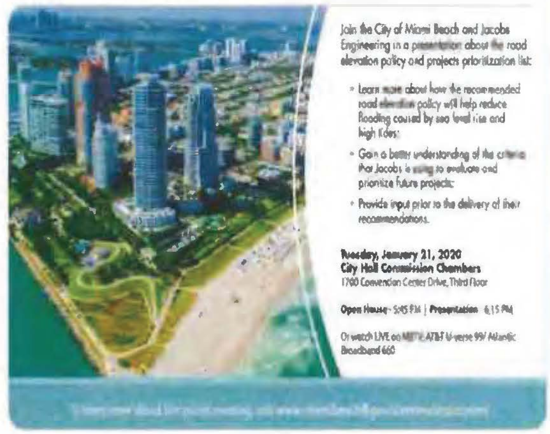
Tonight's stormwater meeting has begun. Stream it live on our Facebook page (facebook.com/cityofmiamibea...) or watch on MBTV (miamibeachfl.gov/government/mbt...) #MBRisingAbove

2 2

Posted on January 21, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 21 ene.

Come out to our open house on tonight to learn about the road elevation policy and projects prioritization list! #MBRisingAbove



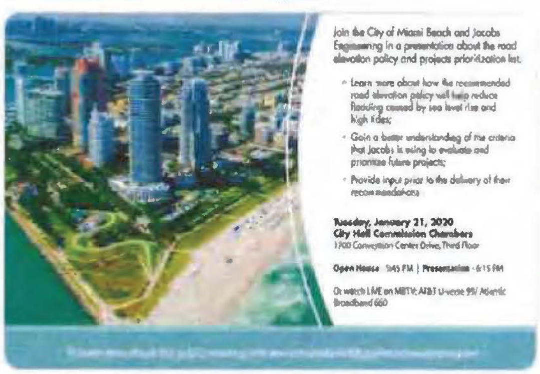
3 5

Posted on January 21, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 16 ene.

City staff will be presenting with Jacobs Engineering & discussing the road elevation policy & projects prioritization list.

Tuesday, January 21
City Hall Commission Chambers
1700 Convention Center Drive #MBRisingAbove

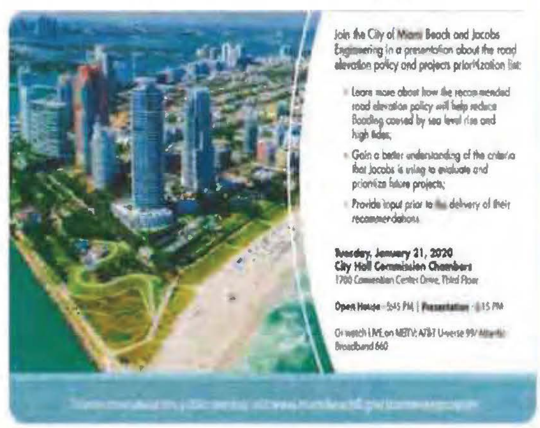


1 7

Posted on January 16, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 14 ene.

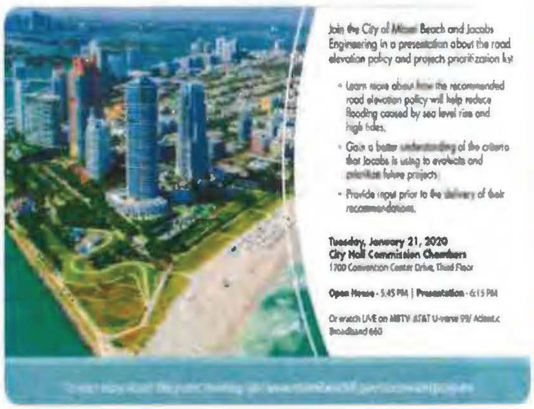
Come out to our open house on Tuesday, January 21 to learn about the road elevation policy and projects prioritization list #MBRisingAbove



4 9

Posted on January 14, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 10 ene.
City staff will be presenting alongside Jacobs Engineering and discussing the road elevation policy and projects prioritization list on Tuesday, January 21 at City Hall #MBRisingAbove

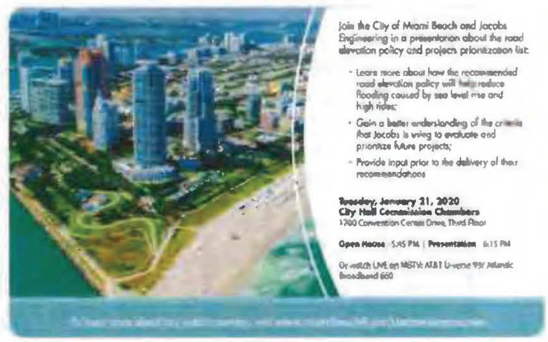


1 5

Posted on January 10, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 9 ene.
Learn more about how the recommended road elevation policy will help reduce flooding caused by sea level rise & high tides during our upcoming community meeting!

Tuesday, January 21
5:45 PM
Miami Beach City Hall
#MBRisingAbove



3 4

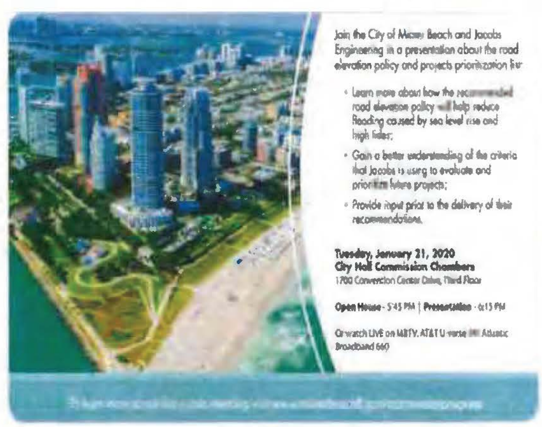
Posted on January 9, 2020 - Twitter

City of Miami Beach @MiamiBeachNews · 7 ene.
Come out to our open house on Tuesday, January 21 to learn about the road elevation policy and projects prioritization list #MBRisingAbove

1 3

Posted on JJanuary 2020 - Twitter

City of Miami Beach @MiamiBeachNews 6 ene.
What's next for the city's stormwater management program? Learn more on Tuesday, January 21 during our open house in City Hall #MBRisingAbove



2 7

Posted on January 6, 2020 - Twitter

Stormwater Management Program Presentation

Community Oureach - Social Media

Posted on January 21, 2020 - Facebook

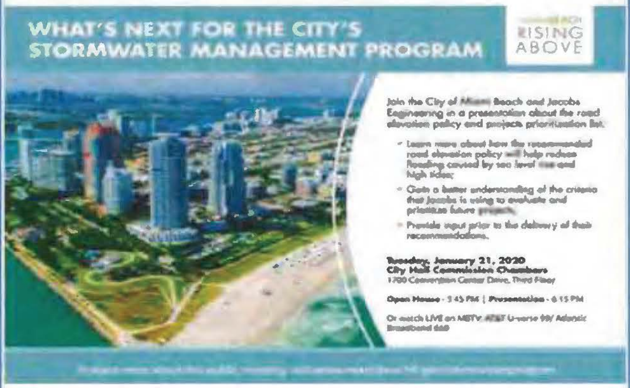
Posted on January 21, 2020 - Facebook

Posted on January 16, 2020 - Facebook

Posted on January 14, 2020 - Facebook

City of Miami Beach Government
10 de enero a las 12:37

City staff will be presenting alongside Jacobs Engineering and discussing the road elevation policy and projects prioritization list on Tuesday, January 21 at City Hall #MBRisingAbove



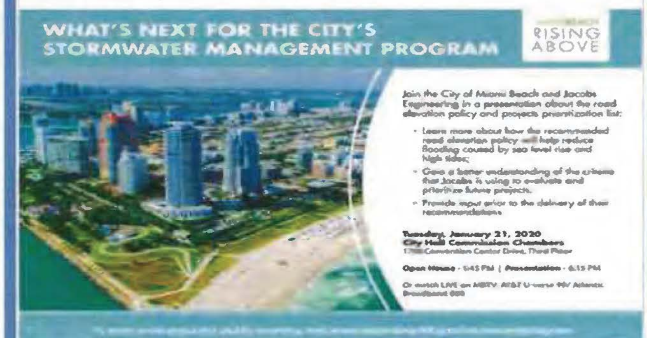
5 · 1 comentario

Me gusta · Comentar · Compartir

Posted on January 10, 2020 - Facebook

City of Miami Beach Government
9 de enero a las 12:18

Learn more about how the recommended road elevation policy will help reduce flooding caused by sea level rise & high tides during our upcoming community meeting!
Tuesday, January 21
5:45 PM
Miami Beach City Hall ... Ver más



8 · 2 comentarios 1 vez compartido

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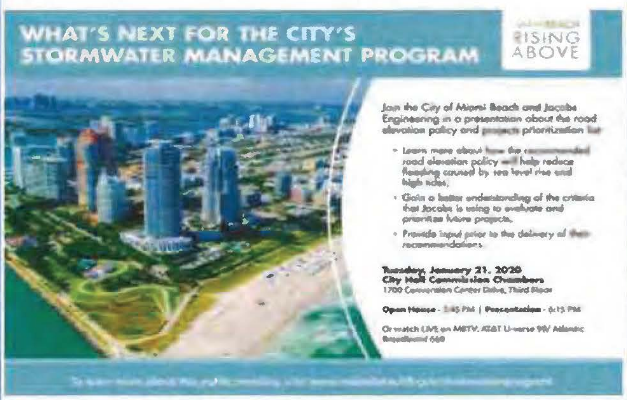
Posted on January 9, 2020 - Facebook

City of Miami Beach Government
7 de enero a las 15:17

Come out to our open house on Tuesday, January 21 to learn about the road elevation policy and projects prioritization list #MBRisingAbove



12 · 2 veces compartido

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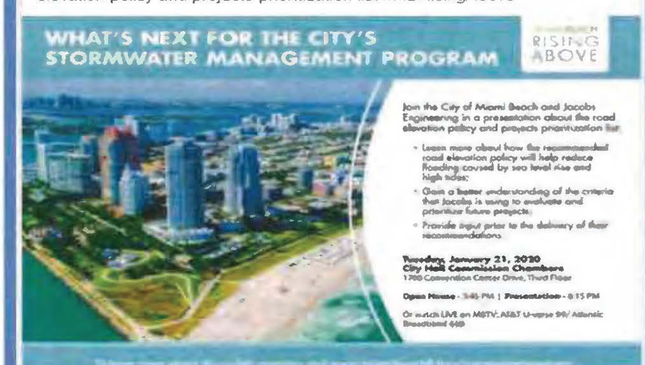
Posted on January 7, 2020 - Facebook

City of Miami Beach Government
30 de diciembre de 2019

What's next for the city's stormwater management program?

Join us on Tuesday, January 21 at City Hall for a presentation about the road elevation policy and projects prioritization list #MBRisingAbove



6 · 1 comentario 3 veces compartido

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Posted on December 30, 2019 - Facebook


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HUMANA
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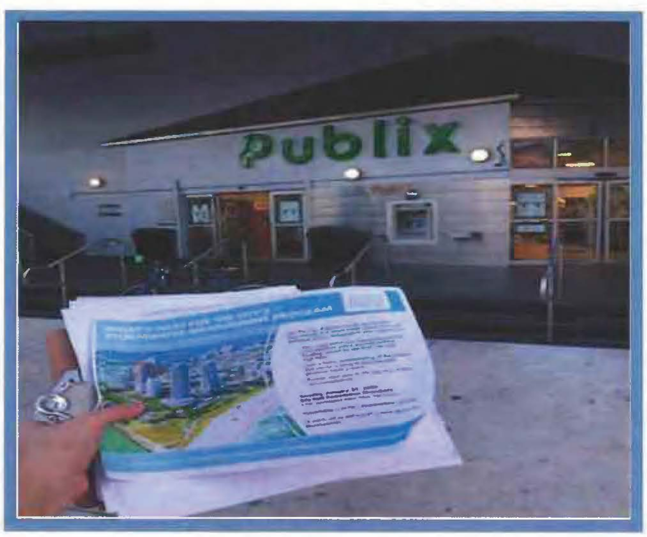
Most Insurances Accepted


IHOP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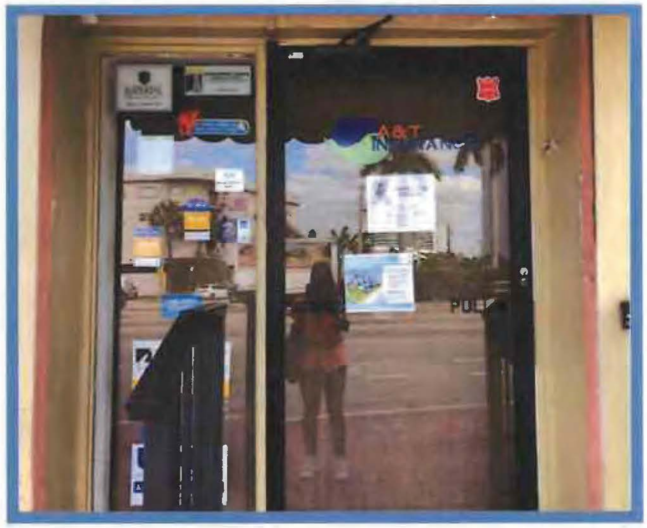
· COIN LAUNDRY
· DRY CLEANING

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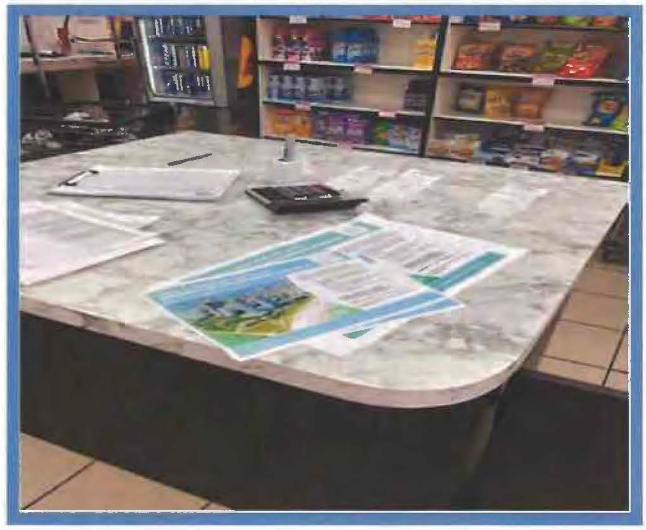


COMMUNITY NEWS
We
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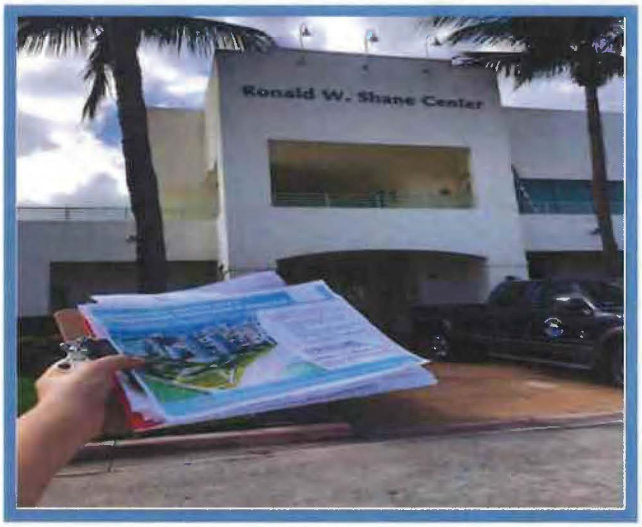
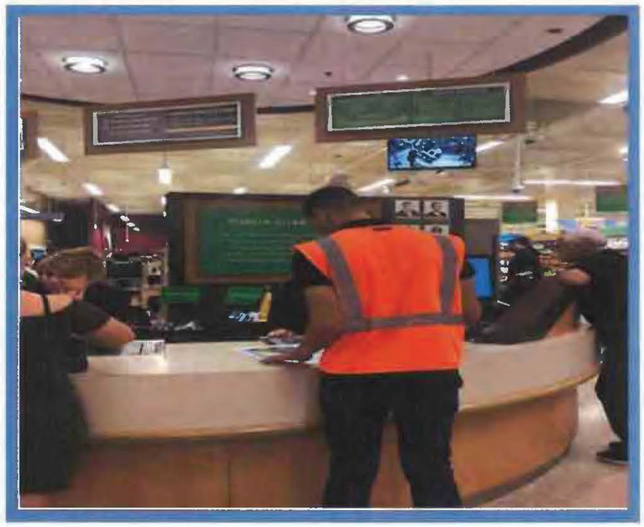
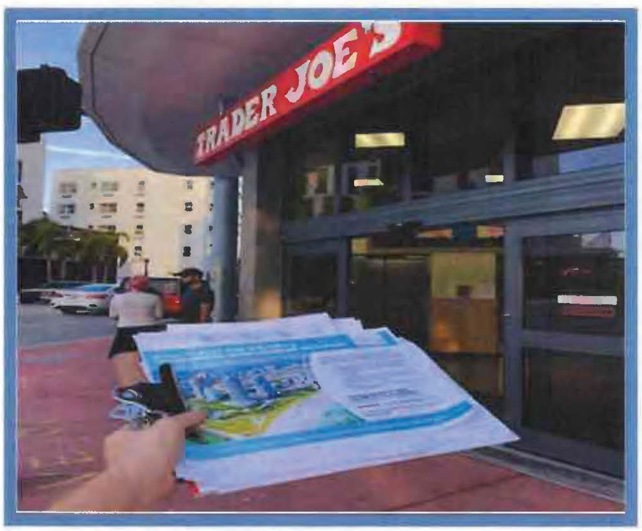
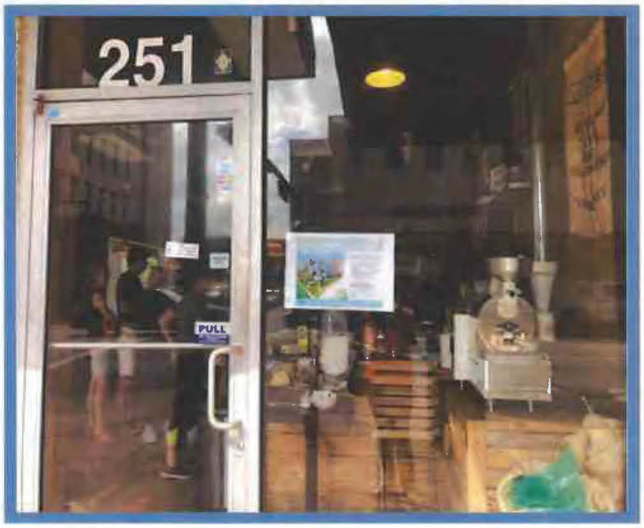

Ronald W. Shane Center




TRADER JOE'S


251
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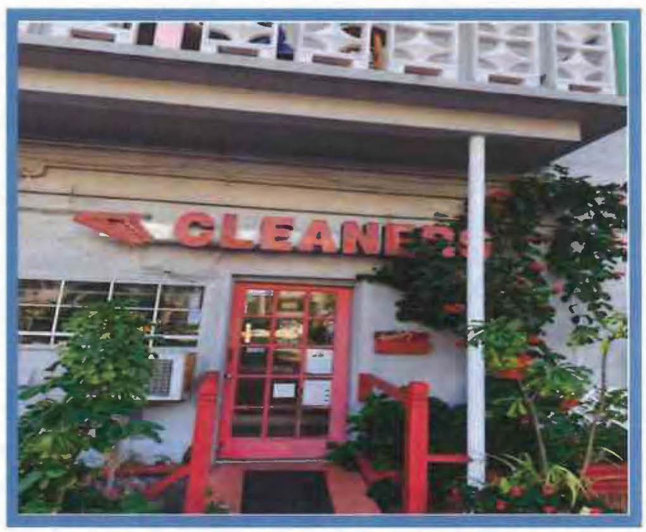
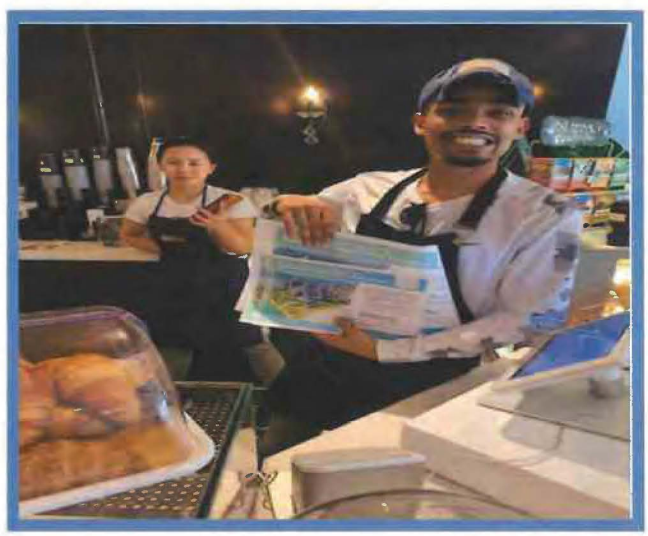
Stormwater Management Program Presentation

Community Outreach

Door to Door - January 20, 2020



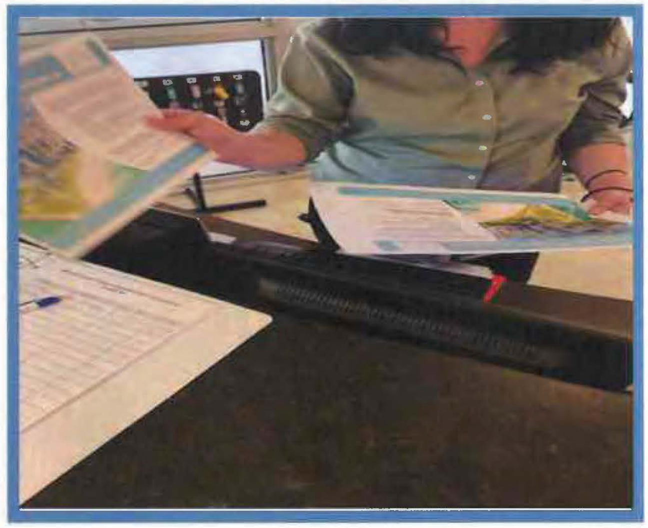


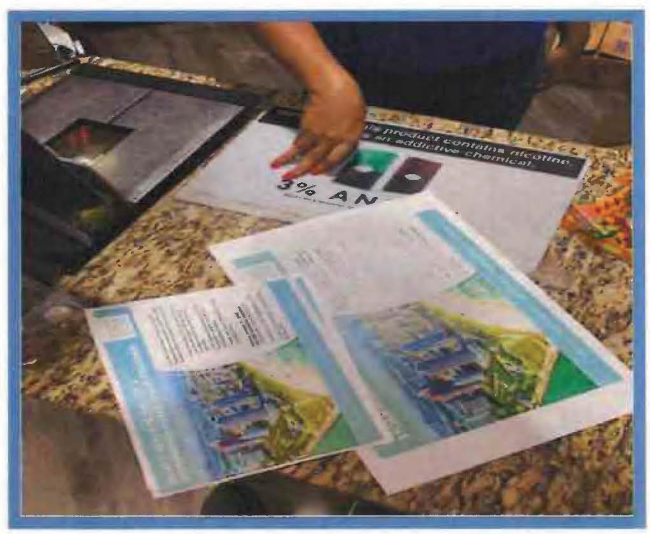
MIAMIBEACH
RISING ABOVE

Stormwater Management Program Presentation

Community Outreach

Door to Door - January 20, 2020



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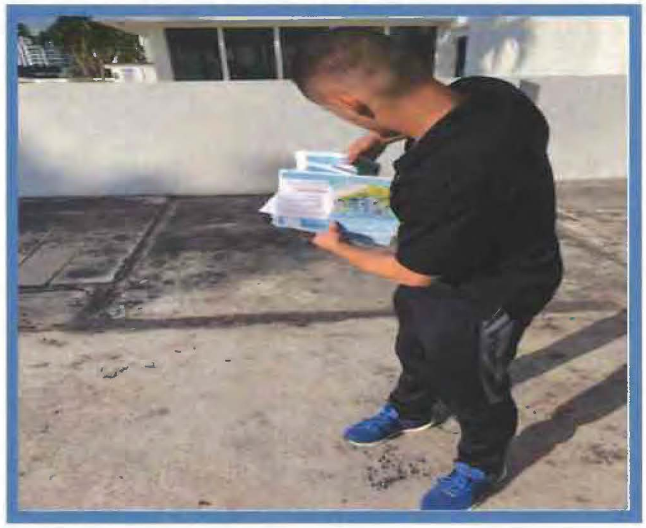


ALL VISITORS PLEASE