TECHNICAL MEMORANDUM

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TO: Jessica Beach, P.E., Public Works Dept., Engineering Division

FROM: Tim Mason, P.E.

CC: Phil Clancy

DATE: June 30, 2019

RE: Concept Design – Inlet Drive Shoreline Stabilization, Davis Shores
Post-Hurricane Irma Update

The following technical memorandum provides a summary of the conceptual analysis and recommended stabilization of the shoreline along Inlet Drive which terminates at Salt Run in St. Augustine. Hurricane Matthew caused erosion damage along the Inlet Drive shoreline in October 2016, and the City of St Augustine (City) requested recommendations for a permanent solution to the shoreline erosion which occurred. Hurricane Irma impacted the project site in early September 2017, after which the City requested that ATM assess the impacts of Irma and update the Concept Design to include the effects of Irma. The additional surveys and analysis to document impacts and any potential changes to the conceptual design are provided in this document.

SCOPE OF SERVICES

ATM's Concept Design Technical Memorandum for Inlet Drive dated September 27, 2017, was authorized under Contract #PW2016-15Y, Encumbrance #20170880, Work Order #2. The post-Irma work for the Post-Irma Concept Design Update was authorized via Work Order #4, Encumbrance #20181113, Task 2:

- *The July 26, 2017 Tech Memo which summarized a desktop coastal engineering and exposure assessment will be amended with any new information as related to Hurricane Irma; that is, the effects of Irma will be evaluated to determine whether Irma was more significant than Matthew and whether the recommended design conditions for shoreline protection need to be updated or can remain as previously identified.*
- *The September 21, 2017 Concept Design Tech Memo will be updated to include effects of Hurricane Irma, specifically the erosion analysis and any additional quantities and probable construction costs, or other considerations related to the proposed rock revetment shoreline protection alternative. Additional alternative solutions or treatments are not included or proposed.*

It is noted that this document provides supplemental information to ATM's September 27, 2017 memo and does not repeat all of the information contained with the previous memo. Thus, the reader should refer back to the previous memo for complete information related to this project.

SITE EXPOSURE ASSESSMENT UPDATE

The project site is exposed to wind, water levels, currents, and waves. ATM (2017a) completed a desktop exposure evaluation which documented Hurricane Matthew conditions and design conditions under 50-year mean recurrence interval (MRI) conditions affecting the site, which would serve as the recommended basis for revetment design. Below are some key findings related to the impacts of Hurricane Irma:

- Observed maximum winds during Hurricane Irma's passage measured at the St. Augustine Beach Pier were recorded as 68 mph sustained (2 minute averaged), with an 84 mph gust from the southeast at 105°. This represents an approximate 25 year MRI wind speed, and is compared to a peak sustained wind speed of approximately 65 mph from the north during Matthew, which coincides with a longer fetch (resulting in larger waves). The wind data referenced was sourced from NOAA online data at www.ndbc.noaa.gov for the SAUF1 station.
- The peak sustained winds measured during Hurricane Matthew were similar to Irma (65 mph sustained), but with a northerly direction which generally coincides with the primary fetch at Inlet Drive. Thus, larger waves would have been expected due to Matthew's winds than Irma's winds.
- Wind generated storm wave conditions at the site, when transformed to nearshore are expected to range as follows:

  Hurricane Matthew conditions: H_{mo} = 1.7 ft, T_p = 3.3 sec (largest waves 2.8 ft)

  Hurricane Irma conditions: H_{mo} = 1.3 ft, T_p = 1.7 sec (largest waves 2.2 ft)
- Measured high water marks for Hurricane Matthew in the Davis Shores vicinity, as found on the USGS Flood Event Viewer https://stn.wim.usgs.gov/fev/, ranged from +7 to +7.5 ft NAVD, which are close to FEMA's predicted 100-year still water levels (SWELs) for Salt Run (+7.2 ft NAVD). For Hurricane Irma, the measured high water marks in the Davis Shores vicinity ranged from +4.8 to +6.4 ft NAVD which at the upper end is close to FEMA's predicted 50-year MRI SWEL of +6.2 ft NAVD (FEMA, 2018). It is noted that following the preparation of the previous concept design memo and exposure assessment, the FEMA Flood Insurance Rate Maps and Flood Insurance Study for St Johns County became effective dated December 7, 2018, thus finalizing the previously reported preliminary SWELs.

When comparing the Matthew and Irma conditions it is apparent that Hurricane Matthew was the more critical case for the Davis Shores area. This is primarily because of the direction of the winds from Matthew subjected the Davis Shores area to a greater fetch - which generated larger waves. The water levels were also higher during Hurricane Matthew which would allow for larger waves to penetrate further inland. This conclusion is further verified by the findings of the post-Irma site inspection and survey analysis which found limited additional damage occurred during Hurricane Irma. The post Irma site inspection and survey analysis will be discussed in the following section.

POST-IRMA SITE CONDITIONS

As discussed in ATM (2017b), there are no known surveys or photographs of the shoreline condition prior to Hurricane Matthew, so the specific level of damage inflicted by the storm is not known. The existing shoreline is basically a living shoreline (Figure 1), with wetland vegetation waterward of a "last line of defense" armoring structure which was intended to resist erosion, but age and deterioration has led to failure of the structure and loss of upland property due to storm impacts.

Figure 1. Remnant shoreline stabilization showing varied materials, crest elevations, and deterioration, as well as presence of mangroves

A site visit following Irma did not reveal obvious significant changes relative to the post-Matthew surveys and observations. Under Task 1 of Work Order #4, ATM conducted a quantitative analysis of changes due to the passing of Hurricane Irma, as described herein. The City commissioned a site-specific survey of the post-Irma upland and nearshore bathymetry, including nearshore visible vegetation, by Geomatics Corp. dated August 25, 2018. The post-Irma survey repeated the post-Matthew survey dated May 4, 2017. ATM completed a volumes analysis in AutoCAD using the post-Matthew and Post-Irma survey datasets. ATM's analysis showed that across the site there was a net additional 10 cubic yards of material from the post-Matthew survey to the post-Irma survey. This addition of material is equivalent to 0.02 cubic yards per linear foot of shoreline at the project site and is likely caused by small differences in locations of survey points and the interpolation of the software used to quantify differences between surveys. Based on this analysis, ATM concluded that no additional damage can be attributed to Hurricane Irma, beyond what was previously reported as damage from Hurricane Matthew.

ATM's findings related to Irma's limited additional damages led the City to not undertake a request to FEMA for reimbursement of funds to repair damage. ATM photos showing a general comparison of pre- and post-Irma photos of the existing shoreline conditions at Inlet Drive are provided as Appendix A.

It is ATM's opinion that the existing structure(s) will continue to undergo additional deterioration into the future and allow for erosion which will eventually threaten the road and properties west of it. The remnant structure appears only marginally functional along the City properties and should be replaced to achieve a uniform level of protection and aesthetic. Cursory observations of the block wall just south of the City parcels indicates the structure is in better condition there – however, the original design intent/criteria, elevations, and construction details are not known.

PRELIMINARY GEOTECHNICAL INVESTIGATION

The geotechnical conditions outlined in the previous memo remain unchanged. Please refer to the September 21, 2017 (ATM, 2017b) memo for details.

CONCEPTUAL DESIGN SOLUTION

Given the lack of additional documented erosion due to Hurricane Irma, the recommended solution for stabilization of the City's Inlet Drive parcels remains a sloped revetment, as identified in ATM (2017b) and summarized below:

1. The existing site topographic conditions lend well to a living shoreline type solution, where the "last line of defense" structure to protect the upland replaced and the tidal wetland vegetation waterward of the remnant structure preserved. This type of stabilization scheme is typically preferred by environmental resource agencies, and preserves the character of the existing shoreline which is configured as a living shoreline.
2. Under normal tide conditions, the structure would not be impacted by significant wave action. The structure would be exposed and need to resist design wave and water level forces during extreme water levels, assumed herein to be the 50-year MRI event and its corresponding waves.
3. Keeping the proposed work at or landward of the existing armoring structures reduces or eliminates concerns of environmental impacts waterward of the MHW line.
4. A sloped revetment structure is preferred from both cost and engineering perspectives, as it dissipates wave energy and minimizes wave reflection, as compared to a vertical bulkhead.
5. Use of regionally sourced coquina rock (or alternate granite if determined to be more cost effective than coquina during bidding) would be aesthetically preferable to a concrete block product, is more robust to maximize stability under design waves, can be modified or raised in the future to accommodate uncertain sea level rise (SLR), and will also dissipate more energy than a smoother, sloped concrete surface.

Refer to attached ATM drawings (5 sheets) for the updated survey and concept design plan and sections. Two Options were prepared for the City's consideration:

Option 1 – Revetment stabilization fronting the City's parcels only (~ 443 LF), with a crest elevation approximating the existing remnant wall at +5.0 ft NAVD, and a maximum slope of 1V:1.5H. The

revetment would tie into the existing adjacent structures with appropriate field tapers. The existing remnant wall and related debris would be excavated down to the new revetment toe level. Suitable materials would be used (assumed 40% of excavation) on site with the balance disposed. If the City desires archiving of the remnant coquina elements, the contractor would stockpile the material on the ROW for the City's forces to remove.

Option 2 – A "mitigation" solution which enhances the level of protection compared to Option 1. Option 2 is a rock revetment, but extending the crest elevation up to +7.0 ft NAVD. This option provides the following benefits when compared to Option 1:

- Reduces wave overtopping and transmission during storm events.
- Accounts for future sea level rise as it will "trip" waves during higher water levels in the future to reduce wave effects on flooding to the properties landward of the structure.
- Includes a revegetation component (which could also be included with Option 1), where the 1,470 +/- SF area between Profile Sta. 1+00 and 2+00 which does support mangroves at present would be excavated to remove rubble/debris and sloped to match adjacent grades, and black mangroves and/or other suitable species planted. An additional ~ 240 +/- SF area could also be planted with spartina (marsh grass). This would help restore the linear vegetation fronting the shoreline structure and provide additional protection.
- It is noted that the effective FEMA Flood Insurance Rate Maps (FEMA, 2018a) indicate that the road and properties landward of it are all within the AE special flood hazard zone, which means wave heights less than 3 ft are expected and building requirements are not as stringent as in a VE zone (Coastal High Hazard zone where wave heights of 3 ft or larger are expected). However, the proposed elevated structure, if shown to withstand the 1% annual frequency design conditions, would reduce the mapped base flood levels landward of it due to a reduction of transmitted wave heights. *Raising the crest will not stop or reduce static flooding due to storm surge.* Such measures would require an impermeable elevated structure which extends along all of Davis Shores and/or gross raising of existing land grades given existing elevations, along with associated stormwater improvements to address drainage. These scenarios are beyond the scope of this study.

Rock sizing and revetment design geometry at the concept level were described in ATM (2017b).

UTILITIES

There are no known existing utilities in the proposed work area which would be directly affected by the proposed work, with the exception of an existing stormwater outfall pipe which currently runs from an inlet at the curb on each side of Inlet Drive to an outlet which discharges through the remnant wall (refer to Figure 7). This stormwater outlet has not been part of the City's Davis Shores stormwater improvements to date. Review of the City's stormwater network in GIS indicates that this is an isolated inlet/outfall in that it is not tied to any other stormwater pipes. ATM recommends replacement of the 2 storm inlets and the existing 12" CMP with a 14" x 23" elliptical concrete pipe, extending from the inlet on the west side of Inlet Drive, as identified previously. This would require saw cut, milling, and resurfacing of the pipe route under Inlet Drive. An in-line check valve will be installed in the new outfall pipe to prevent backflow of water into the stormwater system during high tide.

Figure 2. Photo of stormwater discharge point behind remnant wall (top) and inlet at curb (bottom)

Prior to final design, a utilities locate and identification on the east side of Inlet Drive is recommended, within the limits of the proposed excavation areas, to confirm any necessary buried utilities protection and/or replacement.

PERMITTING OVERVIEW

No additional permitting consultations with FDEP or the USACE were completed, since the proposed solution for the site has not changed. Please refer to ATM (2017b) for the regulatory summary.

Historical Aspects - During the course of the project conceptual design, it was considered that the existing remnant coquina and concrete wall may potentially have some historical significance. City staff directed ATM to obtain a proposal for additional research by a qualified professional to make a determination as to the significance, if any, of this remnant wall, as well as any recommendations related to preservation or recovery. ATM developed a scope in conjunction with local Preservation Consultants Greg C. Smith, PhD., and Marsha A. Chance, M.S., to complete background research, personal interviews, and generate a summary opinion and report including recommendations for additional detailed field studies (if any required) plus preservation/recovery of the wall if deemed historically significant.

A letter report summarizing the findings of the historical determination was prepared and submitted to the City in late October 2018 (Chance and Smith, 2018). Through historical research, personal interviews, and Ms. Chance's experience growing up and living in Davis Shores, it was determined that the existing stacked "wall" does not have the characteristics required to meet federal, state, or local standards for historical significance. Some of the armoring material was determined to be curb and gutter segments from the time of D.P. Davis developing the island. The City may elect to preserve/reuse some of the materials to save disposal costs at the time of demolition, but it is not required based on any historical significance.

CONCEPTUAL ESTIMATE OF CONSTRUCTION COSTS

Order of Magnitude costs for the revetment shoreline stabilization for the two conceptual options are provided in Tables 1 and 2. Costing was based on updated ranges of available costs from similar projects and input received from local contractors.

During completion of this update, ATM met with the City Public Works staff and discussed the potential to separate out the limited stormwater improvements from the larger shoreline stabilization project elements. Given the City's ongoing efforts to improve the stormwater system in Davis Shores and funding availability, it is ATM's understanding that the City may desire to phase this project and place a priority on the stormwater portion of the project. ATM agrees with the potential to phase the project, given the condition of the shoreline and the importance of the stormwater improvements- particularly to limit nuisance flooding as well as during larger storms. For this reason, ATM separated the stormwater portion of the project from the revetment in the conceptual cost estimates. Table 3 provides an order of magnitude concept level construction cost estimate for the Inlet Drive stormwater improvements as described herein.

The costs estimated do not include soft costs (engineering design, permitting, and construction administration support), represent best available information at the time of this report, and would require refinement during design phase. It is understood that the City may utilize City forces for some/all of the project construction, contract with one of the City's continuing service providers, or bid the project.

Table 1.

Inlet Drive Shoreline Stabilization				
Concept Design - Option 1 (base)				
Engineer's Opinion of Probable Construction Cost				
30-Jun-19				
Description	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
Mobilization	LS	1	$ 30,000	$ 30,000
Site Clearing/Select Demolition of wall (allow.)	LF	403	$ 115	$ 46,345
Testing & Erosion and Sediment Control	LS	1	$ 16,200	$ 16,200
Excavation	CY	820	$ 25	$ 20,500
Revetment Stone	TON	855	$ 150	$ 128,250
Geotextile	SY	825	$ 8	$ 6,600
Disposal of Excess Material	CY	490	$ 25	$ 12,250
Sod	SY	188	$ 7	$ 1,316
Mangrove & Marsh Grass Planting (allow.)	LS	0	$ -	$ -
Minor Cofferdam (allow.)	LS	1	$ 5,000	$ 5,000
As-Built Drawings	LS	1	$ 5,000	$ 5,000
Subtotal				**$ 271,461**
Performance Bond (3% of Subtotal)				$ 8,144
Contingency (20% of Subtotal)				$ 54,292
Total				**$ 333,897**

Table 2.

Inlet Drive Shoreline Stabilization				
Concept Design - Option 2 (mitigation)				
Engineer's Opinion of Probable Construction Cost				
30-Jun-19				
Description	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
Mobilization	LS	1	$ 37,000	$ 37,000
Site Clearing/Select Demolition of wall (allow.)	LF	403	$ 115	$ 46,345
Testing & Erosion and Sediment Control	LS	1	$ 16,200	$ 16,200
Excavation	CY	920	$ 25	$ 23,000
Revetment Stone	TON	1,180	$ 150	$ 177,000
Geotextile	SY	1,280	$ 8	$ 10,240
Disposal of Excess Material	CY	550	$ 25	$ 13,750
Sod	SY	132	$ 7	$ 924
Mangrove & Marsh Grass Planting (allow.)	LS	0	$ -	$ -
Minor Cofferdam (allow.)	LS	1	$ 5,000	$ 5,000
As-Built Drawings	LS	1	$ 5,000	$ 5,000
Subtotal				**$ 334,459**
Performance Bond (3% of Subtotal)				$ 10,034
Contingency (20% of Subtotal)				$ 66,892
Total				**$ 411,385**

Table 3.

Inlet Drive Shoreline Stabilization				
Concept Design - Stormwater Outfall Replacement				
Engineer's Opinion of Probable Construction Cost				
30-Jun-19				
Description	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
Mobilization	LS	1	$ 7,500	$ 7,500
Revetment Stone around outfall (5' ea. Side)	TON	25	$ 150	$ 3,750
Geotextile	SY	25	$ 8	$ 200
Sod	SY	10	$ 7	$ 70
FDOT Type C Stormwater Inlet	EA	2	$ 4,150	$ 8,300
Removal of 12" CMP	LF	60	$ 15	$ 900
Asphalt Pavement Removal	SY	30	$ 15	$ 450
14" x 23" Elliptical Pipe - Mitered End Section	LF	60	$ 105	$ 6,300
In-line Check Valve for Elliptical Pipe	EA	1	$ 4,700	$ 4,700
Roadway Restoration	SY	30	$ 650	$ 19,500
As-Built Drawings	LS	1	$ 5,000	$ 5,000
Subtotal				**$ 56,670**
Performance Bond (3% of Subtotal)				$ 1,700
Contingency (20% of Subtotal)				$ 11,334
Total				**$ 69,704**

OTHER ISSUES

The following items are issues that the City will need to consider and evaluate before moving into more detailed design and permitting:

- The City should confirm the ownership of the various parcels at the site. The SJC Tax Assessor (I-Map) webpage shows two (2) #73 parcels, and thus 10 City owned parcels, whereas the survey from Geomatics and the text descriptions from SJC indicate 9 parcels. In addition, the parcel maps suggest that the revetment facing south at the north end of the project site is actually on Lot #73 which is City property and not the adjacent private owner's land. Based on a discussion with Terry Durden of Geomatics, his property lines are based on original plats and are believed to be the most accurate representation of the parcels. However, a field survey of the boundaries is recommended prior to final design.
- If any mitigation is proposed for the structure (i.e., raising the crest elevations to reduce future potential runup and overtopping associated with sea level rise (SLR)), it would require additional analysis during detailed design. This would involve evaluating various combinations of water levels and wave height effects on wave runup/overtopping of the revetment and may also result in larger design waves (and rock size). However, given that there is a reasonable setback from the proposed revetment crest to the existing residences and no known exposed critical City infrastructure along Inlet Drive, some runup and overtopping is deemed acceptable with the lower frequency design

storm events. Raising the revetment crest will not stop static flooding (still water surge on top of the tide) unless the entire peninsula of Davis Shores was raised and protected accordingly. This is because existing grades range from generally +5 to +6 ft NAVD, with some localized areas of +7 and as low as +4 ft, especially along Anastasia Blvd.

- Prior to final design and permitting, some limited test excavation landward of MHW is recommended in the Option 2 revegetation area to determine the approximate depth of the rubble and debris. If the material extends deeper than 1-2 ft, then removal and replacement with a layer of sandy soil may be required to facilitate mangrove planting and survival.

After you have had a chance to review this memo and the attachments, please let me know if you have any questions or need additional information.

REFERENCES

ATM, 2017a. Desktop Wave Exposure Review, Lighthouse Avenue and Inlet Drive. Technical Memorandum. Prepared for City of St Augustine, Public Works Department. July 26, 2017.

ATM, 2017b. Concept Design – Inlet Drive Shoreline Stabilization, Davis Shores. Technical Memorandum prepared for City of St Augustine, Public Works Department. Revised September 21, 2017.

ATM, 2018. Post-Irma Assessment – Inlet Drive Shoreline Stabilization, Davis Shores. Technical Memorandum prepared for City of St Augustine, Public Works Department. October 25, 2018.

Chance, M. A. and G. C. Smith, 2018. *An Historical Evaluation of the Armoring Materials on the Beach at Inlet Drive, St. Augustine, Florida*. Report prepared for ATM, Inc.

FEMA, December 7, 2018a. Flood Insurance Rate Map Number 12109C0318J, St Johns County, Florida, and Incorporated Areas.

FEMA, December 7, 2018b. Flood Insurance Study, St Johns County, Florida and Incorporated Areas, Volume 3 of 7. Flood Insurance Study number 12109CV003D.

USGS, 2017. Hurricane Irma Flood Event viewer, http://stn.wim.usgs.gov/FEV/#Irma September2017.

Attachments:

– Concept plans for Inlet Drive Shoreline Stabilization, June 30, 2019 (5 sheets)

Inlet Drive Pre- (top)
and Post-Irma (bottom)

Inlet Drive Pre- (top)
and Post-Irma (bottom)

Inlet Drive Pre- (top)
and Post-Irma (bottom)

Inlet Drive Pre- (top)
and Post-Irma (bottom)