

APPENDIX A
SUBSURFACE CONDITIONS

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Available Data

To characterize the site conditions at The Hague, several pertinent geotechnical and laboratory data were used. Even though the data is somewhat limited to design different flood mitigation systems, the data can still be used for preliminary site characterization, conceptual design and the general practicality of alternative flood mitigation systems. The historic development of The Hague area is shown in Figure 4-1. The data available to interpret the subsurface stratigraphy and idealized soil properties are the following:

- Geotechnical borings drilled in 1961 for the Route 599 Prestressed Concrete Bridge over The Hague. In addition to the boring data, the data from one flat dilatometer test was used to characterize the undrained shear strength properties of the Norfolk Clay unit. The dilatometer data was obtained near the northwest end of Smith Creek.
- Geotechnical borings and laboratory data for the Norfolk Transit Rail Project. The data was collected in 2006 by GET Solutions, Inc.
- Geotechnical borings and laboratory data for a bulkhead replacement project at the NOAA Marine Operations Center in Norfolk, Virginia. The subsurface explorations and laboratory data were collected in June and July, 2010 by the United States Army Corps of Engineers (USACE).

Regional Geology

Regionally, The Hague project area is located in the Coastal Plain physiographic province. Flat-lying plains and terraces dominate the landscape. The Coastal Plain is underlain by a wedge of Cretaceous to Holocene age sediments that thicken to the east and pinch out at the Fall Line approximately 70 miles west of the project area. Jurassic-Triassic age basement rocks lie approximately 1,800 feet beneath the site. The wedge of Cretaceous and younger sediments were deposited as a result of multiple marine transgressions and regressions. Sediments within the upper 150 feet beneath the site are Pliocene to Recent in age. The Pliocene and younger sediments have been deposited and subsequently eroded in places during the rising and falling sea levels that resulted from glacial and interglacial periods.

Subsurface Stratigraphy

The stratigraphic units encountered beneath The Hague area are described in descending sequence in the following discussion.

Artificial Fill

The top soil layer comprises of very loose to dense artificial fill. The thickness of the fill layer, on both sides of Smith Creek, varies between 6 and 16 feet. The fill material generally comprises of silty to clayey fine sand with gravel, brick and marine shell fragments.

Alluvium

Underlying the artificial fill is an alluvium unit, which comprises predominantly of Norfolk Marine Clay layer. This layer is a thick, extremely soft to firm, normally consolidated fat clay (CH) layer. The clay layer does not include sub-layers with high undrained shear strength, evidence of desiccation or exposure, or other evidence of crust layers. It is inferred that the entire unit to be marine deposits of Holocene-age, which have been deposited subsequent to the submergence of the paleo-bay bottom of the lower Chesapeake Bay about 10,000 years ago as sea level rose and flooded the main channel of the paleo-Subsquehanna River (Chesapeake Bay) since the last glacial sea level lowstand.

The Norfolk Clay layer has a variable thickness. The layer is thickest near the northwest end of Smith Creek with an average thickness of about 50 feet. The thickness gradually decreases with increasing distance from the creek. The shape and trend of the clay unit below Smith Creek is a clear indication of channelization processes (Figures 4-2 and 4-3). At the southeast end of Smith Creek, the clay layer thickness varies between 15 to 25 feet.

The Yorktown Formation

The Yorktown Sand is a regionally-extensive medium dense to dense silty fine to fine sand that is commonly used as a bearing stratum for pile foundations. At the Hague area, the top of the Yorktown Sand was encountered between El. -28 and El. -64 feet (Figures 4-2 and 4-3). Based on the available geotechnical data, the bottom elevation of this layer was not encountered. The deepest borings extended to El. -100 feet and was terminated in the Yorktown sand layer. The marine drilling program for the neighboring Craney Island Eastward Expansion Project, conducted in 2003 (Fugro Atlantic, 2009) demonstrated a bottom elevation of the Yorktown Sand layer between El. -120 to El. -145 feet.

Design Subsurface Profiles for Concept Evaluation

In order to conceptually evaluate possible flood mitigation systems at The Hague, it was necessary to idealize the subsurface conditions, and determine soil properties that will govern the flood mitigation system selection and design. Based on the available data and published correlations between different soil parameters, the following were interpreted:

- Two idealized soil profiles representing an upper and lower bound of expected stratigraphy;
- Idealized moisture content profiles;
- Idealized undrained shear strength profiles for the Norfolk Clay layer;
- Friction angle profiles for the artificial fill and Yorktown Sand layers;
- Ultimate bearing capacity values for the upper and lower boundary profiles based on a continuous strip footing with a unit width;
- Active and passive earth pressure coefficients. A drained condition was assumed for the Norfolk Clay material;

- Compressibility values for the Norfolk Clay layer.

Idealized Stratigraphy

The subsurface condition at The Hague was idealized into two profiles for conceptual evaluation of various flood mitigation systems. The first profile is located at the alluvium channel where the Norfolk Clay layer is expected to be thickest. This profile represents a lower bound of anticipated soil properties and shear strength values. Profile one comprises of a 7 feet artificial fill layer, which is overlying a 50 feet thick Norfolk Clay layer. The bottom layer is the Yorktown Sand layer, which extends to El. -100 feet (equivalent to the deepest available borings).

The second profile is located at the southeast end of Smith Creek where the Norfolk Clay layer is thinnest. This profile represents an upper bound of the anticipated soil properties. The profile comprises of a 13 feet Norfolk Clay layer overlying about 70 feet of Yorktown Sand. The profile extends to El. -100 feet NAVD88.

According to the available geotechnical data, the Plasticity Index (PI) for the Norfolk Clay layer ranges from 24 to 70, and the percent passing the No. 200 sieve ranges between 76 and 94%. The average percent fines content for the artificial fill and Yorktown Sand layers was about 18%. This value was later used to correct the Standard Penetration Test (SPT) blow counts for clean sands.

Idealized Moisture Content Profiles

The idealized moisture content for profiles one and two are shown in Figures A-1 and A-2, respectively. The data shows that the moisture content for the Norfolk Clay layer decreases with depth whereas the moisture content profile for the Yorktown Sand is about 33% for both profiles.

The moisture content profiles were used to estimate a total unit weight profile using phase diagram correlations, and assuming 100% saturation and an average specific gravity (G_s) of 2.7. Based on the total unit weights, effective stress profiles were determined (Figures A-3 and A-4).

Undrained Shear Strength of the Norfolk Clay

The undrained shear strength (S_u) of the Norfolk Clay was calculated based on the shear strength data reduced from one flat dilatometer test. The location of the test, which was performed as part of the Norfolk Rail Transit Project, is shown on Figure 4-3. A mean S_u profile was interpreted for profile one as shown in Figure A-5. This mean profile was assumed to be an upper bound of expected in situ shear strength values. According to the OCR profile, also determined from the dilatometer data, the clay material is normally consolidated. Therefore, the undrained shear strength ratio for normally consolidated material $(S_u/\sigma'_v)_{NC}$ was calculated to be about 0.3. Based on Duncan (2000) recommendations a Coefficient of Variation (COV) for $(S_u/\sigma'_v)_{NC}$ was selected to be 10%. Based on a COV of 10%, a lower bound $(S_u/\sigma'_v)_{NC}$ was



calculated to be about 0.25. From this value, a lower bound S_u profile was determined (Figure A-5). The same upper and lower $(S_u/\sigma'_v)_{NC}$ values were used to back-calculate S_u for the profile two (Figure A-6).

Idealized Friction Angle

The strength properties for the artificial fill and Yorktown Sand were determined by interpreting idealized friction angle (ϕ) profiles from SPT blow counts (N-values). The N-values were corrected for rod length, fines content, and overburden pressure using the correlation provided by Liao and Whitman (1986). The correlations provided by Peck et al. (1974) and the American Petroleum Institute (API) (2000) were then used to estimate ϕ from corrected N-values. The API method resulted in considerably higher ϕ values. Therefore, the mean ϕ values for each layer was calculated based on Peck et al. (1974) and used as an upper bound profile. Two standard deviations were subtracted from the mean value to calculate the lower bound ϕ profile as shown in Figures A-7 and A-8. The upper and lower design ϕ values for each profile are shown in Table A-1.

Table A-1. Idealized Friction Angles

Soil Layer	Effective Stress Friction Angle (degrees)					
	Profile 1			Profile 2		
	Upper Bound	Lower Bound	COV (%)	Upper Bound	Lower Bound	COV (%)
Artificial Fill	29	27	3	-	-	-
Yorktown Sand	33	28	7	33	28	7

Ultimate Bearing Capacity

Some flood mitigation alternatives may be supported on shallow foundations. Therefore, ultimate bearing capacity values were calculated for profiles 1 and 2 based on a continuous strip footing with a unit width. For each profile, lower and upper bound bearing capacity values were determined from the mean and lower bound friction angles, respectively (Figures A-9 and A-10). Further, ultimate bearing capacities for the Norfolk Clay layer were estimated based on undrained and drained conditions. For drained conditions, the upper bound effective stress friction angle was assumed to be 33° degrees. To obtain a lower bound effective stress friction angle, a 7% COV was applied to the upper bound value based on Duncan (2000) recommendations. Tables A-2 and A-3 summarize the bearing capacity factors, which were based on Meyerhof (1963).

Table A-2. Bearing Capacity Factors – Profile 1

Bearing Capacity Factor	Artificial Fill		Norfolk Clay			Yorktown Sand	
	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Undrained	Upper Bound	Lower Bound
N_c	28	24	39	27	5	39	26
N_q	17	14	26	16	1	26	15
N_γ	13	9	26	11	0	26	11
COV (%)	3	-	7	-	-	7	-

Table A-3. Bearing Capacity Factors – Profile 2

Bearing Capacity Factor	Norfolk Clay			Yorktown Sand	
	Upper Bound	Lower Bound	Undrained	Upper Bound	Lower Bound
N_c	39	27	5	39	26
N_q	26	16	1	26	15
N_γ	26	11	0	26	11
COV (%)	7	-	-	7	-

Active and Passive Earth Pressure Coefficients

In addition to the aforementioned engineering parameters, active (k_a) and passive (k_p) earth pressure coefficients were calculated for the two idealized profiles. This will assist in the conceptual design of some flood mitigation alternatives where lateral earth pressure loadings are expected behind a flood mitigation structure such as a retaining or sheet pile wall. The pressure at which the soil fails as the wall moves away from the retained soil is called active earth pressure, whereas the pressure at which the soil fails as the wall moves into the retained soil is called passive pressure. Active and passive earth pressure coefficients were calculated according to Rankine's and Coulomb's theories (Figures A-11 to A-14). Rankine's k_a and k_p were determined based on a frictionless wall where the interface friction (δ) between the retaining structure and the soil is neglected. Coulomb's k_a and k_p were calculated for a steel and concrete wall by varying the value of δ . For a steel wall, δ was equal to $\phi - 5^\circ$, while for a concrete wall, δ was equal to $0.58 \cdot \phi$.

Compressibility

One consolidation test provided by GET Solutions, Inc. was pertinent to The Hague area. The test was conducted on a Norfolk Clay sample obtained from a depth of about 24.5 feet. The test results indicate a compression ratio (C_c) and a recompression ratio (C_r) of 0.77 and 0.08, respectively.

APPENDIX B
MODELING RESULTS

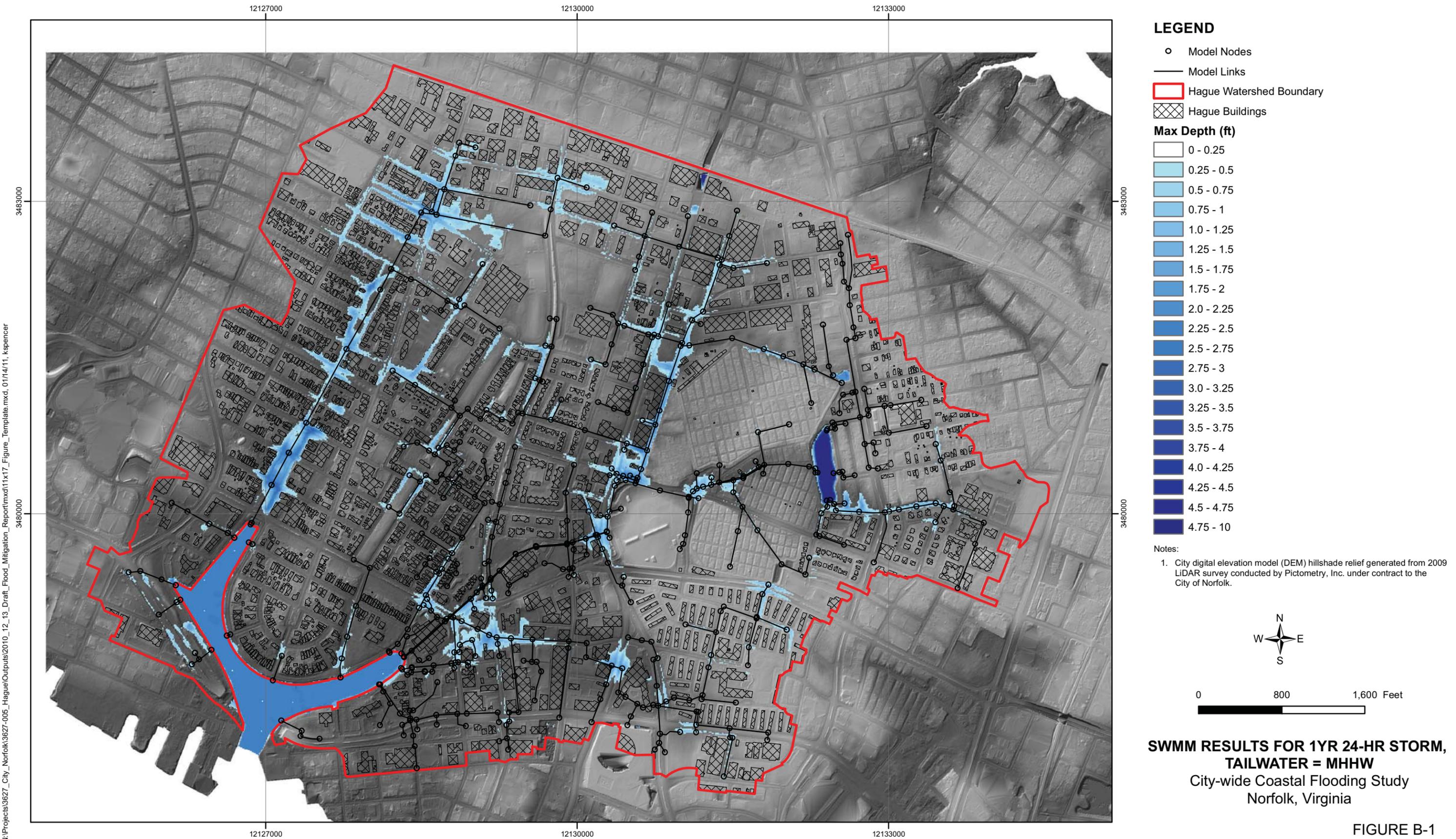
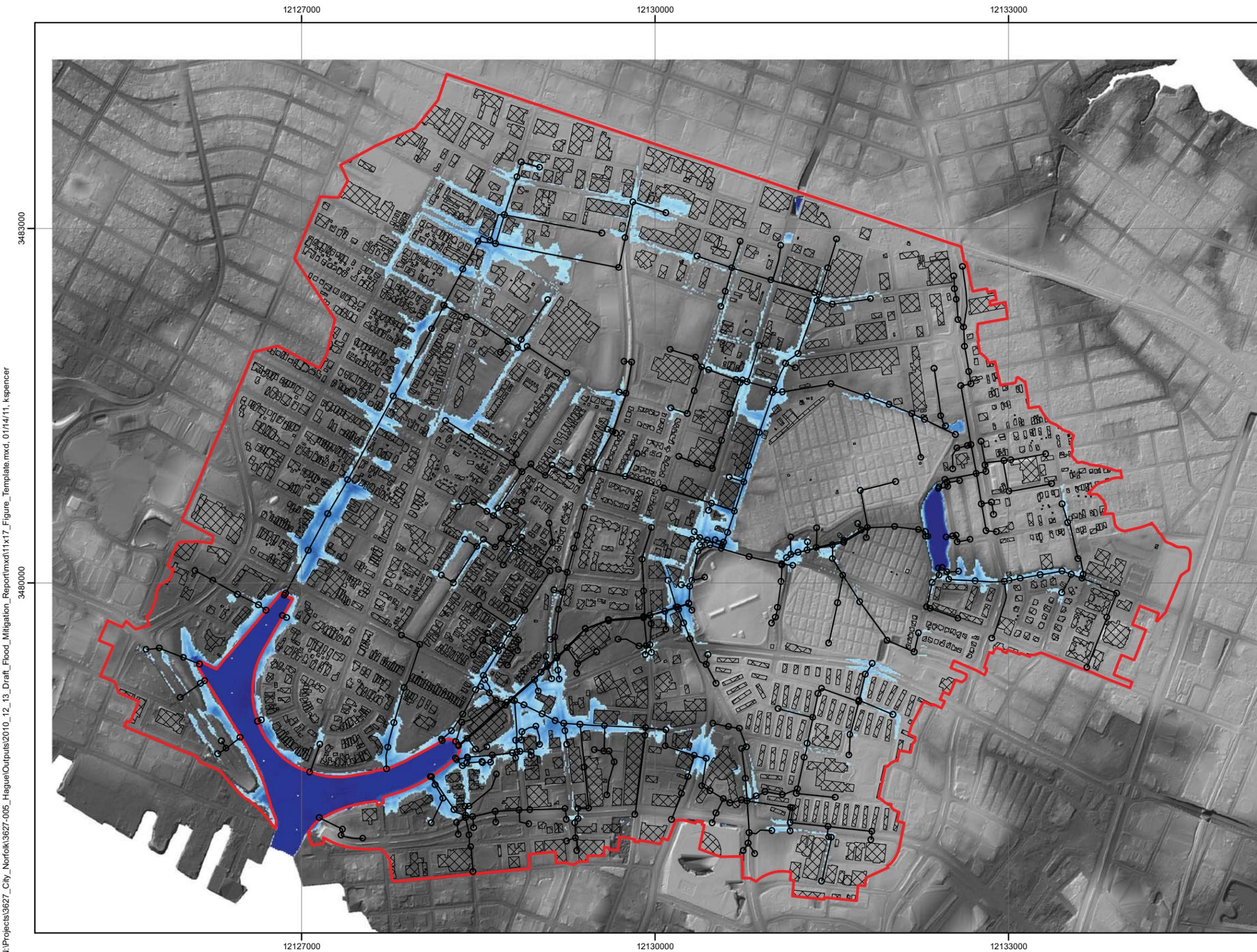


FIGURE B-1

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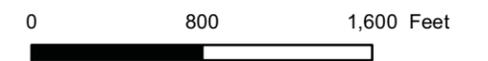
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- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

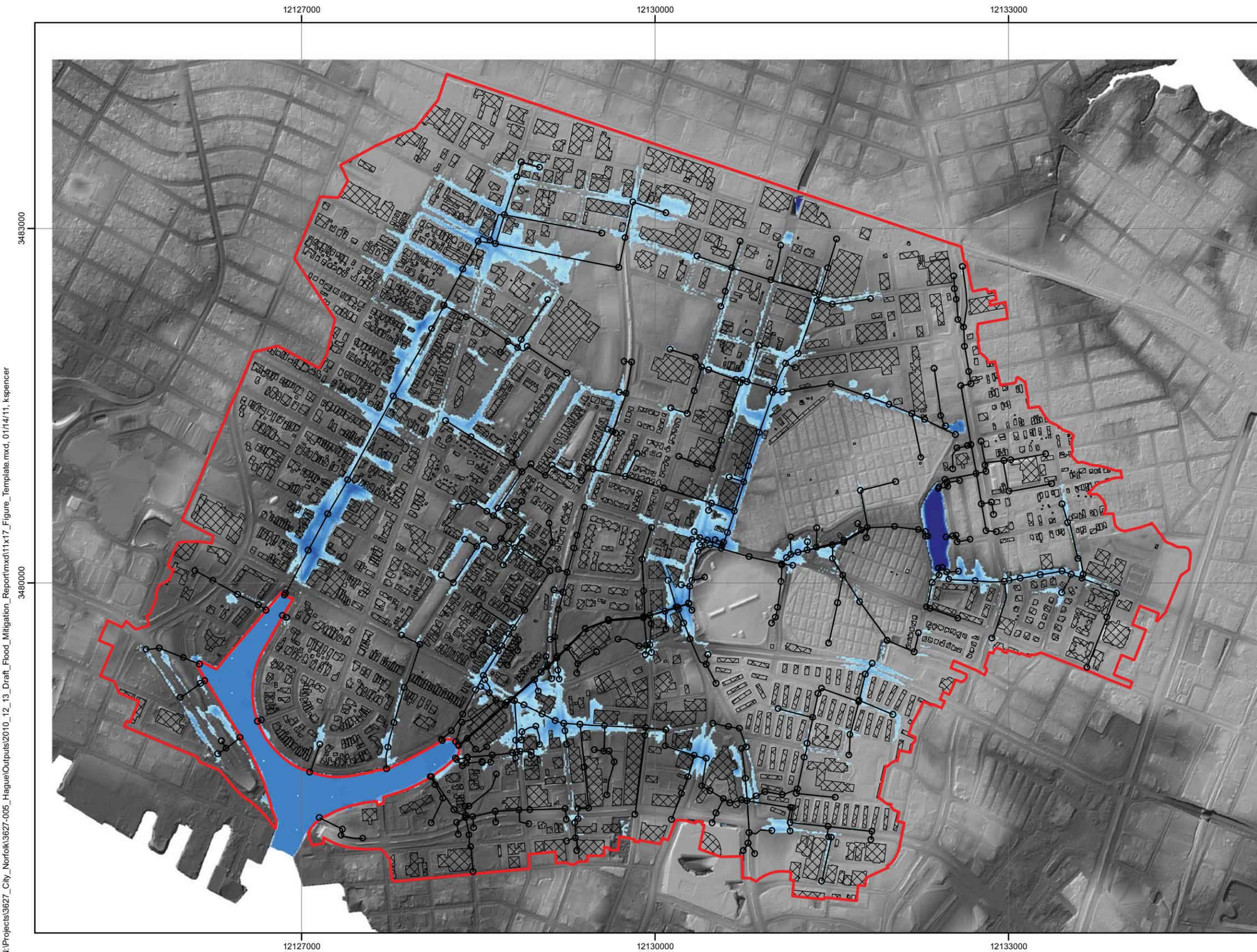
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- 1.0 - 1.25
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- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 1YR 24-HR STORM,
 TAILWATER = 1YR STORM SURGE**
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 Norfolk, Virginia

FIGURE B-2



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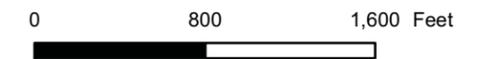
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
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- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

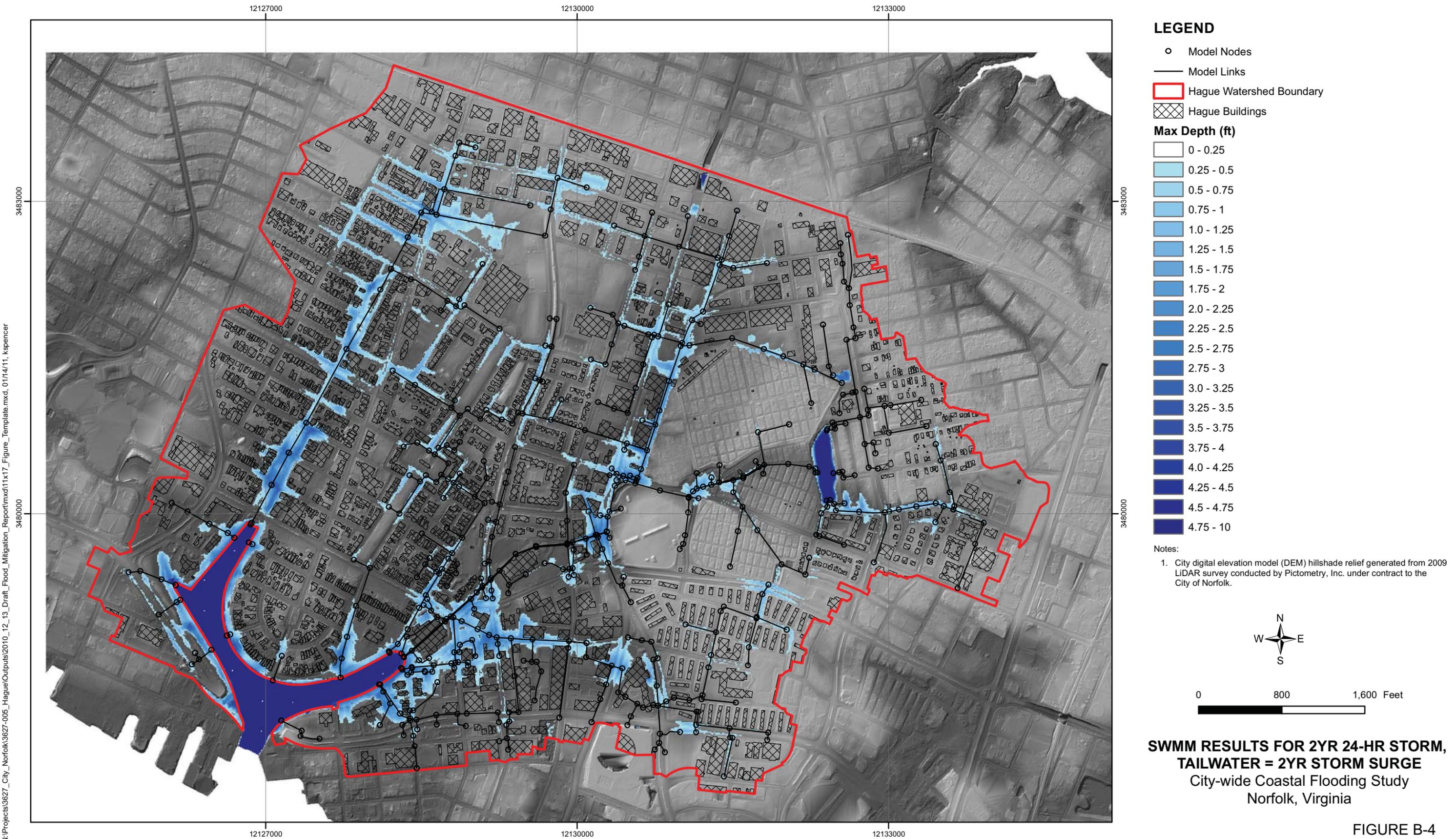
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1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 2YR 24-HR STORM,
 TAILWATER = MHHW**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-3



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- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.

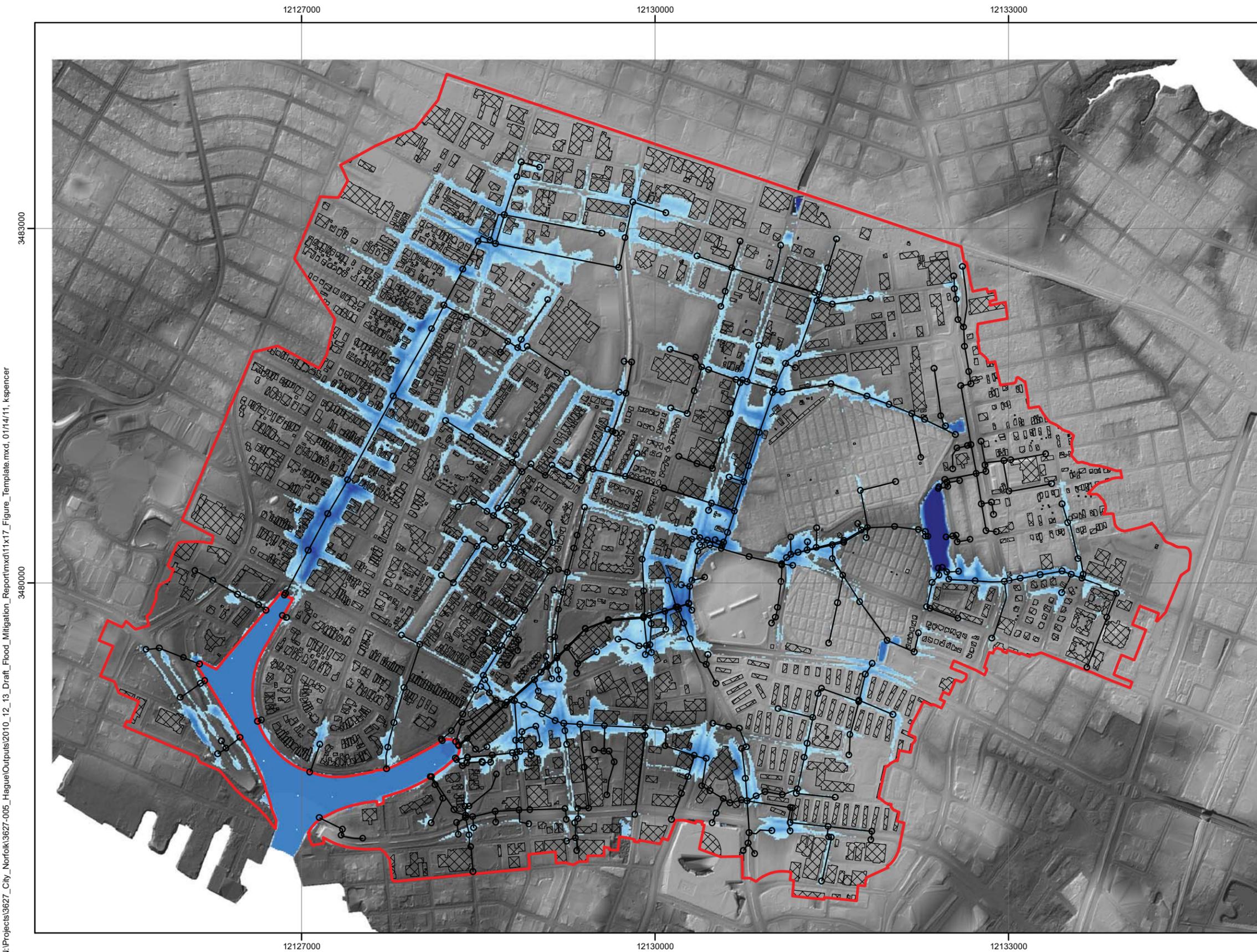


0 800 1,600 Feet

**SWMM RESULTS FOR 2YR 24-HR STORM,
TAILWATER = 2YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-4

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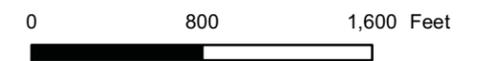
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- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

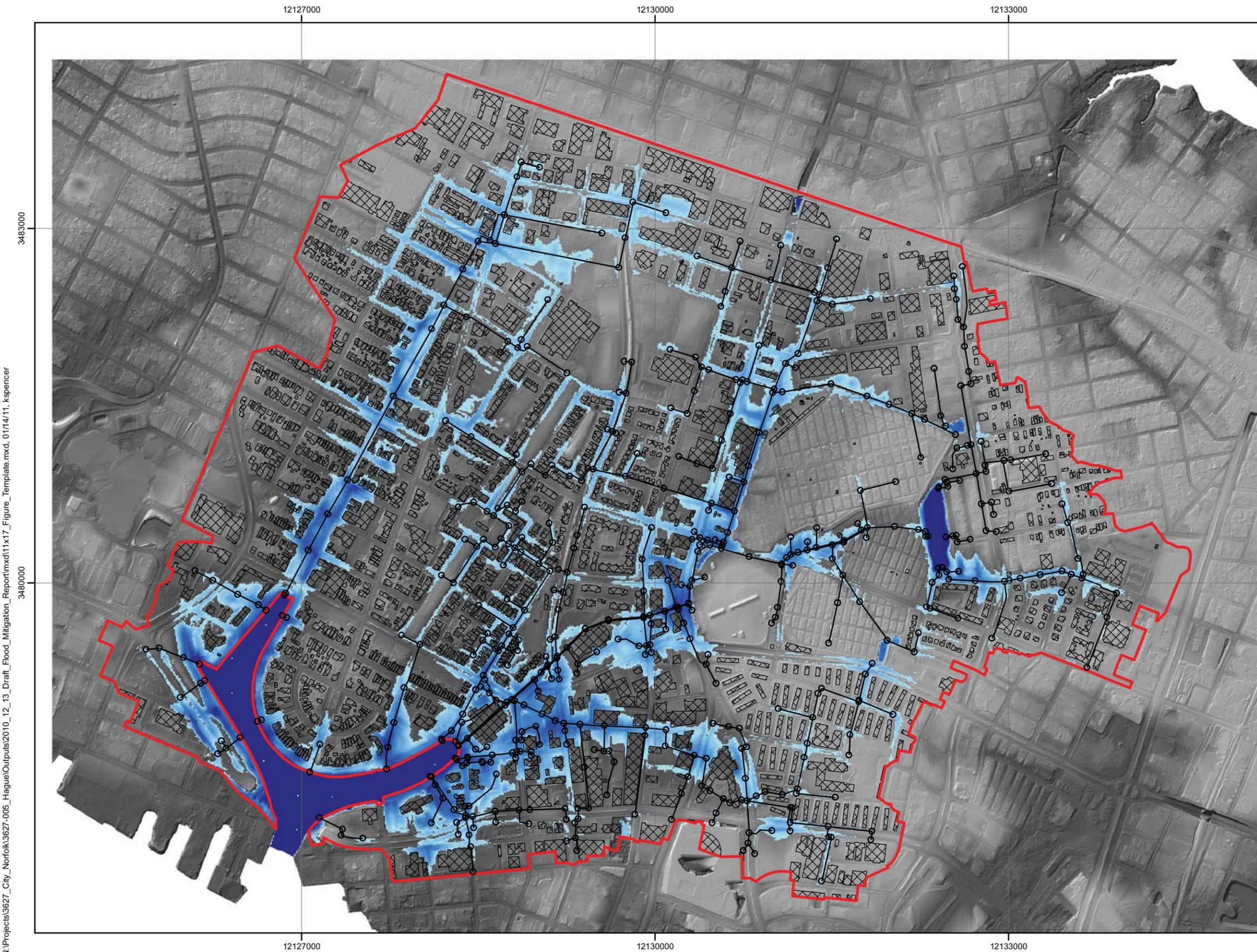
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- 0.75 - 1
- 1.0 - 1.25
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- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = MHHW**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-5



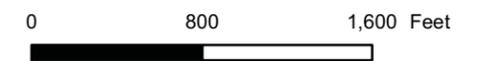
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- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

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- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
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- 4.0 - 4.25
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- 4.5 - 4.75
- 4.75 - 10

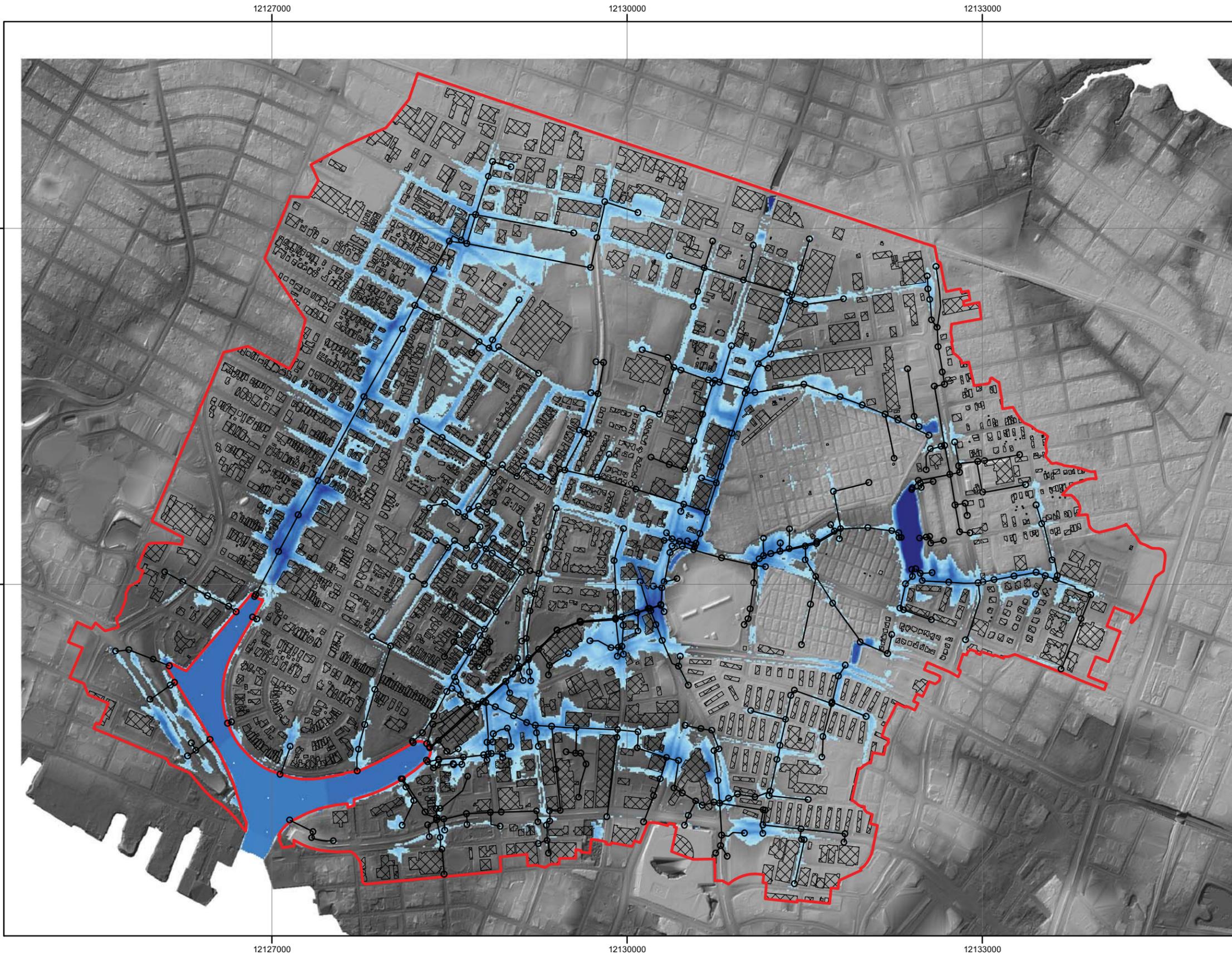
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**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = 10YR STORM SURGE**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-6

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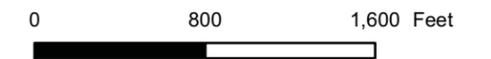
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

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- 0.25 - 0.5
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- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
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- 4.25 - 4.5
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- 4.75 - 10

Notes:

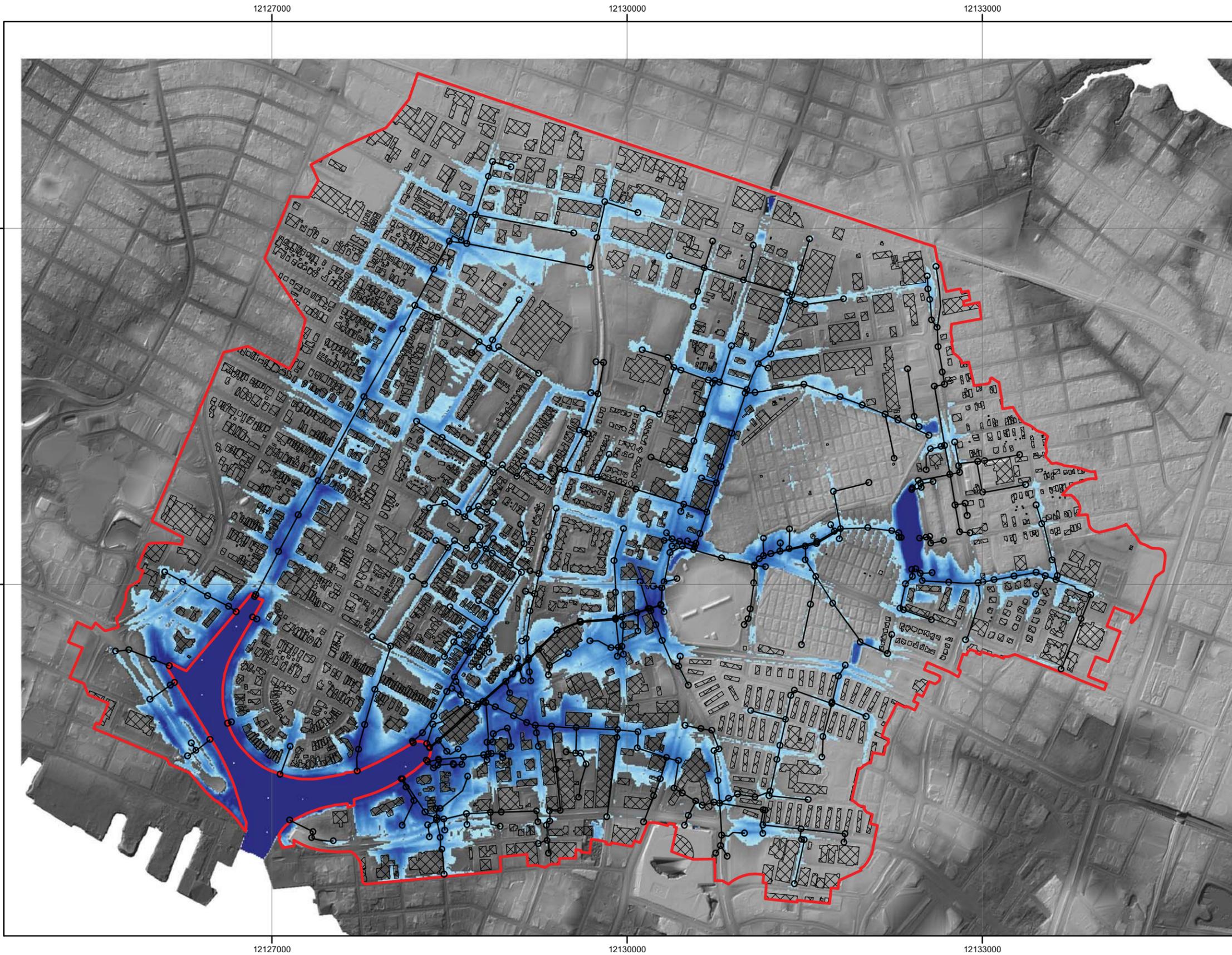
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**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = MHHW**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-7

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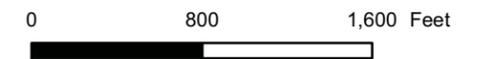
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

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- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
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- 4.5 - 4.75
- 4.75 - 10

Notes:

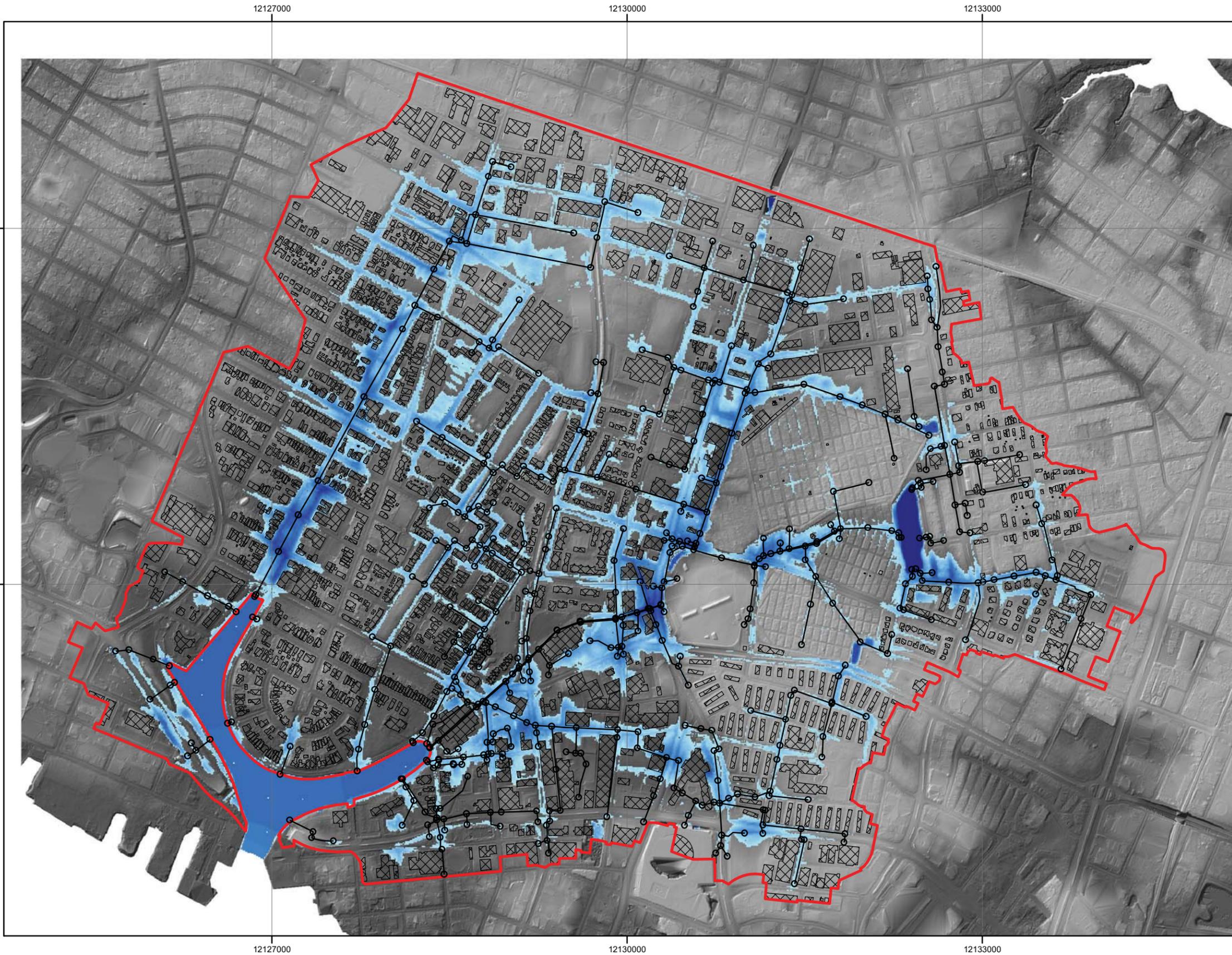
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**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-8

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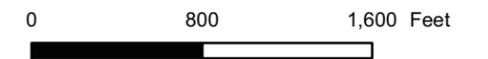
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

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- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
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- 4.75 - 10

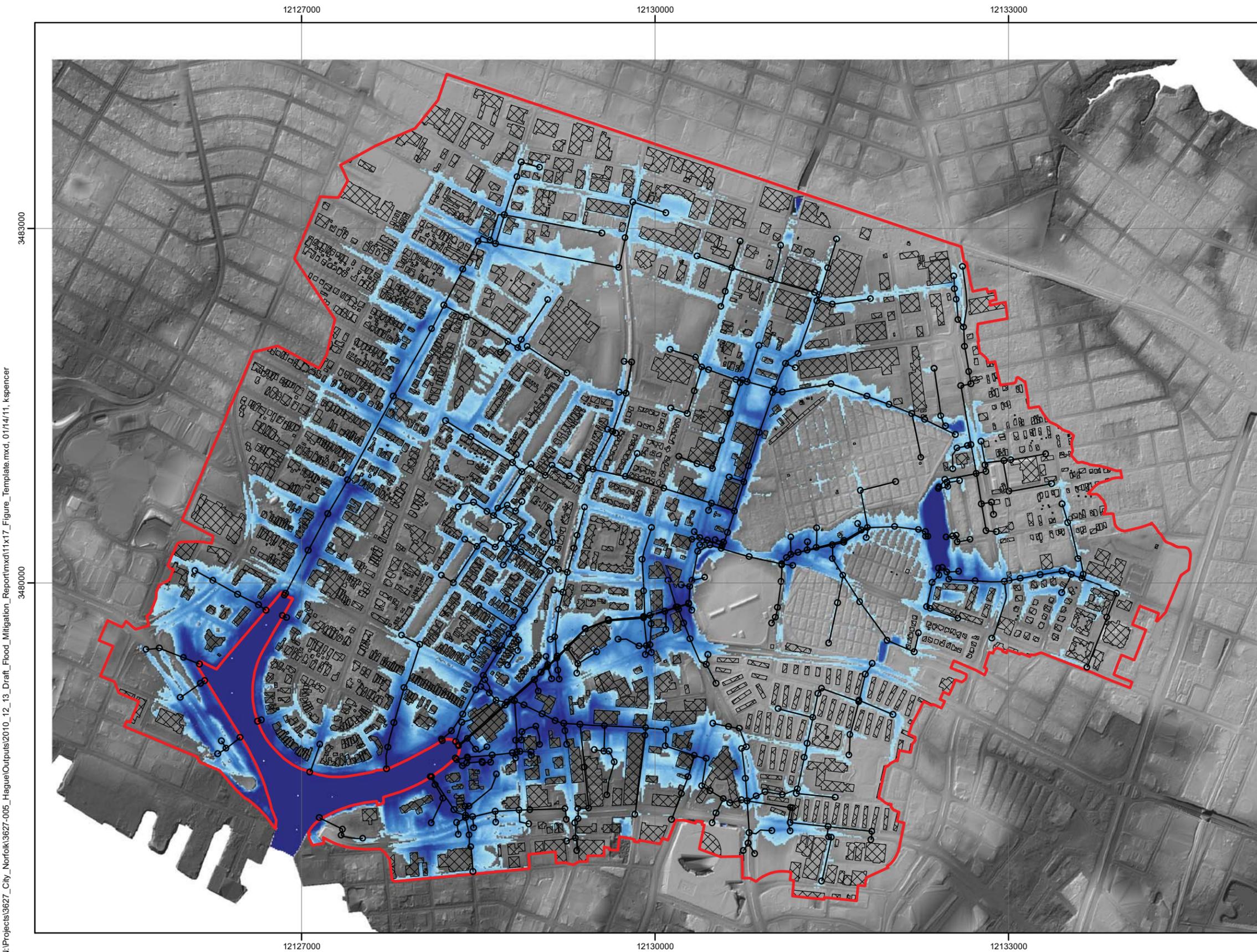
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
TAILWATER = MHHW**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-9



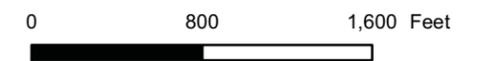
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- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

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- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
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**SWMM RESULTS FOR 50YR 24-HR STORM,
TAILWATER = 50YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

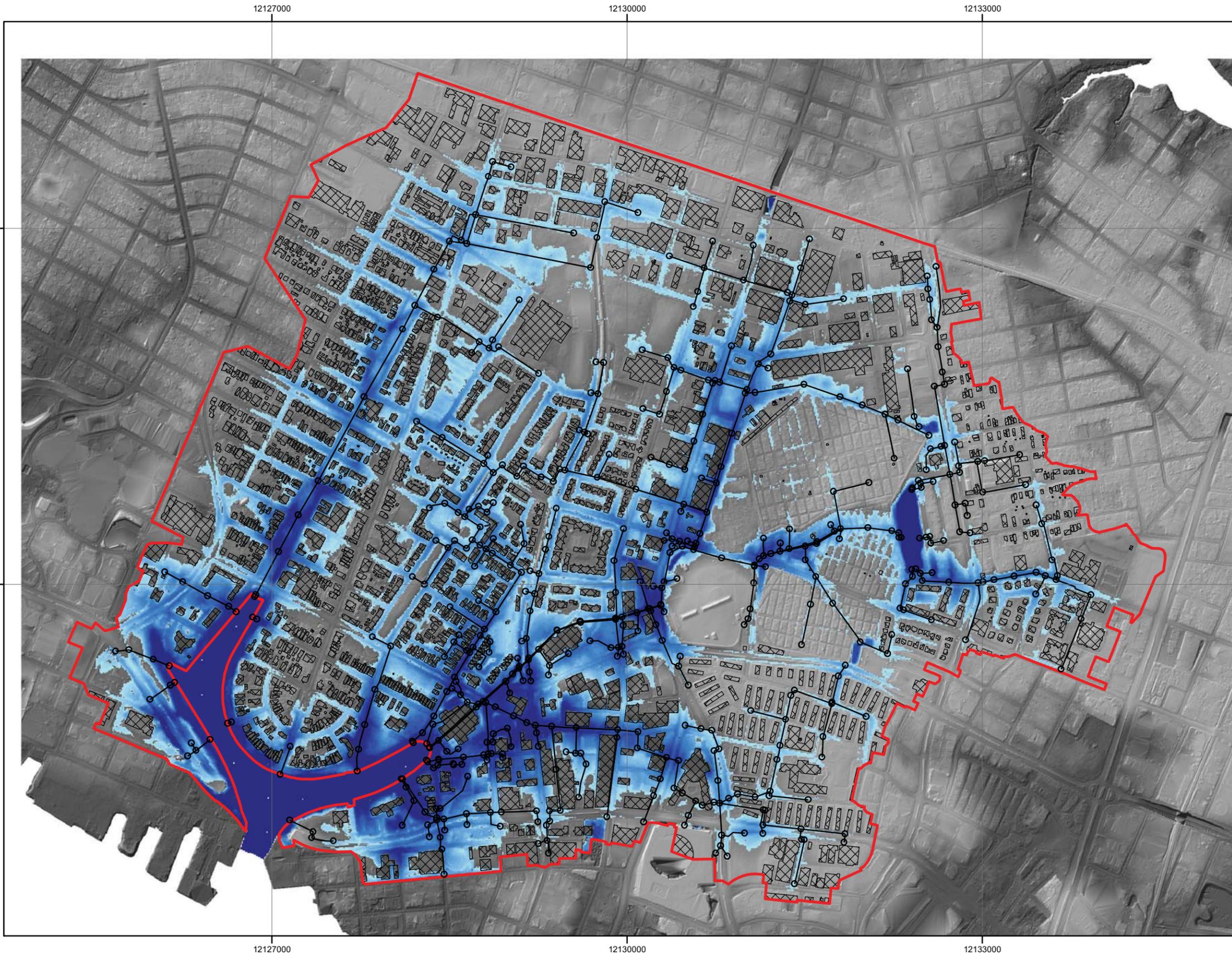
FIGURE B-10



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FIGURE B-11

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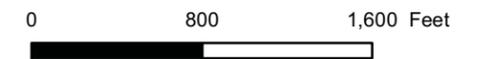
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
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- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = 100YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-12

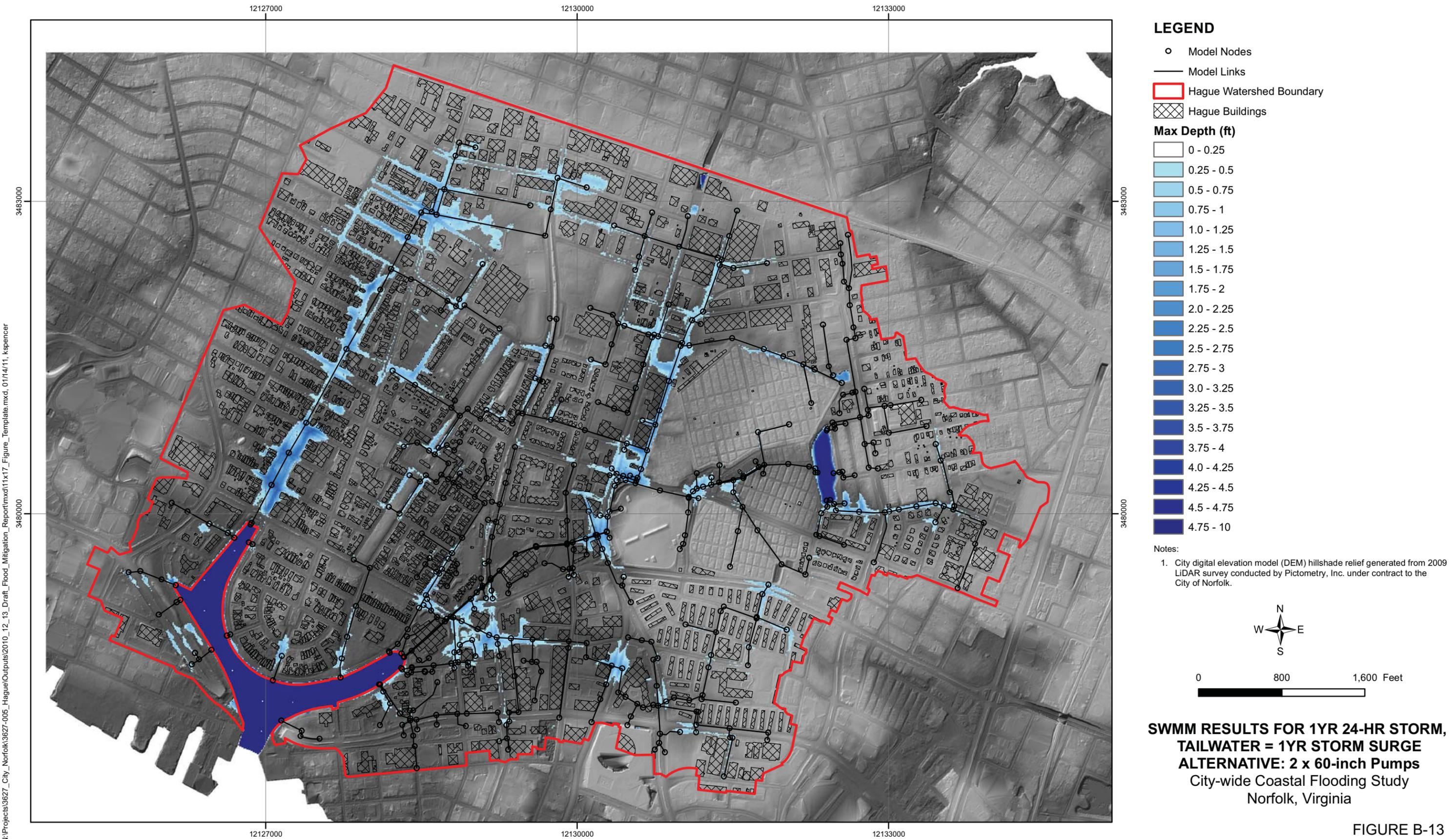
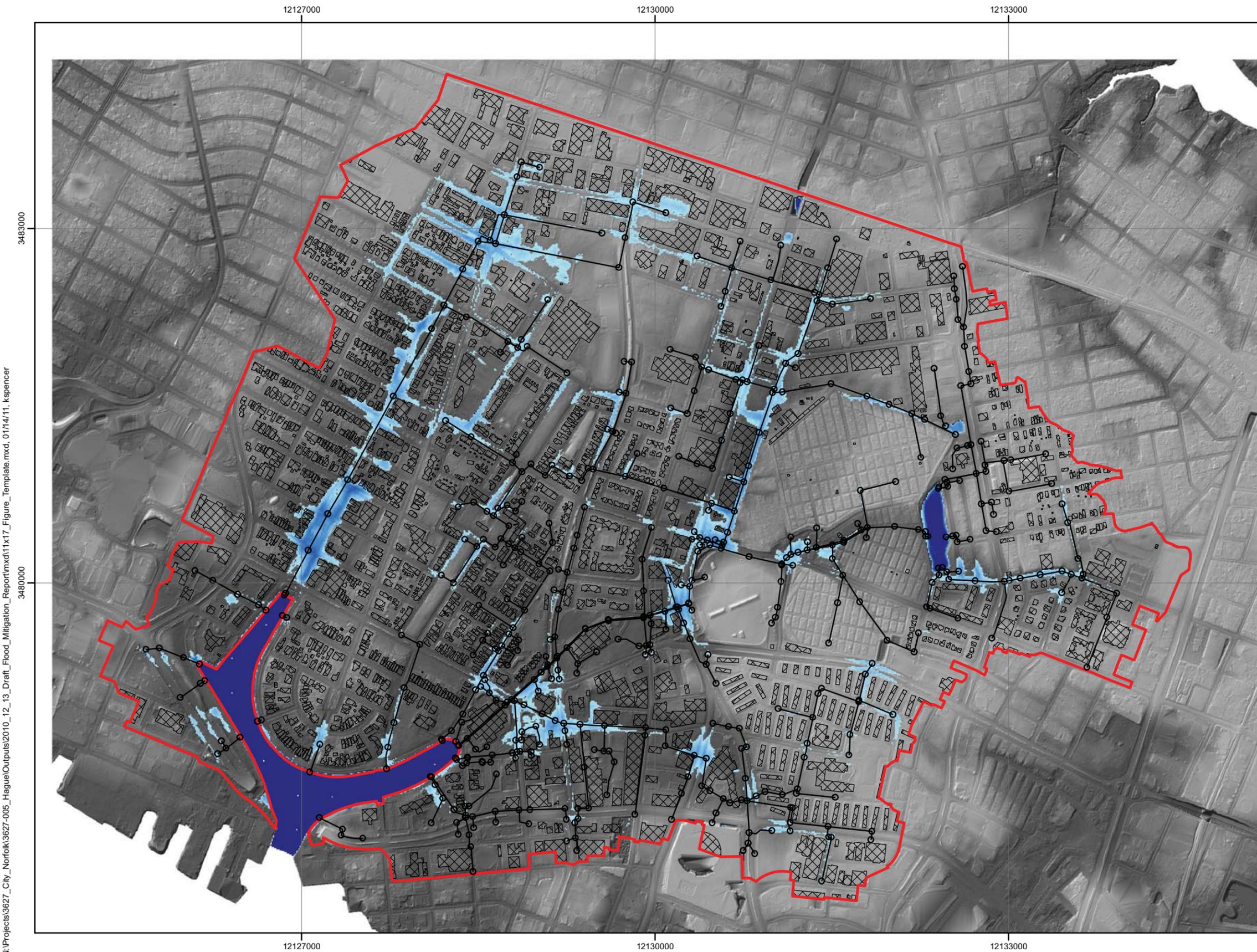


FIGURE B-13

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LEGEND

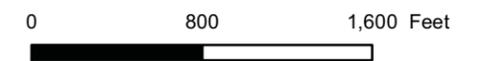
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

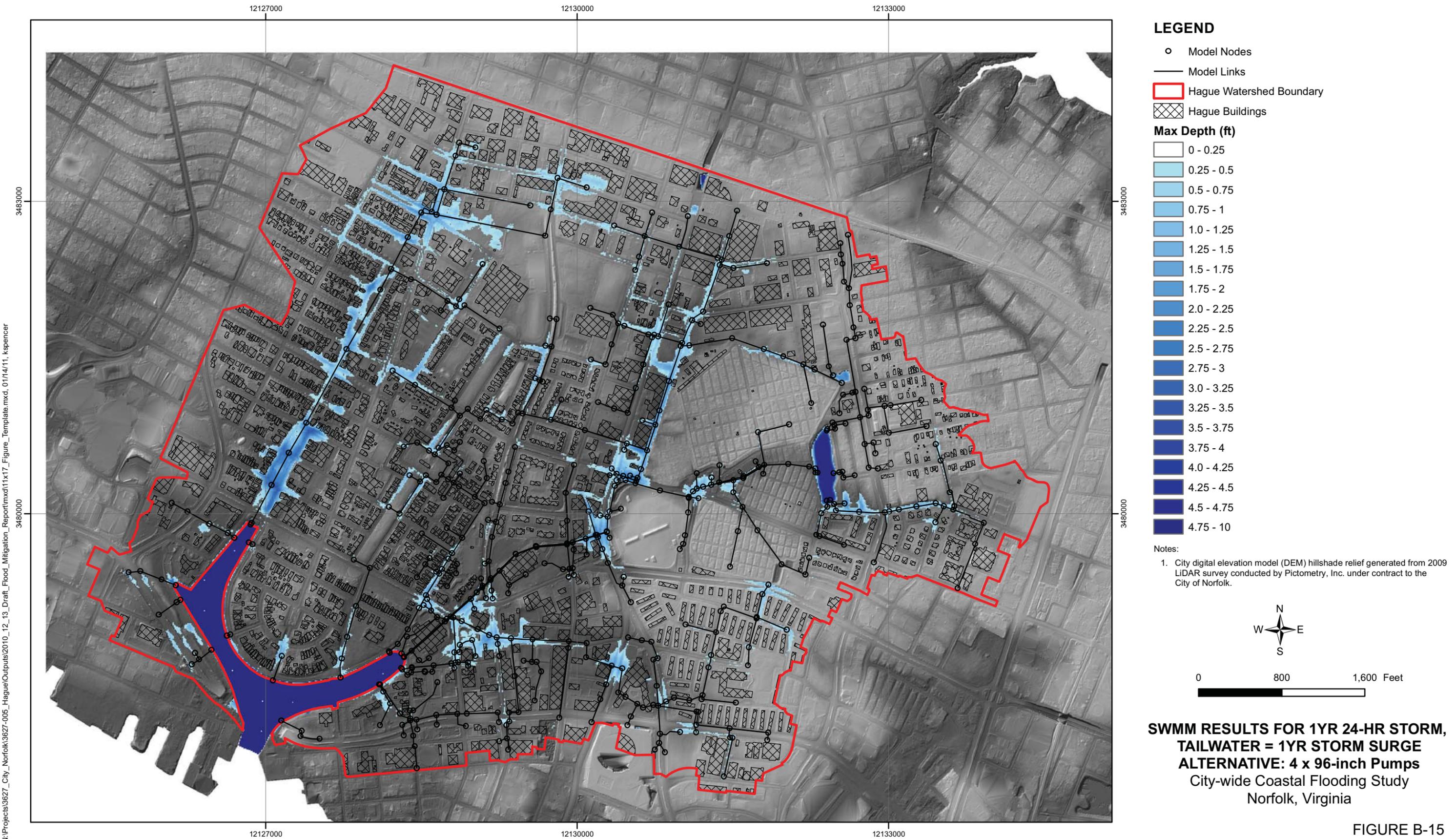
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 1YR 24-HR STORM,
TAILWATER = 1YR STORM SURGE
ALTERNATIVE: 4 x 60-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-14



**SWMM RESULTS FOR 1YR 24-HR STORM,
TAILWATER = 1YR STORM SURGE
ALTERNATIVE: 4 x 96-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-15

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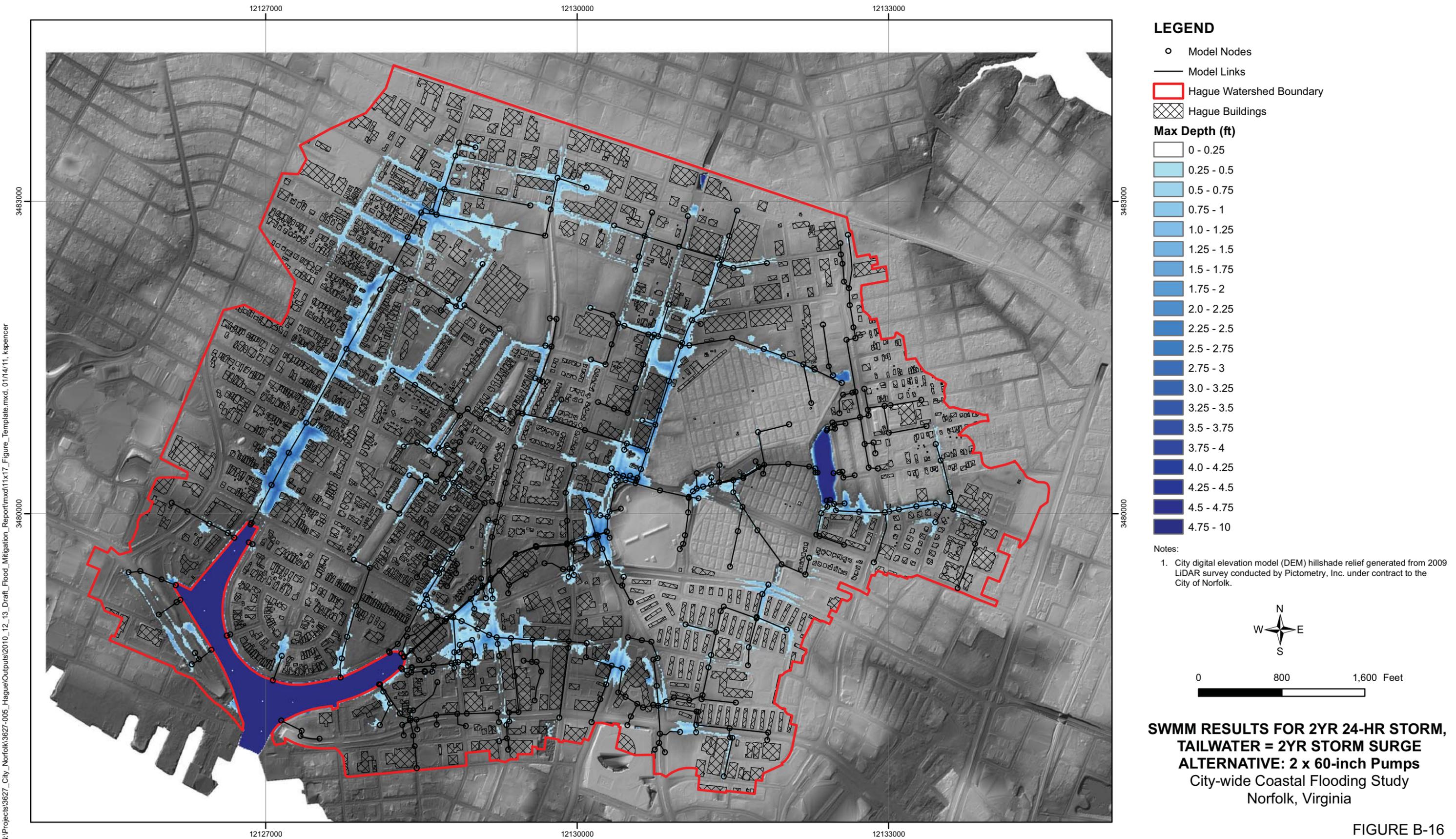
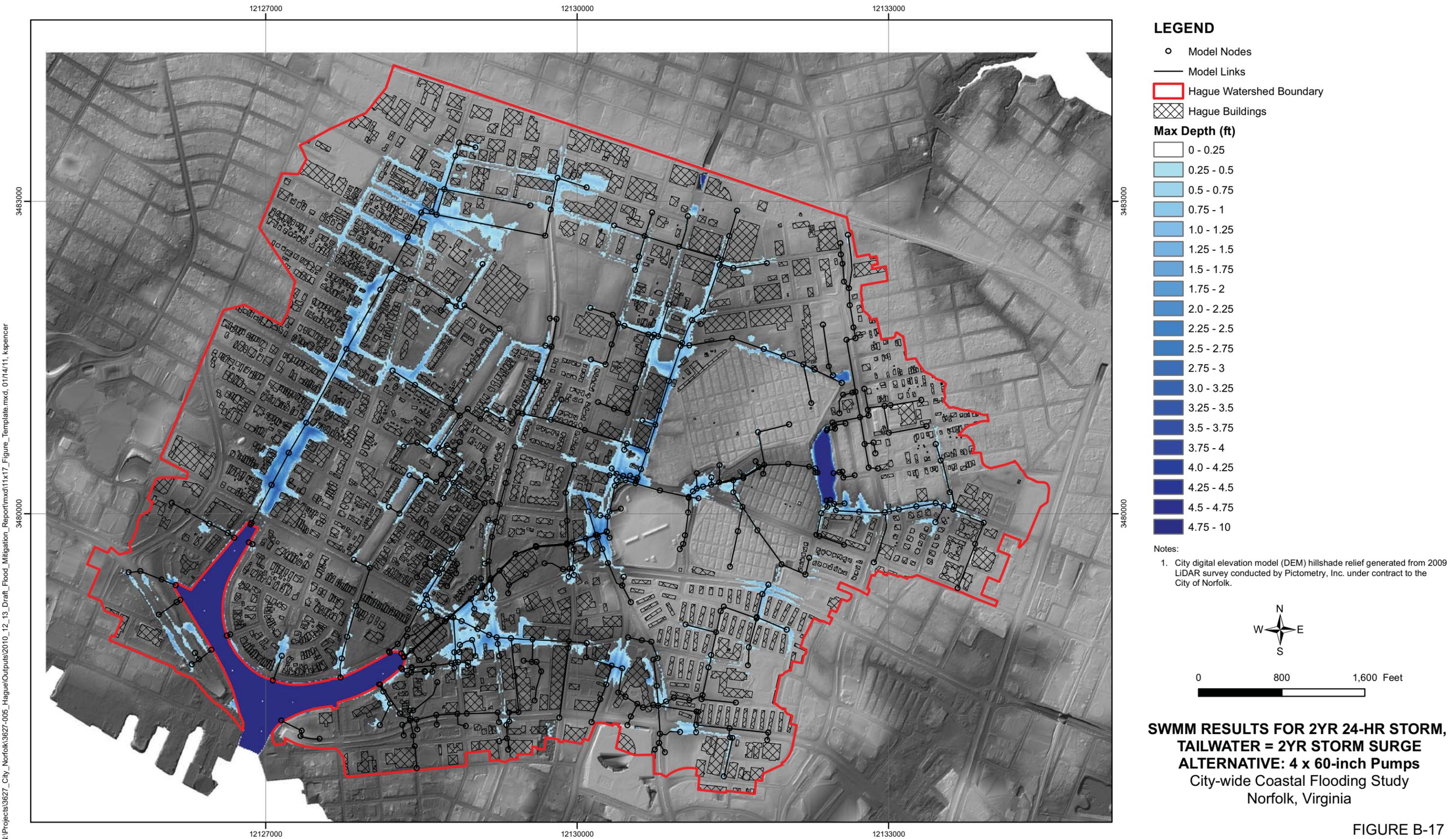


FIGURE B-16

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**SWMM RESULTS FOR 2YR 24-HR STORM,
TAILWATER = 2YR STORM SURGE
ALTERNATIVE: 4 x 60-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-17

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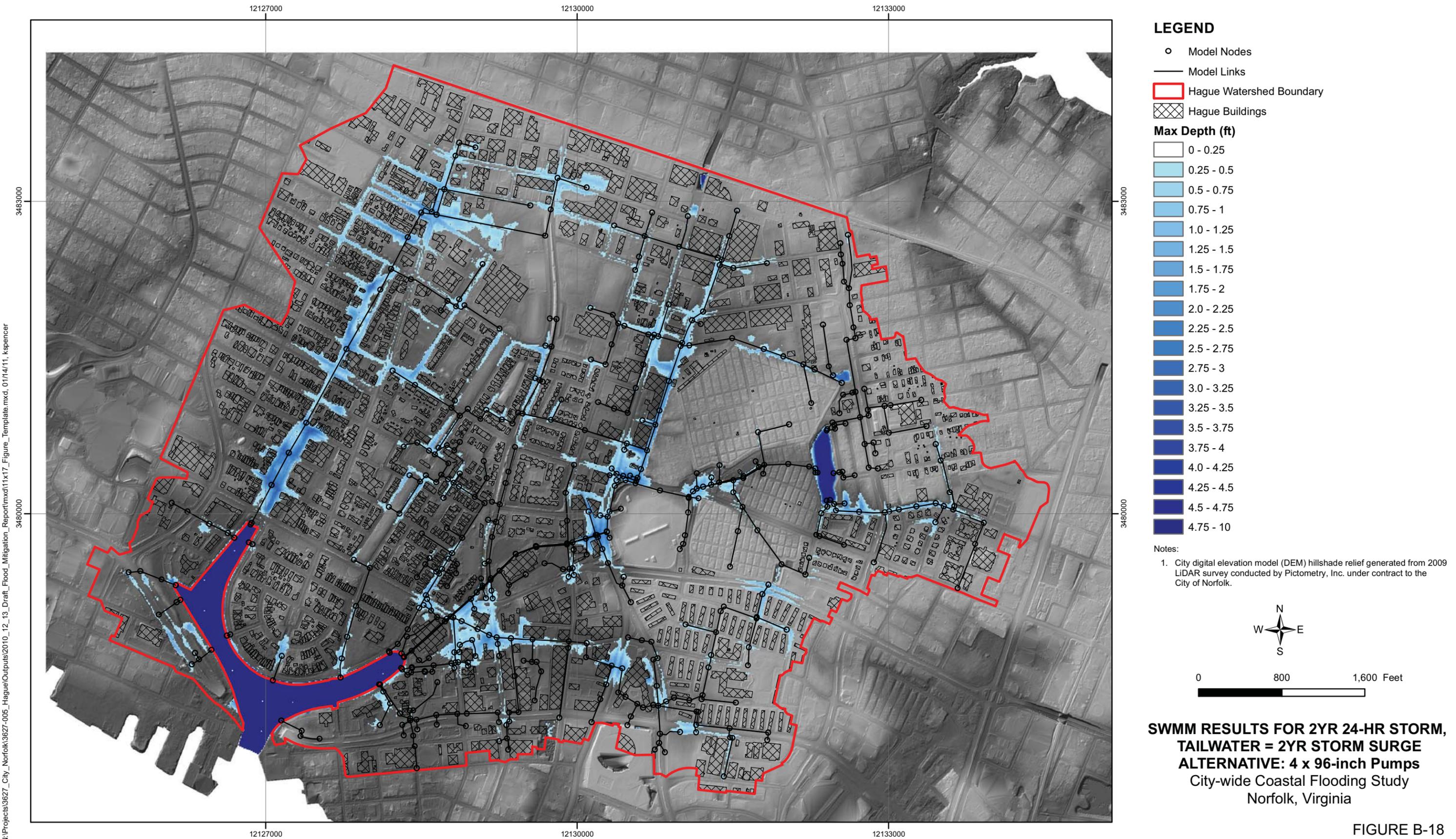
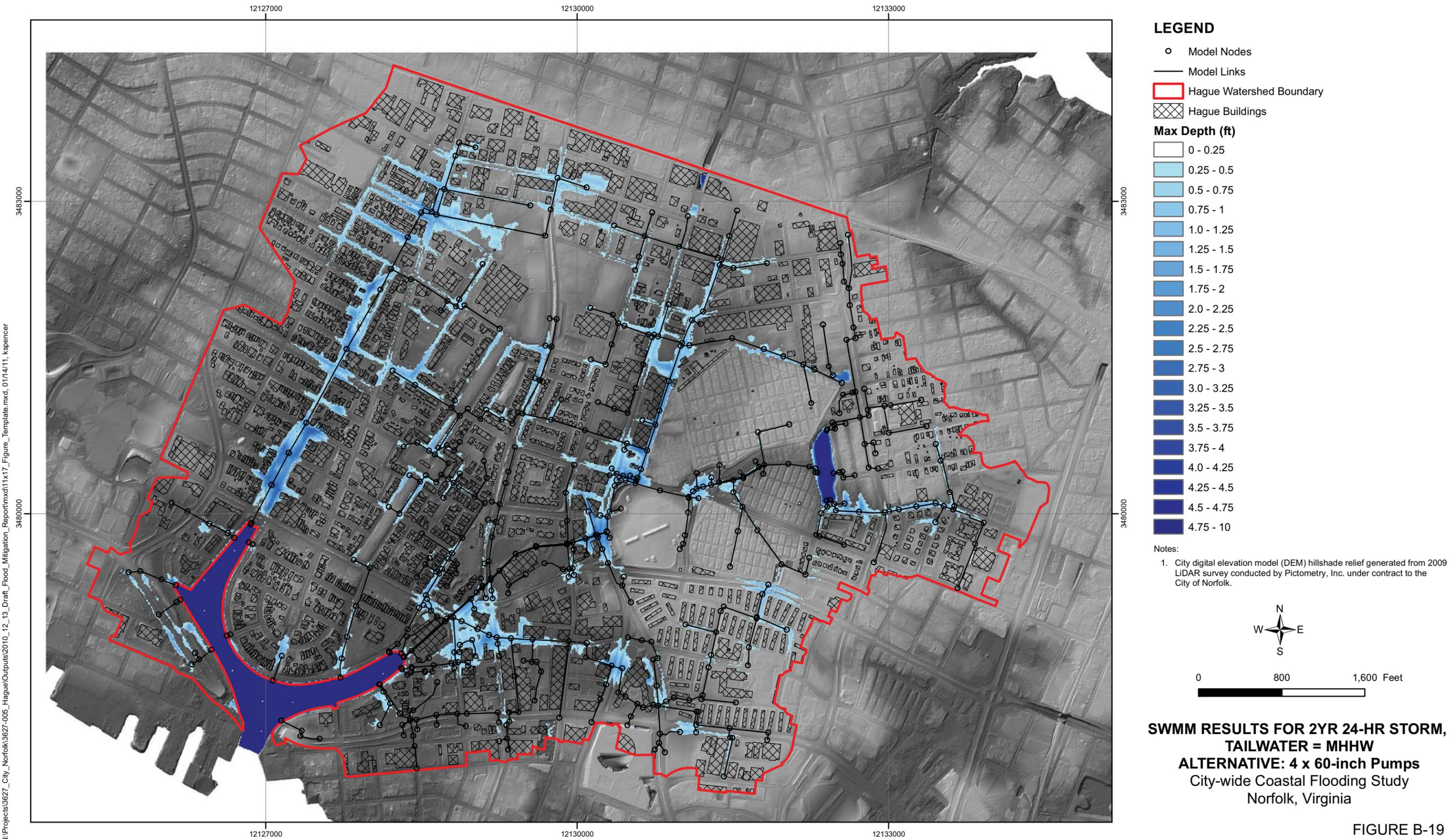


FIGURE B-18

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

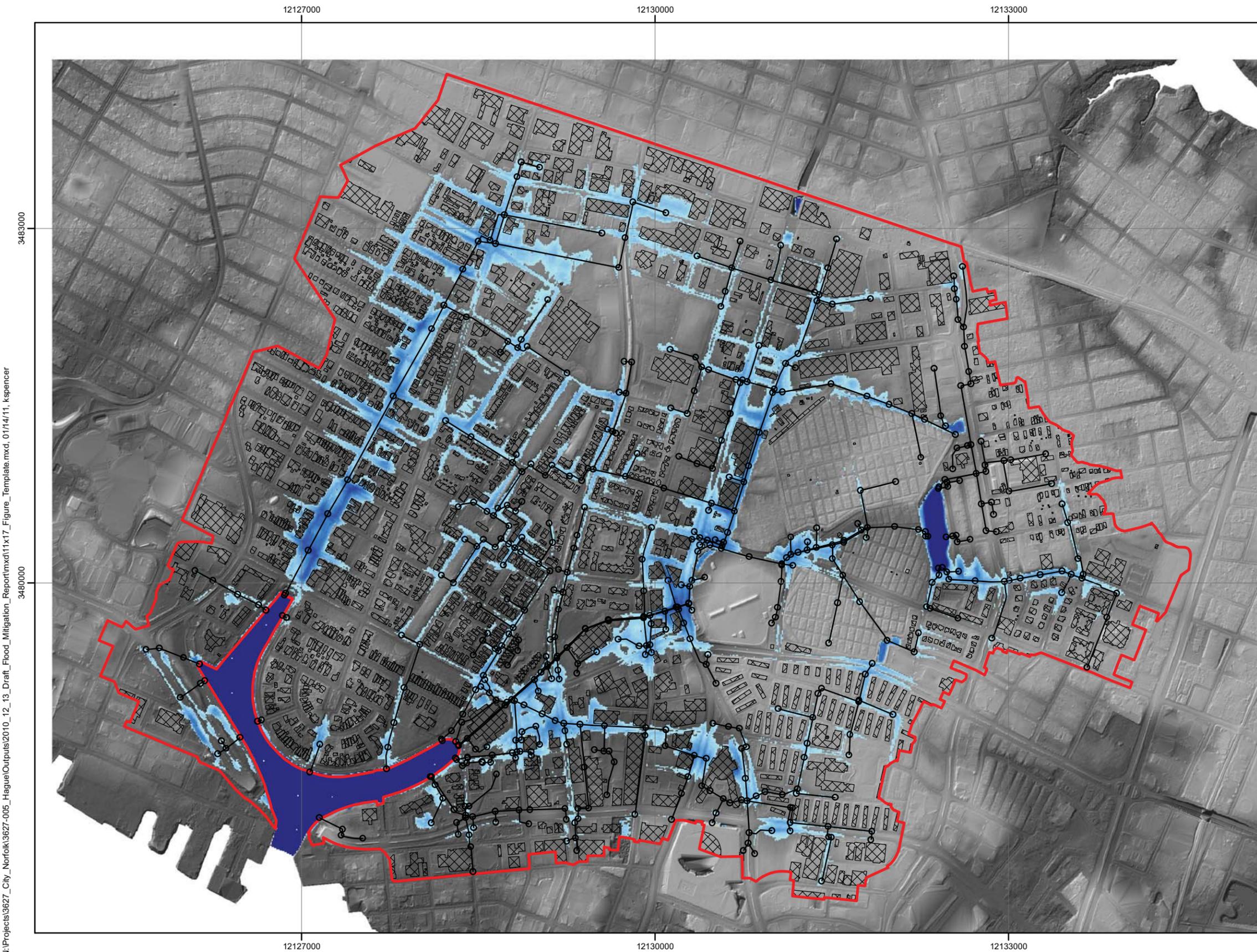
Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



0 800 1,600 Feet

**SWMM RESULTS FOR 2YR 24-HR STORM,
 TAILWATER = MHHW
 ALTERNATIVE: 4 x 60-inch Pumps
 City-wide Coastal Flooding Study
 Norfolk, Virginia**

FIGURE B-19



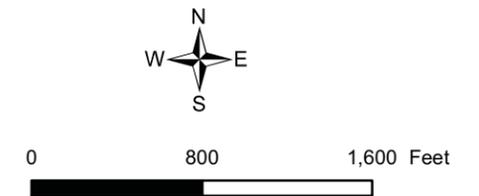
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

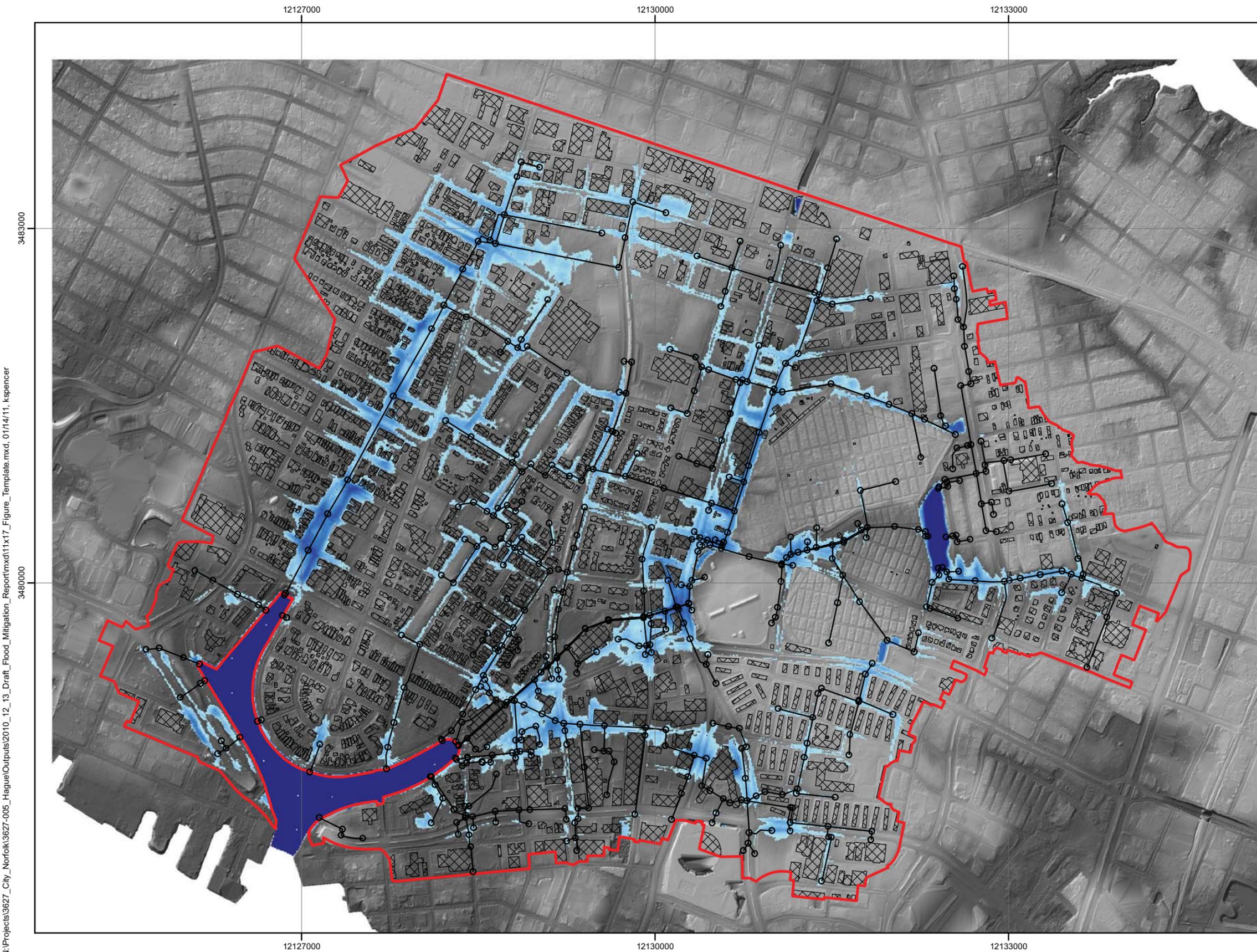
Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = 10YR STORM SURGE
 ALTERNATIVE: 2 x 60-inch Pumps**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-20

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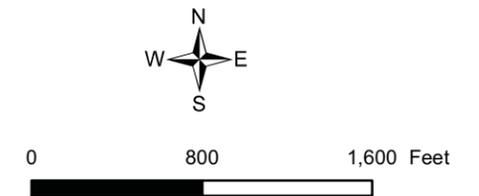
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

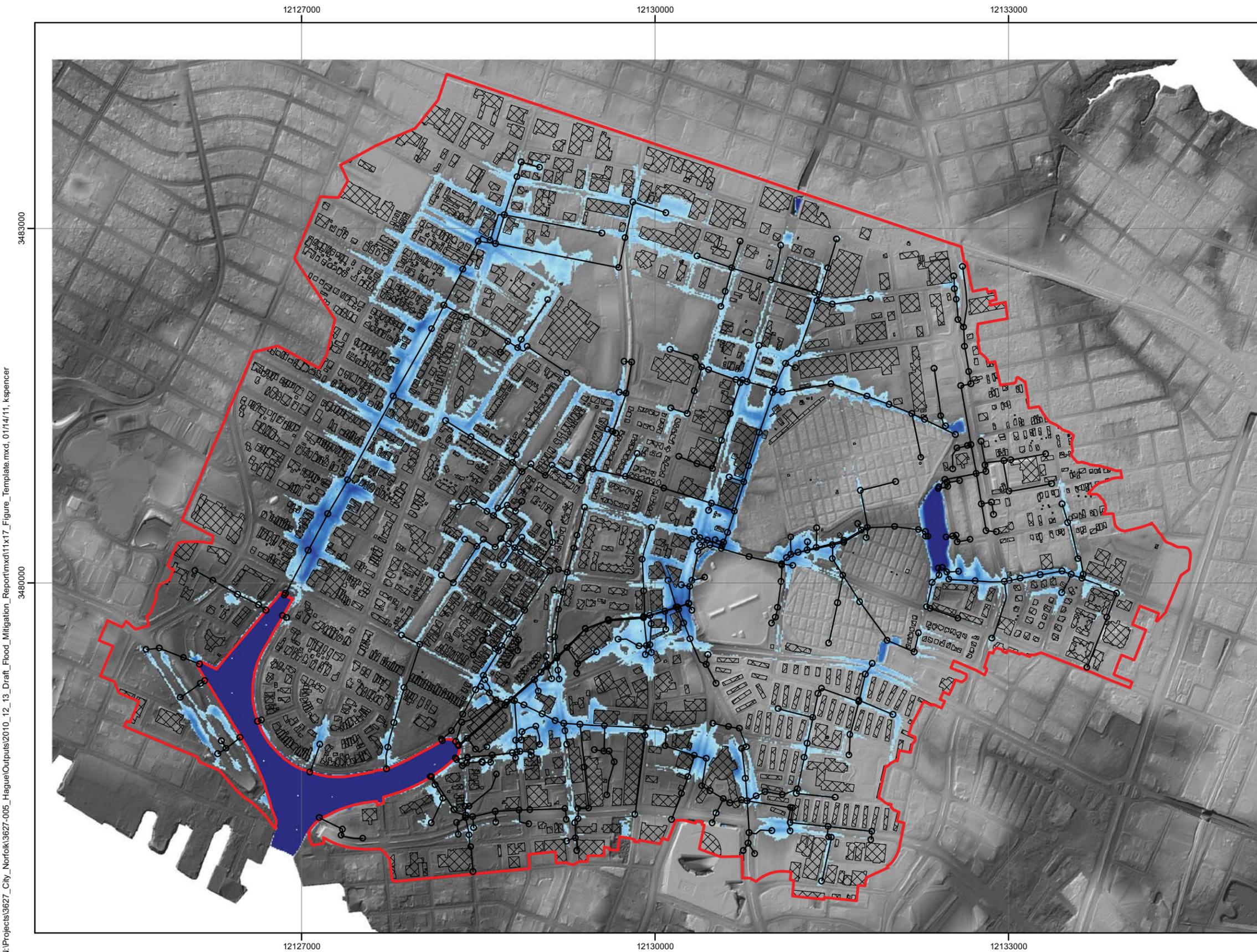
Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = 10YR STORM SURGE
 ALTERNATIVE: 4 x 60-inch Pumps**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-21

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



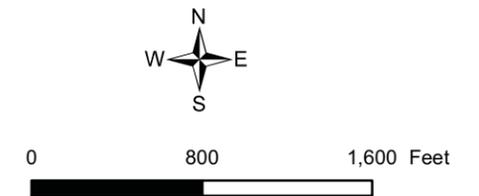
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.

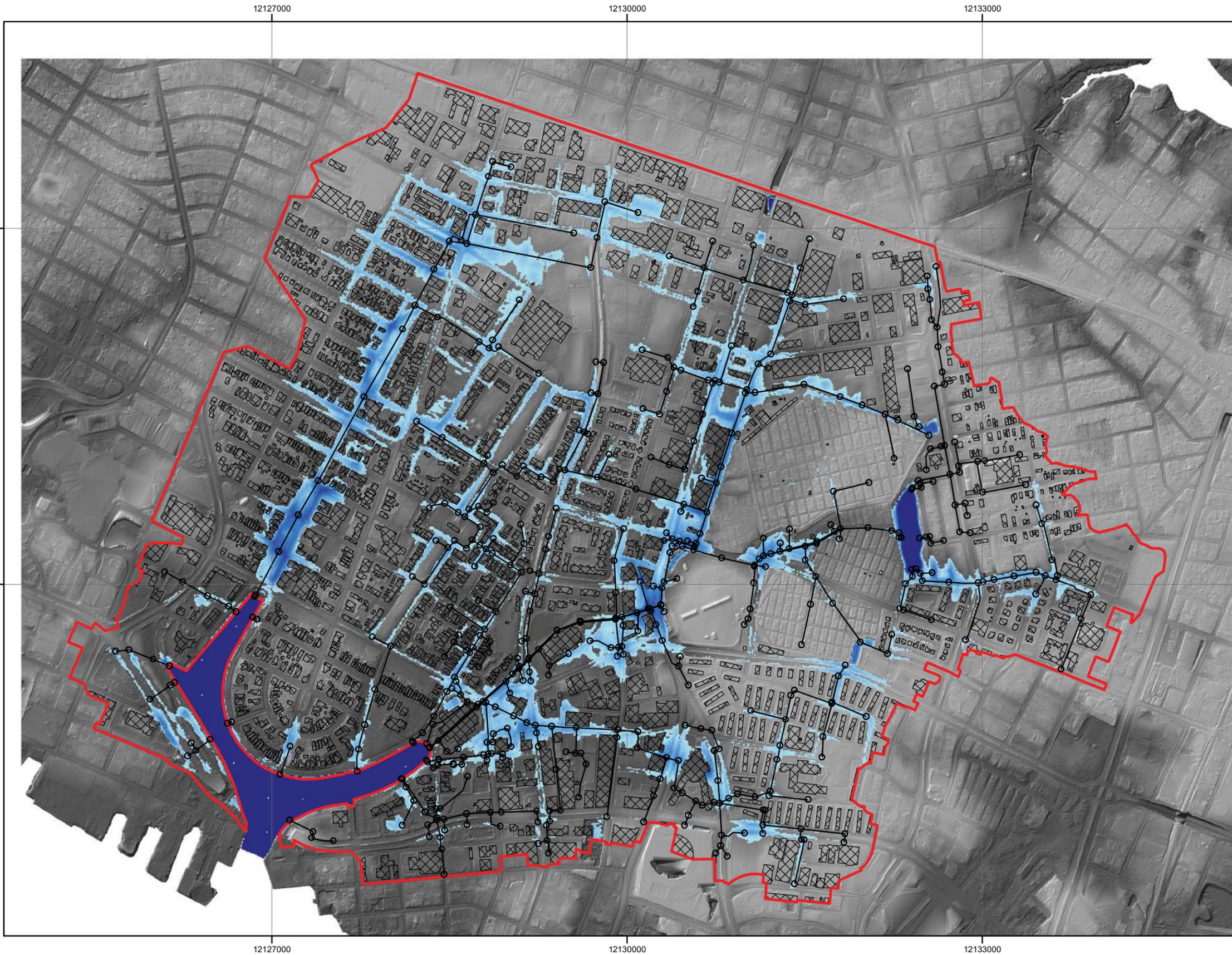


**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = 10YR STORM SURGE
 ALTERNATIVE: 4 x 96-inch Pumps
 City-wide Coastal Flooding Study
 Norfolk, Virginia**

FIGURE B-22

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LEGEND

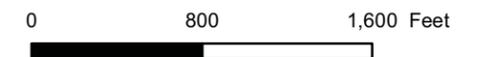
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

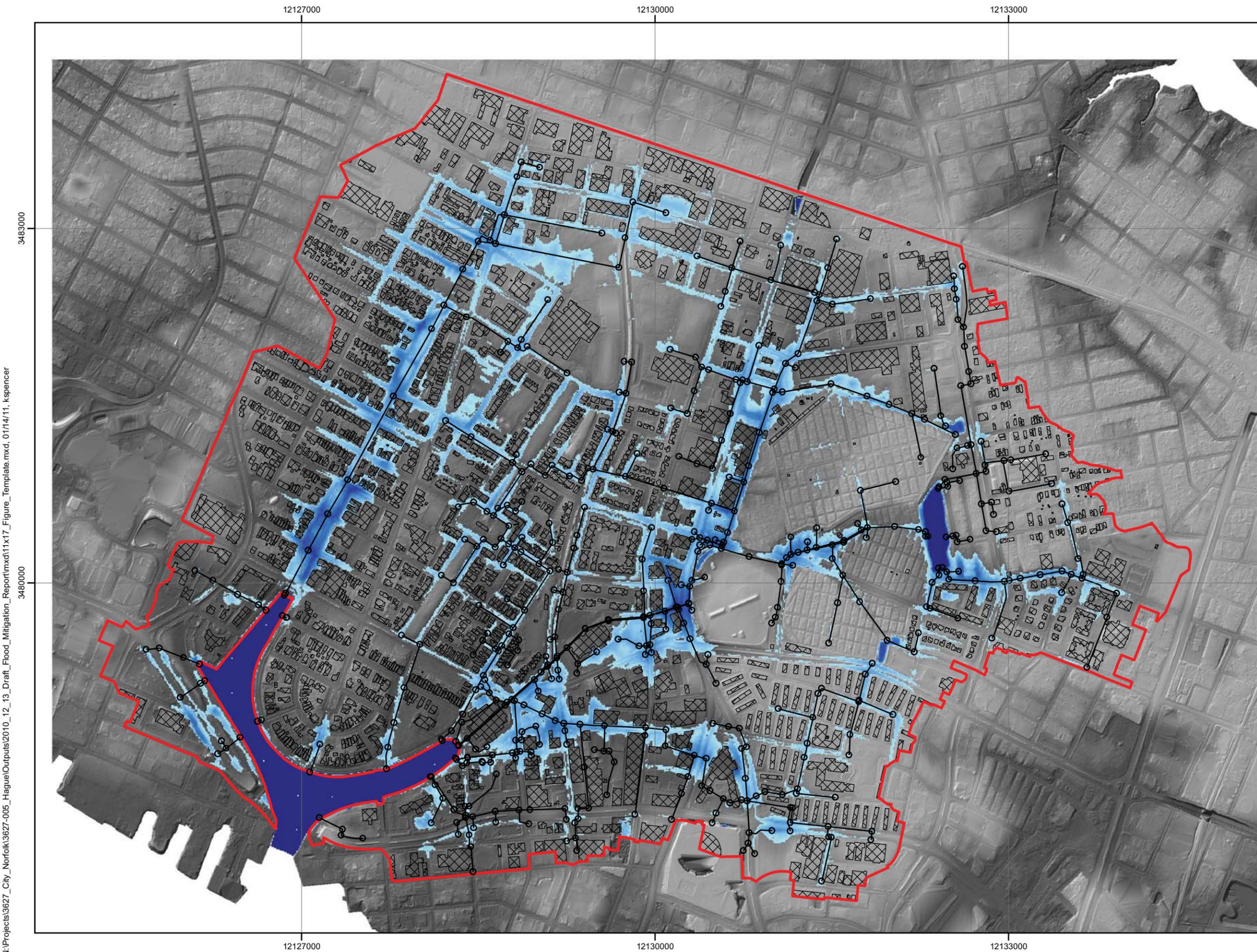
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: 4 x 60-inch Pumps
City-wide Coastal Flooding Study
Norfolk, Virginia**

FIGURE B-23



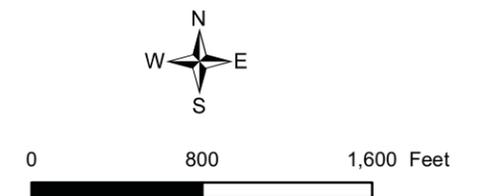
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

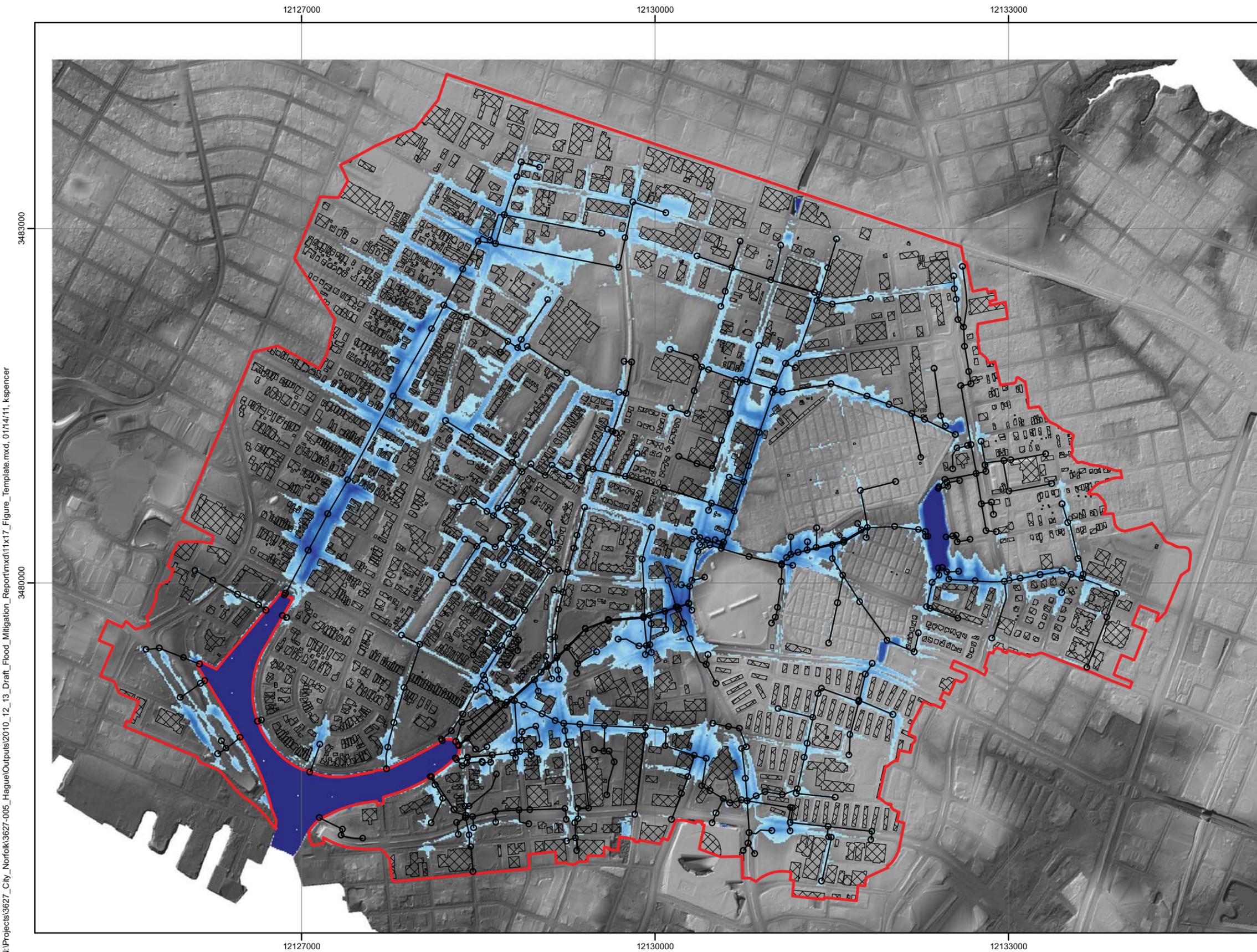
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE
ALTERNATIVE: 2 x 60-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-24



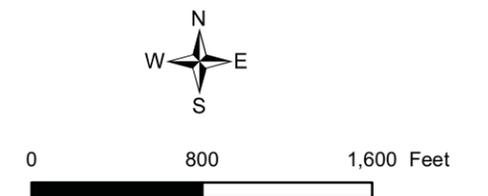
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

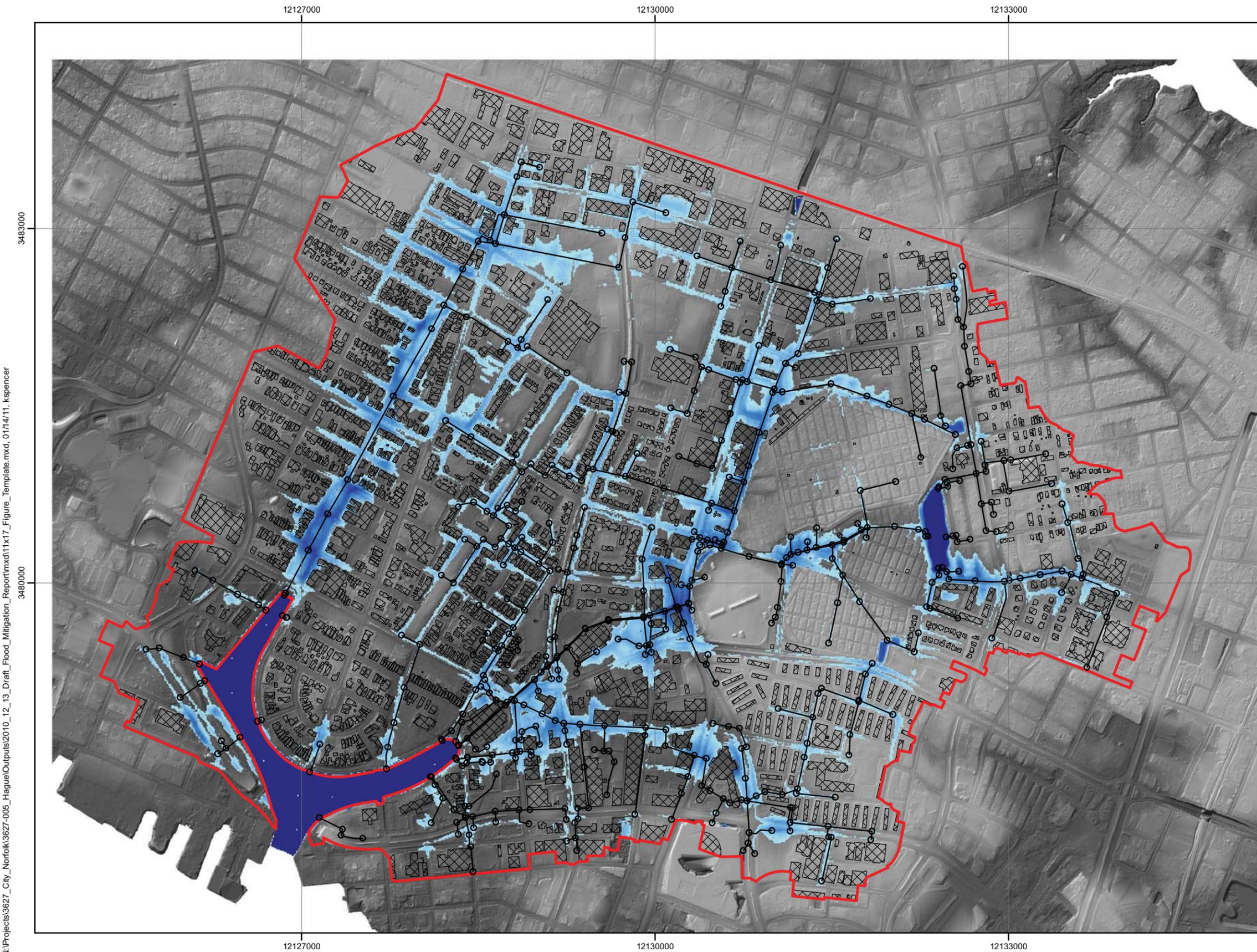
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE
ALTERNATIVE: 4 x 60-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-25



LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE
ALTERNATIVE: 4 x 96-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-26

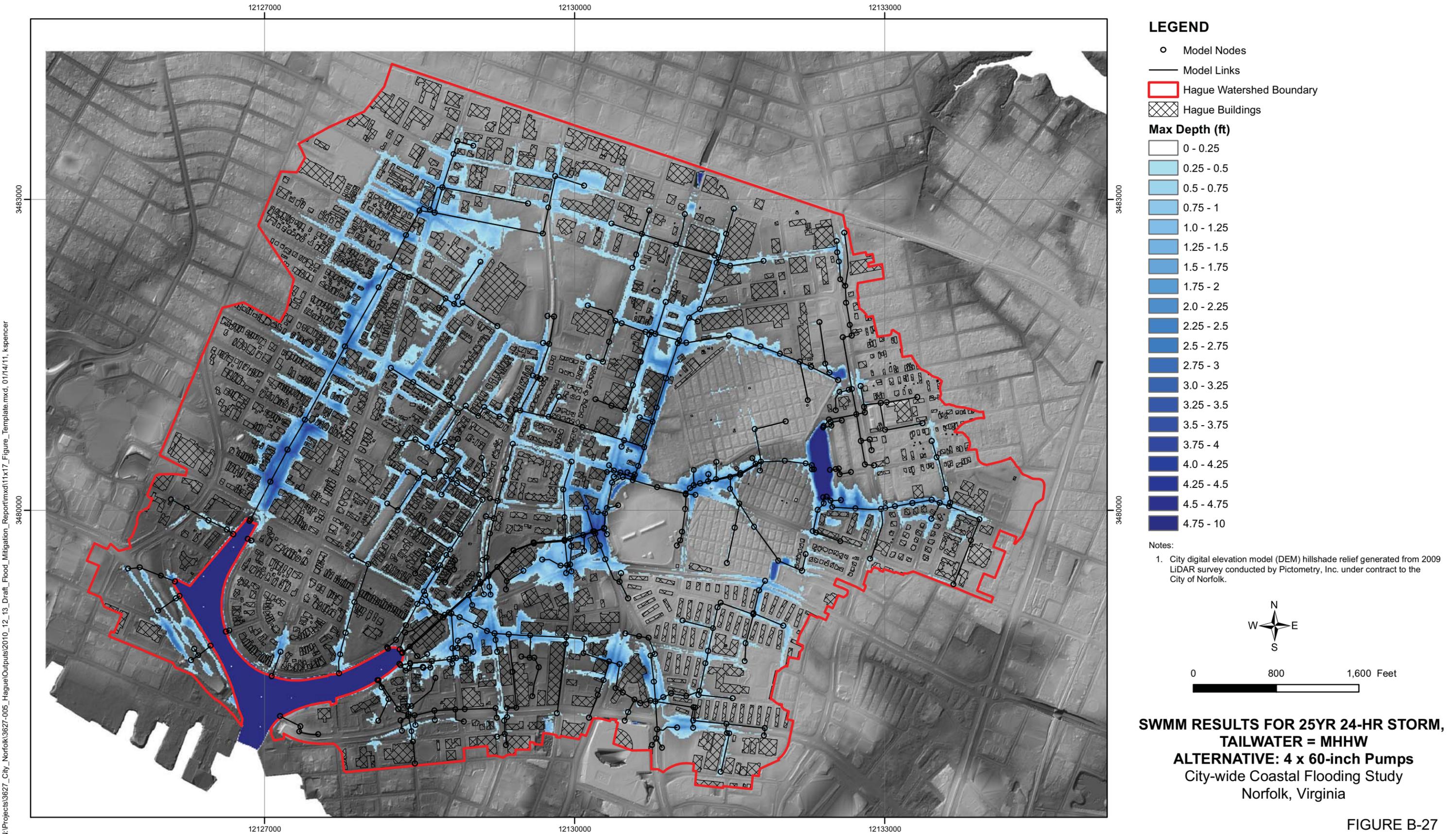
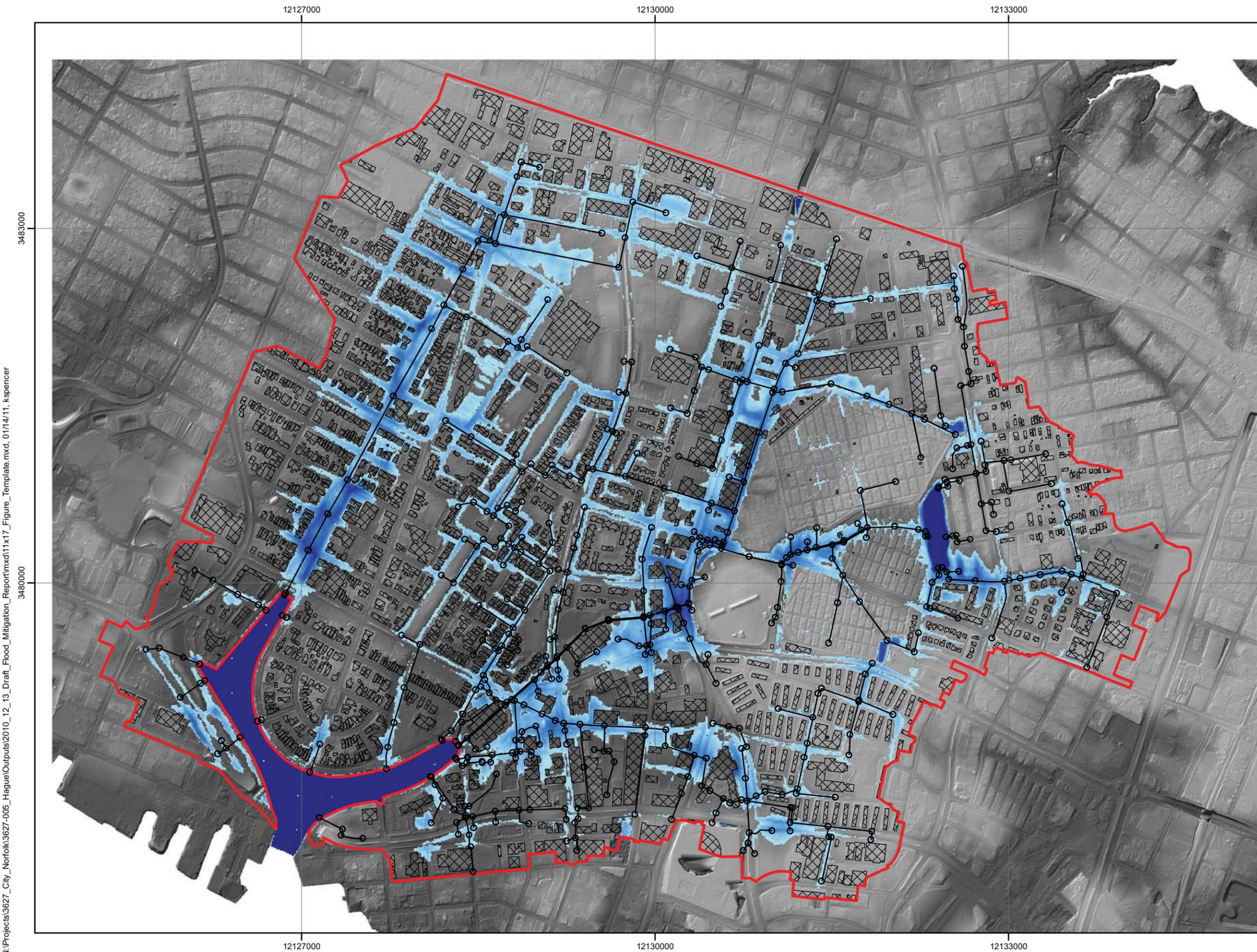


FIGURE B-27

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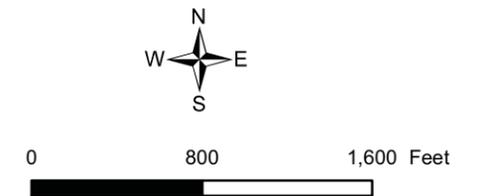
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

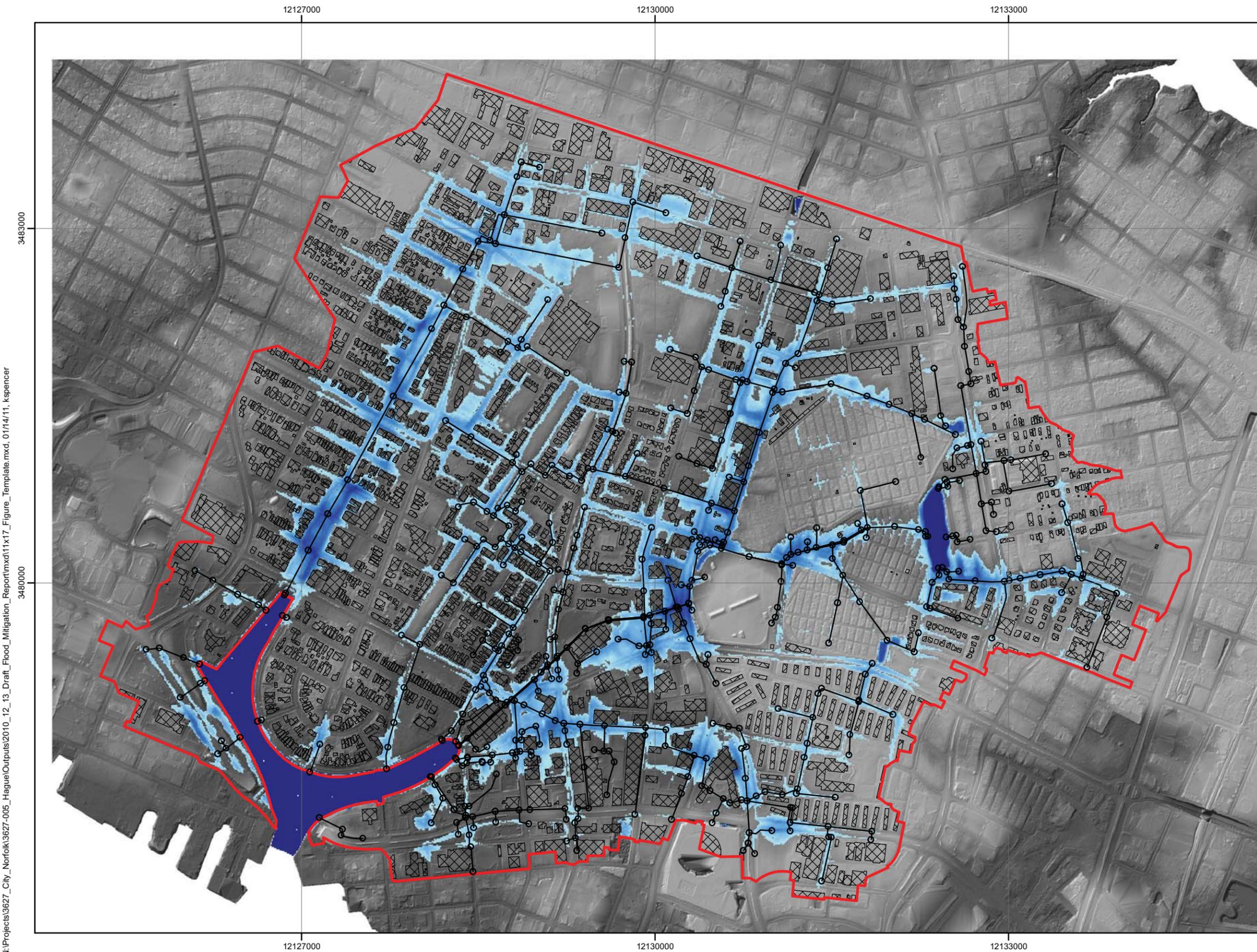
Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
 TAILWATER = 50YR STORM SURGE
 ALTERNATIVE: 2 x 60-inch Pumps**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-28

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

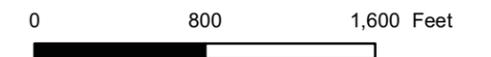
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

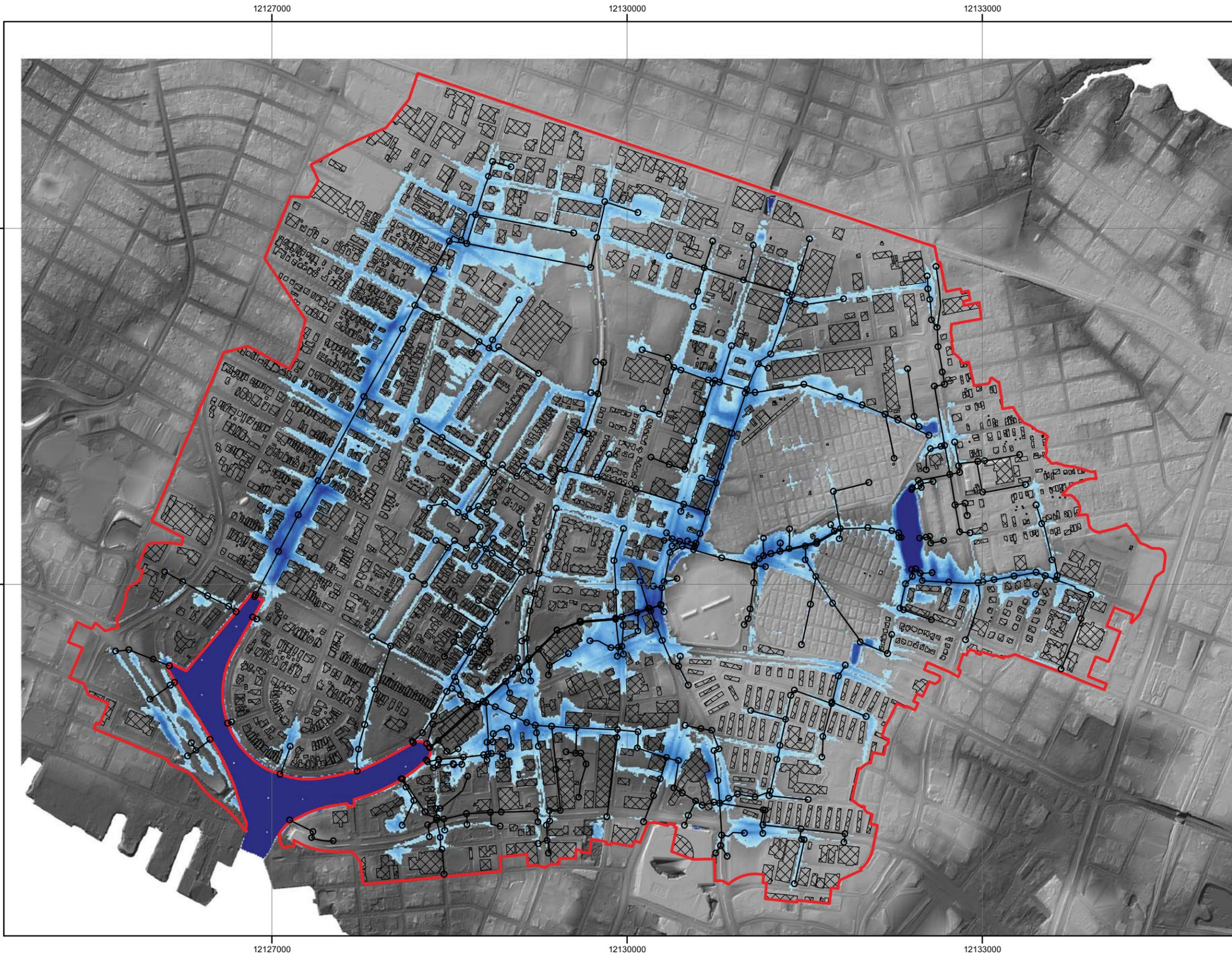
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
 TAILWATER = 50YR STORM SURGE
 ALTERNATIVE: 4 x 60-inch Pumps**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-29

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

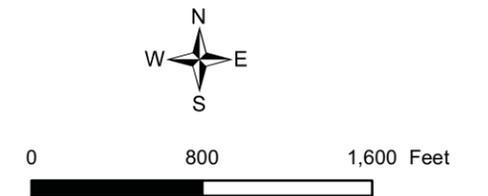
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

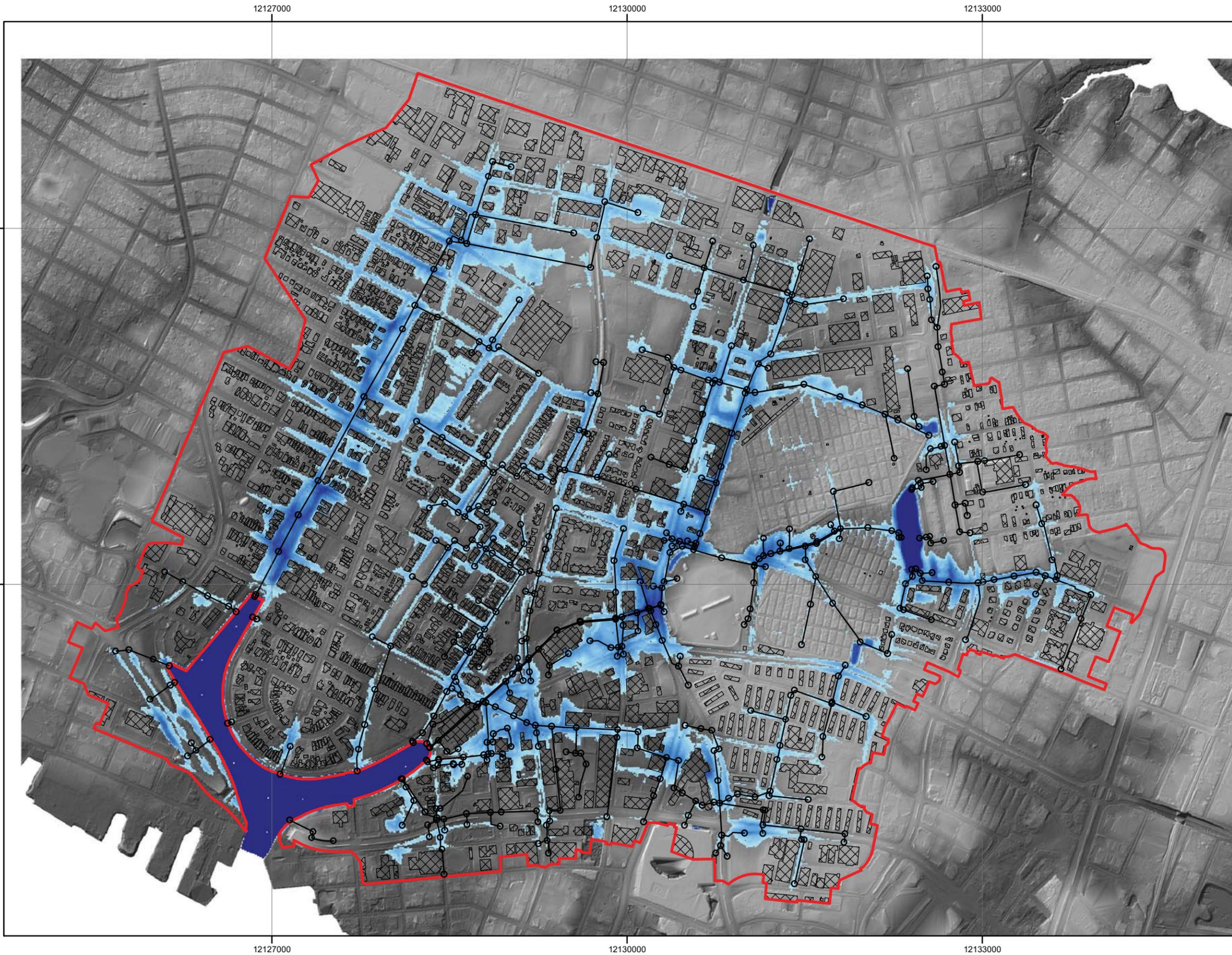
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
TAILWATER = 50YR STORM SURGE
ALTERNATIVE: 4 x 96-inch Pumps
City-wide Coastal Flooding Study
Norfolk, Virginia**

FIGURE B-30

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

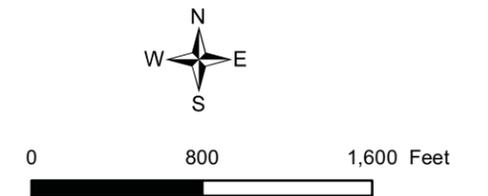
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

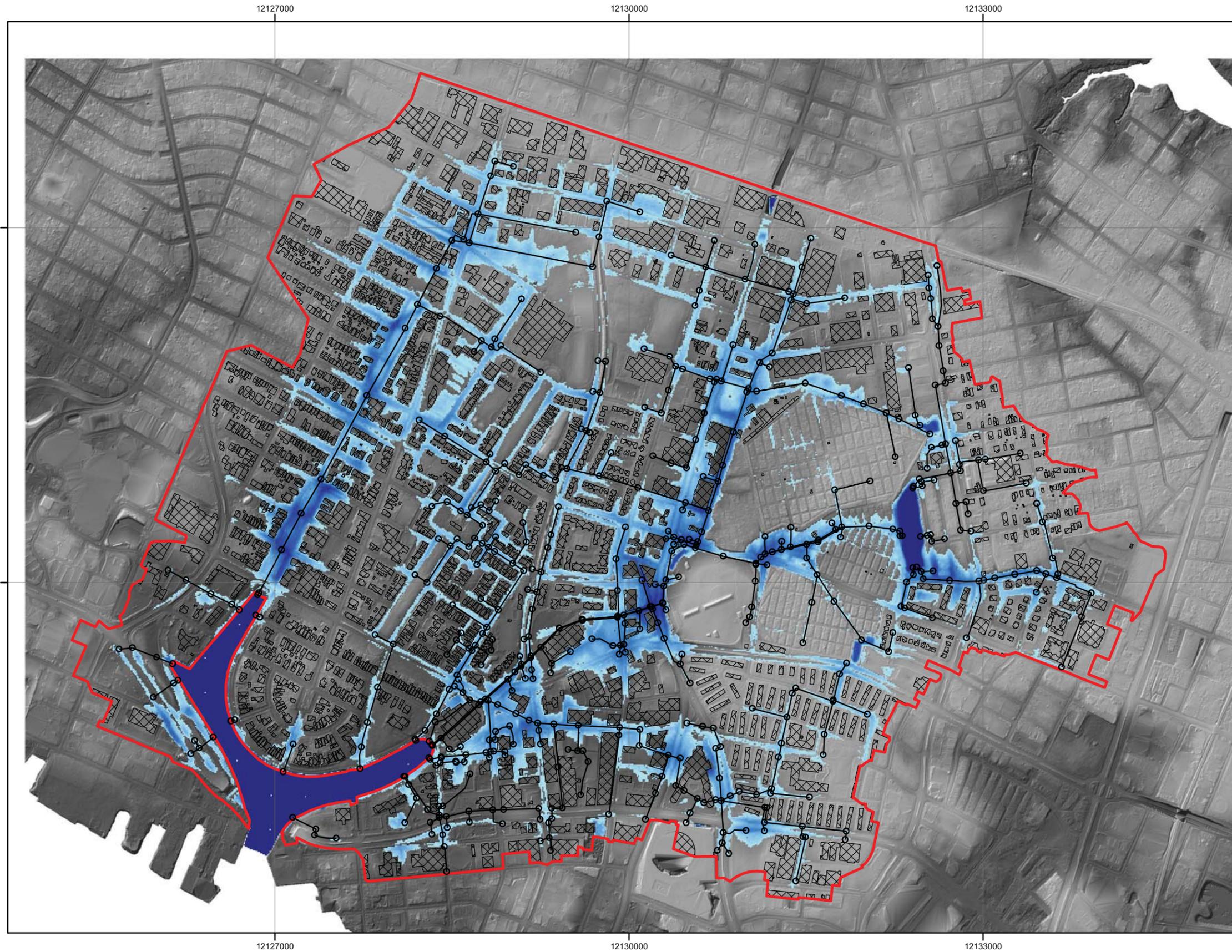
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: 4 x 60-inch Pumps
City-wide Coastal Flooding Study
Norfolk, Virginia**

FIGURE B-31

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

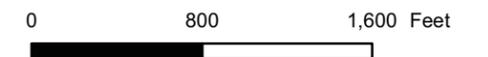
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

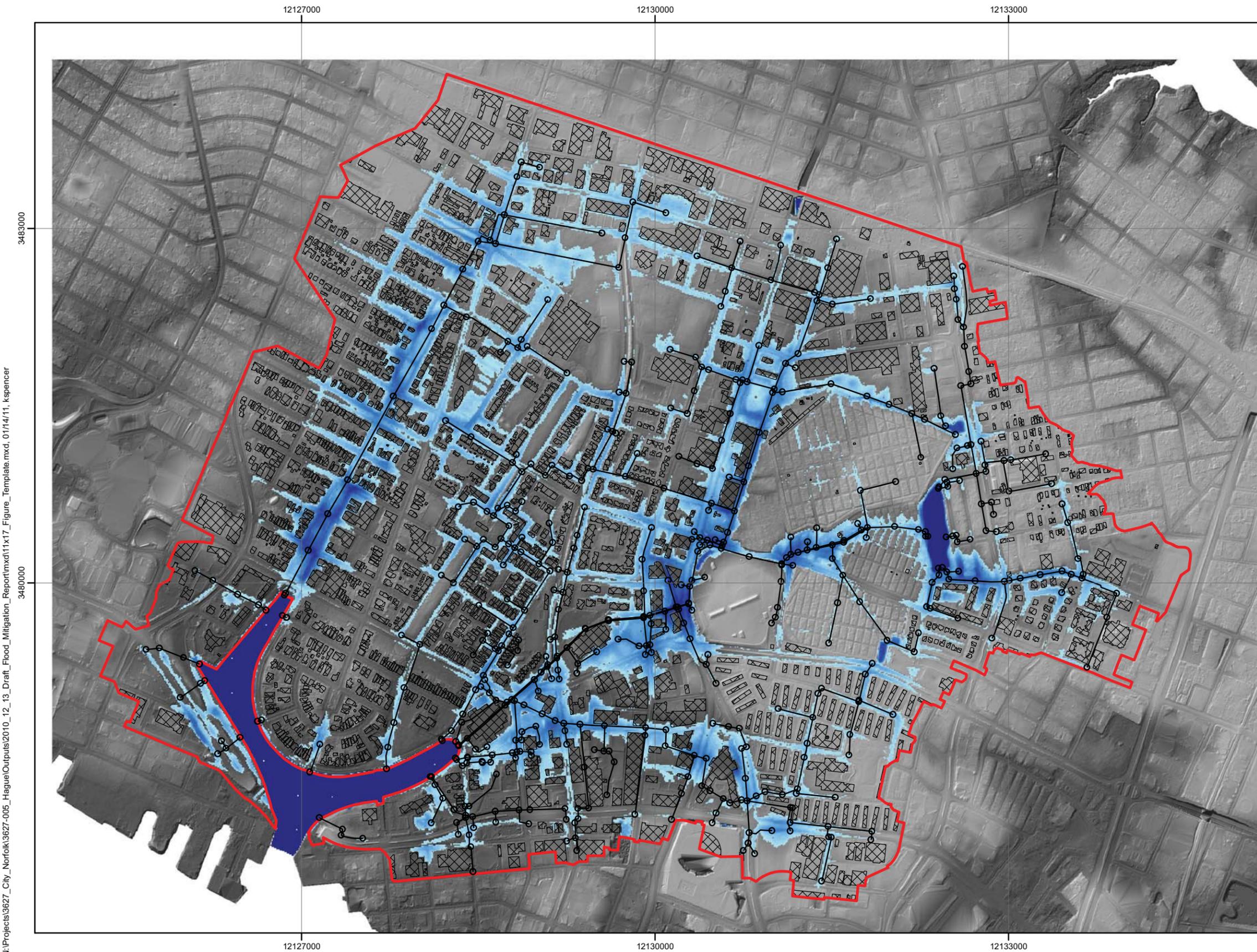
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = 100YR STORM SURGE
ALTERNATIVE: 2 x 60-inch Pumps**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-32



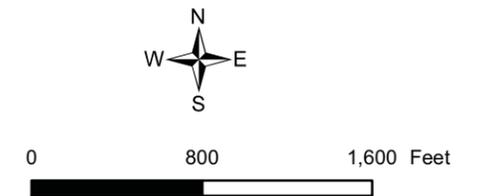
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

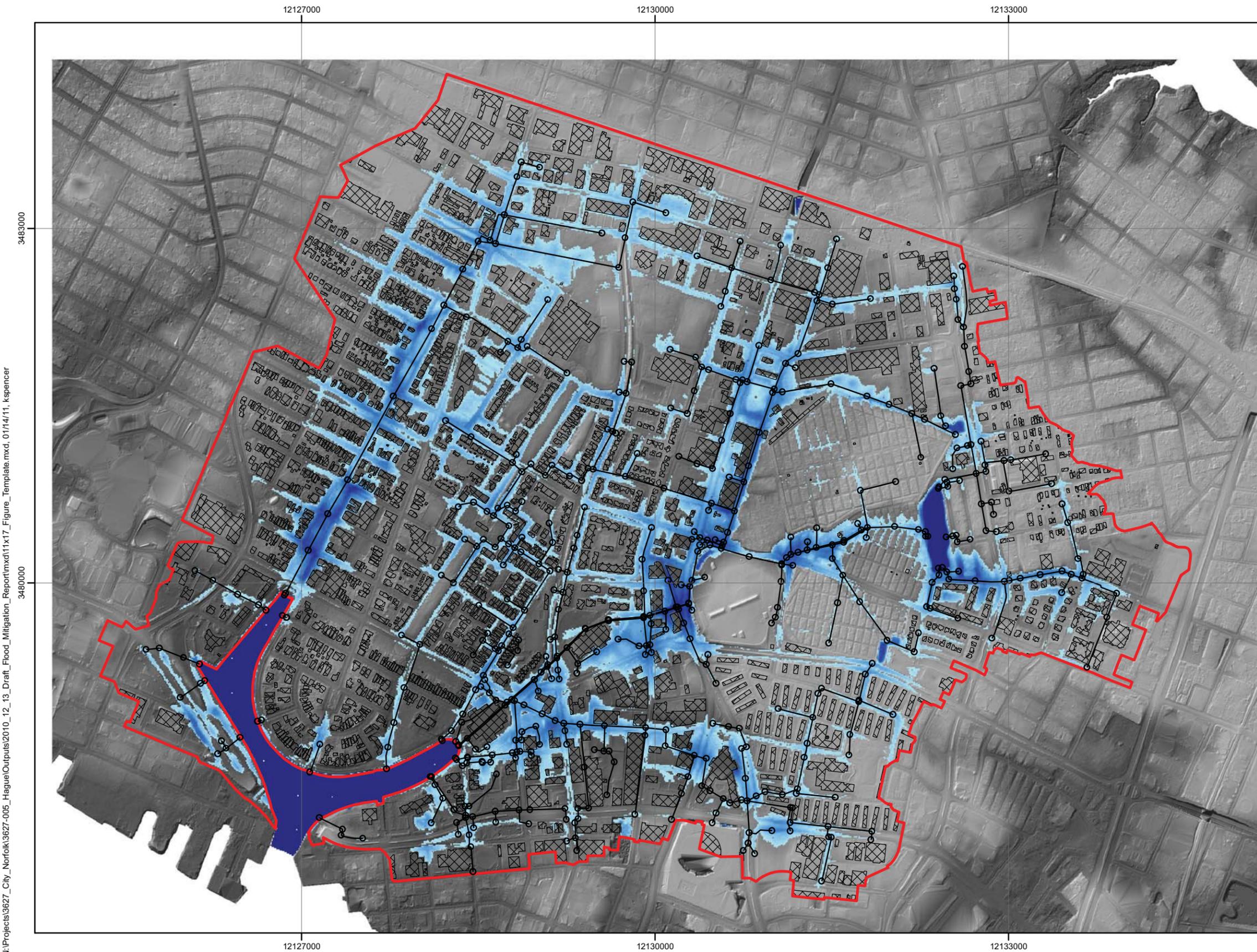
Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
 TAILWATER = 100YR STORM SURGE
 ALTERNATIVE: 4 x 60-inch Pumps**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-33

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd, 01/14/11, kspencer



LEGEND

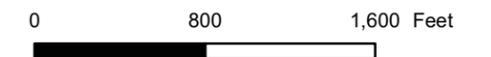
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

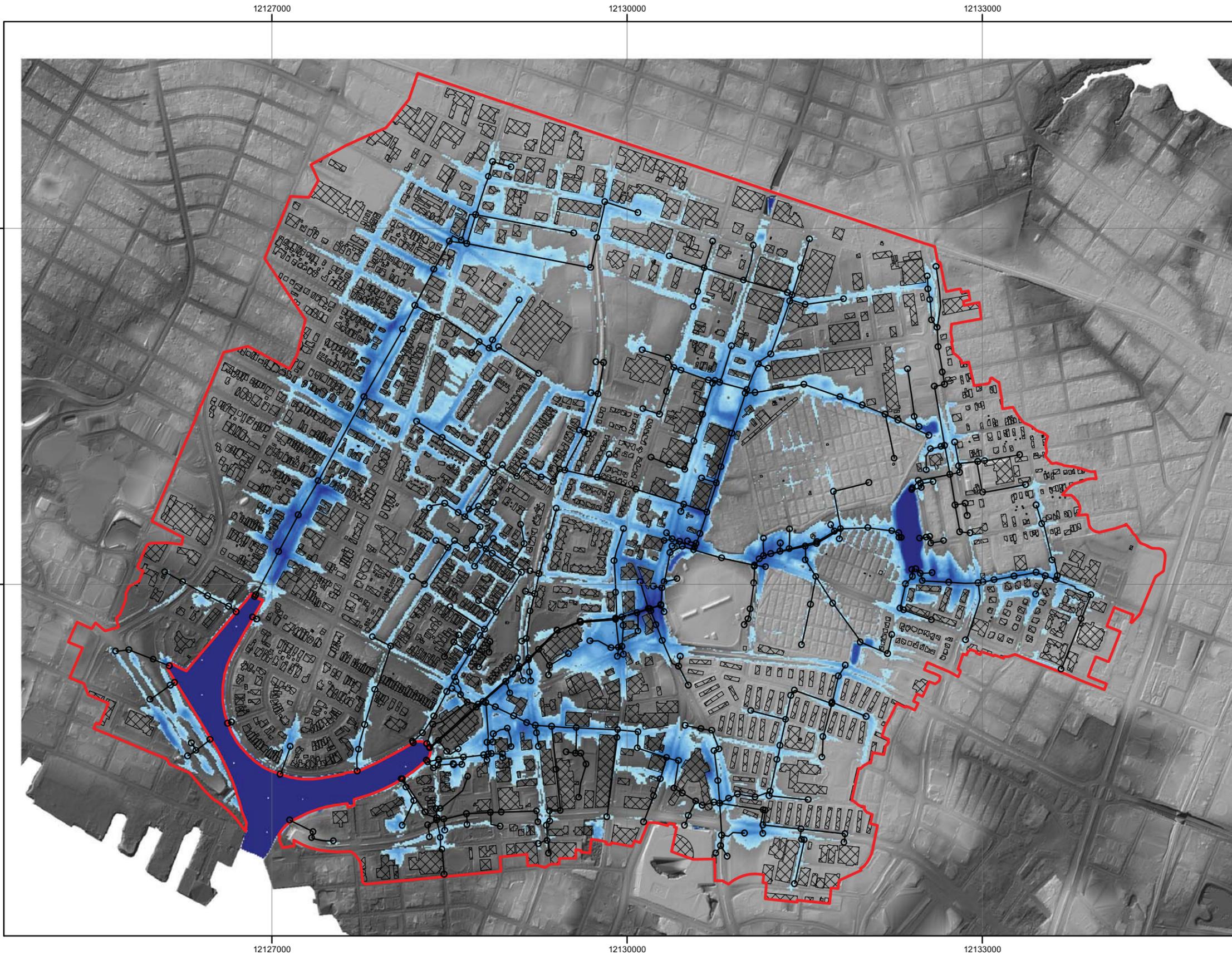
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
 TAILWATER = 100YR STORM SURGE
 ALTERNATIVE: 4 x 96-inch Pumps
 City-wide Coastal Flooding Study
 Norfolk, Virginia**

FIGURE B-34

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



LEGEND

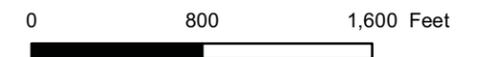
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
 TAILWATER = MHHW
 ALTERNATIVE: 4 x 60-inch Pumps
 City-wide Coastal Flooding Study
 Norfolk, Virginia**

FIGURE B-35

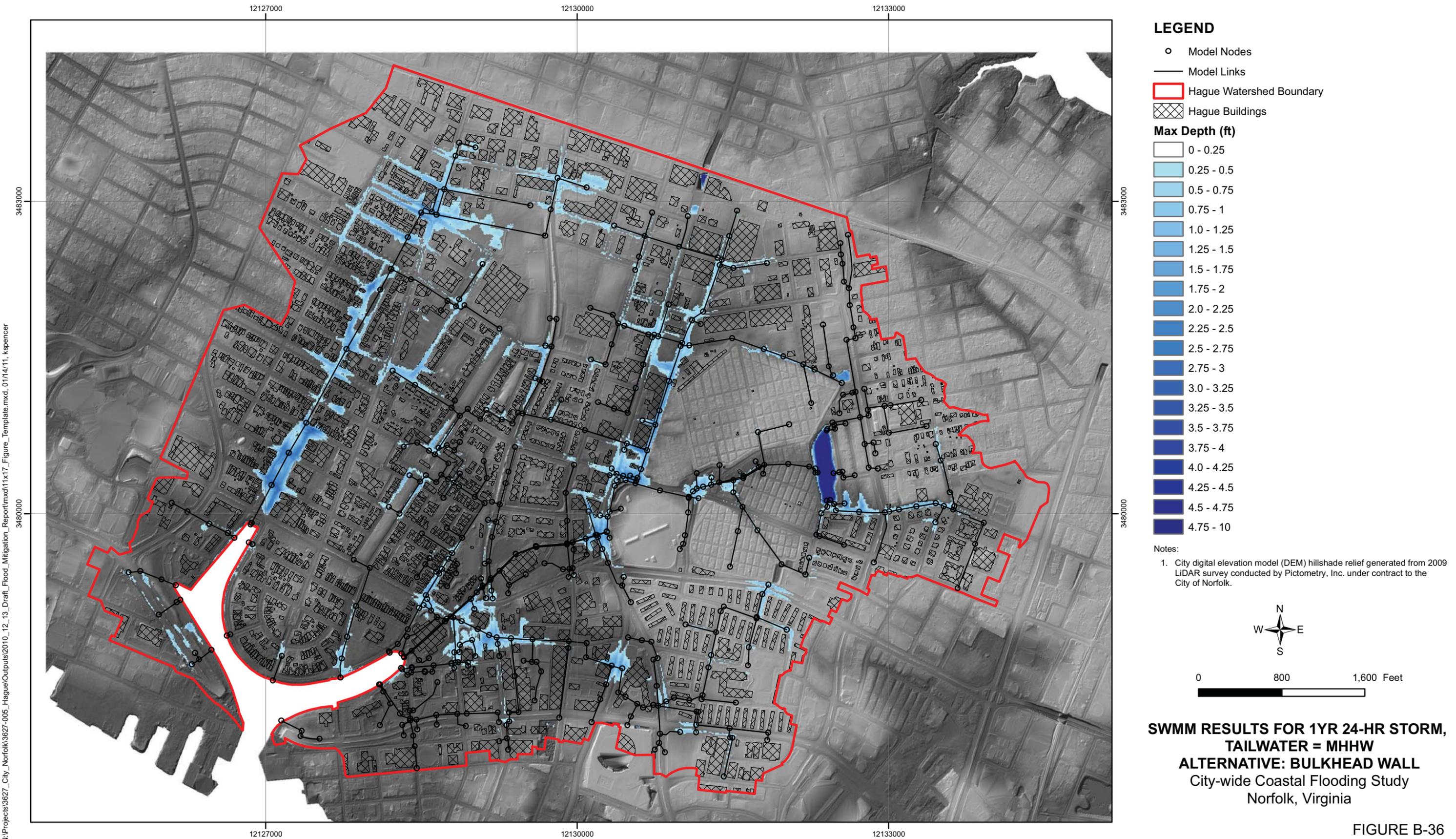
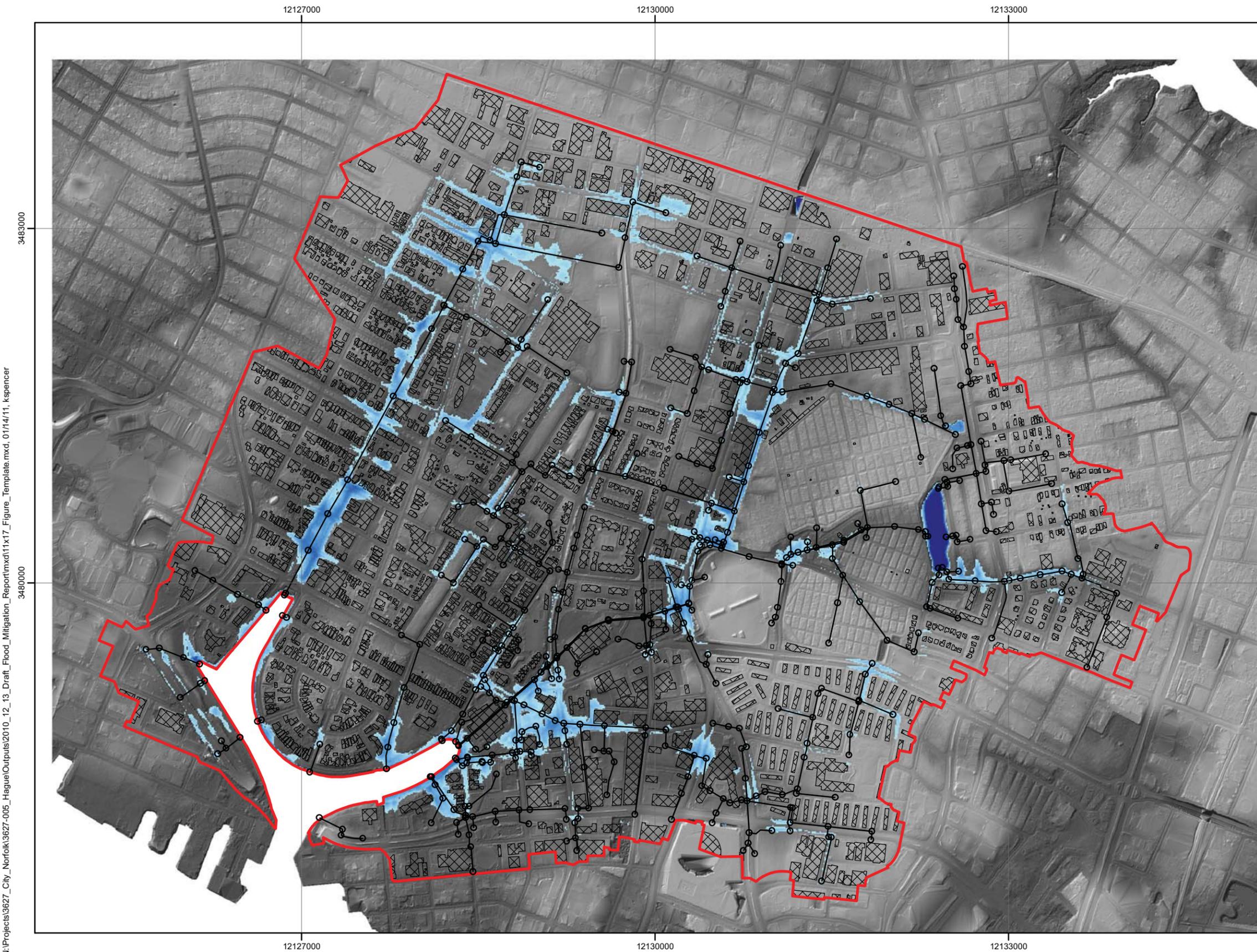


FIGURE B-36

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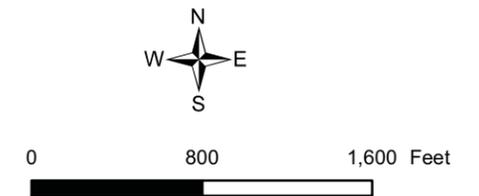
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

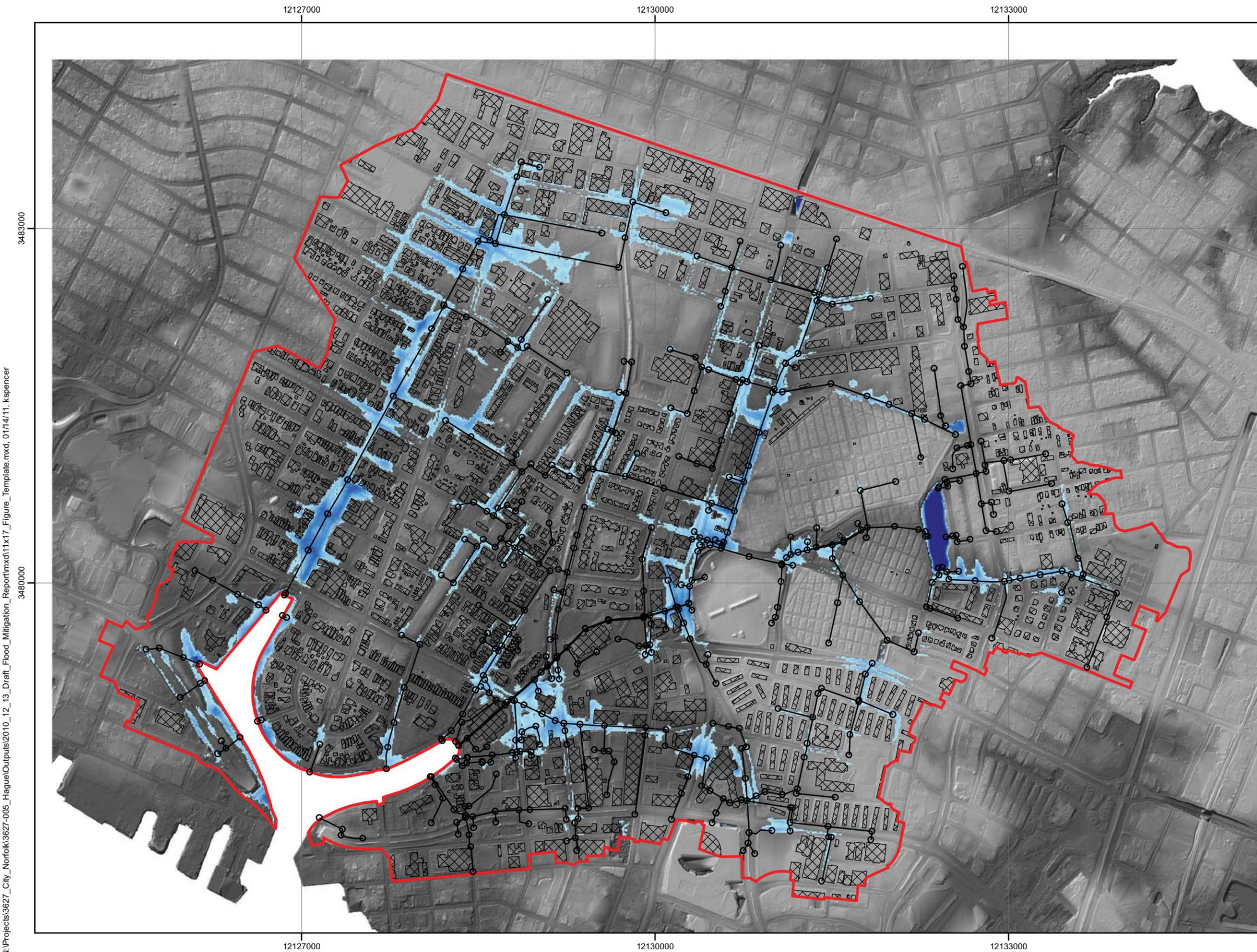
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 1YR 24-HR STORM,
TAILWATER = 1YR STORM SURGE
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

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LEGEND

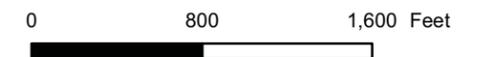
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 2YR 24-HR STORM,
 TAILWATER = MHHW
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-38

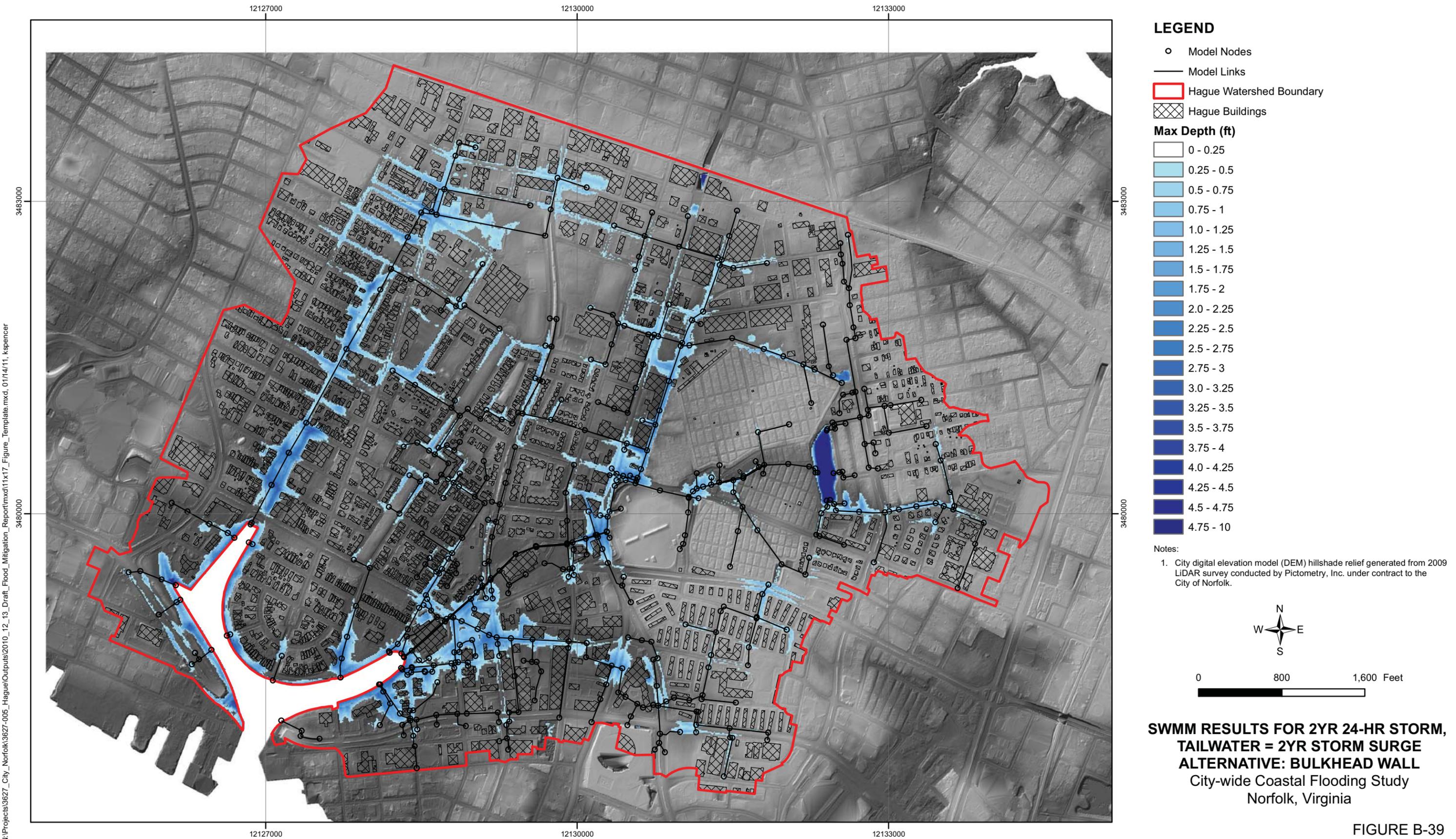
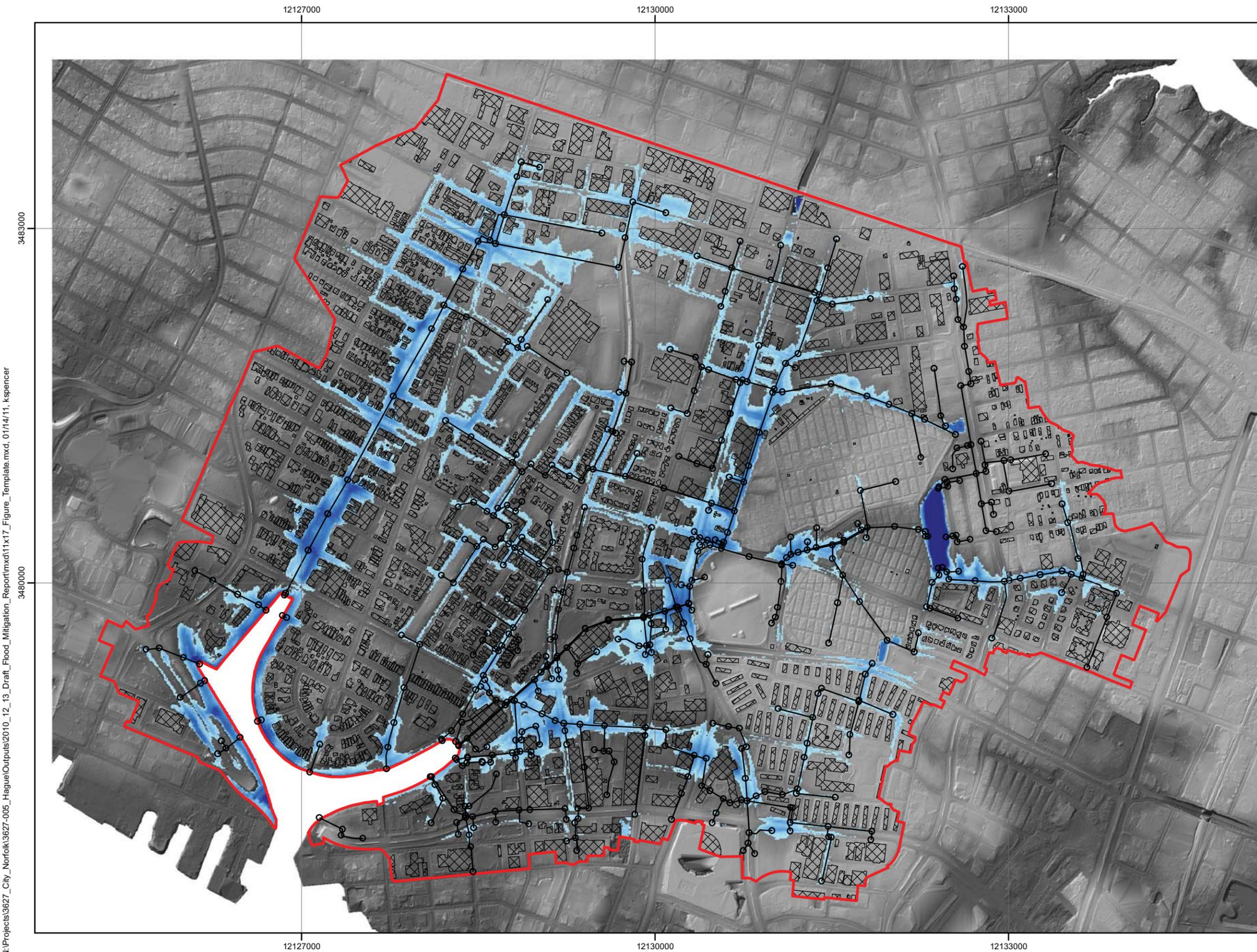


FIGURE B-39

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd_01/14/11_kspencer



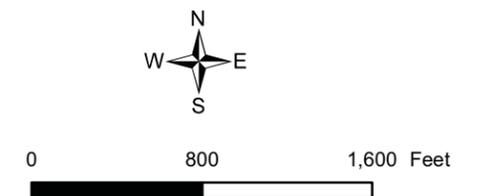
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

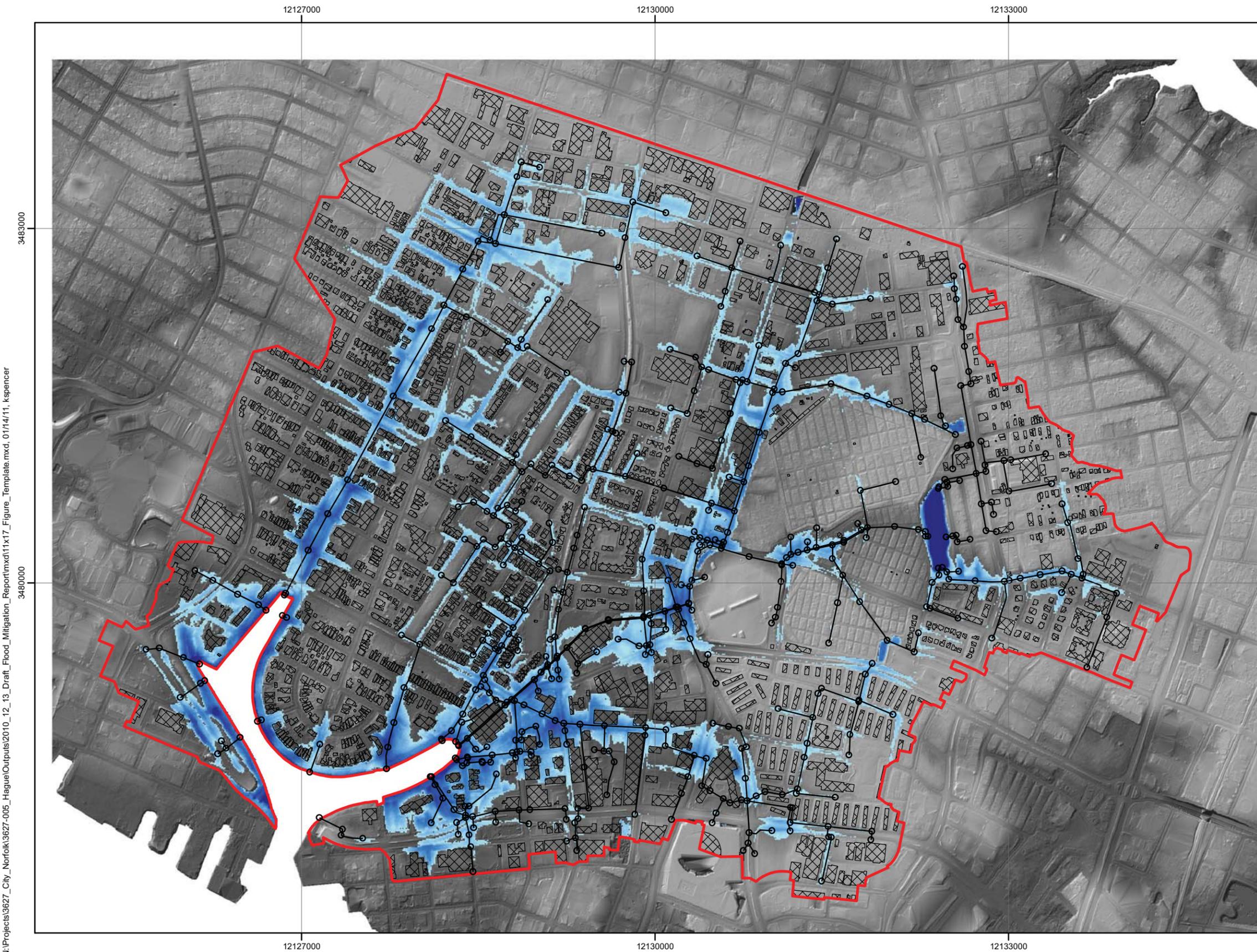
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-40



LEGEND

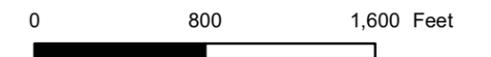
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
 TAILWATER = 10YR STORM SURGE
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-41

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LEGEND

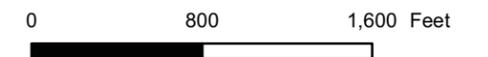
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

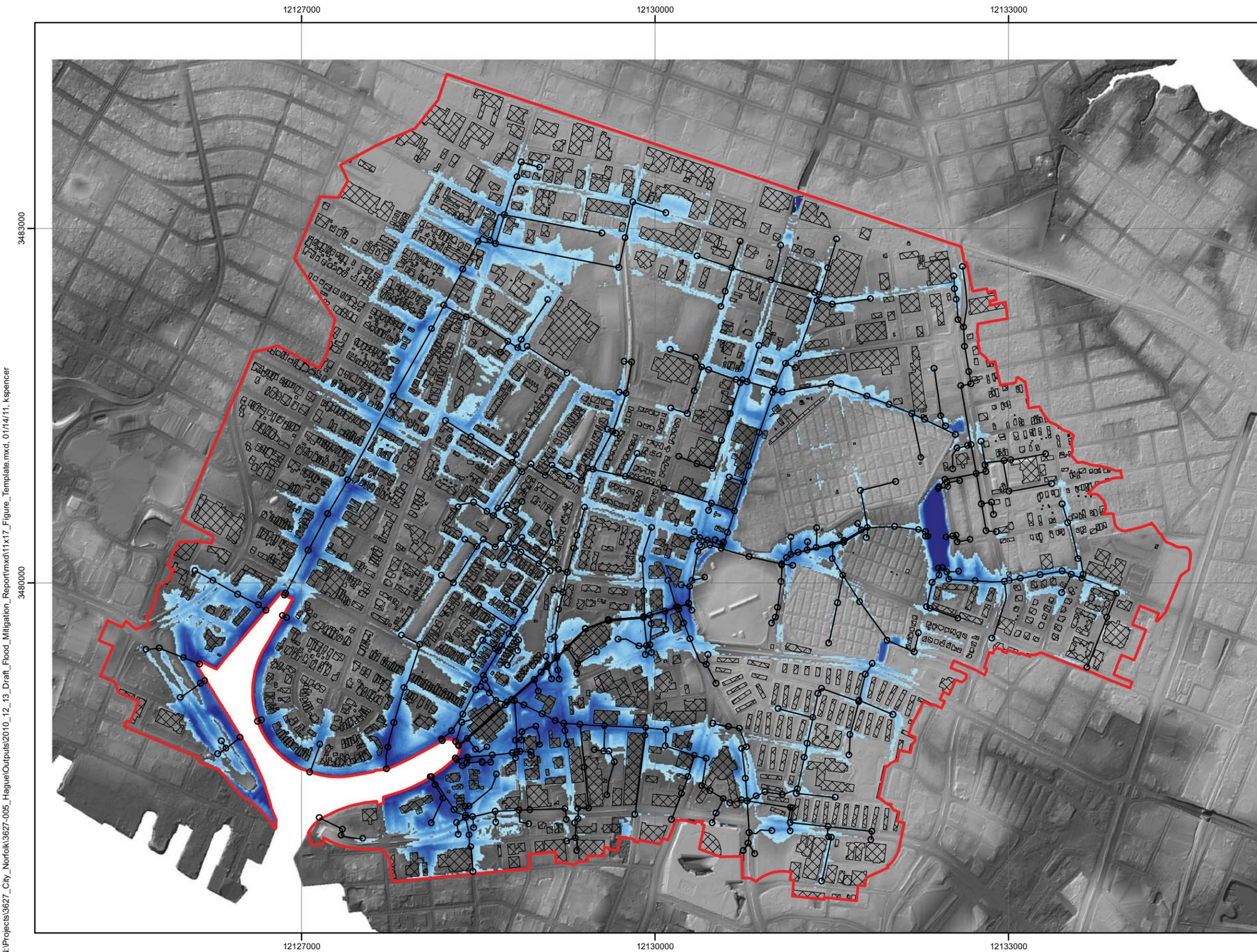
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
 TAILWATER = MHHW
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-42



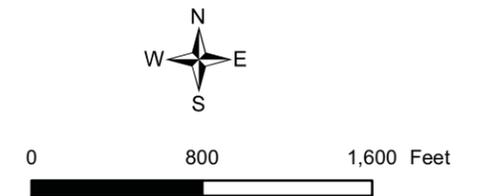
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-43

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd, 01/14/11, kspencer



LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

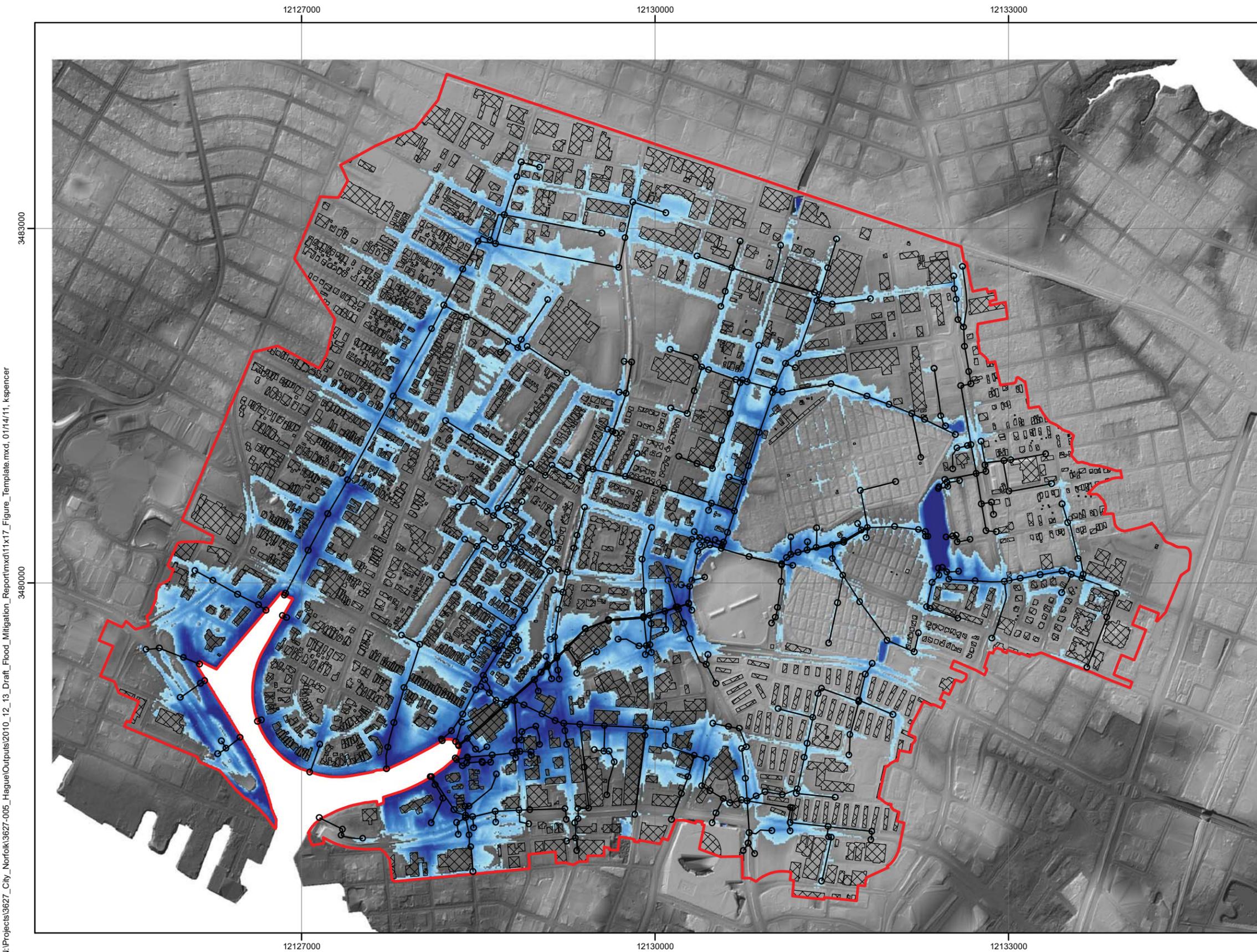
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
 TAILWATER = MHHW
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-44



LEGEND

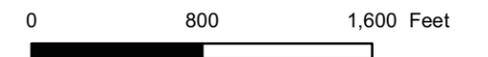
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

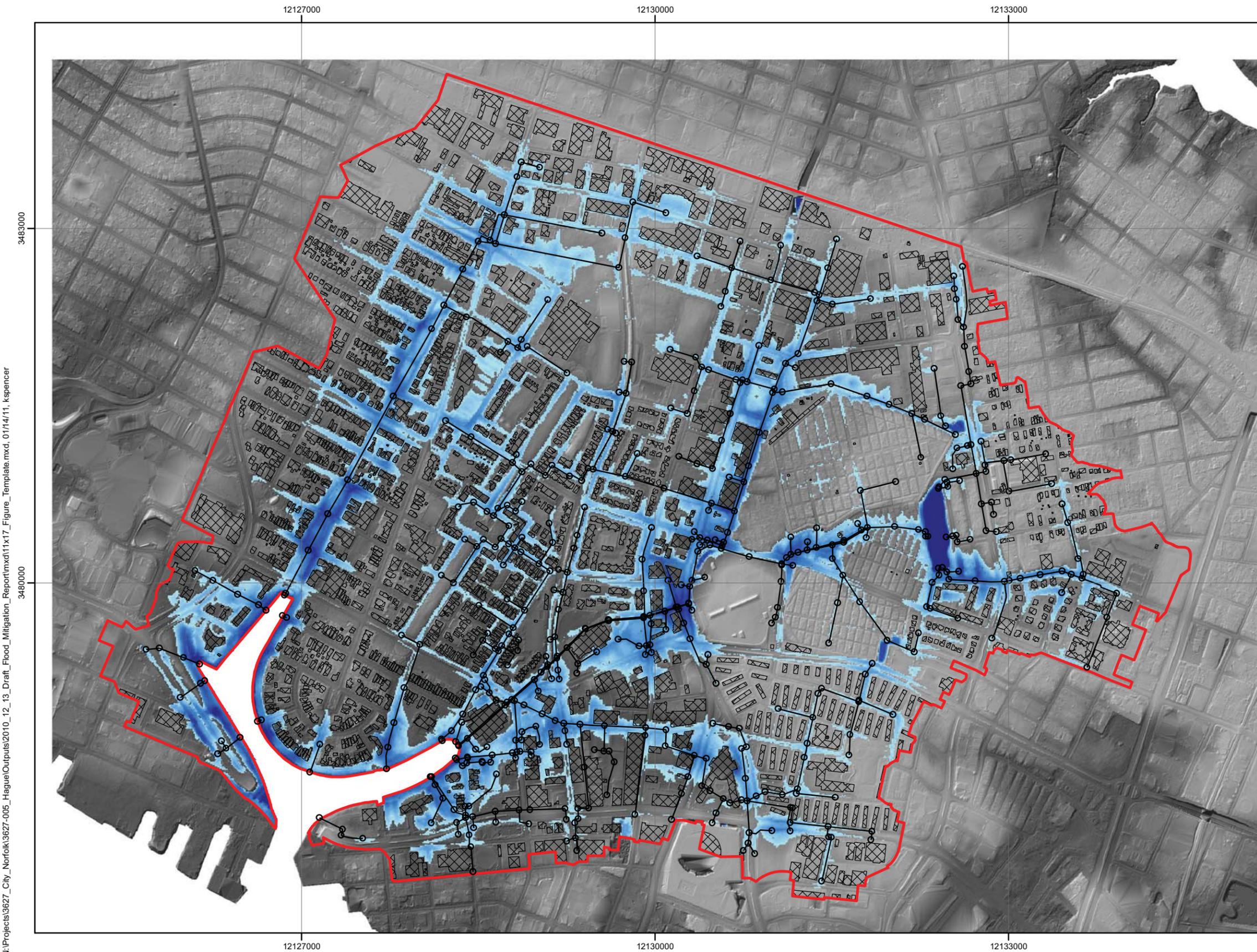
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
 TAILWATER = 50YR STORM SURGE
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-45



LEGEND

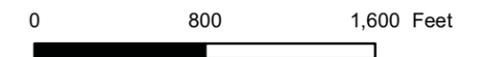
- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

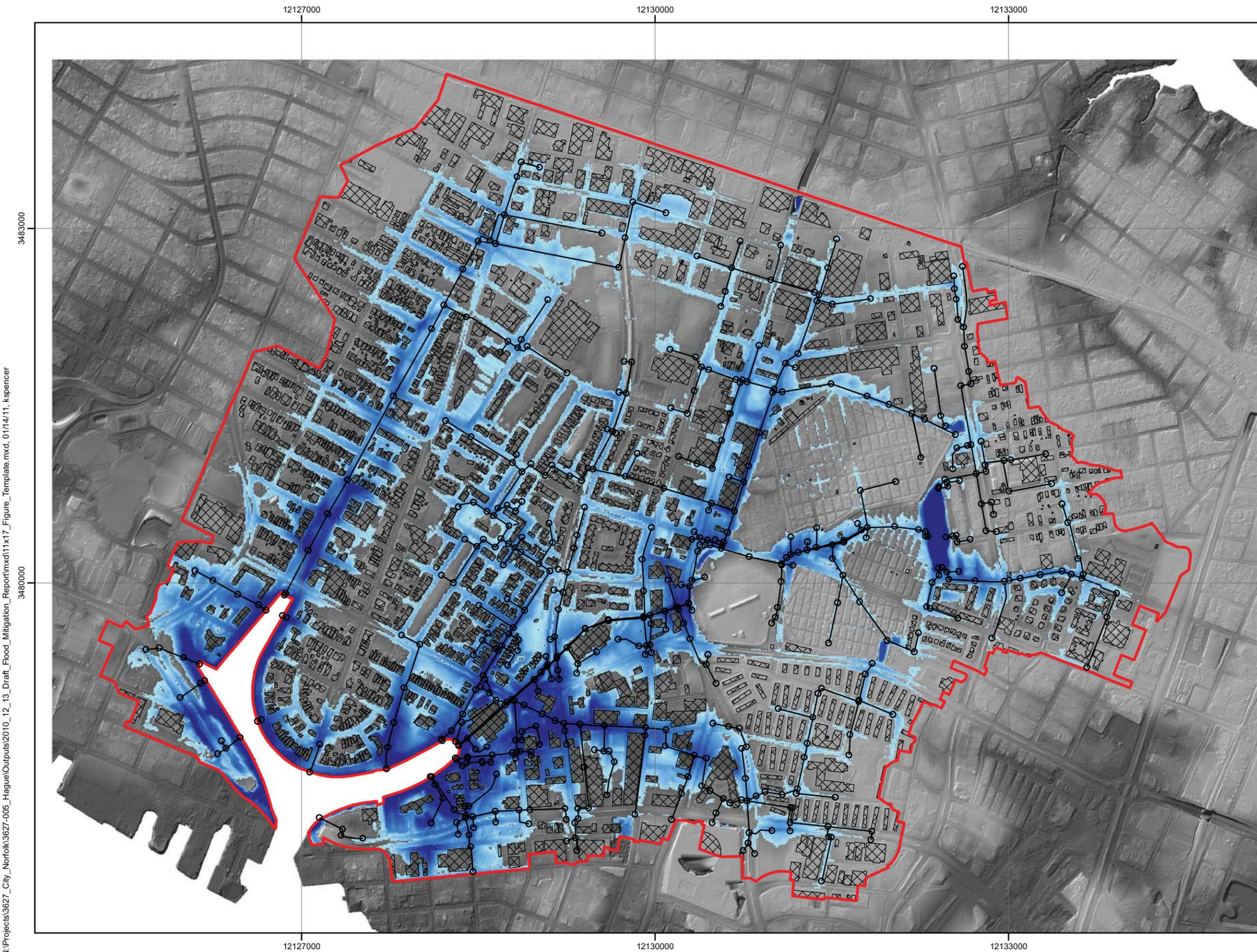
Notes:

1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-46



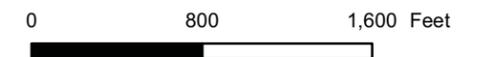
LEGEND

- Model Nodes
- Model Links
- ▭ Hague Watershed Boundary
- ▨ Hague Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
 1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
 TAILWATER = 100YR STORM SURGE
 ALTERNATIVE: BULKHEAD WALL**
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE B-47

APPENDIX C

OPINION OF PROBABLE COST AND OPERATIONAL COST



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

<p>ACTIVITY AND LOCATION</p> <p>City of Norfolk</p> <p>Norfolk, Virginia</p>	<p>CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER</p>
<p>PROJECT TITLE</p> <p>Hague - Alternative 1a Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms</p>	<p>ESTIMATED BY: Moffatt & Nichol</p> <p>CATEGORY CODE NUMBER</p> <p>STATUS OF DESIGN: Conceptual</p> <p>JOB ORDER NUMBER: 6822-03</p>

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$42,200,000
10 - Year Storm Event	\$44,600,000
25 - Year Storm Event	\$45,100,000
50 - Year Storm Event	\$46,800,000
100 - Year Storm Event	\$47,400,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE - HAGUE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +6.3') - Existing Ground Elevation @ +2.0'				
Select Fill	3,612	CY	\$24.00	\$86,688
Fine Grading	3,600	SY	\$10.00	\$36,000
Topsoil	600	CY	\$28.00	\$16,800
Seed	3,600	SY	\$1.25	\$4,500

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	2,800	VLF	\$55.00	\$154,000
Decorative Concrete Cap (West of Bridge)	336	SF	\$40.00	\$13,440
Bulkhead (East of Bridge)	13,700	VLF	\$55.00	\$753,500
Decorative Concrete Cap (East of Bridge)	4,384	SF	\$40.00	\$175,360

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Steel Gate w/ Bulkhead (Hague Opening is 750 LF) -				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE - HAGUE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Gate Assembly

Framed Steel Gate	80	Tons	\$10,125.00	\$810,000
Flanged Steel Wheel Assembly	8	EA	\$3,120.00	\$24,960
Rail	180	LF	\$298.00	\$53,640
Capstan & Cabling	1	LS	\$193,500.00	\$193,500
UHMW Rollers	16	EA	\$2,587.00	\$41,392
Pocket Seal	35	LF	\$4,650.00	\$162,750

Finish Work

Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station

18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations

60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical

Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
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Common Costs

Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE - HAGUE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE - HAGUE		ESTIMATED BY		CATEGORY CODE NUMBER	
Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol			
STATUS OF DESIGN		JOB ORDER NUMBER			
For 2 Year Event @ ELEV +4.3'		Conceptual		6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$22,713,977	
Overhead & Profit	15%			\$3,407,097	
Mobilization/Demobilization	10%			\$2,271,398	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,135,699	
Traffic Control	2%			\$454,280	
Surveying/Engineering/Construction Observation	12%			\$2,725,677	
Subtotal with Mark-ups				\$33,708,127	
Contingency	25%			\$8,427,032	
Subtotal				\$42,135,159	
TOTAL				\$42,135,159	
			SAY	\$42,200,000	



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +7.7') - Existing Ground Elevation @ +2.0'				
Select Fill	5,852	CY	\$24.00	\$140,448
Fine Grading	4,805	SY	\$10.00	\$48,053
Topsoil	801	CY	\$28.00	\$22,425
Seed	4,805	SY	\$1.25	\$6,007

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	1,904	SF	\$40.00	\$76,160
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	12,056	SF	\$40.00	\$482,240

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Steel Gate w/ Bulkhead (Hague Opening is 750 LF) -				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500

<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Gate Assembly

Framed Steel Gate	80	Tons	\$10,125.00	\$810,000
Flanged Steel Wheel Assembly	8	EA	\$3,120.00	\$24,960
Rail	180	LF	\$298.00	\$53,640
Capstan & Cabling	1	LS	\$193,500.00	\$193,500
UHMW Rollers	16	EA	\$2,587.00	\$41,392
Pocket Seal	35	LF	\$4,650.00	\$162,750

Finish Work

Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station

18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations

60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical

Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
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Common Costs

Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
For 10 Year Event @ ELEV +5.7'		

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$24,064,022
Overhead & Profit	15%			\$3,609,603
Mobilization/Demobilization	10%			\$2,406,402
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,203,201
Traffic Control	2%			\$481,280
Surveying/Engineering/Construction Observation	12%			\$2,887,683
Subtotal with Mark-ups				\$35,652,192
Contingency	25%			\$8,913,048
Subtotal				\$44,565,240
TOTAL				\$44,565,240
			SAY	\$44,600,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +8.5') - Existing Ground Elevation @ +2.0'				
Select Fill	7,367	CY	\$24.00	\$176,800
Fine Grading	5,480	SY	\$10.00	\$54,800
Topsoil	913	CY	\$28.00	\$25,573
Seed	5,480	SY	\$1.25	\$6,850

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	2,800	SF	\$40.00	\$112,000
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	16,440	SF	\$40.00	\$657,600

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Steel Gate w/ Bulkhead (Hague Opening is 750 LF) -				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500

<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Gate Assembly

Framed Steel Gate	80	Tons	\$10,125.00	\$810,000
Flanged Steel Wheel Assembly	8	EA	\$3,120.00	\$24,960
Rail	180	LF	\$298.00	\$53,640
Capstan & Cabling	1	LS	\$193,500.00	\$193,500
UHMW Rollers	16	EA	\$2,587.00	\$41,392
Pocket Seal	35	LF	\$4,650.00	\$162,750

Finish Work

Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station

18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations

60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical

Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
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Common Costs

Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

<u>Site Work</u>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<u>Power</u>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
For 25 Year Event @ ELEV +6.5'		

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$24,322,313
Overhead & Profit	15%			\$3,648,347
Mobilization/Demobilization	10%			\$2,432,231
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,216,116
Traffic Control	2%			\$486,446
Surveying/Engineering/Construction Observation	12%			\$2,918,678
Subtotal with Mark-ups				\$36,024,130
Contingency	25%			\$9,006,033
Subtotal				\$45,030,163
TOTAL				\$45,030,163
			SAY	\$45,100,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil

Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
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Earth Levee - (1200 LF @ EL +9.1') - Existing Ground Elevation @ +2.0'

Select Fill	8,615	CY	\$24.00	\$206,752
Fine Grading	5,987	SY	\$10.00	\$59,867
Topsoil	998	CY	\$28.00	\$27,938
Seed	5,987	SY	\$1.25	\$7,483

Site Civil

City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard

Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	3,472	SF	\$40.00	\$138,880
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500
Decorative Concrete Cap (East of Bridge)	19,728	SF	\$40.00	\$789,120

Bulkhead Pump Station

48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Steel Gate w/ Bulkhead (Hague Opening is 750 LF) -

Piling: Steel

Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

Site Work: Excavation & Fill

Gravel Base	58,000	CY	\$32.25	\$1,870,500
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Concrete: Gate Base Slab

Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Gate Assembly

Framed Steel Gate	80	Tons	\$10,125.00	\$810,000
Flanged Steel Wheel Assembly	8	EA	\$3,120.00	\$24,960
Rail	180	LF	\$298.00	\$53,640
Capstan & Cabling	1	LS	\$193,500.00	\$193,500
UHMW Rollers	16	EA	\$2,587.00	\$41,392
Pocket Seal	35	LF	\$4,650.00	\$162,750

Finish Work

Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station

18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations

60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical

Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
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Common Costs

Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$25,272,229
Overhead & Profit		15%		\$3,790,834
Mobilization/Demobilization		10%		\$2,527,223
Difficult Waterside Conditions		est - lump sum		\$1,000,000
Erosion/Sediment Control		5%		\$1,263,611
Traffic Control		2%		\$505,445
Surveying/Engineering/Construction Observation		12%		\$3,032,667
Subtotal with Mark-ups				\$37,392,010
Contingency		25%		\$9,348,002
Subtotal				\$46,740,012
TOTAL				\$46,740,012
			SAY	\$46,800,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
Earth Levee - (1200 LF @ EL +9.9') - Existing Ground Elevation @ +2.0'				
Select Fill	9,959	CY	\$24.00	\$239,008
Fine Grading	6,493	SY	\$10.00	\$64,933
Topsoil	998	CY	\$28.00	\$27,938
Seed	6,493	SY	\$1.25	\$8,117
Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000
Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	8,400	VLF	\$55.00	\$462,000
Decorative Concrete Cap (West of Bridge)	4,144	SF	\$40.00	\$165,760
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500
Decorative Concrete Cap (East of Bridge)	23,016	SF	\$40.00	\$920,640
Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000
Steel Gate w/ Bulkhead (Hague Opening is 750 LF) -				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE		ESTIMATED BY		
Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol		
For 100 Year Event @ ELEV +7.7'		STATUS OF DESIGN		
		Conceptual		
		JOB ORDER NUMBER		
		6822-03		
Tremie Concrete Base				
	180	CY	\$985.00	\$177,300
Gate Assembly				
Framed Steel Gate	80	Tons	\$10,125.00	\$810,000
Flanged Steel Wheel Assembly	8	EA	\$3,120.00	\$24,960
Rail	180	LF	\$298.00	\$53,640
Capstan & Cabling	1	LS	\$193,500.00	\$193,500
UHMW Rollers	16	EA	\$2,587.00	\$41,392
Pocket Seal	35	LF	\$4,650.00	\$162,750
Finish Work				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500
Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000
Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000
Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
Common Costs				



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 100 Year Event @ ELEV +7.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1a - Tidal Barrier with Steel Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
For 100 Year Event @ ELEV +7.7'		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$25,622,585	
Overhead & Profit	15%			\$3,843,388	
Mobilization/Demobilization	10%			\$2,562,258	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,281,129	
Traffic Control	2%			\$512,452	
Surveying/Engineering/Construction Observation	12%			\$3,074,710	
Subtotal with Mark-ups				\$37,896,522	
Contingency	25%			\$9,474,131	
Subtotal				\$47,370,653	
TOTAL				\$47,370,653	
			SAY	\$47,400,000	



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER	
PROJECT TITLE Hague - Alternative 1b Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		ESTIMATED BY Moffatt & Nichol	
		STATUS OF DESIGN	JOB ORDER NUMBER
		Conceptual	6822-03
Summary			
Scenario		Opinion of Probable Cost	
2 - Year Storm Event		\$43,900,000	
10 - Year Storm Event		\$47,200,000	
25 - Year Storm Event		\$48,000,000	
50 - Year Storm Event		\$49,900,000	
100 - Year Storm Event		\$50,800,000	



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +6.3') - Existing Ground Elevation @ +2.0'				
Select Fill	3,612	CY	\$24.00	\$86,688
Fine Grading	3,600	SY	\$10.00	\$36,000
Topsoil	600	CY	\$28.00	\$16,800
Seed	3,600	SY	\$1.25	\$4,500

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	2,800	VLF	\$55.00	\$154,000
Decorative Concrete Cap (West of Bridge)	336	SF	\$40.00	\$13,440
Bulkhead (East of Bridge)	13,700	VLF	\$55.00	\$753,500
Decorative Concrete Cap (East of Bridge)	4,384	SF	\$40.00	\$175,360

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Obermeyer Gate w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +6.3'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	104,200	SF	\$28.50	\$2,969,700
Treat Embedded Interlocks	24,000	LF	\$7.25	\$174,000
30" DIA Steel Pipe End Piles	380	LF	\$363.00	\$137,940
Special Sheet Fabrication	600	LF	\$42.50	\$25,500

<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500

<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

<u>Dam Assembly</u>				
Gate with Operating System - 12.3' High x 50 LF	615	SF	\$4,000.00	\$2,460,000

<u>Finish Work</u>				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000

<u>Common Costs</u>				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 2 Year Event @ ELEV +4.3'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$23,664,775
Overhead & Profit	15%			\$3,549,716
Mobilization/Demobilization	10%			\$2,366,478
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,183,239
Traffic Control	2%			\$473,296
Surveying/Engineering/Construction Observation	12%			\$2,839,773
Subtotal with Mark-ups				\$35,077,276
Contingency	25%			\$8,769,319
Subtotal				\$43,846,595
TOTAL				\$43,846,595
			SAY	\$43,900,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Civil

Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
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Earth Levee - (1200 LF @ EL +7.7') - Existing Ground Elevation @ +2.0'

Select Fill	5,852	CY	\$24.00	\$140,448
Fine Grading	4,805	SY	\$10.00	\$48,053
Topsoil	801	CY	\$28.00	\$22,425
Seed	4,805	SY	\$1.25	\$6,007

Site Civil

City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard

Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	1,904	SF	\$40.00	\$76,160
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	12,056	SF	\$40.00	\$482,240

Bulkhead Pump Station

48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Obermeyer Gate w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +7.7'

Piling: Steel

Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

Site Work: Excavation & Fill

Gravel Base	58,000	CY	\$32.25	\$1,870,500
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Concrete: Gate Base Slab

Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Dam Assembly				
Gate with Operating System - 13.7' High x 50 LF	685	SF	\$4,000.00	\$2,740,000

Finish Work				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000

Common Costs				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 10 Year Event @ ELEV +5.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$25,517,780
Overhead & Profit	15%			\$3,827,667
Mobilization/Demobilization	10%			\$2,551,778
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,275,889
Traffic Control	2%			\$510,356
Surveying/Engineering/Construction Observation	12%			\$3,062,134
Subtotal with Mark-ups				\$37,745,603
Contingency	25%			\$9,436,401
Subtotal				\$47,182,004
TOTAL				\$47,182,004
			SAY	\$47,200,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE				
Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY		CATEGORY CODE NUMBER	
For 25 Year Event @ ELEV +6.5'	Moffatt & Nichol			
STATUS OF DESIGN				
Conceptual	JOB ORDER NUMBER		6822-03	
Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
Earth Levee - (1200 LF @ EL +8.5') - Existing Ground Elevation @ +2.0'				
Select Fill	7,367	CY	\$24.00	\$176,800
Fine Grading	5,480	SY	\$10.00	\$54,800
Topsoil	913	CY	\$28.00	\$25,573
Seed	5,480	SY	\$1.25	\$6,850
Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000
Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	2,800	SF	\$40.00	\$112,000
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	16,440	SF	\$40.00	\$657,600
Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000
Obermeyer Gate w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +8.5'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

<u>Dam Assembly</u>				
Gate with Operating System - 15.1' High x 50 LF	725	SF	\$4,000.00	\$2,900,000

<u>Finish Work</u>				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500

Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000

Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000

Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000

<u>Common Costs</u>				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 25 Year Event @ ELEV +6.5'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$25,936,071
Overhead & Profit	15%			\$3,890,411
Mobilization/Demobilization	10%			\$2,593,607
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,296,804
Traffic Control	2%			\$518,721
Surveying/Engineering/Construction Observation	12%			\$3,112,328
Subtotal with Mark-ups				\$38,347,942
Contingency	25%			\$9,586,985
Subtotal				\$47,934,927
TOTAL				\$47,934,927
			SAY	\$48,000,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol			
For 50 Year Event @ ELEV +7.1'		STATUS OF DESIGN		JOB ORDER NUMBER	
		Conceptual		6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400	
Earth Levee - (1200 LF @ EL +9.1') - Existing Ground Elevation @ +2.0'					
Select Fill	8,615	CY	\$24.00	\$206,752	
Fine Grading	5,987	SY	\$10.00	\$59,867	
Topsoil	998	CY	\$28.00	\$27,938	
Seed	5,987	SY	\$1.25	\$7,483	
Site Civil					
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000	
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760	
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394	
Utility Relocation	3,300	LF	\$560.00	\$1,848,000	
Bulkhead Elevation w/ 2' Freeboard					
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000	
Decorative Concrete Cap (West of Bridge)	3,472	SF	\$40.00	\$138,880	
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500	
Decorative Concrete Cap (East of Bridge)	19,728	SF	\$40.00	\$789,120	
Bulkhead Pump Station					
48" Pump	1	EA	\$455,000.00	\$455,000	
15" Pump	1	EA	\$110,000.00	\$110,000	
Obermeyer Gate w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +9.1'					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200	
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500	
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200	
Special Sheet Fabrication	640	LF	\$42.50	\$27,200	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	58,000	CY	\$32.25	\$1,870,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950	
Tremie Concrete Base	180	CY	\$985.00	\$177,300	



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
Dam Assembly				
Gate with Operating System - 15.1' High x 50 LF	755	SF	\$4,000.00	\$3,020,000
Finish Work				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500
Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000
Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000
Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
Common Costs				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Site Work

Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$27,005,987
Overhead & Profit	15%			\$4,050,898
Mobilization/Demobilization	10%			\$2,700,599
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,350,299
Traffic Control	2%			\$540,120
Surveying/Engineering/Construction Observation	12%			\$3,240,718
Subtotal with Mark-ups				\$39,888,621
Contingency	25%			\$9,972,155
Subtotal				\$49,860,777
TOTAL				\$49,860,777
			SAY	\$49,900,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE		ESTIMATED BY		
Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol		
For 100 Year Event @ ELEV +7.7'		STATUS OF DESIGN		
		Conceptual		
		JOB ORDER NUMBER		
		6822-03		
Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
Earth Levee - (1200 LF @ EL +9.9') - Existing Ground Elevation @ +2.0'				
Select Fill	9,959	CY	\$24.00	\$239,008
Fine Grading	6,493	SY	\$10.00	\$64,933
Topsoil	998	CY	\$28.00	\$27,938
Seed	6,493	SY	\$1.25	\$8,117
Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000
Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	8,400	VLF	\$55.00	\$462,000
Decorative Concrete Cap (West of Bridge)	4,144	SF	\$40.00	\$165,760
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500
Decorative Concrete Cap (East of Bridge)	23,016	SF	\$40.00	\$920,640
Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000
Obermeyer Gate w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +9.7'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
Dam Assembly				
Gate with Operating System - 15.7' High x 50 LF	795	SF	\$4,000.00	\$3,180,000
Finish Work				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500
Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000
Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000
Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
Common Costs				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
For 100 Year Event @ ELEV +7.7'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

<u>Site Work</u>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<u>Power</u>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1b - Tidal Barrier with Obermeyer Gate, 2-60" Dia. Pumps, and Closure Walls and Berms For 100 Year Event @ ELEV +7.7'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$27,516,343	
Overhead & Profit	15%			\$4,127,451	
Mobilization/Demobilization	10%			\$2,751,634	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,375,817	
Traffic Control	2%			\$550,327	
Surveying/Engineering/Construction Observation	12%			\$3,301,961	
Subtotal with Mark-ups				\$40,623,534	
Contingency	25%			\$10,155,883	
Subtotal				\$50,779,417	
TOTAL				\$50,779,417	
			SAY	\$50,800,000	



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE - HAGUE Hague - Alternative 1c Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$48,500,000
10 - Year Storm Event	\$52,200,000
25 - Year Storm Event	\$53,400,000
50 - Year Storm Event	\$55,600,000
100 - Year Storm Event	\$56,700,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk	CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
Norfolk, Virginia	ESTIMATED BY		CATEGORY CODE NUMBER	
PROJECT TITLE				
Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms				
Moffatt & Nichol				
STATUS OF DESIGN				
Conceptual				
JOB ORDER NUMBER				
6822-03				
For 2 Year Event @ ELEV +4.3'				
Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
Earth Levee - (1200 LF @ EL +6.3') - Existing Ground Elevation @ +2.0'				
Select Fill	3,612	CY	\$24.00	\$86,688
Fine Grading	3,600	SY	\$10.00	\$36,000
Topsoil	600	CY	\$28.00	\$16,800
Seed	3,600	SY	\$1.25	\$4,500
Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000
Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	2,800	VLF	\$55.00	\$154,000
Decorative Concrete Cap (West of Bridge)	336	SF	\$40.00	\$13,440
Bulkhead (East of Bridge)	13,700	VLF	\$55.00	\$753,500
Decorative Concrete Cap (East of Bridge)	4,384	SF	\$40.00	\$175,360
Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000
Inflatable Dam w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +6.3'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	104,200	SF	\$28.50	\$2,969,700
Treat Embedded Interlocks	24,000	LF	\$7.25	\$174,000
30" DIA Steel Pipe End Piles	380	LF	\$363.00	\$137,940
Special Sheet Fabrication	600	LF	\$42.50	\$25,500
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300
<u>Dam Assembly</u>				
Rubber Dam - 11.3' High x 140 LF	1,582	SF	\$3,000.00	\$4,746,000
Dam Operating System	1	LS	\$248,000.00	\$248,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia		ESTIMATED BY		CATEGORY CODE NUMBER	
PROJECT TITLE		Moffatt & Nichol			
Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		STATUS OF DESIGN		JOB ORDER NUMBER	
For 2 Year Event @ ELEV +4.3'		Conceptual		6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Finish Work					
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500	
Top Slab	273	CY	\$630.00	\$171,990	
Handrail	1,250	LF	\$178.00	\$222,500	
Monticello Culvert - Pump Station					
18" HDPE Line	2,400	LF	\$90.00	\$216,000	
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000	
Dewatering	1	LS	\$40,000.00	\$40,000	
Stormwater Vaults	2	EA	\$35,000.00	\$70,000	
Stormwater Pumps	2	EA	\$150,000.00	\$300,000	
Flaggates	1	EA	\$2,500.00	\$2,500	
Culvert Realignment	1	EA	\$100,000.00	\$100,000	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flaggates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
Common Costs					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 2 Year Event @ ELEV +4.3'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

ITEM DESCRIPTION	QUANTITY NUMBER	UNIT	ENGINEERING ESTIMATE UNIT COST	TOTAL
<u>Site Work</u>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<u>Power</u>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
For 2 Year Event @ ELEV +4.3'		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$26,198,775	
Overhead & Profit	15%			\$3,929,816	
Mobilization/Demobilization	10%			\$2,619,878	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,309,939	
Traffic Control	2%			\$523,976	
Surveying/Engineering/Construction Observation	12%			\$3,143,853	
Subtotal with Mark-ups				\$38,726,236	
Contingency	25%			\$9,681,559	
Subtotal				\$48,407,795	
TOTAL				\$48,407,795	
			SAY	\$48,500,000	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 10 Year Event @ ELEV +5.7'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

Site Civil

Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
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Earth Levee - (1200 LF @ EL +7.7') - Existing Ground Elevation @ +2.0'

Select Fill	5,852	CY	\$24.00	\$140,448
Fine Grading	4,805	SY	\$10.00	\$48,053
Topsoil	801	CY	\$28.00	\$22,425
Seed	4,805	SY	\$1.25	\$6,007

Site Civil

City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.26	AC	\$500,000.00	\$132,002
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard

Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	1,904	SF	\$40.00	\$76,160
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	12,056	SF	\$40.00	\$482,240

Bulkhead Pump Station

48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Inflatable Dam w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +7.7'

Piling: Steel

Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

Site Work: Excavation & Fill

Gravel Base	58,000	CY	\$32.25	\$1,870,500
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Concrete: Gate Base Slab

Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300

Dam Assembly

Rubber Dam - 12.7' High x 140 LF	1,778	SF	\$3,000.00	\$5,334,000
Dam Operating System	1	LS	\$248,000.00	\$248,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 10 Year Event @ ELEV +5.7'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Finish Work					
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500	
Top Slab	273	CY	\$630.00	\$171,990	
Handrail	1,250	LF	\$178.00	\$222,500	
Monticello Culvert - Pump Station					
18" HDPE Line	2,400	LF	\$90.00	\$216,000	
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000	
Dewatering	1	LS	\$40,000.00	\$40,000	
Stormwater Vaults	2	EA	\$35,000.00	\$70,000	
Stormwater Pumps	2	EA	\$150,000.00	\$300,000	
Flapgates	1	EA	\$2,500.00	\$2,500	
Culvert Realignment	1	EA	\$100,000.00	\$100,000	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
Common Costs					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 10 Year Event @ ELEV +5.7'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

ITEM DESCRIPTION	QUANTITY NUMBER	UNIT	ENGINEERING ESTIMATE UNIT COST	TOTAL
<i>Site Work</i>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<i>Power</i>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 10 Year Event @ ELEV +5.7'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$28,302,388	
Overhead & Profit	15%			\$4,245,358	
Mobilization/Demobilization	10%			\$2,830,239	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,415,119	
Traffic Control	2%			\$566,048	
Surveying/Engineering/Construction Observation	12%			\$3,396,287	
Subtotal with Mark-ups				\$41,755,439	
Contingency	25%			\$10,438,860	
Subtotal				\$52,194,298	
TOTAL				\$52,194,298	
			SAY	\$52,200,000	



ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 25 Year Event @ ELEV +6.5'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +8.5') - Existing Ground Elevation @ +2.0'				
Select Fill	7,367	CY	\$24.00	\$176,800
Fine Grading	5,480	SY	\$10.00	\$54,800
Topsoil	913	CY	\$28.00	\$25,573
Seed	5,480	SY	\$1.25	\$6,850

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	2,800	SF	\$40.00	\$112,000
Bulkhead (East of Bridge)	27,400	VLF	\$55.00	\$1,507,000
Decorative Concrete Cap (East of Bridge)	16,440	SF	\$40.00	\$657,600

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Inflatable Dam w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +8.5'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500

<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300

<u>Dam Assembly</u>				
Rubber Dam - 12.7' High x 140 LF	1,890	SF	\$3,000.00	\$5,670,000
Dam Operating System	1	LS	\$248,000.00	\$248,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 25 Year Event @ ELEV +6.5'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Finish Work					
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500	
Top Slab	273	CY	\$630.00	\$171,990	
Handrail	1,250	LF	\$178.00	\$222,500	
Monticello Culvert - Pump Station					
18" HDPE Line	2,400	LF	\$90.00	\$216,000	
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000	
Dewatering	1	LS	\$40,000.00	\$40,000	
Stormwater Vaults	2	EA	\$35,000.00	\$70,000	
Stormwater Pumps	2	EA	\$150,000.00	\$300,000	
Flapgates	1	EA	\$2,500.00	\$2,500	
Culvert Realignment	1	EA	\$100,000.00	\$100,000	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
Common Costs					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
Site Work					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 25 Year Event @ ELEV +6.5'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	ENGINEERING ESTIMATE UNIT UNIT COST TOTAL

Power

Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 25 Year Event @ ELEV +6.5'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
	ENGINEERING ESTIMATE UNIT COST	
	TOTAL	

Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859
SUBTOTAL				\$28,954,071
Overhead & Profit	15%			\$4,343,111
Mobilization/Demobilization	10%			\$2,895,407
Difficult Waterside Conditions	est - lump sum			\$1,000,000
Erosion/Sediment Control	5%			\$1,447,704
Traffic Control	2%			\$579,081
Surveying/Engineering/Construction Observation	12%			\$3,474,488
Subtotal with Mark-ups				\$42,693,862
Contingency	25%			\$10,673,465
Subtotal				\$53,367,327
TOTAL				\$53,367,327
			SAY	\$53,400,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER
Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol		
For 50 Year Event @ ELEV +7.1'		STATUS OF DESIGN		JOB ORDER NUMBER
		Conceptual		6822-03
Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400
Earth Levee - (1200 LF @ EL +9.1') - Existing Ground Elevation @ +2.0'				
Select Fill	8,615	CY	\$24.00	\$206,752
Fine Grading	5,987	SY	\$10.00	\$59,867
Topsoil	998	CY	\$28.00	\$27,938
Seed	5,987	SY	\$1.25	\$7,483
Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000
Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	5,600	VLF	\$55.00	\$308,000
Decorative Concrete Cap (West of Bridge)	3,472	SF	\$40.00	\$138,880
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500
Decorative Concrete Cap (East of Bridge)	19,728	SF	\$40.00	\$789,120
Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000
Inflatable Dam w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +9.1'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200
<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500
<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300
<u>Dam Assembly</u>				
Rubber Dam - 14.1' High x 140 LF	1,974	SF	\$3,000.00	\$5,922,000
Dam Operating System	1	LS	\$248,000.00	\$248,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL
ACTIVITY AND LOCATION				
City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER
Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		Moffatt & Nichol		
For 50 Year Event @ ELEV +7.1'		STATUS OF DESIGN		JOB ORDER NUMBER
		Conceptual		6822-03
Finish Work				
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500
Top Slab	273	CY	\$630.00	\$171,990
Handrail	1,250	LF	\$178.00	\$222,500
Monticello Culvert - Pump Station				
18" HDPE Line	2,400	LF	\$90.00	\$216,000
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000
Dewatering	1	LS	\$40,000.00	\$40,000
Stormwater Vaults	2	EA	\$35,000.00	\$70,000
Stormwater Pumps	2	EA	\$150,000.00	\$300,000
Flapgates	1	EA	\$2,500.00	\$2,500
Culvert Realignment	1	EA	\$100,000.00	\$100,000
Pump Stations				
60" pumps	3	EA	\$1,380,000.00	\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000
Concrete Headwall	1	EA	\$80,000.00	\$80,000
Flapgates	3	EA	\$19,200.00	\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000
Electrical				
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000
Common Costs				
Line Truck	20	DY	\$283.25	\$5,665
Backhoe	10	DY	\$395.52	\$3,955
Scissors Lift	40	DY	\$265.20	\$10,608



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER		
For 50 Year Event @ ELEV +7.1'	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL

<u>Site Work</u>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<u>Power</u>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
For 50 Year Event @ ELEV +7.1'		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$30,155,987	
Overhead & Profit	15%			\$4,523,398	
Mobilization/Demobilization	10%			\$3,015,599	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,507,799	
Traffic Control	2%			\$603,120	
Surveying/Engineering/Construction Observation	12%			\$3,618,718	
Subtotal with Mark-ups				\$44,424,621	
Contingency	25%			\$11,106,155	
Subtotal				\$55,530,777	
TOTAL				\$55,530,777	
			SAY	\$55,600,000	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 100 Year Event @ ELEV +7.7'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

Site Civil				
Clearing and Grubbing	4	AC	\$1,600.00	\$6,400

Earth Levee - (1200 LF @ EL +9.9') - Existing Ground Elevation @ +2.0'				
Select Fill	9,959	CY	\$24.00	\$239,008
Fine Grading	6,493	SY	\$10.00	\$64,933
Topsoil	998	CY	\$28.00	\$27,938
Seed	6,493	SY	\$1.25	\$8,117

Site Civil				
City of Norfolk Easement	49,500	SF	\$6.00	\$297,000
Temporary Easement (8% of CoN Easement)	1	LS	\$23,760.00	\$23,760
Wetland Mitigation	0.38	AC	\$500,000.00	\$189,394
Utility Relocation	3,300	LF	\$560.00	\$1,848,000

Bulkhead Elevation w/ 2' Freeboard				
Bulkhead (West of Bridge)	8,400	VLF	\$55.00	\$462,000
Decorative Concrete Cap (West of Bridge)	4,144	SF	\$40.00	\$165,760
Bulkhead (East of Bridge)	41,100	VLF	\$55.00	\$2,260,500
Decorative Concrete Cap (East of Bridge)	23,016	SF	\$40.00	\$920,640

Bulkhead Pump Station				
48" Pump	1	EA	\$455,000.00	\$455,000
15" Pump	1	EA	\$110,000.00	\$110,000

Inflatable Dam w/ Bulkhead (Hague Opening is 750 LF) - Bulkhead Elevation @ EL +9.9'				
<u>Piling: Steel</u>				
Install AZ 14 Steel Sheet Piles	111,200	SF	\$28.50	\$3,169,200
Treat Embedded Interlocks	26,000	LF	\$7.25	\$188,500
30" DIA Steel Pipe End Piles	400	LF	\$363.00	\$145,200
Special Sheet Fabrication	640	LF	\$42.50	\$27,200

<u>Site Work: Excavation & Fill</u>				
Gravel Base	58,000	CY	\$32.25	\$1,870,500

<u>Concrete: Gate Base Slab</u>				
Precast Concrete Gate Base	60	CY	\$1,832.50	\$109,950
Tremie Concrete Base	180	CY	\$985.00	\$177,300

<u>Dam Assembly</u>				
Rubber Dam - 14.7' High x 140 LF	2,058	SF	\$3,000.00	\$6,174,000
Dam Operating System	1	LS	\$248,000.00	\$248,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia		ESTIMATED BY		CATEGORY CODE NUMBER	
PROJECT TITLE		Moffatt & Nichol			
Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		STATUS OF DESIGN		JOB ORDER NUMBER	
For 100 Year Event @ ELEV +7.7'		Conceptual		6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Finish Work					
Concrete Fascia	12,300	SF	\$85.00	\$1,045,500	
Top Slab	273	CY	\$630.00	\$171,990	
Handrail	1,250	LF	\$178.00	\$222,500	
Monticello Culvert - Pump Station					
18" HDPE Line	2,400	LF	\$90.00	\$216,000	
Installation of HDPE Line	2,400	LF	\$35.00	\$84,000	
Dewatering	1	LS	\$40,000.00	\$40,000	
Stormwater Vaults	2	EA	\$35,000.00	\$70,000	
Stormwater Pumps	2	EA	\$150,000.00	\$300,000	
Flapgates	1	EA	\$2,500.00	\$2,500	
Culvert Realignment	1	EA	\$100,000.00	\$100,000	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
Common Costs					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms For 100 Year Event @ ELEV +7.7'	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03
ITEM DESCRIPTION	QUANTITY NUMBER	UNIT
		ENGINEERING ESTIMATE UNIT COST
		TOTAL

ITEM DESCRIPTION	QUANTITY NUMBER	UNIT	ENGINEERING ESTIMATE UNIT COST	TOTAL
<i>Site Work</i>				
Trench & Backfill	400	LF	\$1.96	\$784
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338
Quasite Handhole	3	EA	\$607.04	\$1,821
<i>Power</i>				
Switchboard	1	LS	\$74,231.00	\$74,231
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698
4" GRS Conduit	1500	LF	\$49.80	\$74,700
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700
4" GRS Fittings	100	EA	\$455.00	\$45,500
3/4" GRS Fittings	200	EA	\$42.95	\$8,590
1/2" GRS Fittings	200	EA	\$35.45	\$7,090
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290
#8 THWN Copper	1500	LF	\$0.91	\$1,365
#12 THWN Copper	25000	LF	\$0.50	\$12,500
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866
Motor Connection	3	EA	\$9,203.13	\$27,609
VFD Drive	3	EA	\$150,000.00	\$450,000
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000
Annunciator	1	LS	\$14,200.00	\$14,200
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Hague Alt. 1c - Tidal Barrier with Inflatable Dam, 2-60" Dia. Pumps, and Closure Walls and Berms		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
For 100 Year Event @ ELEV +7.7'		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$30,758,343	
Overhead & Profit	15%			\$4,613,751	
Mobilization/Demobilization	10%			\$3,075,834	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$1,537,917	
Traffic Control	2%			\$615,167	
Surveying/Engineering/Construction Observation	12%			\$3,691,001	
Subtotal with Mark-ups				\$45,292,014	
Contingency	25%			\$11,323,003	
Subtotal				\$56,615,017	
TOTAL				\$56,615,017	
			SAY	\$56,700,000	



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER
PROJECT TITLE Hague - Alternative 2a Tidal Barrier with Steel Gate, 4-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol STATUS OF DESIGN Conceptual CATEGORY CODE NUMBER JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$53,600,000
10 - Year Storm Event	\$56,100,000
25 - Year Storm Event	\$56,500,000
50 - Year Storm Event	\$58,800,000
100 - Year Storm Event	\$59,500,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER
PROJECT TITLE Hague - Alternative 2b Tidal Barrier with Obermeyer Gate, 4-60" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual
	JOB ORDER NUMBER 6822-03

Summary	
Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$55,900,000
10 - Year Storm Event	\$58,700,000
25 - Year Storm Event	\$59,400,000
50 - Year Storm Event	\$61,900,000
100 - Year Storm Event	\$62,300,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER
PROJECT TITLE Hague - Alternative 2c Tidal Barrier with Inflatable Dam, 4-60" Dia. Pumps, and Closure Walls and Berms	STATUS OF DESIGN Conceptual	JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$60,500,000
10 - Year Storm Event	\$63,800,000
25 - Year Storm Event	\$65,500,000
50 - Year Storm Event	\$67,600,000
100 - Year Storm Event	\$68,700,000



Opinion of Probable Cost

DATE PREPARED

17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER
PROJECT TITLE Hague - Alternative 3a Tidal Barrier with Steel Gate, 4-96" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol STATUS OF DESIGN JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$88,800,000
10 - Year Storm Event	\$90,100,000
25 - Year Storm Event	\$90,600,000
50 - Year Storm Event	\$93,400,000
100 - Year Storm Event	\$94,000,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER
PROJECT TITLE Hague - Alternative 3b Tidal Barrier with Obermeyer Gate, 4-96" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN Conceptual
	JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$90,500,000
10 - Year Storm Event	\$92,700,000
25 - Year Storm Event	\$93,500,000
50 - Year Storm Event	\$96,500,000
100 - Year Storm Event	\$97,400,000



Opinion of Probable Cost

DATE PREPARED
17-Jan-11

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER
PROJECT TITLE Hague - Alternative 3c Tidal Barrier with Inflatable Dam, 4-96" Dia. Pumps, and Closure Walls and Berms	ESTIMATED BY Moffatt & Nichol
	CATEGORY CODE NUMBER STATUS OF DESIGN Conceptual
	JOB ORDER NUMBER 6822-03

Summary

Scenario	Opinion of Probable Cost
2 - Year Storm Event	\$95,000,000
10 - Year Storm Event	\$97,900,000
25 - Year Storm Event	\$98,900,000
50 - Year Storm Event	\$101,100,000
100 - Year Storm Event	\$102,200,000



Opinion of Probable Cost

DATE PREPARED
20-Dec-10

ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia	CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER
	ESTIMATED BY	CATEGORY CODE NUMBER
PROJECT TITLE Hague - Alternative 4 Bulkhead Wall and Earthen Berm	Moffatt & Nichol	
	STATUS OF DESIGN	JOB ORDER NUMBER
	Conceptual	6822-03

Summary

Scenario	Opinion of Probable Cost
Granite Wall Elev +5.0	\$4,700,000
2 - Year Storm Event	\$19,400,000
10 - Year Storm Event	\$22,400,000
25 - Year Storm Event	\$23,400,000
50 - Year Storm Event	\$25,400,000
100 - Year Storm Event	\$26,400,000

		Opinion of Probable Cost		DATE PREPARED 20-Dec-10	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
PROJECT TITLE Hague - Alternative 5 Buyout 20% Damage Level		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-03	
		Summary			
Scenario		Opinion of Probable Cost			
2 - Year Storm Event		\$31,308,900			
10 - Year Storm Event		\$76,871,725			
25 - Year Storm Event		\$199,107,825			
50 - Year Storm Event		\$292,957,350			
100 - Year Storm Event		\$462,079,800			



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (2 Gen Sets)	100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)	2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year	100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$11,538,500.00



moffatt & nichol

Opinion of Probable Cost

DATE PREPARED

7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (2 Gen Sets)	100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)	2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year	100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$12,522,500.00



moffatt & nichol

Opinion of Probable Cost

DATE PREPARED

7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (2 Gen Sets)	100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)	2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year	100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$13,738,500.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Steel Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$17,997,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$18,981,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$20,197,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$23,229,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$24,213,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Hague - Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Additional Floodwall				
Inspections (Completed Every 5 Years)	10	\$10,000	EACH	\$100,000.00
Minor Repairs (Years 15, 35, 45)	3	\$50,000	EACH	\$150,000.00
Major Repairs (Years 25 & 40)	2	\$250,000	EACH	\$500,000.00
Total				\$25,429,000.00

APPENDIX D

BENEFIT/COST RATIO CALCULATIONS

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM				DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM				DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,452,865			
		0.50		\$18,778,579	\$9,387,412	\$9,387,412
0.500	2		\$20,104,294			
		0.4		\$30,806,003	\$12,322,401	\$21,709,813
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$24,546,501
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$25,788,396
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$26,618,709
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$367,358,052 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM				DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS	
					INTERVAL	SUMMATION
0.990	1		(\$241,108)			
		0.49		\$800,423	\$392,286	\$392,286
0.500	2		\$1,841,954			
		0.4		\$920,977	\$368,391	\$760,677
0.100	10		\$0			
		0.06		\$0	\$0	\$760,677
0.040	25		\$0			
		0.02		\$0	\$0	\$760,677
0.020	50		\$0			
		0.01		\$0	\$0	\$760,677
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
\$10,497,911 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$48,500,000	PRESENT WORTH PROJECT COST	\$275,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,795,205	PRESENT WORTH O&M COSTS	\$52,295,205	PRESENT WORTH TOTAL PROJECT COST
0.20 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$43,900,000	PRESENT WORTH PROJECT COST	\$251,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,463,987	PRESENT WORTH O&M COSTS	\$47,363,987	PRESENT WORTH TOTAL PROJECT COST
0.22 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$42,200,000	PRESENT WORTH PROJECT COST	\$231,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,187,972	PRESENT WORTH O&M COSTS	\$45,387,972	PRESENT WORTH TOTAL PROJECT COST
0.23 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 10 YR SURGE							
PROJ NO: DESIGNER: JDM DATE: 19-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$17,211,756				
		0.50		\$19,579,002	\$9,787,543	\$9,787,543	
0.500	2		\$21,946,248				
		0.40		\$31,726,980	\$12,690,792	\$22,478,335	
0.100	10		\$41,507,713				
		0.06		\$47,278,132	\$2,836,688	\$25,315,023	
0.040	25		\$53,048,551				
		0.02		\$62,094,719	\$1,241,894	\$26,556,918	7.00% INTEREST RATE
0.020	50		\$71,140,888				50 YEARS
		0.01		\$83,031,352	\$830,314	\$27,387,231	\$377,964,229 PRESENT WORTH
0.010	100		\$94,921,815				
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 10 YR SURGE							
PROJ NO: DESIGNER: JDM DATE: 19-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$17,452,865				
		0.50		\$18,778,579	\$9,387,412	\$9,387,412	
0.500	2		\$20,104,294				
		0.4		\$25,166,575	\$10,066,630	\$19,454,042	
0.100	10		\$30,228,856				
		0.06		\$41,638,703	\$2,498,322	\$21,952,364	
0.040	25		\$53,048,551				
		0.02		\$62,094,719	\$1,241,894	\$23,194,259	7.00% INTEREST RATE
0.020	50		\$71,140,888				50 YEARS
		0.01		\$83,031,352	\$830,314	\$24,024,572	\$331,557,024 PRESENT WORTH
0.010	100		\$94,921,815				
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 10 YR SURGE							
PROJ NO: DESIGNER: JDM DATE: 19-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		(\$241,108)				
		0.49		\$800,423	\$392,286	\$392,286	
0.500	2		\$1,841,954				
		0.4		\$6,560,405	\$2,624,162	\$3,016,448	
0.100	10		\$11,278,857				
		0.06		\$5,639,428	\$338,366	\$3,354,814	
0.040	25		\$0				
		0.02		\$0	\$0	\$3,354,814	7.00% INTEREST RATE
0.020	50		\$0				50 YEARS
		0.01		\$0	\$0	\$3,354,814	\$46,298,939 PRESENT WORTH
0.010	100		\$0				

Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$52,200,000	PRESENT WORTH PROJECT COST	\$275,000	ANNUAL OPERATION & MAINTENANCE (O&M) COST:
\$3,795,205	PRESENT WORTH O&M COSTS	\$55,995,205	PRESENT WORTH TOTAL PROJECT COST
0.83 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$47,200,000	PRESENT WORTH PROJECT COST	\$251,000	ANNUAL OPERATION & MAINTENANCE (O&M) COST:
\$3,463,987	PRESENT WORTH O&M COSTS	\$50,663,987	PRESENT WORTH TOTAL PROJECT COST
0.91 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$44,600,000	PRESENT WORTH PROJECT COST	\$231,000	ANNUAL OPERATION & MAINTENANCE (O&M) COST:
\$3,187,972	PRESENT WORTH O&M COSTS	\$47,787,972	PRESENT WORTH TOTAL PROJECT COST
0.97 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 25 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS \$377,964,229 PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 25 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,452,865			
		0.50		\$18,778,579	\$9,387,412	\$9,387,412
0.500	2		\$20,104,294			
		0.4		\$25,166,575	\$10,066,630	\$19,454,042
0.100	10		\$30,228,856			
		0.06		\$31,913,593	\$1,914,816	\$21,368,858
0.040	25		\$33,598,330			
		0.02		\$52,369,609	\$1,047,392	\$22,416,250
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$23,246,563
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS \$320,819,922 PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 25 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$241,108)			
		0.49		\$800,423	\$392,286	\$392,286
0.500	2		\$1,841,954			
		0.4		\$6,560,405	\$2,624,162	\$3,016,448
0.100	10		\$11,278,857			
		0.06		\$15,364,538	\$921,872	\$3,938,321
0.040	25		\$19,450,220			
		0.02		\$9,725,110	\$194,502	\$4,132,823
0.020	50		\$0			
		0.01		\$0	\$0	\$4,132,823
0.010	100		\$0			
7.00% INTEREST RATE 50 YEARS \$57,036,041 PRESENT WORTH						

Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps	
\$53,400,000 PRESENT WORTH PROJECT COST	\$275,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,795,205 PRESENT WORTH O&M COSTS	\$57,195,205 PRESENT WORTH TOTAL PROJECT COST
1.00 B/C RATIO	

Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps	
\$48,000,000 PRESENT WORTH PROJECT COST	\$251,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,463,987 PRESENT WORTH O&M COSTS	\$51,463,987 PRESENT WORTH TOTAL PROJECT COST
1.11 B/C RATIO	

Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps	
\$45,100,000 PRESENT WORTH PROJECT COST	\$231,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,187,972 PRESENT WORTH O&M COSTS	\$48,287,972 PRESENT WORTH TOTAL PROJECT COST
1.18 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 50 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS \$377,964,229 PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 50 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,452,865			
		0.50		\$18,778,579	\$9,387,412	\$9,387,412
0.500	2		\$20,104,294			
		0.4		\$25,166,575	\$10,066,630	\$19,454,042
0.100	10		\$30,228,856			
		0.06		\$31,913,593	\$1,914,816	\$21,368,858
0.040	25		\$33,598,330			
		0.02		\$35,624,809	\$712,496	\$22,081,354
0.020	50		\$37,651,287			
		0.01		\$66,286,551	\$662,866	\$22,744,219
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS \$313,887,200 PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 50 YR SURGE						
PROJ NO:		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$241,108)			
		0.49		\$800,423	\$392,286	\$392,286
0.500	2		\$1,841,954			
		0.4		\$6,560,405	\$2,624,162	\$3,016,448
0.100	10		\$11,278,857			
		0.06		\$15,364,538	\$921,872	\$3,938,321
0.040	25		\$19,450,220			
		0.02		\$26,469,910	\$529,398	\$4,467,719
0.020	50		\$33,489,601			
		0.01		\$16,744,800	\$167,448	\$4,635,167
0.010	100		\$0			
7.00% INTEREST RATE 50 YEARS \$63,968,764 PRESENT WORTH						

Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps			
\$55,600,000	PRESENT WORTH PROJECT COST	\$275,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,795,205	PRESENT WORTH O&M COSTS	\$59,395,205	PRESENT WORTH TOTAL PROJECT COST
		1.08	B/C RATIO

Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps			
\$49,900,000	PRESENT WORTH PROJECT COST	\$251,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,463,987	PRESENT WORTH O&M COSTS	\$53,363,987	PRESENT WORTH TOTAL PROJECT COST
		1.20	B/C RATIO

Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps			
\$46,800,000	PRESENT WORTH PROJECT COST	\$231,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,187,972	PRESENT WORTH O&M COSTS	\$49,987,972	PRESENT WORTH TOTAL PROJECT COST
		1.28	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$377,964,229

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,452,865			
		0.50		\$18,778,579	\$9,387,412	\$9,387,412
0.500	2		\$20,104,294			
		0.4		\$25,166,575	\$10,066,630	\$19,454,042
0.100	10		\$30,228,856			
		0.06		\$31,913,593	\$1,914,816	\$21,368,858
0.040	25		\$33,598,330			
		0.02		\$35,624,809	\$712,496	\$22,081,354
0.020	50		\$37,651,287			
		0.01		\$39,971,402	\$399,714	\$22,481,068
0.010	100		\$42,291,517			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$310,255,513

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS	
					INTERVAL	SUMMATION
0.990	1		(\$241,108)			
		0.49		\$800,423	\$392,286	\$392,286
0.500	2		\$1,841,954			
		0.4		\$6,560,405	\$2,624,162	\$3,016,448
0.100	10		\$11,278,857			
		0.06		\$15,364,538	\$921,872	\$3,938,321
0.040	25		\$19,450,220			
		0.02		\$26,469,910	\$529,398	\$4,467,719
0.020	50		\$33,489,601			
		0.01		\$43,059,950	\$430,599	\$4,898,318
0.010	100		\$52,630,298			

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$67,600,451

Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$56,700,000	PRESENT WORTH PROJECT COST	\$275,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,795,205	PRESENT WORTH O&M COSTS	\$60,495,205	PRESENT WORTH TOTAL PROJECT COST
1.12 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$50,800,000	PRESENT WORTH PROJECT COST	\$251,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,463,987	PRESENT WORTH O&M COSTS	\$54,263,987	PRESENT WORTH TOTAL PROJECT COST
1.25 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps

\$47,400,000	PRESENT WORTH PROJECT COST	\$231,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,187,972	PRESENT WORTH O&M COSTS	\$50,587,972	PRESENT WORTH TOTAL PROJECT COST
1.34 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,448,169			
		0.50		\$18,779,798	\$9,388,021	\$9,388,021
0.500	2		\$20,111,427			
		0.4		\$30,809,570	\$12,323,828	\$21,711,849
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$24,548,537
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$25,790,431
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$26,620,745
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$367,386,148 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$236,413)			
		0.49		\$799,204	\$391,689	\$391,689
0.500	2		\$1,834,821			
		0.4		\$917,410	\$366,964	\$758,653
0.100	10		\$0			
		0.06		\$0	\$0	\$758,653
0.040	25		\$0			
		0.02		\$0	\$0	\$758,653
0.020	50		\$0			
		0.01		\$0	\$0	\$758,653
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
\$10,469,980 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$60,500,000	PRESENT WORTH PROJECT COST	\$404,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,575,502	PRESENT WORTH O&M COSTS	\$66,075,502	PRESENT WORTH TOTAL PROJECT COST
0.16 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$55,900,000	PRESENT WORTH PROJECT COST	\$380,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,244,284	PRESENT WORTH O&M COSTS	\$61,144,284	PRESENT WORTH TOTAL PROJECT COST
0.17 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4- 60" Pumps

\$53,600,000	PRESENT WORTH PROJECT COST	\$360,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,968,269	PRESENT WORTH O&M COSTS	\$58,568,269	PRESENT WORTH TOTAL PROJECT COST
0.18 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES	
					INTERVAL	SUMMATION
1.000	1		\$17,448,169			
		0.50		\$18,779,798	\$9,388,021	\$9,388,021
0.500	2		\$20,111,427			
		0.4		\$25,169,106	\$10,067,642	\$19,455,663
0.100	10		\$30,226,784			
		0.06		\$41,637,667	\$2,498,260	\$21,953,924
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$23,195,818
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$24,026,131
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS	
					INTERVAL	SUMMATION
0.990	1		(\$236,413)			
		0.49		\$799,204	\$391,689	\$391,689
0.500	2		\$1,834,821			
		0.4		\$6,557,875	\$2,623,150	\$3,014,839
0.100	10		\$11,280,929			
		0.06		\$5,640,464	\$338,428	\$3,353,267
0.040	25		\$0			
		0.02		\$0	\$0	\$3,353,267
0.020	50		\$0			
		0.01		\$0	\$0	\$3,353,267
0.010	100		\$0			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
\$46,277,584						

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$63,800,000	PRESENT WORTH PROJECT COST	\$404,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,575,502	PRESENT WORTH O&M COSTS	\$69,375,502	PRESENT WORTH TOTAL PROJECT COST
0.67 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$58,700,000	PRESENT WORTH PROJECT COST	\$380,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,244,284	PRESENT WORTH O&M COSTS	\$63,944,284	PRESENT WORTH TOTAL PROJECT COST
0.72 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4- 60" Pumps

\$56,100,000	PRESENT WORTH PROJECT COST	\$360,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,968,269	PRESENT WORTH O&M COSTS	\$61,068,269	PRESENT WORTH TOTAL PROJECT COST
0.76 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,448,169			
		0.50		\$18,779,798	\$9,388,021	\$9,388,021
0.500	2		\$20,111,427			
		0.4		\$25,169,106	\$10,067,642	\$19,455,663
0.100	10		\$30,226,784			
		0.06		\$31,910,564	\$1,914,634	\$21,370,297
0.040	25		\$33,594,344			
		0.02		\$52,367,616	\$1,047,352	\$22,417,650
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$23,247,963
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$236,413)			
		0.49		\$799,204	\$391,689	\$391,689
0.500	2		\$1,834,821			
		0.4		\$6,557,875	\$2,623,150	\$3,014,839
0.100	10		\$11,280,929			
		0.06		\$15,367,568	\$922,054	\$3,936,893
0.040	25		\$19,454,207			
		0.02		\$9,727,103	\$194,542	\$4,131,435
0.020	50		\$0			
		0.01		\$0	\$0	\$4,131,435
0.010	100		\$0			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
\$57,016,887						

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$65,500,000	PRESENT WORTH PROJECT COST	\$404,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,575,502	PRESENT WORTH O&M COSTS	\$71,075,502	PRESENT WORTH TOTAL PROJECT COST
0.80 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$59,400,000	PRESENT WORTH PROJECT COST	\$380,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,244,284	PRESENT WORTH O&M COSTS	\$64,644,284	PRESENT WORTH TOTAL PROJECT COST
0.88 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4- 60" Pumps

\$56,500,000	PRESENT WORTH PROJECT COST	\$360,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,968,269	PRESENT WORTH O&M COSTS	\$61,468,269	PRESENT WORTH TOTAL PROJECT COST
0.93 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$377,964,229

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,448,169			
		0.50		\$18,779,798	\$9,388,021	\$9,388,021
0.500	2		\$20,111,427			
		0.4		\$25,169,106	\$10,067,642	\$19,455,663
0.100	10		\$30,226,784			
		0.06		\$31,910,564	\$1,914,634	\$21,370,297
0.040	25		\$33,594,344			
		0.02		\$35,318,439	\$706,369	\$22,076,666
0.020	50		\$37,042,534			
		0.01		\$65,982,175	\$659,822	\$22,736,488
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$313,780,500

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$236,413)			
		0.49		\$799,204	\$391,689	\$391,689
0.500	2		\$1,834,821			
		0.4		\$6,557,875	\$2,623,150	\$3,014,839
0.100	10		\$11,280,929			
		0.06		\$15,367,568	\$922,054	\$3,936,893
0.040	25		\$19,454,207			
		0.02		\$26,776,280	\$535,526	\$4,472,419
0.020	50		\$34,098,354			
		0.01		\$17,049,177	\$170,492	\$4,642,910
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$64,075,628

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$67,600,000	PRESENT WORTH PROJECT COST	\$404,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,575,502	PRESENT WORTH O&M COSTS	\$73,175,502	PRESENT WORTH TOTAL PROJECT COST
0.88 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$61,900,000	PRESENT WORTH PROJECT COST	\$380,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,244,284	PRESENT WORTH O&M COSTS	\$67,144,284	PRESENT WORTH TOTAL PROJECT COST
0.95 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4- 60" Pumps

\$58,800,000	PRESENT WORTH PROJECT COST	\$360,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,968,269	PRESENT WORTH O&M COSTS	\$63,768,269	PRESENT WORTH TOTAL PROJECT COST
1.00 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$377,964,229

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,448,169			
		0.50		\$18,779,798	\$9,388,021	\$9,388,021
0.500	2		\$20,111,427			
		0.4		\$25,169,106	\$10,067,642	\$19,455,663
0.100	10		\$30,226,784			
		0.06		\$31,910,564	\$1,914,634	\$21,370,297
0.040	25		\$33,594,344			
		0.02		\$35,318,439	\$706,369	\$22,076,666
0.020	50		\$37,042,534			
		0.01		\$40,065,894	\$400,659	\$22,477,325
0.010	100		\$43,089,254			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$310,203,860

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-60" PUMPS - 100 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$236,413)			
		0.49		\$799,204	\$391,689	\$391,689
0.500	2		\$1,834,821			
		0.4		\$6,557,875	\$2,623,150	\$3,014,839
0.100	10		\$11,280,929			
		0.06		\$15,367,568	\$922,054	\$3,936,893
0.040	25		\$19,454,207			
		0.02		\$26,776,280	\$535,526	\$4,472,419
0.020	50		\$34,098,354			
		0.01		\$42,965,458	\$429,655	\$4,902,073
0.010	100		\$51,832,561			

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$67,652,268

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$68,700,000	PRESENT WORTH PROJECT COST	\$404,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,575,502	PRESENT WORTH O&M COSTS	\$74,275,502	PRESENT WORTH TOTAL PROJECT COST
0.91 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps

\$62,300,000	PRESENT WORTH PROJECT COST	\$380,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,244,284	PRESENT WORTH O&M COSTS	\$67,544,284	PRESENT WORTH TOTAL PROJECT COST
1.00 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4- 60" Pumps

\$59,500,000	PRESENT WORTH PROJECT COST	\$360,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,968,269	PRESENT WORTH O&M COSTS	\$64,468,269	PRESENT WORTH TOTAL PROJECT COST
1.05 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,463,659			
		0.50		\$18,781,776	\$9,389,010	\$9,389,010
0.500	2		\$20,099,894			
		0.4		\$30,803,803	\$12,321,521	\$21,710,532
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$24,547,219
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$25,789,114
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$26,619,427
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$367,367,964 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 2 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$251,903)			
		0.49		\$797,226	\$390,719	\$390,719
0.500	2		\$1,846,354			
		0.4		\$923,177	\$369,271	\$759,990
0.100	10		\$0			
		0.06		\$0	\$0	\$759,990
0.040	25		\$0			
		0.02		\$0	\$0	\$759,990
0.020	50		\$0			
		0.01		\$0	\$0	\$759,990
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
\$10,488,432 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$95,000,000	PRESENT WORTH PROJECT COST	\$509,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,024,580	PRESENT WORTH O&M COSTS	\$102,024,580	PRESENT WORTH TOTAL PROJECT COST
0.10 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$90,500,000	PRESENT WORTH PROJECT COST	\$485,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,693,362	PRESENT WORTH O&M COSTS	\$97,193,362	PRESENT WORTH TOTAL PROJECT COST
0.11 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$88,800,000	PRESENT WORTH PROJECT COST	\$465,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,417,347	PRESENT WORTH O&M COSTS	\$95,217,347	PRESENT WORTH TOTAL PROJECT COST
0.11 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,463,659			
		0.50		\$18,781,776	\$9,389,010	\$9,389,010
0.500	2		\$20,099,894			
		0.4		\$25,158,503	\$10,063,401	\$19,452,411
0.100	10		\$30,217,112			
		0.06		\$41,632,831	\$2,497,970	\$21,950,381
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$23,192,276
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$24,022,589
0.010	100		\$94,921,815			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 10 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$251,903)			
		0.49		\$797,226	\$390,719	\$390,719
0.500	2		\$1,846,354			
		0.4		\$6,568,477	\$2,627,391	\$3,018,110
0.100	10		\$11,290,600			
		0.06		\$5,645,300	\$338,718	\$3,356,828
0.040	25		\$0			
		0.02		\$0	\$0	\$3,356,828
0.020	50		\$0			
		0.01		\$0	\$0	\$3,356,828
0.010	100		\$0			
7.00% INTEREST RATE 50 YEARS PRESENT WORTH						
\$46,326,736						

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$97,900,000	PRESENT WORTH PROJECT COST	\$509,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,024,580	PRESENT WORTH O&M COSTS	\$104,924,580	PRESENT WORTH TOTAL PROJECT COST
0.44 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$92,700,000	PRESENT WORTH PROJECT COST	\$485,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,693,362	PRESENT WORTH O&M COSTS	\$99,393,362	PRESENT WORTH TOTAL PROJECT COST
0.47 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$90,100,000	PRESENT WORTH PROJECT COST	\$465,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,417,347	PRESENT WORTH O&M COSTS	\$96,517,347	PRESENT WORTH TOTAL PROJECT COST
0.48 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,463,659			
		0.50		\$18,781,776	\$9,389,010	\$9,389,010
0.500	2		\$20,099,894			
		0.4		\$25,158,503	\$10,063,401	\$19,452,411
0.100	10		\$30,217,112			
		0.06		\$31,904,244	\$1,914,255	\$21,366,666
0.040	25		\$33,591,375			
		0.02		\$52,366,131	\$1,047,323	\$22,413,989
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$23,244,302
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$320,788,718 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 25 YR SURGE						
PROJ NO: DESIGNER: JDM					DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$251,903)			
		0.49		\$797,226	\$390,719	\$390,719
0.500	2		\$1,846,354			
		0.4		\$6,568,477	\$2,627,391	\$3,018,110
0.100	10		\$11,290,600			
		0.06		\$15,373,888	\$922,433	\$3,940,544
0.040	25		\$19,457,176			
		0.02		\$9,728,588	\$194,572	\$4,135,115
0.020	50		\$0			
		0.01		\$0	\$0	\$4,135,115
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
\$57,067,678 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$98,900,000	PRESENT WORTH PROJECT COST	\$509,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,024,580	PRESENT WORTH O&M COSTS	\$105,924,580	PRESENT WORTH TOTAL PROJECT COST
0.54 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$93,500,000	PRESENT WORTH PROJECT COST	\$485,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,693,362	PRESENT WORTH O&M COSTS	\$100,193,362	PRESENT WORTH TOTAL PROJECT COST
0.57 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$90,600,000	PRESENT WORTH PROJECT COST	\$465,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,417,347	PRESENT WORTH O&M COSTS	\$97,017,347	PRESENT WORTH TOTAL PROJECT COST
0.59 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,463,659			
		0.50		\$18,781,776	\$9,389,010	\$9,389,010
0.500	2		\$20,099,894			
		0.4		\$25,158,503	\$10,063,401	\$19,452,411
0.100	10		\$30,217,112			
		0.06		\$31,904,244	\$1,914,255	\$21,366,666
0.040	25		\$33,591,375			
		0.02		\$35,343,999	\$706,880	\$22,073,546
0.020	50		\$37,096,622			
		0.01		\$66,009,219	\$660,092	\$22,733,638
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$313,741,174 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 50 YR SURGE						
PROJ NO: DESIGNER: JDM						DATE: 19-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$251,903)			
		0.49		\$797,226	\$390,719	\$390,719
0.500	2		\$1,846,354			
		0.4		\$6,568,477	\$2,627,391	\$3,018,110
0.100	10		\$11,290,600			
		0.06		\$15,373,888	\$922,433	\$3,940,544
0.040	25		\$19,457,176			
		0.02		\$26,750,720	\$535,014	\$4,475,558
0.020	50		\$34,044,265			
		0.01		\$17,022,133	\$170,221	\$4,645,779
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
\$64,115,222 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$101,100,000	PRESENT WORTH PROJECT COST	\$509,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,024,580	PRESENT WORTH O&M COSTS	\$108,124,580	PRESENT WORTH TOTAL PROJECT COST
0.59 B/C RATIO			

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$96,500,000	PRESENT WORTH PROJECT COST	\$485,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,693,362	PRESENT WORTH O&M COSTS	\$103,193,362	PRESENT WORTH TOTAL PROJECT COST
0.62 B/C RATIO			

Steel Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps

\$93,400,000	PRESENT WORTH PROJECT COST	\$465,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,417,347	PRESENT WORTH O&M COSTS	\$99,817,347	PRESENT WORTH TOTAL PROJECT COST
0.64 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 100 YR SURGE						
PROJ NO:		DESIGNER: JDM			DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,211,756			
		0.50		\$19,579,002	\$9,787,543	\$9,787,543
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,478,335
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,315,023
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,556,918
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,387,231
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 100 YR SURGE						
PROJ NO:		DESIGNER: JDM			DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$17,463,659			
		0.50		\$18,781,776	\$9,389,010	\$9,389,010
0.500	2		\$20,099,894			
		0.4		\$25,158,503	\$10,063,401	\$19,452,411
0.100	10		\$30,217,112			
		0.06		\$31,904,244	\$1,914,255	\$21,366,666
0.040	25		\$33,591,375			
		0.02		\$35,343,999	\$706,880	\$22,073,546
0.020	50		\$37,096,622			
		0.01		\$40,092,564	\$400,926	\$22,474,472
0.010	100		\$43,088,505			
0.99						

7.00% INTEREST RATE
50 YEARS
\$310,164,482 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 4-96" PUMPS - 100 YR SURGE						
PROJ NO:		DESIGNER: JDM			DATE: 19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		(\$251,903)			
		0.49		\$797,226	\$390,719	\$390,719
0.500	2		\$1,846,354			
		0.4		\$6,568,477	\$2,627,391	\$3,018,110
0.100	10		\$11,290,600			
		0.06		\$15,373,888	\$922,433	\$3,940,544
0.040	25		\$19,457,176			
		0.02		\$26,750,720	\$535,014	\$4,475,558
0.020	50		\$34,044,265			
		0.01		\$42,938,788	\$429,388	\$4,904,946
0.010	100		\$51,833,310			

7.00% INTEREST RATE
50 YEARS
\$67,691,913 PRESENT WORTH

Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps	
\$102,200,000 PRESENT WORTH PROJECT COST	\$509,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,024,580 PRESENT WORTH O&M COSTS	\$109,224,580 PRESENT WORTH TOTAL PROJECT COST
0.62 B/C RATIO	

Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps	
\$97,400,000 PRESENT WORTH PROJECT COST	\$485,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,693,362 PRESENT WORTH O&M COSTS	\$104,093,362 PRESENT WORTH TOTAL PROJECT COST
0.65 B/C RATIO	

Steel Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps	
\$94,000,000 PRESENT WORTH PROJECT COST	\$465,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,417,347 PRESENT WORTH O&M COSTS	\$100,417,347 PRESENT WORTH TOTAL PROJECT COST
0.67 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - HAGUE - 2-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$17,211,756					
		0.50		\$19,579,002	\$9,787,543	\$9,787,543		
0.500	2		\$21,946,248					
		0.40		\$31,726,980	\$12,690,792	\$22,478,335		
0.100	10		\$41,507,713					
		0.06		\$47,278,132	\$2,836,688	\$25,315,023		
0.040	25		\$53,048,551					
		0.02		\$62,094,719	\$1,241,894	\$26,556,918	7.00% INTEREST RATE	
0.020	50		\$71,140,888				50 YEARS	
		0.01		\$83,031,352	\$830,314	\$27,387,231	\$377,964,229 PRESENT WORTH	
0.010	100		\$94,921,815					
0.99								

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - HAGUE - 2-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$16,843,327					
		0.50		\$19,106,893	\$9,551,536	\$9,551,536		
0.500	2		\$21,370,458					
		0.4		\$31,439,086	\$12,575,634	\$22,127,170		
0.100	10		\$41,507,713					
		0.06		\$47,278,132	\$2,836,688	\$24,963,858		
0.040	25		\$53,048,551					
		0.02		\$62,094,719	\$1,241,894	\$26,205,752	7.00% INTEREST RATE	
0.020	50		\$71,140,888				50 YEARS	
		0.01		\$83,031,352	\$830,314	\$27,036,066	\$373,117,887 PRESENT WORTH	
0.010	100		\$94,921,815					
0.99								

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - HAGUE - 2-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$368,429					
		0.49		\$472,109	\$231,380	\$231,380		
0.500	2		\$575,789					
		0.4		\$287,895	\$115,158	\$346,538		
0.100	10		\$0					
		0.06		\$0	\$0	\$346,538		
0.040	25		\$0					
		0.02		\$0	\$0	\$346,538	7.00% INTEREST RATE	
0.020	50		\$0				50 YEARS	
		0.01		\$0	\$0	\$346,538	\$4,782,484 PRESENT WORTH	
0.010	100		\$0					

Hague Floodwall, Earthen Berm and Bulkhead

\$19,400,000	PRESENT WORTH PROJECT COST	\$97,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$1,338,672	PRESENT WORTH O&M COSTS	\$20,738,672	PRESENT WORTH TOTAL PROJECT COST
		0.23	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - HAGUE - 10-yr Bulkhead - SURGE				DATE:	
PROJ NO:		DESIGNER: JDM				20-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$17,211,756				
		0.50		\$19,579,002	\$9,787,543	\$9,787,543	
0.500	2		\$21,946,248				
		0.40		\$31,726,980	\$12,690,792	\$22,478,335	
0.100	10		\$41,507,713				
		0.06		\$47,278,132	\$2,836,688	\$25,315,023	
0.040	25		\$53,048,551				
		0.02		\$62,094,719	\$1,241,894	\$26,556,918	
0.020	50		\$71,140,888				
		0.01		\$83,031,352	\$830,314	\$27,387,231	
0.010	100		\$94,921,815				
0.99							

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH
\$377,964,229

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - HAGUE - 10-yr Bulkhead - SURGE				DATE:	
PROJ NO:		DESIGNER: JDM				20-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$16,843,327				
		0.50		\$19,106,893	\$9,551,536	\$9,551,536	
0.500	2		\$21,370,458				
		0.4		\$30,480,076	\$12,192,030	\$21,743,566	
0.100	10		\$39,589,693				
		0.06		\$46,319,122	\$2,779,147	\$24,522,714	
0.040	25		\$53,048,551				
		0.02		\$62,094,719	\$1,241,894	\$25,764,608	
0.020	50		\$71,140,888				
		0.01		\$83,031,352	\$830,314	\$26,594,922	
0.010	100		\$94,921,815				
0.99							

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH
\$367,029,765

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - HAGUE - 10-yr Bulkhead - SURGE				DATE:	
PROJ NO:		DESIGNER: JDM				20-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$368,429				
		0.49		\$472,109	\$231,380	\$231,380	
0.500	2		\$575,789				
		0.4		\$1,246,904	\$498,762	\$730,142	
0.100	10		\$1,918,019				
		0.06		\$959,010	\$57,541	\$787,682	
0.040	25		\$0				
		0.02		\$0	\$0	\$787,682	
0.020	50		\$0				
		0.01		\$0	\$0	\$787,682	
0.010	100		\$0				

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH
\$10,870,606

Hague Floodwall, Earthen Berm and Bulkhead	
\$22,400,000	PRESENT WORTH PROJECT COST
\$112,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$1,545,684	PRESENT WORTH O&M COSTS
\$23,945,684	PRESENT WORTH TOTAL PROJECT COST
0.45	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - HAGUE - 25-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$17,211,756					
		0.50		\$19,579,002	\$9,787,543	\$9,787,543		
0.500	2		\$21,946,248					
		0.40		\$31,726,980	\$12,690,792	\$22,478,335		
0.100	10		\$41,507,713					
		0.06		\$47,278,132	\$2,836,688	\$25,315,023		
0.040	25		\$53,048,551					
		0.02		\$62,094,719	\$1,241,894	\$26,556,918	7.00% INTEREST RATE	
0.020	50		\$71,140,888				50 YEARS	
		0.01		\$83,031,352	\$830,314	\$27,387,231	\$377,964,229 PRESENT WORTH	
0.010	100		\$94,921,815					
0.99								

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - HAGUE - 25-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$16,843,327					
		0.50		\$19,106,893	\$9,551,536	\$9,551,536		
0.500	2		\$21,370,458					
		0.4		\$30,480,076	\$12,192,030	\$21,743,566		
0.100	10		\$39,589,693					
		0.06		\$43,973,965	\$2,638,438	\$24,382,004		
0.040	25		\$48,358,237					
		0.02		\$59,749,562	\$1,194,991	\$25,576,995	7.00% INTEREST RATE	
0.020	50		\$71,140,888				50 YEARS	
		0.01		\$83,031,352	\$830,314	\$26,407,309	\$364,440,572 PRESENT WORTH	
0.010	100		\$94,921,815					
0.99								

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - HAGUE - 25-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$368,429					
		0.49		\$472,109	\$231,380	\$231,380		
0.500	2		\$575,789					
		0.4		\$1,246,904	\$498,762	\$730,142		
0.100	10		\$1,918,019					
		0.06		\$3,304,167	\$198,250	\$928,392		
0.040	25		\$4,690,314					
		0.02		\$2,345,157	\$46,903	\$975,295	7.00% INTEREST RATE	
0.020	50		\$0				50 YEARS	
		0.01		\$0	\$0	\$975,295	\$13,459,800 PRESENT WORTH	
0.010	100		\$0					

Hague Floodwall, Earthen Berm and Bulkhead

\$23,400,000	PRESENT WORTH PROJECT COST	\$117,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$1,614,687	PRESENT WORTH O&M COSTS	\$25,014,687	PRESENT WORTH TOTAL PROJECT COST
		0.54	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - HAGUE - 50-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$17,211,756					
		0.50		\$19,579,002	\$9,787,543	\$9,787,543		
0.500	2		\$21,946,248					
		0.40		\$31,726,980	\$12,690,792	\$22,478,335		
0.100	10		\$41,507,713					
		0.06		\$47,278,132	\$2,836,688	\$25,315,023		
0.040	25		\$53,048,551					
		0.02		\$62,094,719	\$1,241,894	\$26,556,918		7.00% INTEREST RATE
0.020	50		\$71,140,888					50 YEARS
		0.01		\$83,031,352	\$830,314	\$27,387,231		PRESENT WORTH
0.010	100		\$94,921,815					
		0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - HAGUE - 50-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$16,843,327					
		0.50		\$19,106,893	\$9,551,536	\$9,551,536		
0.500	2		\$21,370,458					
		0.4		\$30,480,076	\$12,192,030	\$21,743,566		
0.100	10		\$39,589,693					
		0.06		\$43,973,965	\$2,638,438	\$24,382,004		
0.040	25		\$48,358,237					
		0.02		\$55,844,672	\$1,116,893	\$25,498,898		7.00% INTEREST RATE
0.020	50		\$63,331,106					50 YEARS
		0.01		\$79,126,461	\$791,265	\$26,290,162		PRESENT WORTH
0.010	100		\$94,921,815					
		0.99						

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - HAGUE - 50-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$368,429					
		0.49		\$472,109	\$231,380	\$231,380		
0.500	2		\$575,789					
		0.4		\$1,246,904	\$498,762	\$730,142		
0.100	10		\$1,918,019					
		0.06		\$3,304,167	\$198,250	\$928,392		
0.040	25		\$4,690,314					
		0.02		\$6,250,048	\$125,001	\$1,053,393		7.00% INTEREST RATE
0.020	50		\$7,809,781					50 YEARS
		0.01		\$3,904,891	\$39,049	\$1,092,442	\$15,076,512	PRESENT WORTH
0.010	100		\$0					

Hague Floodwall, Earthen Berm and Bulkhead

\$25,400,000	PRESENT WORTH PROJECT COST	\$127,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$1,752,695	PRESENT WORTH O&M COSTS	\$27,152,695	PRESENT WORTH TOTAL PROJECT COST
		0.56	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - HAGUE - 100-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$17,211,756					
		0.50		\$19,579,002	\$9,787,543	\$9,787,543		
0.500	2		\$21,946,248					
		0.40		\$31,726,980	\$12,690,792	\$22,478,335		
0.100	10		\$41,507,713					
		0.06		\$47,278,132	\$2,836,688	\$25,315,023		
0.040	25		\$53,048,551					
		0.02		\$62,094,719	\$1,241,894	\$26,556,918		
0.020	50		\$71,140,888					
		0.01		\$83,031,352	\$830,314	\$27,387,231		
0.010	100		\$94,921,815					
0.99								

7.00% INTEREST RATE
50 YEARS
\$377,964,229 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - HAGUE - 100-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$16,843,327					
		0.50		\$19,106,893	\$9,551,536	\$9,551,536		
0.500	2		\$21,370,458					
		0.4		\$30,480,076	\$12,192,030	\$21,743,566		
0.100	10		\$39,589,693					
		0.06		\$43,973,965	\$2,638,438	\$24,382,004		
0.040	25		\$48,358,237					
		0.02		\$55,844,672	\$1,116,893	\$25,498,898		
0.020	50		\$63,331,106					
		0.01		\$72,653,712	\$726,537	\$26,225,435		
0.010	100		\$81,976,317					
0.99								

7.00% INTEREST RATE
50 YEARS
\$361,930,572 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - HAGUE - 100-yr Bulkhead - SURGE				DATE:		20-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$368,429					
		0.49		\$472,109	\$231,380	\$231,380		
0.500	2		\$575,789					
		0.4		\$1,246,904	\$498,762	\$730,142		
0.100	10		\$1,918,019					
		0.06		\$3,304,167	\$198,250	\$928,392		
0.040	25		\$4,690,314					
		0.02		\$6,250,048	\$125,001	\$1,053,393		
0.020	50		\$7,809,781					
		0.01		\$10,377,640	\$103,776	\$1,157,169		
0.010	100		\$12,945,498					

7.00% INTEREST RATE
50 YEARS
\$15,969,799 PRESENT WORTH

Hague Floodwall, Earthen Berm and Bulkhead			
\$26,400,000	PRESENT WORTH PROJECT COST	\$132,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$1,821,699	PRESENT WORTH O&M COSTS	\$28,221,699	PRESENT WORTH TOTAL PROJECT COST
0.57		B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 2 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$18,910,700			
		0.50		\$20,428,474	\$10,212,194	\$10,212,194
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,902,986
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,739,674
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,981,569
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,811,882
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$383,824,731 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 2 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$15,681,737			
		0.50		\$16,915,823	\$8,456,220	\$8,456,220
0.500	2		\$18,149,909			
		0.4		\$27,388,134	\$10,955,254	\$19,411,473
0.100	10		\$36,626,359			
		0.06		\$41,904,538	\$2,514,272	\$21,925,746
0.040	25		\$47,182,716			
		0.02		\$55,870,488	\$1,117,410	\$23,043,155
0.020	50		\$64,558,260			
		0.01		\$76,110,887	\$761,109	\$23,804,264
0.010	100		\$87,663,514			
0.99						

7.00% INTEREST RATE
50 YEARS
\$328,516,613 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 2 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$3,228,964			
		0.49		\$3,512,651	\$1,721,547	\$1,721,547
0.500	2		\$3,796,339			
		0.4		\$4,338,846	\$1,735,539	\$3,457,086
0.100	10		\$4,881,354			
		0.06		\$5,373,594	\$322,416	\$3,779,501
0.040	25		\$5,865,834			
		0.02		\$6,224,231	\$124,485	\$3,903,986
0.020	50		\$6,582,628			
		0.01		\$6,920,465	\$69,205	\$3,973,190
0.010	100		\$7,258,302			

7.00% INTEREST RATE
50 YEARS
\$54,832,993 PRESENT WORTH

Hague Buyout 20% Damage Level	
\$31,308,900 PRESENT WORTH PROJECT COST	\$344,398 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,752,948 PRESENT WORTH O&M COSTS	\$36,061,848 PRESENT WORTH TOTAL PROJECT COST
1.52 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 10 YR BUYOUT							
PROJ NO:		DESIGNER: JDM		DATE:		19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1	0.50	\$18,910,700	\$20,428,474	\$10,212,194	\$10,212,194	
0.500	2	0.40	\$21,946,248	\$31,726,980	\$12,690,792	\$22,902,986	
0.100	10	0.06	\$41,507,713	\$47,278,132	\$2,836,688	\$25,739,674	
0.040	25	0.02	\$53,048,551	\$62,094,719	\$1,241,894	\$26,981,569	7.00% INTEREST RATE
0.020	50	0.01	\$71,140,888	\$83,031,352	\$830,314	\$27,811,882	50 YEARS
0.010	100		\$94,921,815			\$383,824,731	PRESENT WORTH
		0.99					

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 10 YR BUYOUT							
PROJ NO:		DESIGNER: JDM		DATE:		19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1	0.50	\$14,112,344	\$15,078,258	\$7,537,621	\$7,537,621	
0.500	2	0.4	\$16,044,171	\$24,641,261	\$9,856,504	\$17,394,125	
0.100	10	0.06	\$33,238,350	\$38,156,140	\$2,289,368	\$19,683,494	
0.040	25	0.02	\$43,073,929	\$51,490,297	\$1,029,806	\$20,713,300	7.00% INTEREST RATE
0.020	50	0.01	\$59,906,665	\$71,159,805	\$711,598	\$21,424,898	50 YEARS
0.010	100		\$82,412,946			\$295,679,578	PRESENT WORTH
		0.99					

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 10 YR BUYOUT							
PROJ NO:		DESIGNER: JDM		DATE:		19-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1	0.49	\$4,798,356	\$5,350,216	\$2,622,136	\$2,622,136	
0.500	2	0.4	\$5,902,077	\$7,085,720	\$2,834,288	\$5,456,424	
0.100	10	0.06	\$8,269,362	\$9,121,992	\$547,320	\$6,003,743	
0.040	25	0.02	\$9,974,621	\$10,604,422	\$212,088	\$6,215,832	7.00% INTEREST RATE
0.020	50	0.01	\$11,234,223	\$11,871,546	\$118,715	\$6,334,547	50 YEARS
0.010	100		\$12,508,870			\$87,421,476	PRESENT WORTH

Hague Buyout 20% Damage Level

\$76,871,725	PRESENT WORTH PROJECT COST	\$845,589	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$11,669,759	PRESENT WORTH O&M COSTS	\$88,541,484	PRESENT WORTH TOTAL PROJECT COST
		0.99	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 25 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$18,910,700			
		0.50		\$20,428,474	\$10,212,194	\$10,212,194
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,902,986
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,739,674
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,981,569
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,811,882
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$383,824,731 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 25 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$12,510,404			
		0.50		\$13,238,248	\$6,617,800	\$6,617,800
0.500	2		\$13,966,092			
		0.4		\$20,570,594	\$8,228,238	\$14,846,038
0.100	10		\$27,175,096			
		0.06		\$31,158,197	\$1,869,492	\$16,715,530
0.040	25		\$35,141,298			
		0.02		\$42,668,829	\$853,377	\$17,568,906
0.020	50		\$50,196,360			
		0.01		\$60,379,682	\$603,797	\$18,172,703
0.010	100		\$70,563,004			
0.99						

7.00% INTEREST RATE
50 YEARS
\$250,796,865 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 25 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$6,400,296			
		0.49		\$7,190,226	\$3,523,923	\$3,523,923
0.500	2		\$7,980,156			
		0.4		\$11,156,386	\$4,462,554	\$7,986,477
0.100	10		\$14,332,617			
		0.06		\$16,119,935	\$967,196	\$8,953,673
0.040	25		\$17,907,253			
		0.02		\$19,425,890	\$388,518	\$9,342,191
0.020	50		\$20,944,528			
		0.01		\$22,651,669	\$226,517	\$9,568,708
0.010	100		\$24,358,811			

7.00% INTEREST RATE
50 YEARS
\$132,055,307 PRESENT WORTH

Hague Buyout 20% Damage Level	
\$199,107,825 PRESENT WORTH PROJECT COST	\$2,190,186 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$30,226,202 PRESENT WORTH O&M COSTS	\$229,334,027 PRESENT WORTH TOTAL PROJECT COST
0.58 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 50 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$18,910,700			
		0.50		\$20,428,474	\$10,212,194	\$10,212,194
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,902,986
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,739,674
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,981,569
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,811,882
0.010	100		\$94,921,815			
		0.99				

7.00% INTEREST RATE
50 YEARS
\$383,824,731 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 50 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$9,253,732			
		0.50		\$10,345,249	\$5,171,590	\$5,171,590
0.500	2		\$11,436,766			
		0.4		\$16,000,104	\$6,400,042	\$11,571,632
0.100	10		\$20,563,443			
		0.06		\$23,514,565	\$1,410,874	\$12,982,506
0.040	25		\$26,465,687			
		0.02		\$34,131,281	\$682,626	\$13,665,131
0.020	50		\$41,796,875			
		0.01		\$50,115,493	\$501,155	\$14,166,286
0.010	100		\$58,434,112			
		0.99				

7.00% INTEREST RATE
50 YEARS
\$195,505,322 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 50 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$9,656,968			
		0.49		\$10,083,225	\$4,941,779	\$4,941,779
0.500	2		\$10,509,482			
		0.4		\$15,726,876	\$6,290,750	\$11,232,529
0.100	10		\$20,944,269			
		0.06		\$23,763,566	\$1,425,814	\$12,658,343
0.040	25		\$26,582,864			
		0.02		\$27,963,438	\$559,269	\$13,217,612
0.020	50		\$29,344,013			
		0.01		\$32,915,858	\$329,159	\$13,546,770
0.010	100		\$36,487,703			

7.00% INTEREST RATE
50 YEARS
\$186,955,541 PRESENT WORTH

Hague Buyout 20% Damage Level	
\$292,957,350 PRESENT WORTH PROJECT COST	\$3,222,531 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$44,473,331 PRESENT WORTH O&M COSTS	\$337,430,681 PRESENT WORTH TOTAL PROJECT COST
	0.55 B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - HAGUE - 100 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$18,910,700			
		0.50		\$20,428,474	\$10,212,194	\$10,212,194
0.500	2		\$21,946,248			
		0.40		\$31,726,980	\$12,690,792	\$22,902,986
0.100	10		\$41,507,713			
		0.06		\$47,278,132	\$2,836,688	\$25,739,674
0.040	25		\$53,048,551			
		0.02		\$62,094,719	\$1,241,894	\$26,981,569
0.020	50		\$71,140,888			
		0.01		\$83,031,352	\$830,314	\$27,811,882
0.010	100		\$94,921,815			
0.99						

7.00% INTEREST RATE
50 YEARS
\$383,824,731 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - HAGUE - 100 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$7,964,746			
		0.50		\$8,526,663	\$4,262,479	\$4,262,479
0.500	2		\$9,088,581			
		0.4		\$12,927,399	\$5,170,960	\$9,433,439
0.100	10		\$16,766,217			
		0.06		\$18,372,037	\$1,102,322	\$10,535,761
0.040	25		\$19,977,856			
		0.02		\$25,066,178	\$501,324	\$11,037,084
0.020	50		\$30,154,499			
		0.01		\$37,826,075	\$378,261	\$11,415,345
0.010	100		\$45,497,651			
0.99						

7.00% INTEREST RATE
50 YEARS
\$157,540,283 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - HAGUE - 100 YR BUYOUT		DESIGNER: JDM		DATE: 19-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$10,945,954			
		0.49		\$11,901,811	\$5,833,066	\$5,833,066
0.500	2		\$12,857,667			
		0.4		\$18,799,581	\$7,519,832	\$13,352,898
0.100	10		\$24,741,496			
		0.06		\$28,906,095	\$1,734,366	\$15,087,264
0.040	25		\$33,070,694			
		0.02		\$37,028,542	\$740,571	\$15,827,835
0.020	50		\$40,986,389			
		0.01		\$45,205,277	\$452,053	\$16,279,887
0.010	100		\$49,424,165			

7.00% INTEREST RATE
50 YEARS
\$224,674,596 PRESENT WORTH

Hague Buyout 20% Damage Level	
\$462,079,800 PRESENT WORTH PROJECT COST	\$5,082,878 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$70,147,507 PRESENT WORTH O&M COSTS	\$532,227,307 PRESENT WORTH TOTAL PROJECT COST
0.42 B/C RATIO	