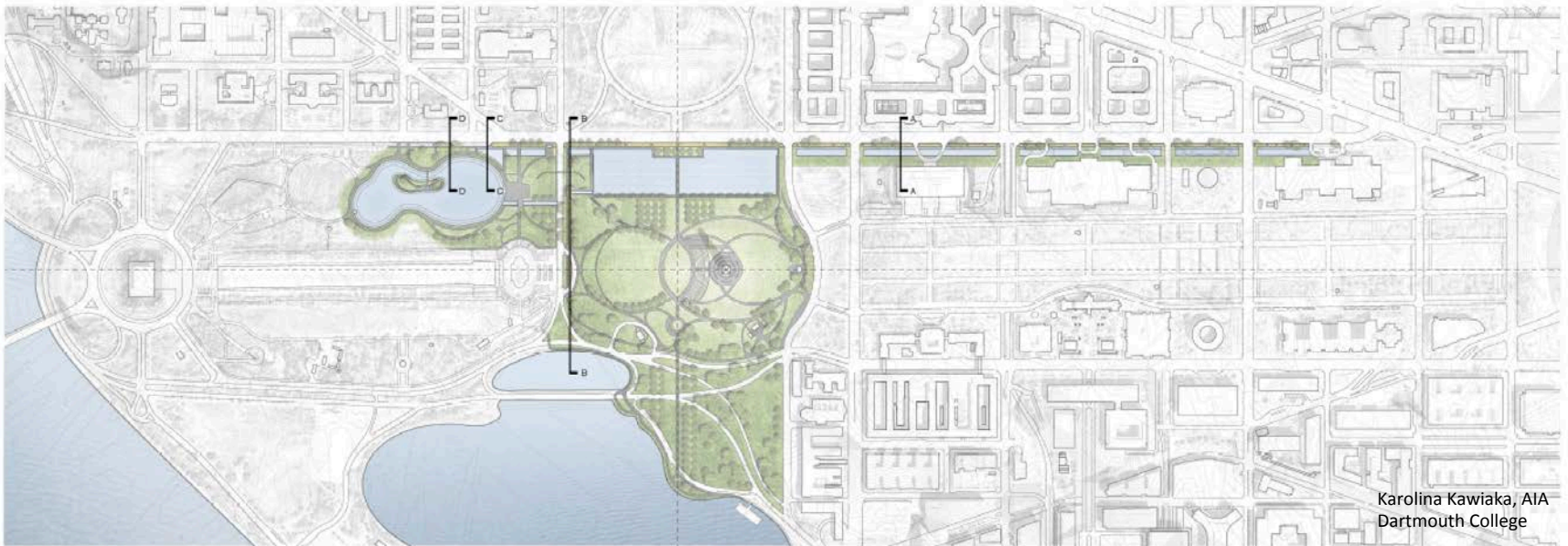


Restoring the Role of Washington DC's Lost Tiber Creek: Flood Mitigation for the Nation's Capitol

April, 2014



Karolina Kawiaka, AIA
Dartmouth College

Karolina Kawiaka, AIA
Dartmouth College

Special thanks to

The William H. Neukom Institute for Computational Science at
Dartmouth College and the Vermont Arts Council
for making this research possible.



Washington, DC Floods

1889



1936



1942



2006



Understanding Flood Risks



- Geographic Factors
 - At confluence of 2 major rivers
 - Three buried streams and high water table
 - Development in floodplains

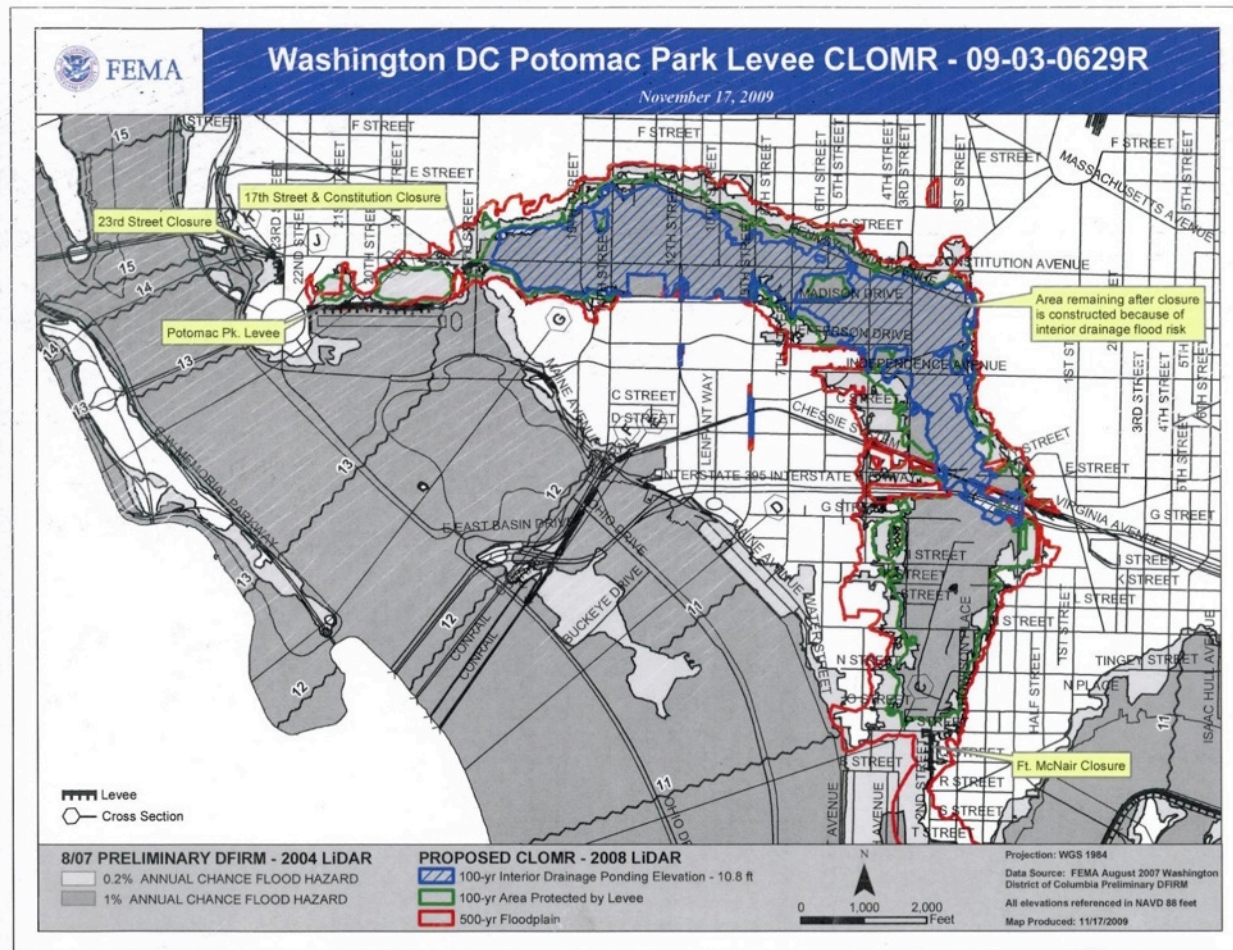
Current Flood Area for Storm Water Drainage



Constitution Avenue is the lowest area in the Federal Triangle and was the site of Goose Creek, later renamed Tiber Creek. Later fill towards the Potomac has left Constitution Avenue as the lowest area in the Federal Triangle, trapping flood waters coming from inland. Goose Creek also ran north of the Capitol.

Karolina Kawiaka, AIA
Dartmouth College

The 17th Street Levee will address Potomac River flooding, but interior storm water mitigation is not addressed by it.



Current FEMA Map

Karolina Kawiaka, AIA
Dartmouth College

A Washington Monument Retention Area on the site of the Washington City Canal could store storm water.



Karolina Kawiaka, AIA
Dartmouth College

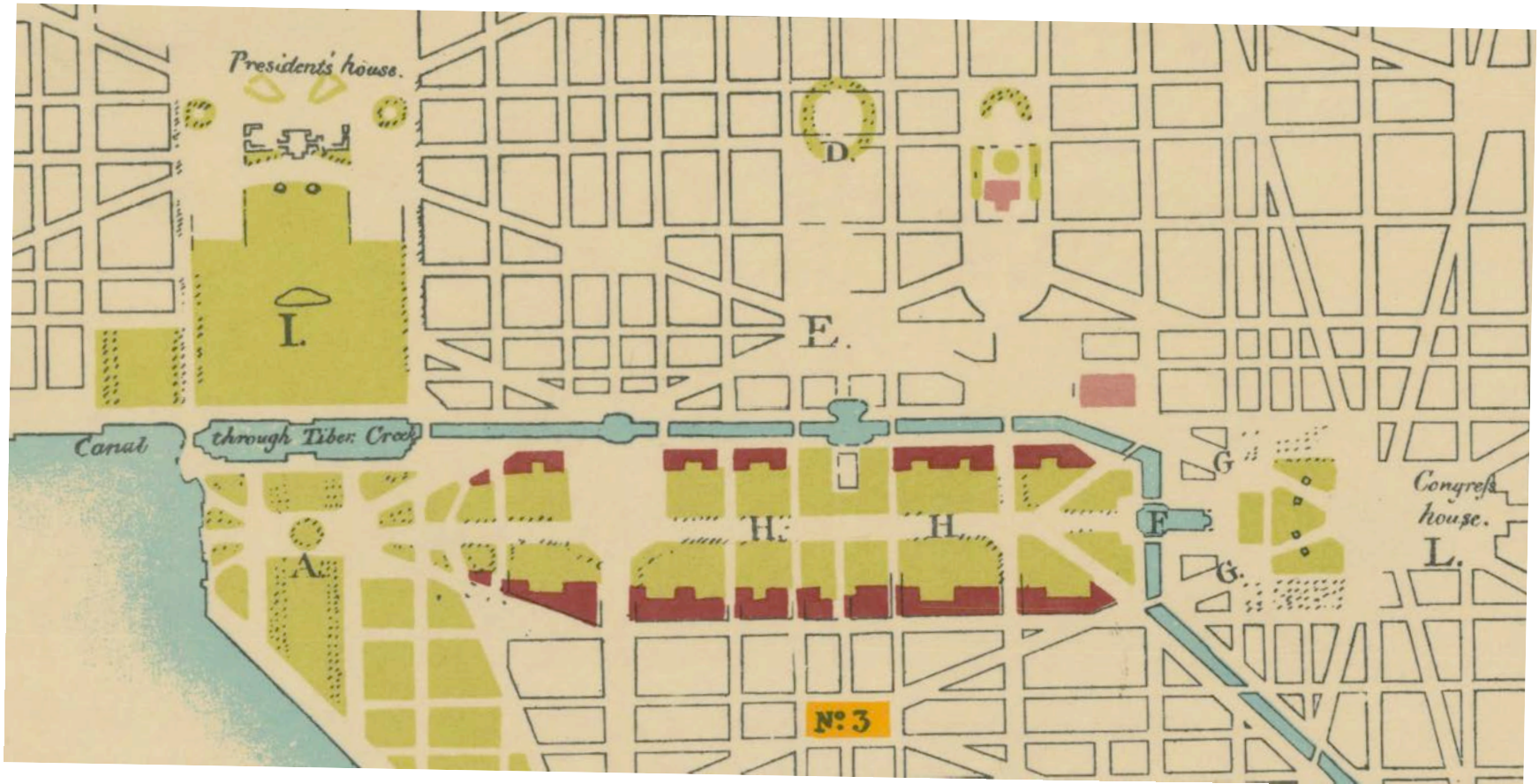
This Retention Area could be a landscaped area with stepped sides for seating and used for functions or as playing fields when not needed for flood mitigation.



MONUMENT GROUNDS - RETENTION AREA WHEN EMPTY - SWALE OR CULVERT TO TIDAL BASIN

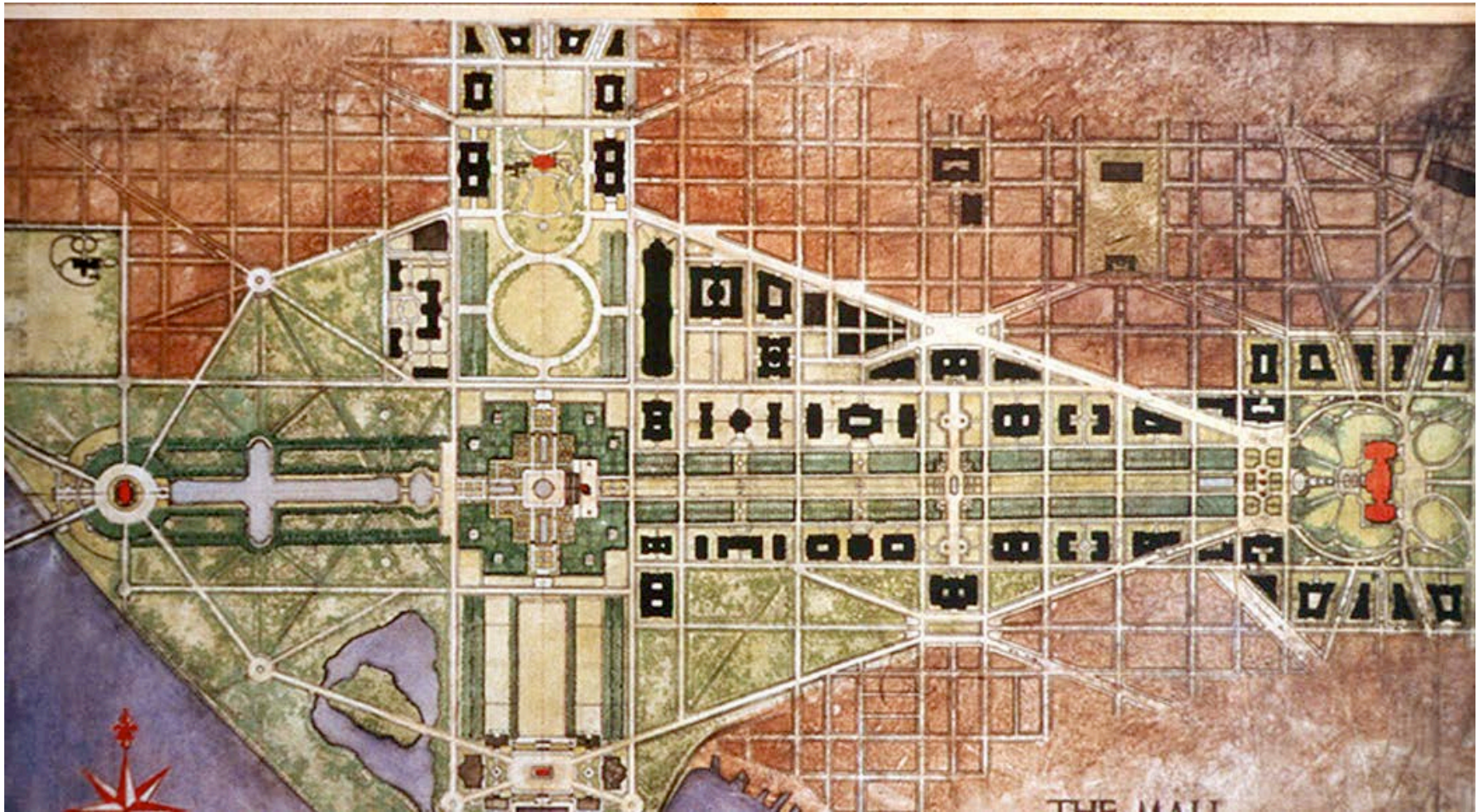
Karolina Kawiaka, AIA
Dartmouth College

Restoring the function of Tiber Creek



The Washington Monument Retention Area would be on the very site where Tiber Creek was channeled into the “Washington City Canal” following L'Enfant's 1791 plan for the city and was filled in in the later 1800's.

Karolina Kawiaka, AIA
Dartmouth College



Landfill dredged from the Potomac River in the 1880s created new land west and south of the Washington Monument resulting in Constitution Avenue being the lowest area of the National Mall and Federal Triangle area (and the city).

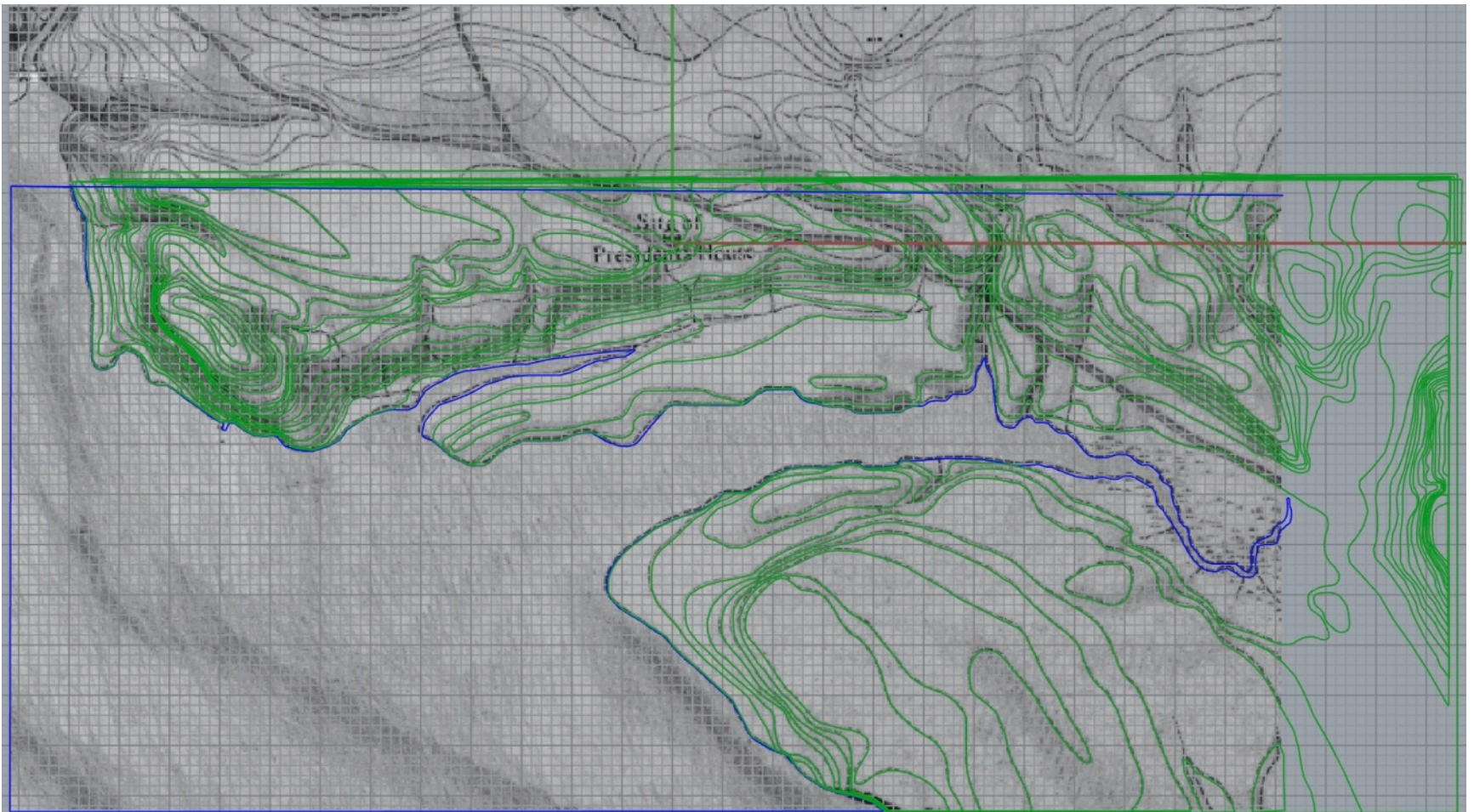
Karolina Kawiaka, AIA
Dartmouth College

Constitution Avenue Juxtaposed on Ellicott Map showing Tiber Creek

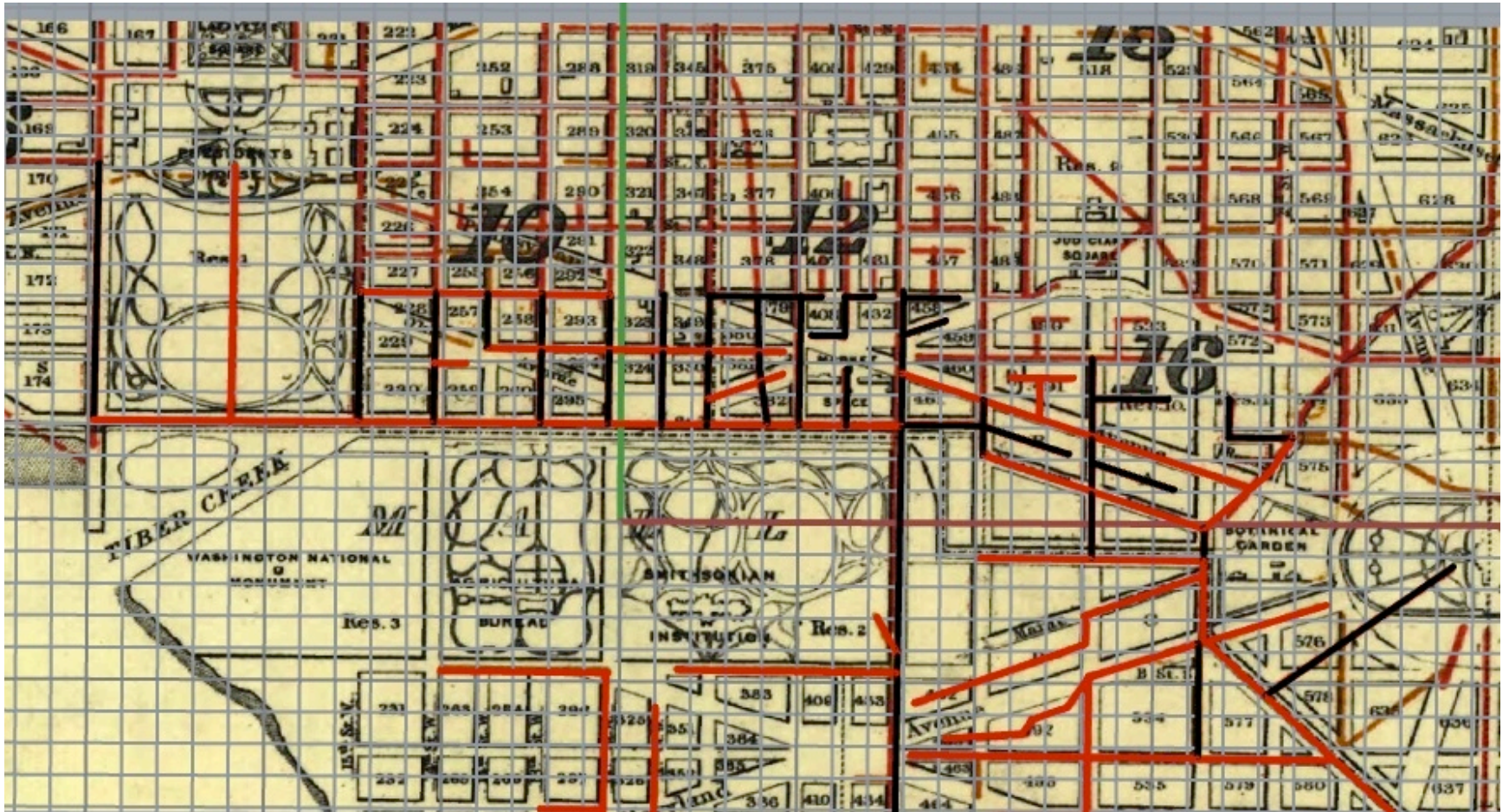


Karolina Kawiaka, AIA
Dartmouth College

A reconstruction of topography from Hawkins 1791 Topographic Map showing Tiber Creek



Historic Map of DC Stormwater and Sewage Pipes Late 1800's



Karolina Kawiaka, AIA
Dartmouth College

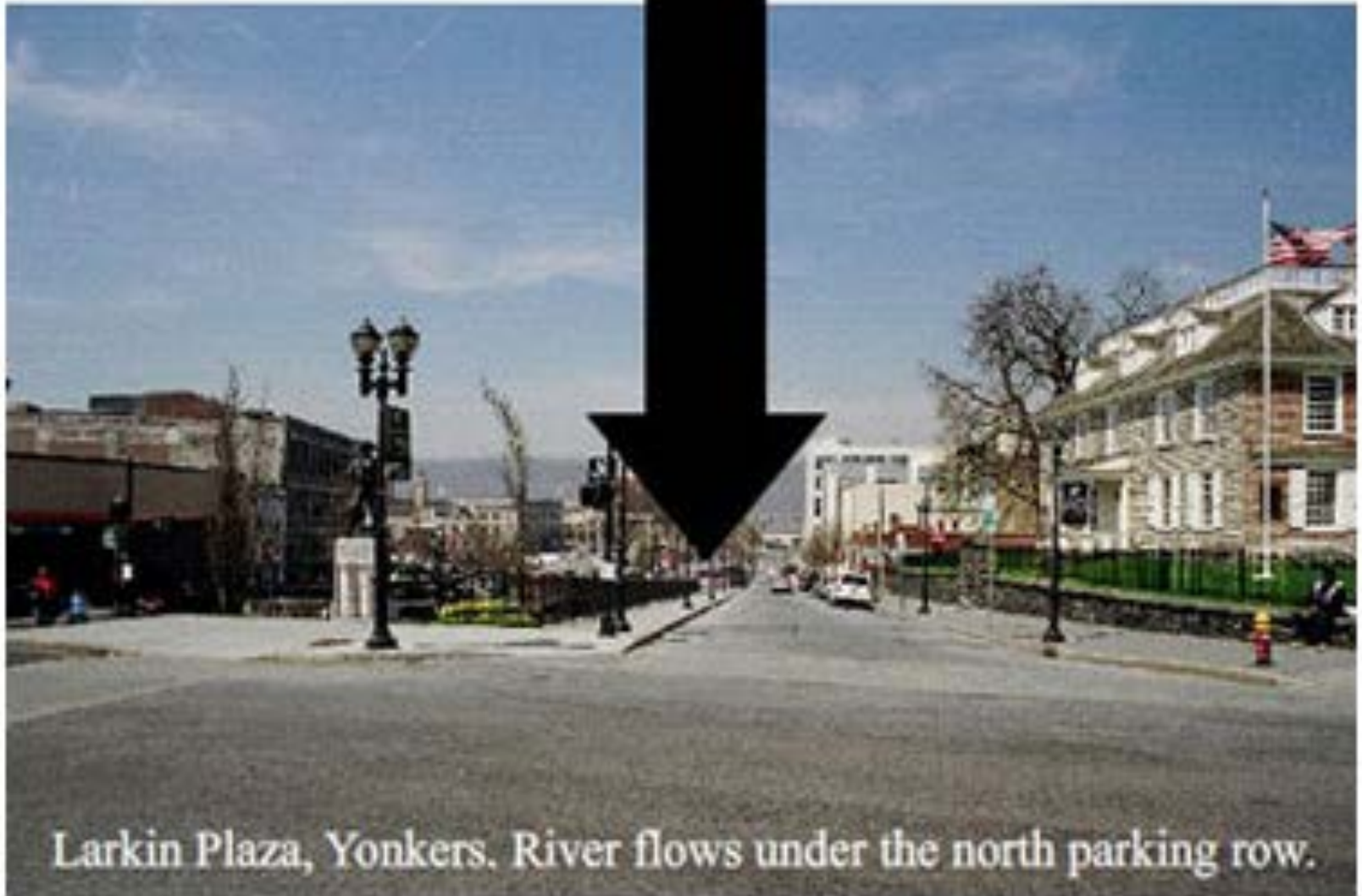
Precedents

- In this case, depending on the level of the groundwater which appears to be at -5 feet, the swales and retention areas will probably be dry most of the year.
- However, the swales and retention area run directly over the original Tiber Creek and Washington Canal restoring the natural drainage patterns, so the design intentionally restores their drainage function along Constitution Avenue and they could become water features.
- There are many examples of restoring underground rivers.



Karolina Kawiaka, AIA
Dartmouth College

Can you find the hidden river?



Before

Karolina Kawiaka, AIA
Dartmouth College

<http://news.nationalgeographic.com/news/2013/07/130730-daylighting-exposing-underground-rivers-water-urban-renewal/>

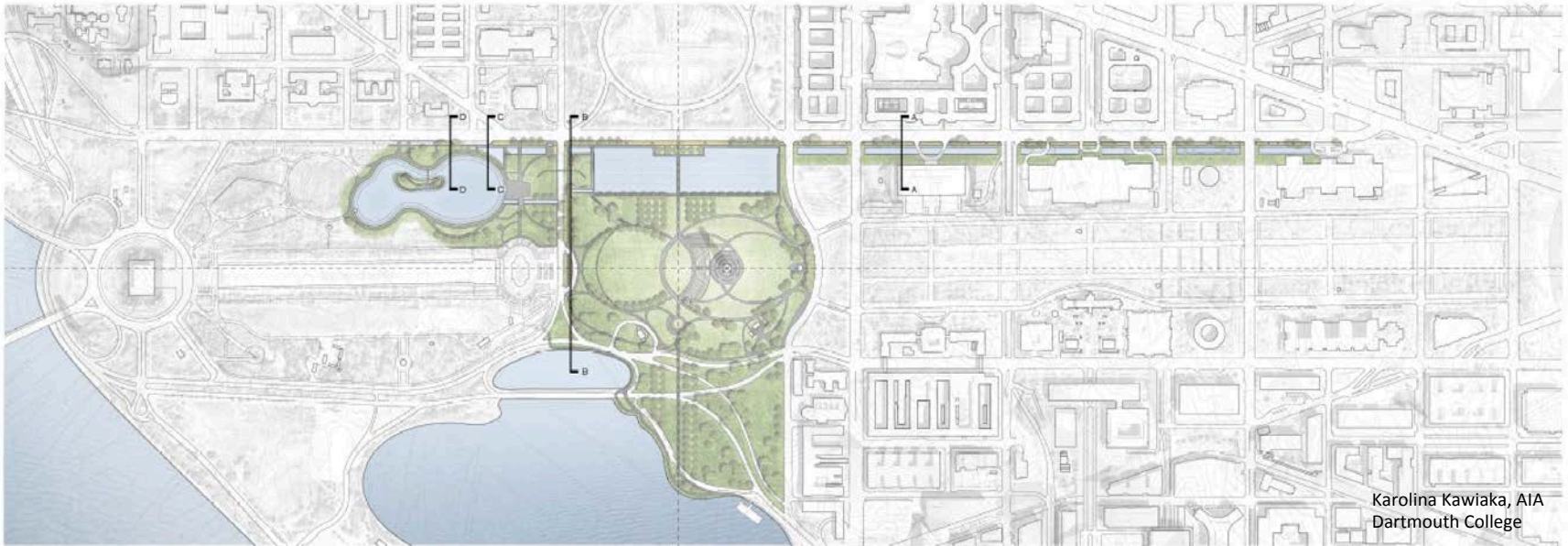


After

Karolina Kawiaka, AIA
After
Dartmouth College

<http://news.nationalgeographic.com/news/2013/07/130730-daylighting-exposing-underground-rivers-water-urban-renewal/>

Proposal: Restoring the Role of Washington DC's Lost Tiber Creek

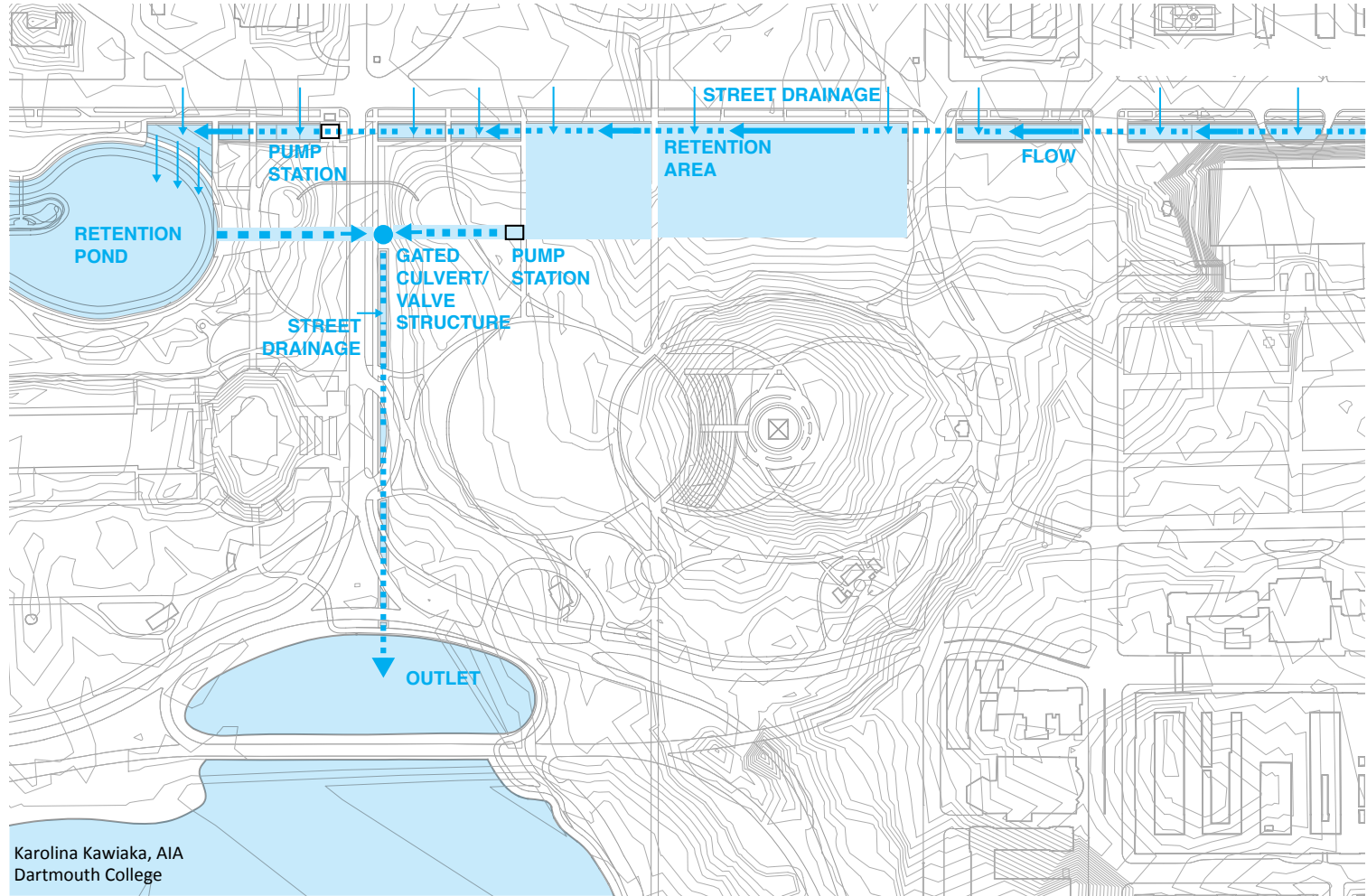


Karolina Kawiaka, AIA
Dartmouth College

- Bioswales along Constitution would filter and channel 24 MG of water to a Washington Monument Retention Area.
- An additional 10 million gallons of capacity at Constitution Gardens can be accessed via pumps for either inland or Potomac River flooding.
- A swale along 17th Street would filter the water and act as an outlet to the Tidal Basin.

Karolina Kawiaka, AIA
Dartmouth College

Flood Mitigation Storm Water Flow and Retention Diagram



WATER FLOW AND RETENTION DIAGRAM

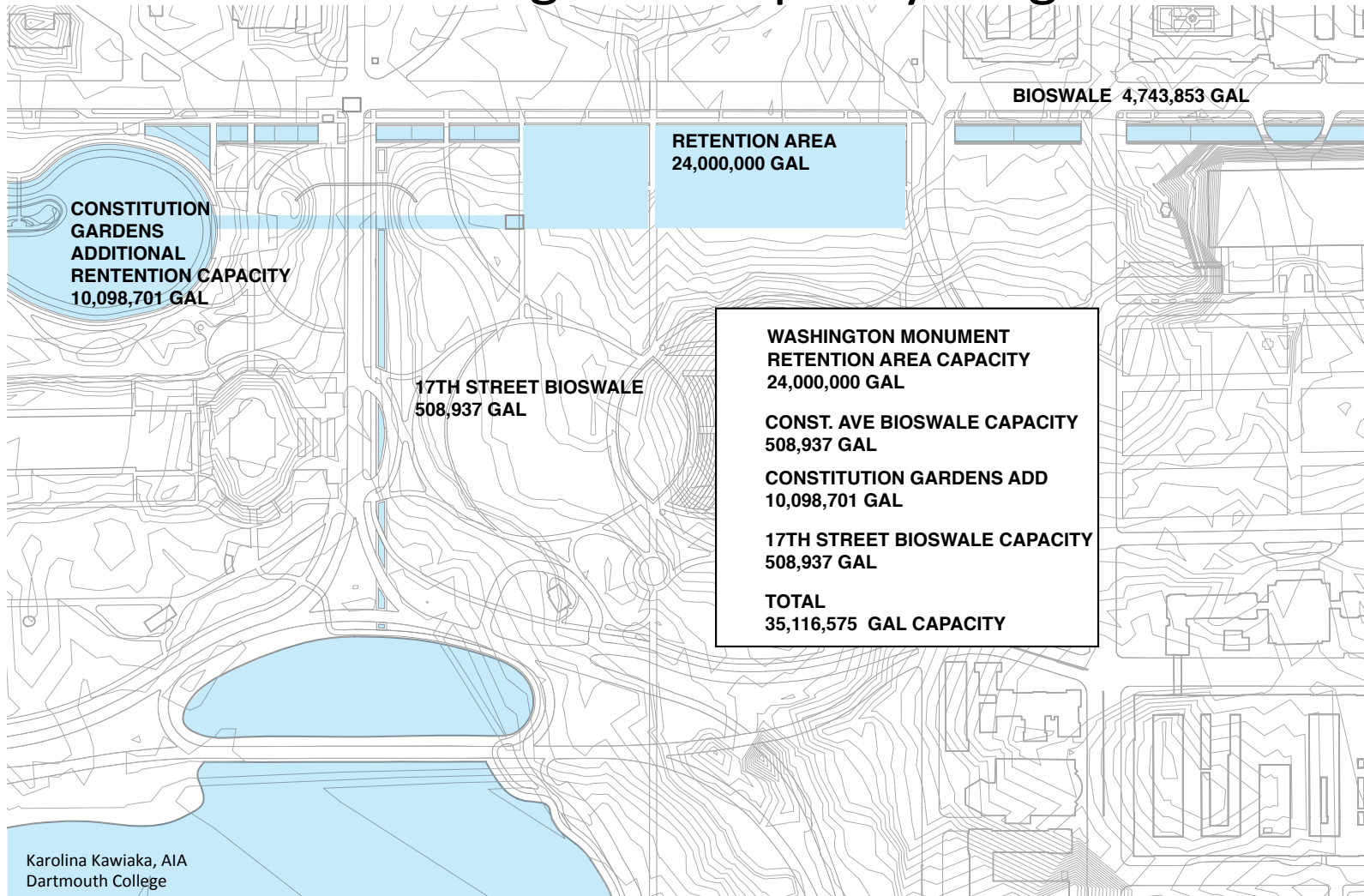
Karolina Kawiaka, AIA
Dartmouth College

Restoring Washington DC's Lost Tiber Creek: Concept

- Restore the path of Tiber Creek and Washington City Canal, and restore drainage for the low area in the Federal Triangle/Constitution Avenue
- Provide a flood control retention area near the Washington Monument on the original site the Washington City Canal with a 24 million gallon (MG) minimum holding capacity to drain the Federal Triangle area.
- In non-flooding conditions this Washington Monument Retention Area will act as a flat gathering place for events and/or playing fields for sports.
- Provide an outlet for gravity drainage and pumping as necessary to convey water from the flood control Retention Area to the Tidal Basin by a swale along 17th Street thus restoring an outlet for the water draining from the Federal Triangle.
- Swale sizing along Constitution Avenue and for the Washington Monument Retention Area is based on the flow calculations for the Federal Triangle Flooding Event in 2006.

Karolina Kawiaka, AIA
Dartmouth College

Flood Mitigation Capacity Diagram



Karolina Kawiaka, AIA
Dartmouth College

Karolina Kawiaka, AIA
Dartmouth College

Section Through Constitution Avenue: Swale Under Existing Sidewalks and Roadways In Some Sections Allows Drainage From Constitution Avenue



Karolina Kawiaka, AIA
Dartmouth College

Section Through Constitution Avenue: Open Bioswale in some areas cleans water and allows drainage from Constitution Avenue



Karolina Kawiaka, AIA
Dartmouth College



Karolina Kawiaka, AIA
Dartmouth College

Section Through 17th Street Bioswale Filters Water on the way to the Tidal Basin.



Karolina Kawiaka, AIA
Dartmouth College

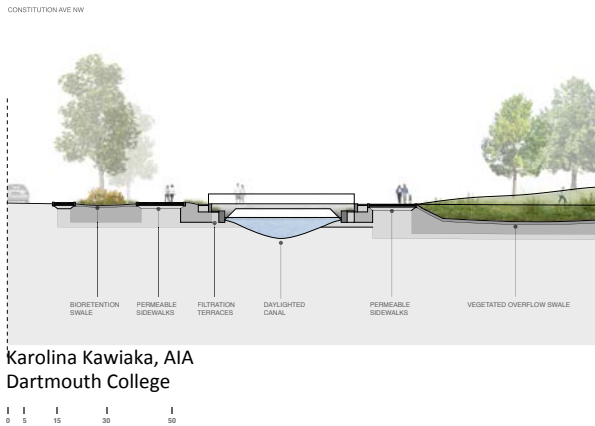
Historic Canal Lockkeeper's House can be used for pumping stations controls and for an exhibit to explain the history of the site and current flood control measures.



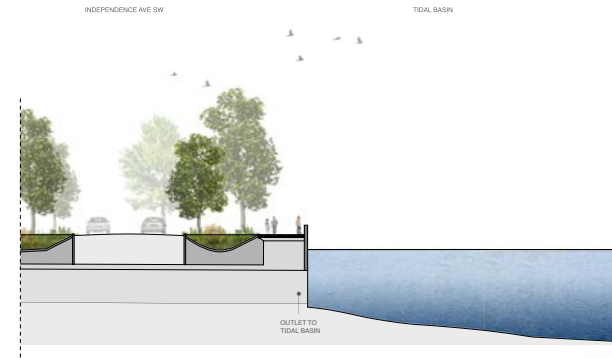
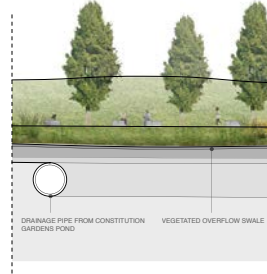
Karolina Kawiaka, AIA
Dartmouth College

Karolina Kawiaka, AIA
Dartmouth College

Constitution Gardens can be landscaped to provide 10 million gallons of added flood retention capacity but requires pumping.

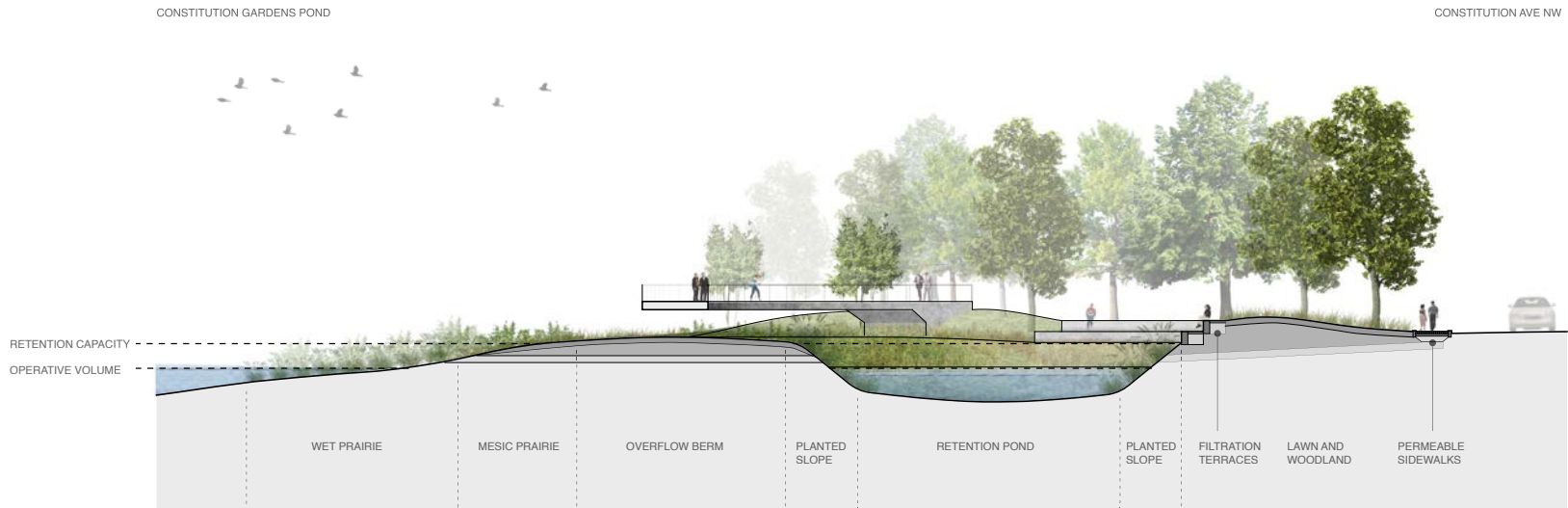


Karolina Kawiaka, AIA
Dartmouth College



Karolina Kawiaka, AIA
Dartmouth College

Constitution Gardens can give added capacity to the retention areas for inland flooding (requires pumping) or Potomac River flooding.



Karolina Kawiaka, AIA
Dartmouth College

0 5 15 30 50

Karolina Kawiaka, AIA
Dartmouth College

Constitution Gardens can be planted for water filtration.



Karolina Kawiaka, AIA
Dartmouth College

30 50

Karolina Kawiaka, AIA
Dartmouth College

Proposed Constitution Avenue and 17th Street Drainage Bioswales and Washington Monument Retention Area

- Swale sizing is based on the Flow Calculations for the Federal Triangle Flooding Event in 2006.
- The 2006 flood occurred over about 4 hours where approximately 6 inches of rain fell from 9pm on June 25 to 1 am on June 26 (Reference Greeley and Hansen Report, Figure 3-1:
http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_full.pdf.)
- The estimated storage volume required for a 200 year storm is about ~ 24 million gallons.
- The average flow rate over the four hour storm duration was approximately 144 million gallons per day(MGD).
- The Constitution Avenue swale (and culvert under the existing sidewalk where necessary) partially restores the original Tiber Creek and Washington City Canal allowing natural drainage for surface flooding and preventing ponding in the low point of the Federal Triangle by providing an outlet to the Tidal Basin.
- The proposed Washington Monument Retention Area effectively addresses the capacity of this system.
- The retention area can be unwatered over time after a flooding event by gravity and by pumping. Valves in the pumping station can be operated to prevent river flooding on the protected side of the 17th Street Levee.

Karolina Kawiaka, AIA
Dartmouth College

Advantages of the Proposed Constitution Avenue and 17th Street Drainage Swales and Washington Monument Retention Area

- The drainage swales basically return the old stream bed/canal to restore an outlet to the Tidal Basin and also provide drainage for roof drains (rain gardens) and basement pumping from Constitution Avenue.
- The proposed drainage swales/culverts are low tech and use gravity wherever possible and provide drainage flow out of the Federal triangle for less cost relative to the more complex proposed underground reservoirs and pump stations by regrading the edge of Constitution Avenue to drain to the south into culvert/swales (similar to highway designs with no curb).
- With the regrading of the edge on the south side of Constitution Avenue the the overflow from the existing catch basins will be directed to the swale/culvert under the sidewalk, allowing the existing Storm Sewer to remain.
- The needed capacity of the subsurface pump station proposed for fully unwatering the Flood Retention area will depend on the desired unwatering rate, but it is projected to be less than ten per cent of the 435 MGD pump station described in Alternative F (Greeley & Hansen 2011)

Karolina Kawiaka, AIA
Dartmouth College

Visualization of swale/restored canal along Constitution Avenue



Karolina Kawiaka, AIA
Dartmouth College

- Eliminating curb along Constitution
- New, permeable sidewalk sloped toward the swale
- Stepped areas provide seating

Karolina Kawiaka, AIA
Dartmouth College

Combined Interior and River Flooding System Design Numbers

Interior Flooding:

- A 200 year flood= 6" of rain (the 2006 Event – Greeley & Hansen http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_full.pdf- figure 3.- was somewhere between 200 and 500 year flood)
- A 500 year flood would be 7" of rain over 6 hours (Greeley & Hansen Section 5-2 and 5-3)

Potomac River Flooding:

- A 100 year would be El. 12.2 feet
- A 200 Year Rain would be El. 8-8.5 feet
- If you project it a 500 year rainfall event combined with 100 year River flooding would be to Elevation 9 feet at 15th Street and Constitution Avenue
- A 500 year flood ponds to El. 8 feet(Greeley & Hansen p. 5-7)

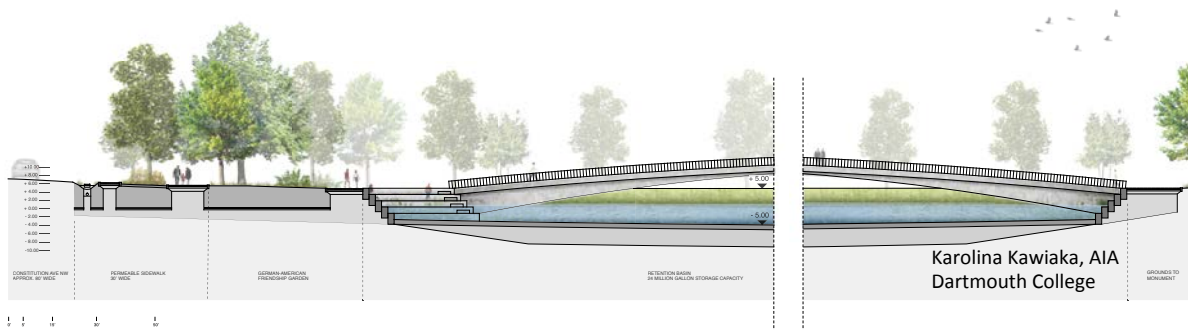
Combined Probability of Interior and River Flooding (Greeley & Hansen p. 5-8):

- 23. 8 million gallons at 500 year rain with a 10 year river flood would be El. 6.8 feet gallons which this scheme could address with its 35 MG capacity.
- 500 year river flood would be 19.9 million gallons which this scheme could address.

It should be noted that the efficiency of storm drainage currently decreases as the river level rises.

Karolina Kawiaka, AIA
Dartmouth College

View of Proposed Retention Area at the Washington Monument



Contact: Karolina.Kawiaka@Dartmouth.edu

Karolina Kawiaka, AIA
Dartmouth College