Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

Base Image: Google Earth

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

TOPIC:

For centuries, communities have relied on pipes and pumps infrastructure to manage storm water and prevent floods. In nearly all cases, this is not only expensive but it rarely contributes to the betterment of a community in social terms. Typically, the infrastructure is designed to function mechanically and never be seen – an invisible force at work. This report hypothesizes on alternative methods - both grey and green- of conceiving and implementing storm water solutions. Can combinations of grey and green storm water infrastructures not only manage large amounts of water, but have secondary uses and purposes that benefit the community and its public realm?

BACKGROUND:

The City of Hoboken, NJ, is defined by its proximity to water. The city relies on its location for economic and infrastructural advantage, but this location's geography creates the city's most pressing environmental and economic issue: frequent flooding of the combined sewer overflow system (CSO). Hoboken's sewer outfalls (designed to release excess sewer flow during rain events) lie below Hudson River's high tide mark; they are mechanically closed during high tide which creates a closed loop. When rain occurs during high tide, the system is incapable of discharge and back flow of storm water mixed with wastewater floods Hoboken's low lying streets. This problem is projected to worsen because of rising water levels due to climate change. The integration of green and grey infrastructure as complimentary systems is a crucial strategy to containing the volume of stormwater before it enters the sewer system.

METHOD:

Research will rely on three overlapping processes. First, develop an understanding of Hoboken's specific situation through research and interviews of city officials and industry experts. Second, research contemporary green and grey storm water technologies and innovations. Lastly, investigate relevant case studies that utilize green and grey infrastructures to mitigate flooding as well as establish a relationship to their larger social realms (when applicable).

DELIVERABLE:

The report will be a comprehensive design vision, consisting of three chapters. The first will present a matrix framework of potential green and grey design strategies developed for Hoboken's specific situation. This tool will allow the CIty of Hoboken to determine the appropriate combinations of green and grey based upon cost, social impact, and magnitude of desired flood prevention. The second chapter will present a selected design vision based on a specific percentage of green and grey infrastructure. The last chapter will document the research and case studies that the design solutions are founded upon.

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

DRAFT

PART I - HOBOKEN'S EXISTING STORM WATER SYSTEM.

1-1. How does one know where the water causing the flooding problem is coming from? For example, is it coming from the Hudson River, rain, surface run-off, or a combination?

1-2. How does the existing system deal with excess water?

1-3. What are the factors involved in systematic flooding? For example, high tide, high wind?

PART II - HOBOKEN.

2-1. Given the geographical circumstances of Hoboken, has the city established a goal or baseline level of acceptable flood risk? For example, 1" of rain at high tide?

2-2. What solutions has Hoboken considered? For example, the $20 million pumps?

2-3. Beside the acquired site (parking lot between Paterson Avenue and Observer Highway), has Hoboken considered utilizing streets or other public spaces to assist in this problem?

PART III - TECHNOLOGY.

3-1. What are known and/or available technologies applicable or specific to Hoboken?

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

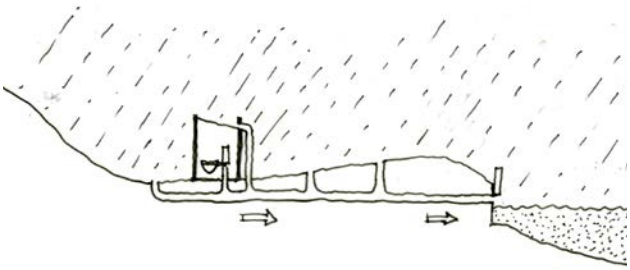
# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

## Hoboken's Topography

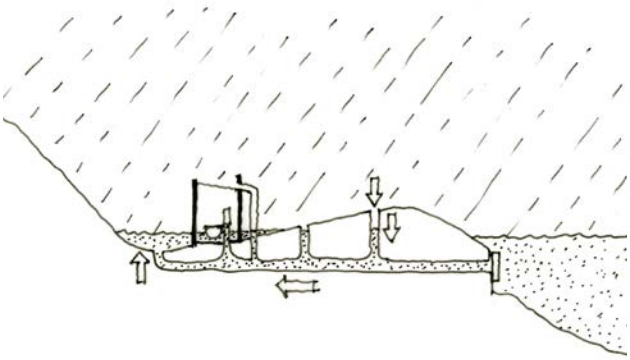
Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

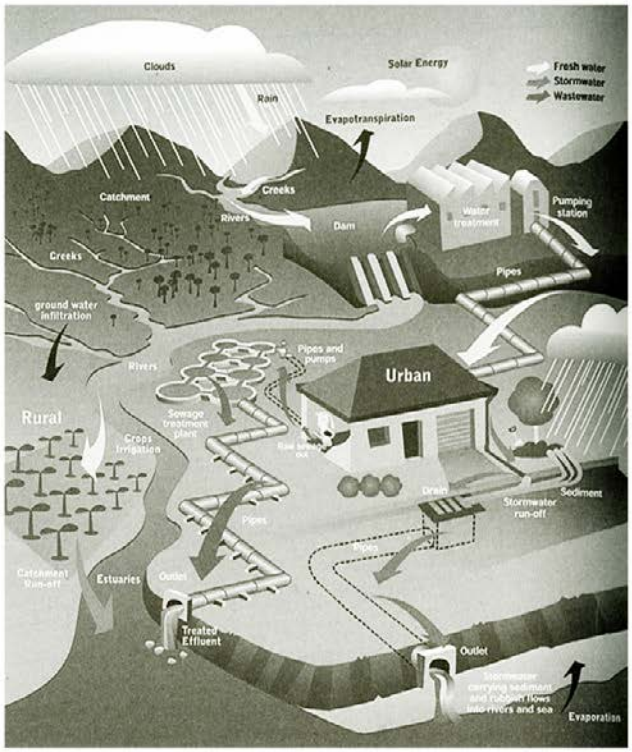


Hoboken's water infrastructure is a combined sewer outflow (CSO). At low tide (left) excess water (storm + sewer) evacuates into the Hudson river.



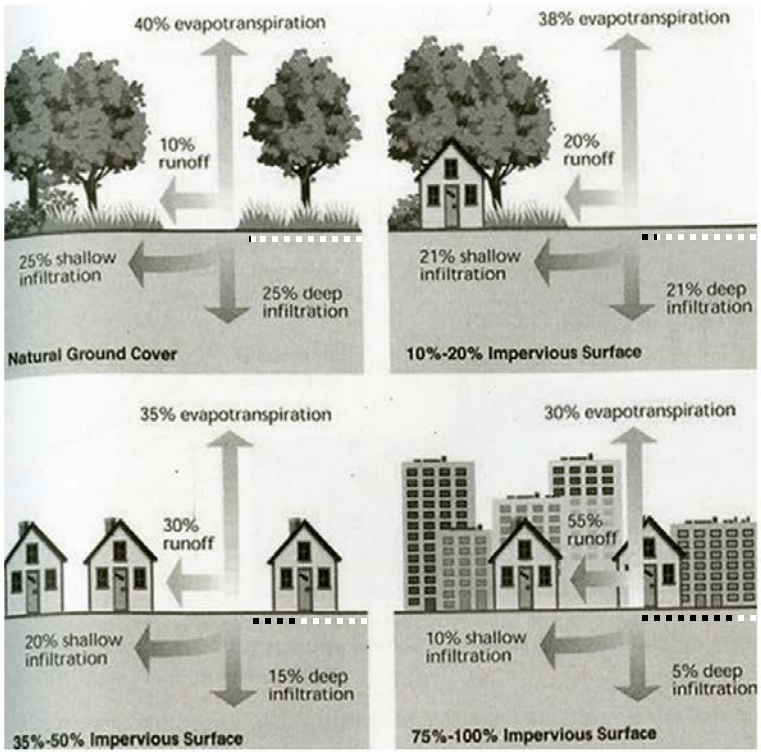
At high tide (left) a tidal gate closes and makes the system a closed loop. Excess water can not evacuate into the Hudson and instead flows vertically until equilibrium is reached, typically above the lowest levels of Hoboken. Hence, the frequent flooding.

Complexity of current urban water use




Images: Sarte, S.Bry, *Sustainable Infrastructure*, Wiley, 2010

Water runoff comparison (below): from natural to urban ground cover. A higher percentage of impervious ground cover means storwater runoff volume increases.



Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

Flooding In Hoboken During Rain and Hudson River High Tide - Failed CSO System

Images:
Top: Mayor Presentation, MICD Conference, December 2011
Top: MICD Meeting Report, December 2011

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

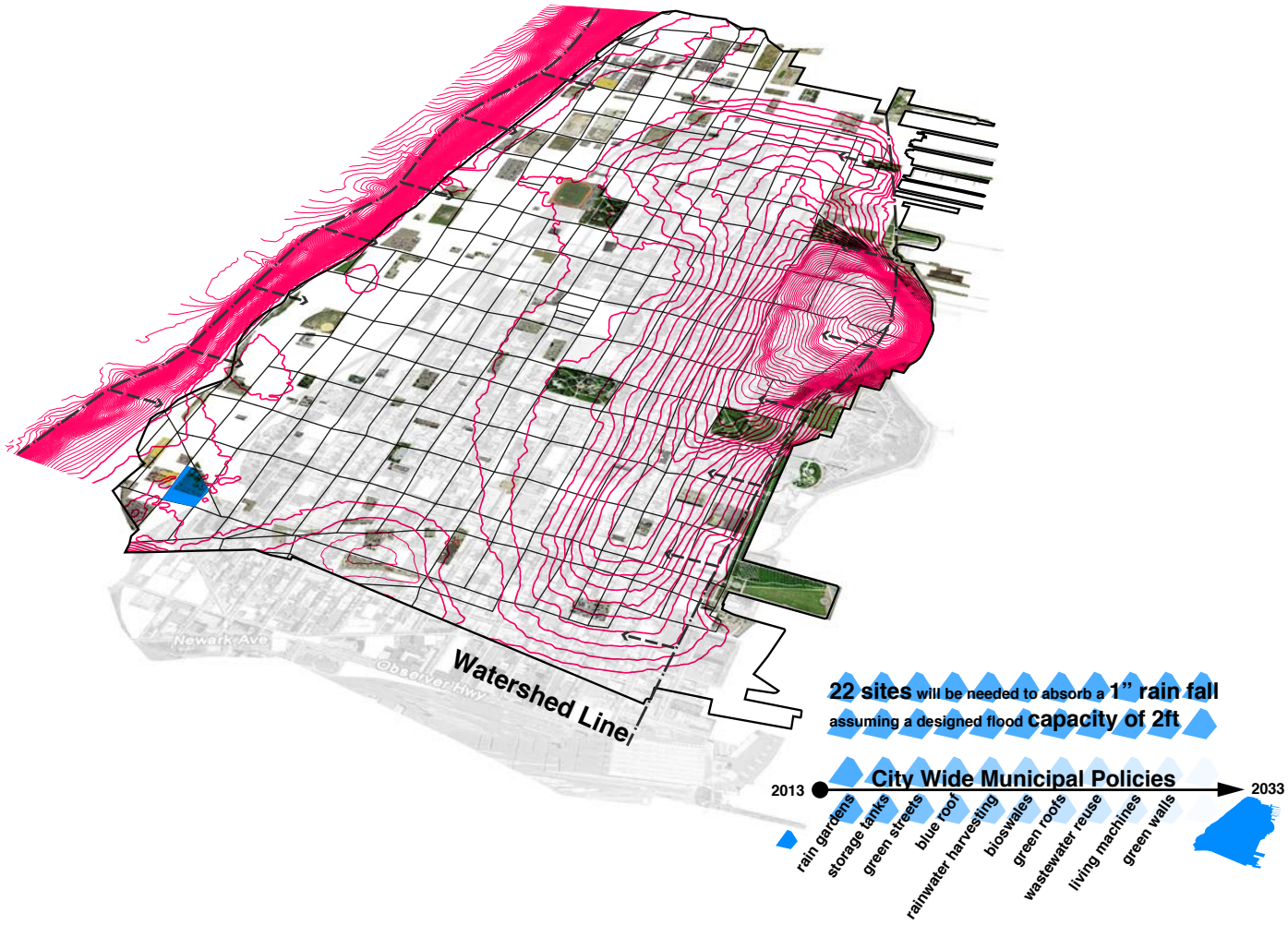
DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

The volumetric scale of water is immense. One (1) inch of rain falling within Hoboken's CSO shed* (+/- 33.7 million square feet) is equivalent to 2.8 million cubic feet). Is it estimated that 80% of this water will make it into Hoboken's water infrastructure.; this equates to 2.2 million cubic feet (16.5 million gallons).

This volume of water applied to the 50,000 square foot property acquired by Hoboken would fill a tank 45 feet deep (bottom).

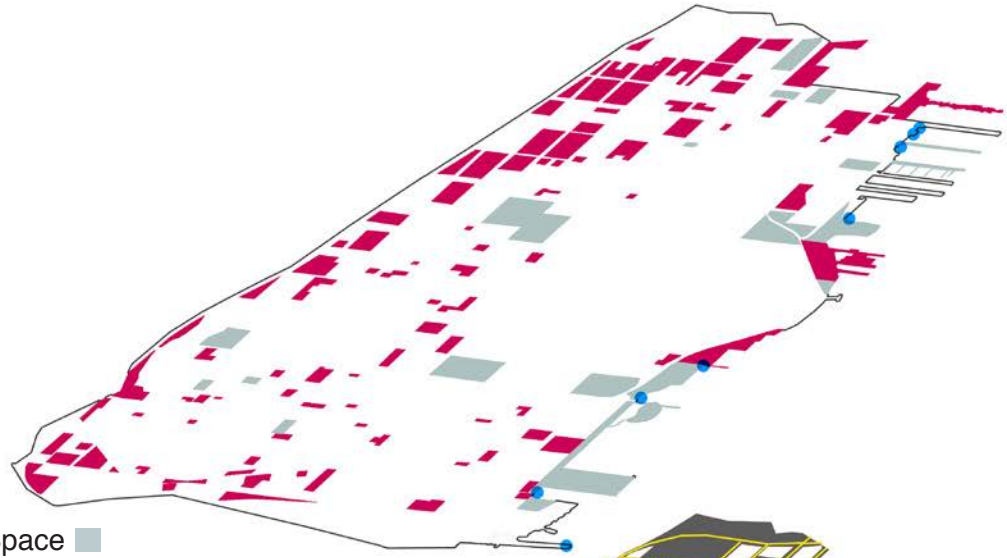
* CSO shed to be confirmed by City of Hoboken



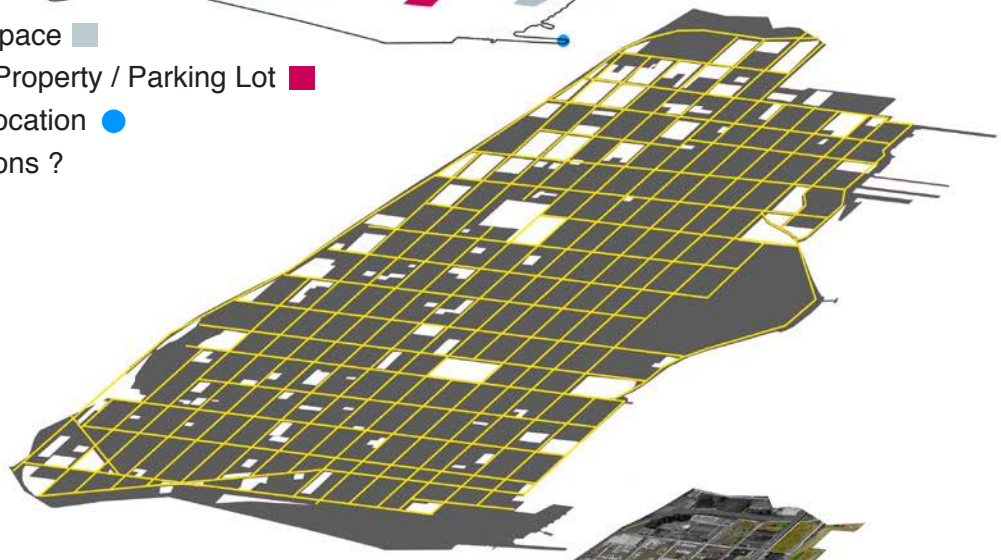
Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

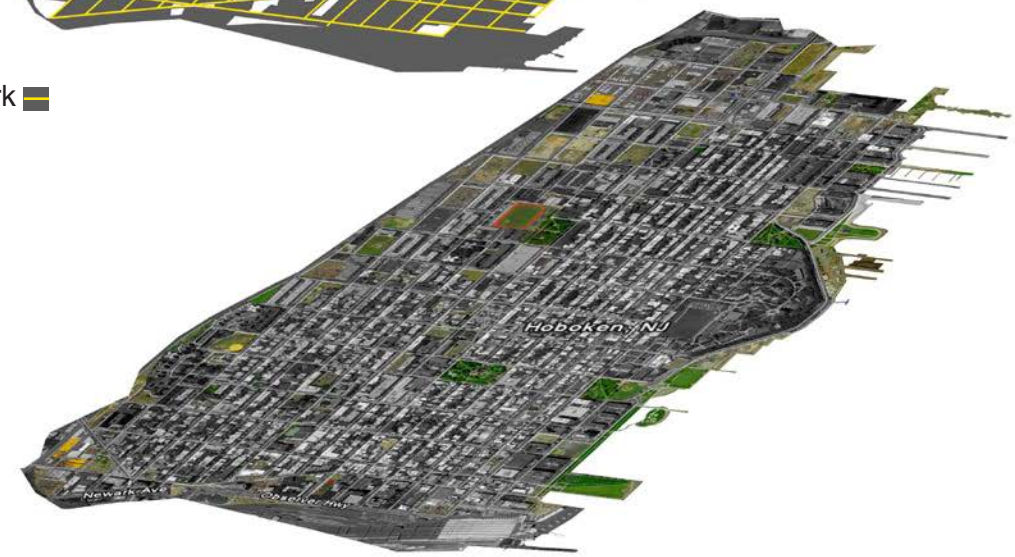
# **Mixed Use Water Infrastructure** | Hoboken, New Jersey



Public Open Space
Undeveloped Property / Parking Lot
CSO Outfall Location
Public Institutions ?



Street Network




Hoboken Urban Fabric

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

image 01

www.dear-japan.blogspot.com
http://4.bp.blogsot.com/-FE-1ZFFBVME/TrFwQchhbnk/AAAAAAAAAM4/gfA8vuCVXaI?s1600?zitadellekl.jpg

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

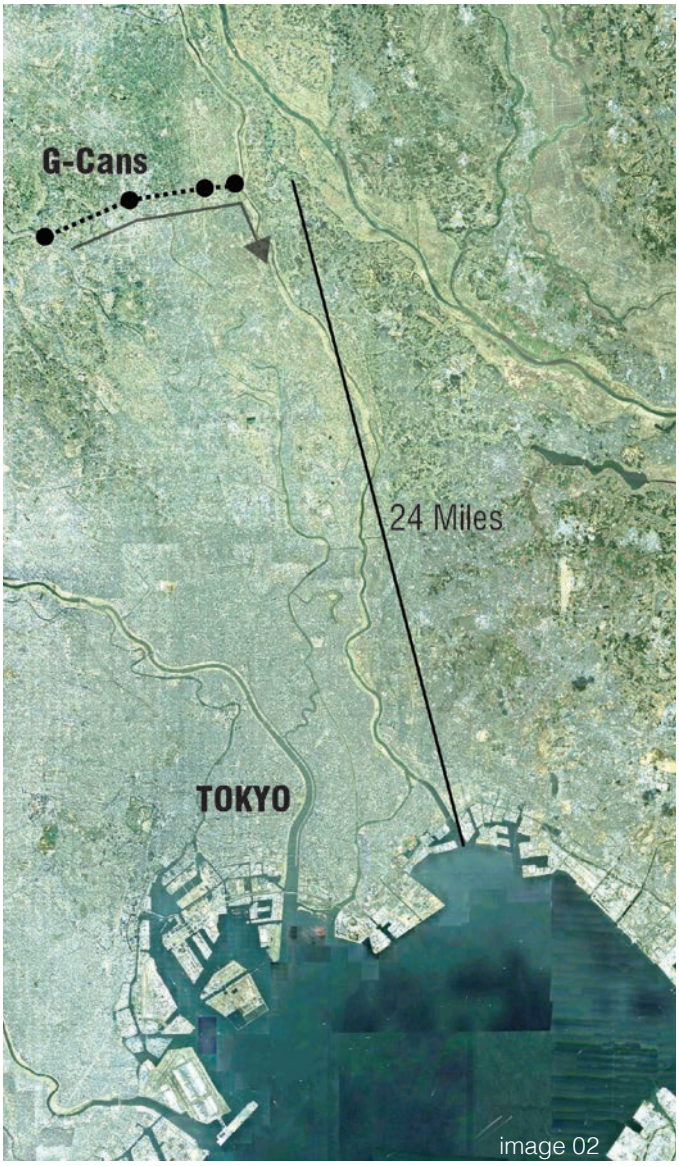


image 02

image 03

**project:** Tokyo G-CANS
**location:** Tokyo, Japan
**date:** Open: 2006 (construction : 13 years)
**cost:** $2,000,000,000 (estimated)
**type:** Flood Prevention from River Overflow
**discharge:** 47,000 gallons (200 tons) per second

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

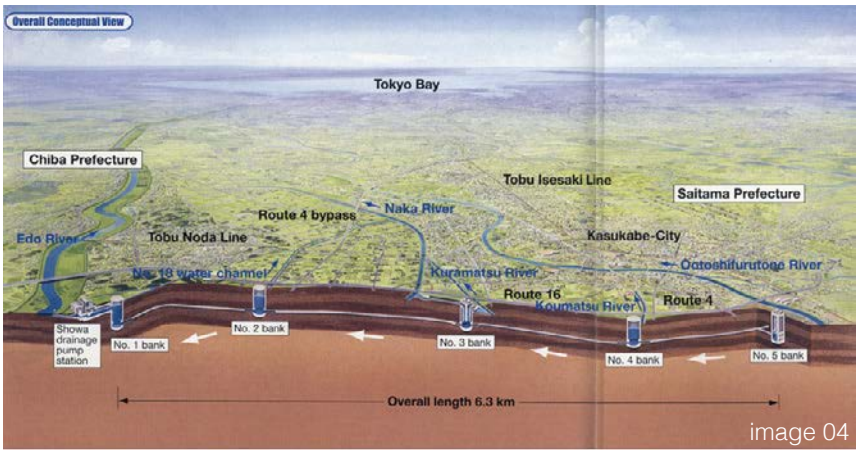


image 04

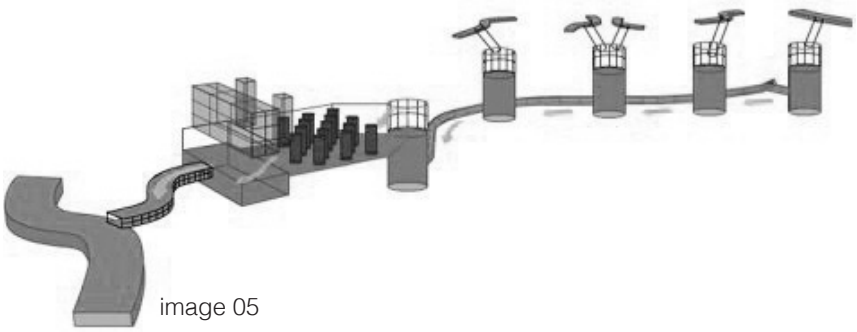


image 05

image 06

The Tokyo Metropolitan Area Outer Underground Discharge Chamber (G-Cans) is a wonder of engineering and flood prevention. It captures flood/overflow water from four (4) waterways flowing towards Tokyo and diverts it, through a series of underground chambers and tunnels, towards the Edo river (images 04, 05). Final evacuation occurs via a series of huge engines capable of pumping 47,000 gallons of water per second into the Edo River. G-Cans implementation eliminated the flood risk to 30,000 residences.

The main chamber (image 01, 06) is one of the largest underground chambers in the world. Unexpectedly, its scale and uniqueness has made it a tourist destination. Tours are now offered regularly, and Land Rover filmed a commercial there in 2006. Above the main chamber lays a football field (image 07). It is most ironic that the football field lacks appropriate drainage while sitting atop one of the globe's most incredible pieces of water management infrastructure.

The G-Cans was not designed with a civic role (other then flood prevention) in mind. One can only imagine the potential if it had been conceived with a civic/public role in mind.

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

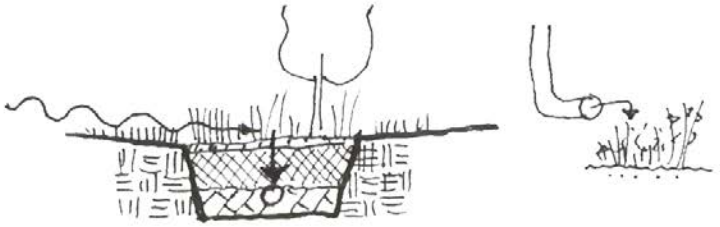
**Mixed Use Water Infrastructure** | Hoboken, New Jersey

image 07

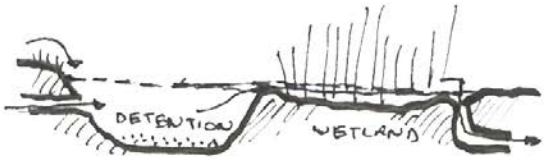
Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

## **Mixed Use Water Infrastructure** | Hoboken, New Jersey



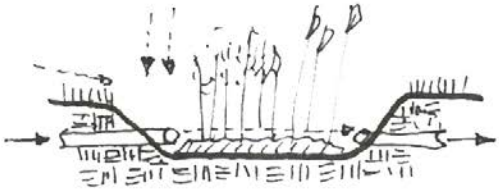
BIORETENTION / RAIN GARDEN
- Pollution is removed from stormwater though organic filters (soil, grass, plants
- Clean water is collected.
- Stormwater from impervious urban surfaces is absorbed by soil / vegetation.



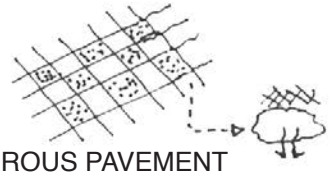

DETENTION BASIN
- Storing / Holding excess stormwater temporarily in an open volume.
- Water Drains slowly as additional room becomes available.
- Helps in pre-treatment as pollutants starts to settle

BIOSWALE
- Recessed, linear landscape filled with vegetation or compost.
- Filters out silt / pollution before surface runoff enters sewage system.

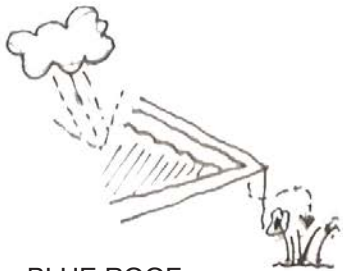
LIVING MACHINE
- Wastewater treatment system (trademarked)
- Mimicking biological workings of wetlands
- Further disinfection (using UV, ozone or chlorine) is possible
- Non-potable reuse



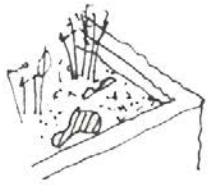
CONSTRUCTED WETLAND
- Artificial wetland to treat wastewater, stormwater runoff and sewage (biofiltration).
- New or restored habitat for wildlife
- Reclaimed polluted land.
- Flood control.



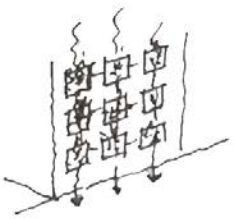
POROUS PAVEMENT
- Prevent / reduce stormwater runoff
- Water collects in a reservoir, slowly seeping into surrounding rock or soil.



BLUE ROOF
- Designed to store stormwater.
- Retaining, distributing, treating and re-using water



GREEN ROOF
- Landscaped with vegetation.
- Absorbs and processes excess stormwater



GREEN WALL
- Facades covered in vegetation
- Filters air and greywater

## **Some Green Infrastructure Strategies**

Source: Gang, Jeanne, *Reverse Effect: Renewing Chicago's Waterways*, Studio Gang, 2011

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

DRAFT

## Integrated Green Infrastructure: Design Matrix

| | | VEGETATED SWALE | STORMWATER PLANTER | CURB EXTENSION | PERVIOUS PAVING | GREEN GUTTER | RAIN GARDEN |
|---|---|---|---|---|---|---|---|
| Low-Density Residential | | ◉ | ◉ (site dependent) | ◉ | ◉ | ◉ | ◉ |
| High-Density Residential | | | ◉ | ◉ | ◉ | | |
| Commercial Main Street | | ◉ (site dependent) | ◉ | ◉ | ◉ | ◉ (site dependent) | ◉ (site dependent) |
| Arterial and Boulevard | | ◉ | ◉ | ◉ | | ◉ | |
| Parking Lot | | ◉ | ◉ | | ◉ | ◉ | ◉ |

Stormwater strategies based on specific urban conditions

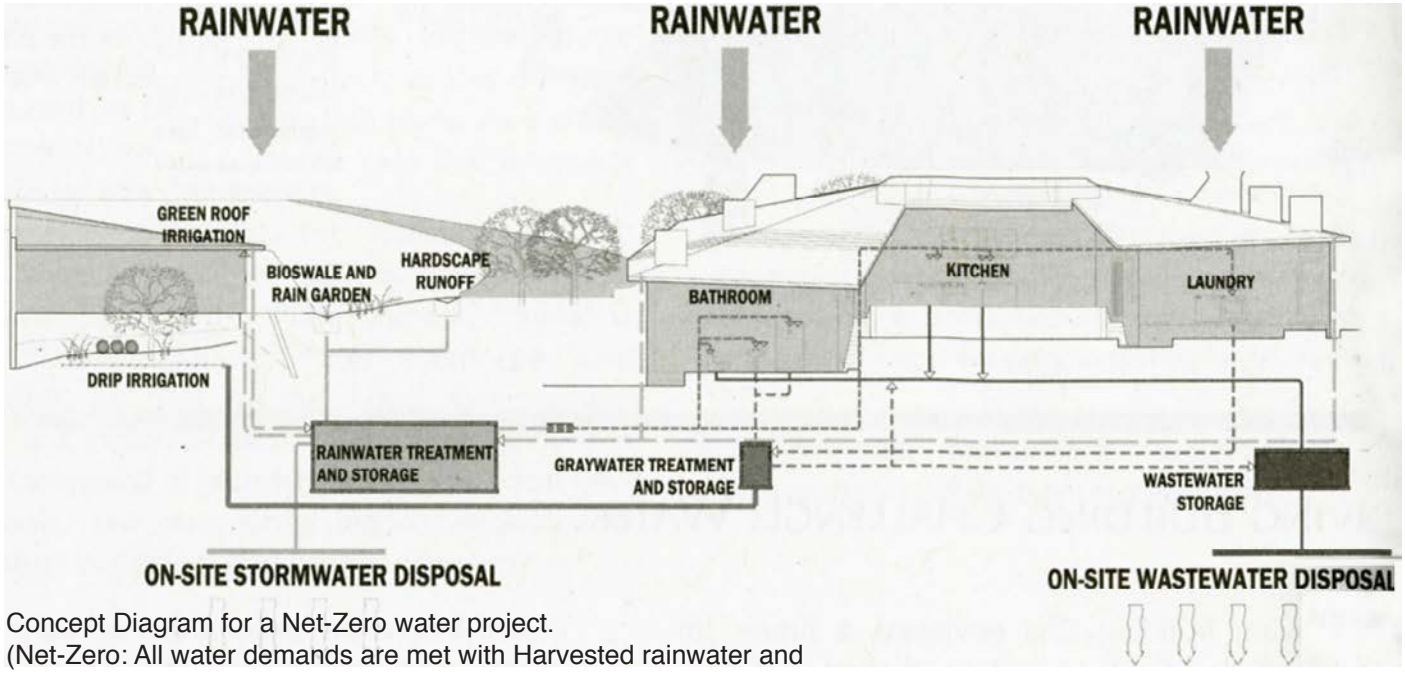
Source: San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook
http://www.flowstobay.org/documents/municipalities/sustainable%20streets/Book%20Layout%20Guidebook/Green%v%20revised%20book%20layout%20Guidebook.pdf

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

# **Mixed Use Water Infrastructure** | Hoboken, New Jersey

## Integrated Green Infrastructure: Water Re-Use




Concept Diagram for a Net-Zero water project.
(Net-Zero: All water demands are met with Harvested rainwater and reused water. Wastewater and stormwater are managed on site)
Source: Sarte, S.Bry, *Sustainable Infrastructure*, Wiley, 2010, P.74

## Integrated Green Infrastructure: Green Streets

Street Before

Street After: Curb Extension

Porous Pavement

Stormwater Street Planters

Stormwater Curb Extension: Water Retention

System Monitoring

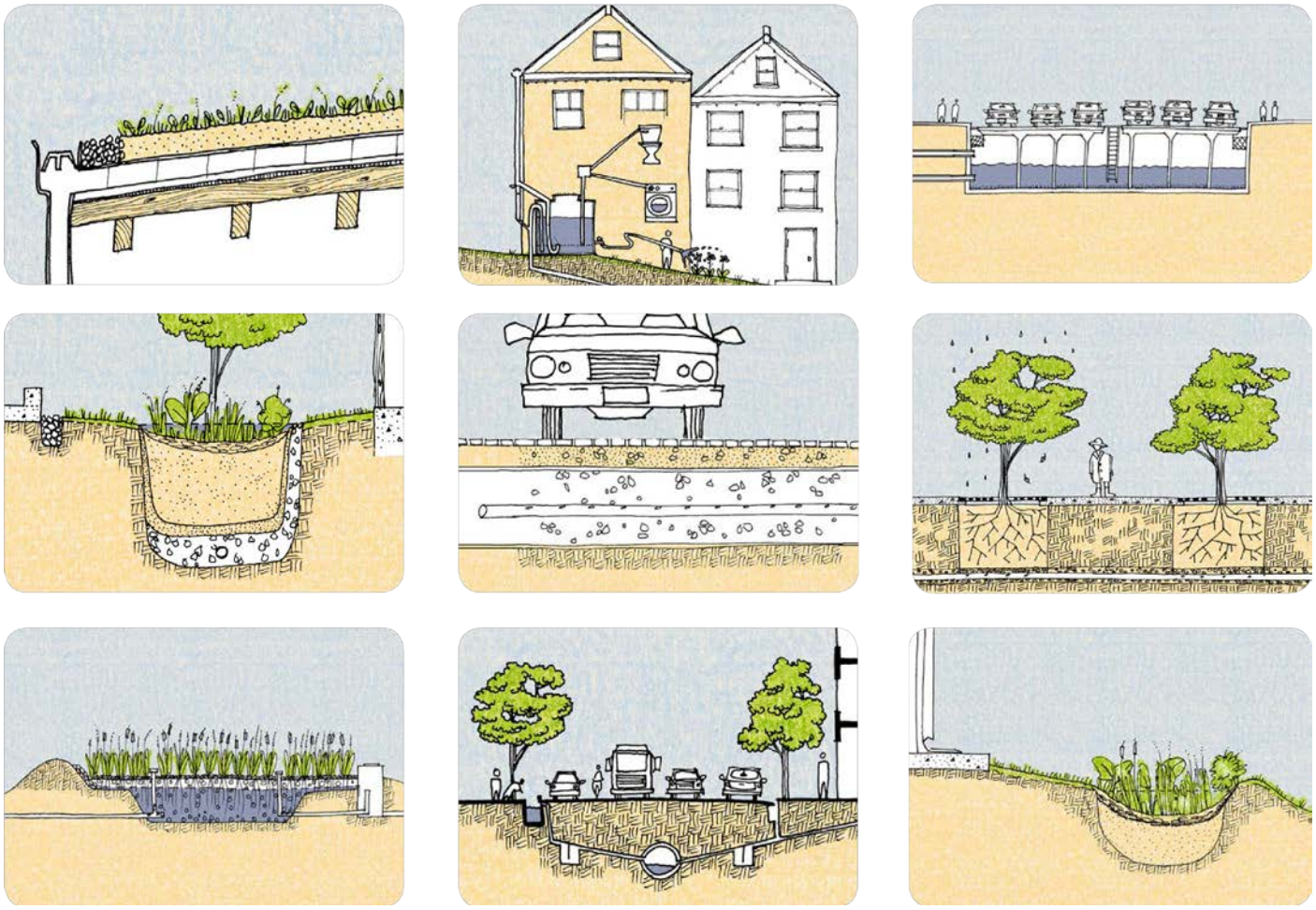
Source: Portland Green Streets Program, http://www.portlandonline.com/BES/index.cfm?c=44407.

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

DRAFT

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

## Integrated Green Infrastructure: Municipal Policy and Initiatives



San Francisco Stormwater Design Guidelines, Cover

Integrated Urban Design To Convey and Treat Stormwater
Malmo, Sweden

Stormwater Runoff Channelling, Malmo, Sweden

Source: San Franciso Stormwater Design Guidelines, http://sfwater.org/index.aspx?page=446

Columbia University in the City of New York | Graduate School of Architecture, Planning, and Preservation
Independent Research Seminar, Spring 2012
Professor: Mojdeh Baratloo
Graduate Research Associates: Ori Guy | Matthew Henry

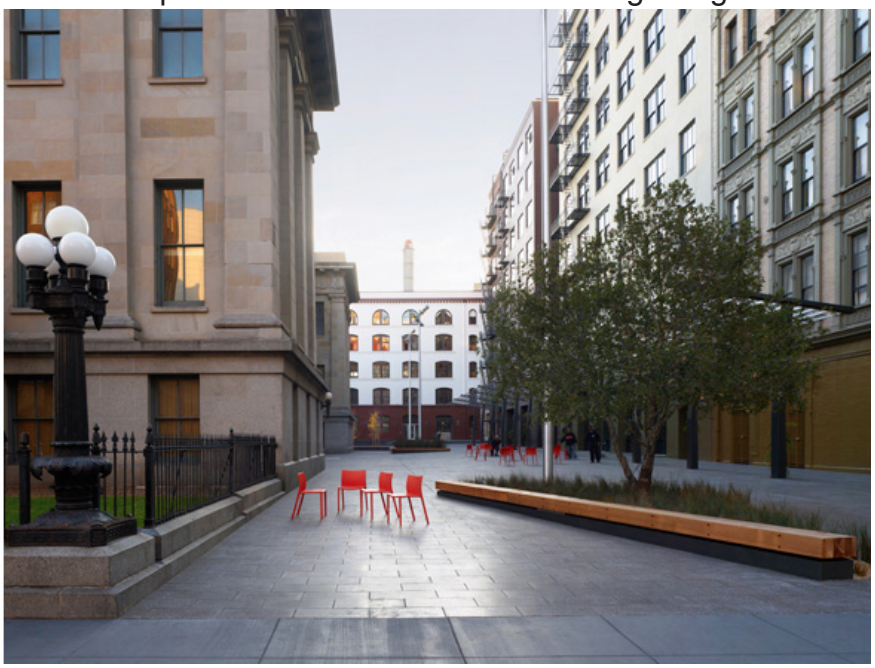
DRAFT

**Mixed Use Water Infrastructure** | Hoboken, New Jersey

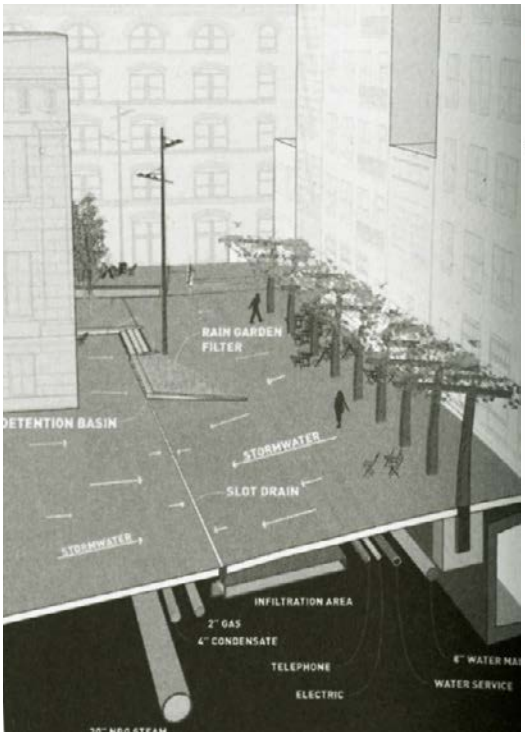
## Integrated Green Infrastructure: Public Space

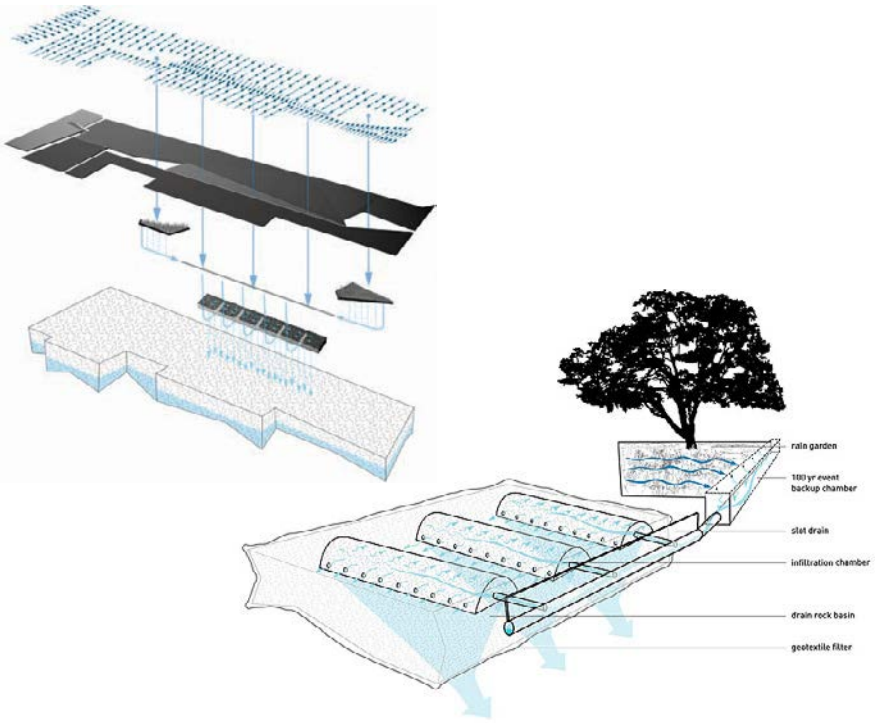
**Old Mint Plaza, San Francisco I** CMG Landscape Architecture + Sherwood Design Engineers

Before: City Street



After: Public Plaza




Green infrastructure integrated into the design of public space

Source: Sarte, S.Bry, *Sustainable Infrastructure*, Wiley, 2010, P.126 and CMG website: http://www.cmgsite.com/projects/