COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

EVALUATING THE LIVING BUILDING CHALLENGE IN NEW YORK CITY

LIVING BUILDING CHALLENGE

Summer 2014 Workshop Team

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1 EXECUTIVE SUMMARY

The purpose of this study is to determine the feasibility of a Net Positive Water-certified building in Gowanus, Brooklyn. The Net Positive Water Petal building certification is awarded by the Living Building Challenge to recognize innovative building designs for water management. The Living Building Challenge is administered by the International Living Future Institute (ILFI). To receive certification, the building site must harvest its own water, recycle and reuse its waste water, and manage its storm water on site. A Net Positive Water site can contribute to overall New York City conservation and resiliency plans.

For this study, the International Living Future Institute (referred to as “the client”) engaged the Columbia University Master’s in Sustainability Management Capstone team (referred to as “the team”) to perform a proof-of-concept study to determine if Net Positive Water is feasible in Brooklyn, NYC in the summer of 2014.

Our project objectives were:

1. To calculate the amount of water required for all household uses in a three-story residential building in the Gowanus neighborhood.
2. Determine how to meet water demands for the building through rainwater harvesting, water recycling and reuse.
3. Manage storm water runoff on site. This runoff will be any storm water not harvested for on-site use.
4. Develop a proof-of-concept building site with the technology sized for the building.
5. Identify challenges to Net Positive Water certification in Gowanus; and
6. Recommend next steps for the client.

Our methodology included a system and technology review to determine precedents for our proof-of-concept design. We reviewed New York City policy to understand regulations affecting water harvesting, recycling and reuse and to determine any policy barriers to Net Positive Water certification. Additionally we examined maps of Gowanus topology, and existing and proposed land-use zoning maps, to determine physical or community challenges to Net Positive Water. With this base, we developed our proof-of-concept for Gowanus; benchmarked our analysis using case studies and interviews; and performed a cost analysis for the proof-of-concept site.

Our proof-of-concept building was a multifamily, three-story low-rise residential building. The lot size is 1,574 square feet and the building roof is 1,200 square feet.[1]. Average annual rainfall in Gowanus is 50 inches per year.

- Our design would harvest 29,882.92 gallons of water per year.
- We calculated water demand for a business as usual scenario for twelve residents as 237,600 gallons per year. This demand was greater than the rainfall harvested, resulting in an 87% annual shortfall.
- We recalculated the water demand for the residents to account for water efficiency and a composting toilet as well as positive human behavioral change[2]. This reduced shortfall by 6% to 81%.

We included a 5,000 gallon storage cistern to hold a twelve day supply of water in the event of droughts. Also in the design was a 500 gallon[3] septic tank to protect ground water from untreated sewage, however the space required for the tank exceed the lot size.

Our findings showed the small lot size, a result of the high population density in Gowanus, currently 26,983 people per square mile, limited how much water we could harvest. A solution is to increase the roof space available by six to 7,200 square feet. This will increase supply to 179,297.55 gallons/year and result in a 12% surplus. The other option is to decrease the number of residents to one. This will decrease demand to 23,568 gallons per year and result in a 27% surplus.

Our regulation analysis, found that for public health protection, New York City Department of Health does not allow buildings to be independent of the city's municipal water and sewer system. This regulation is a barrier to Net Positive Water Certification. The Living Building Challenge certification process does, however, have an exception in place for cities with such regulations and will allow certification if a building meets its water demand and both treats and recycles all water on site.

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[1] http://www.trulia.com/homes/New_York/Brooklyn/sold/23613281-123-3rd-St-Brooklyn-NY-11231?sem=1.2.12.1.7.1.0.87&gclid=CPfIgNX-1L8CFTJp7AodgRcAyQ

[2] Dolnicar, Sara, Anna Hurlimann, and Bettina Grün. "Water conservation behavior in Australia." Journal of environmental management 105 (2012): 44-52.

[3]

Our study concludes that a Net Positive Water Building is feasible in Gowanus with applicable Living Building Challenge exceptions. Further, the small lot size limits the rain water harvesting surfaces available. A solution is to allow shared water harvesting across property lines. This will increase the roof area needed to meet the water requirements of the building.

We recommend as a next step that ILFI work with the Mayor’s office, practitioners and the Gowanus community to convene a working group to address policy changes required to allow shared water harvesting across property lines. We hope our study can be a resource in these efforts.

2 PROJECT OVERVIEW

2.1 Client Description

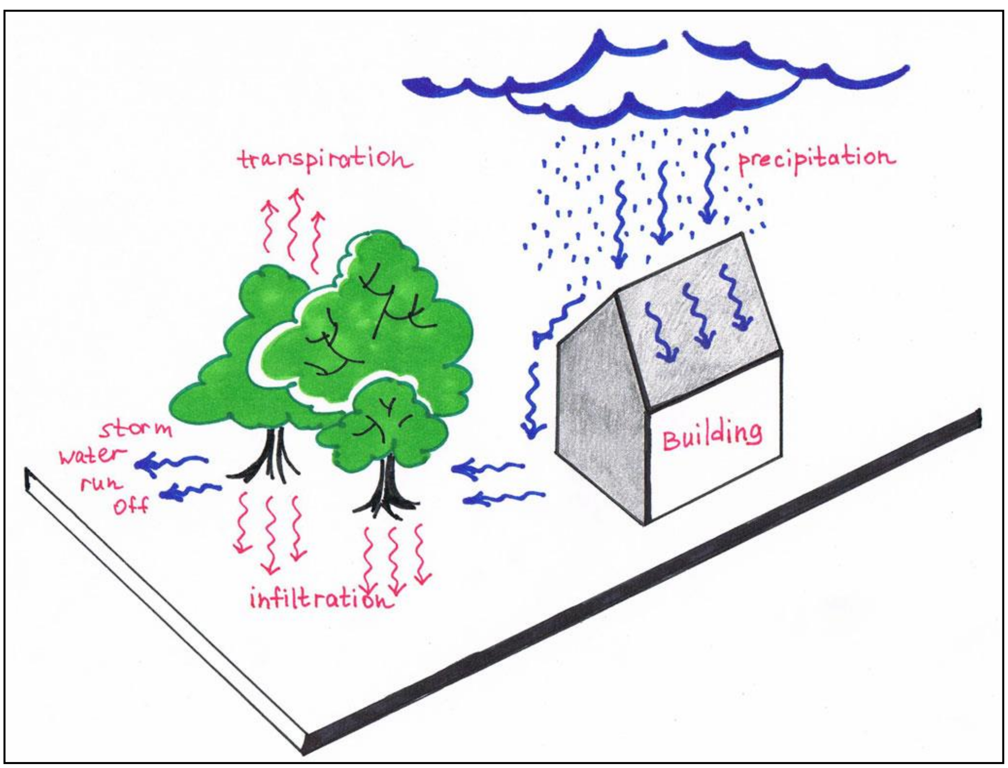
The International Living Future Institute (ILFI) a nonprofit organization that administers the Living Building Challenge (LBC) certification. The Living Building Challenge was started in 2006, and it is a built environment standard that measures a building's ability to mimic the natural environment for all systems on the building site.

One of ILFI's goals is to better understand the regulatory environment of different countries and states to facilitate LBC certification. ILFI has affiliates in Europe (Ireland), Australia, Canada, Mexico.

2.2 Net Positive Water

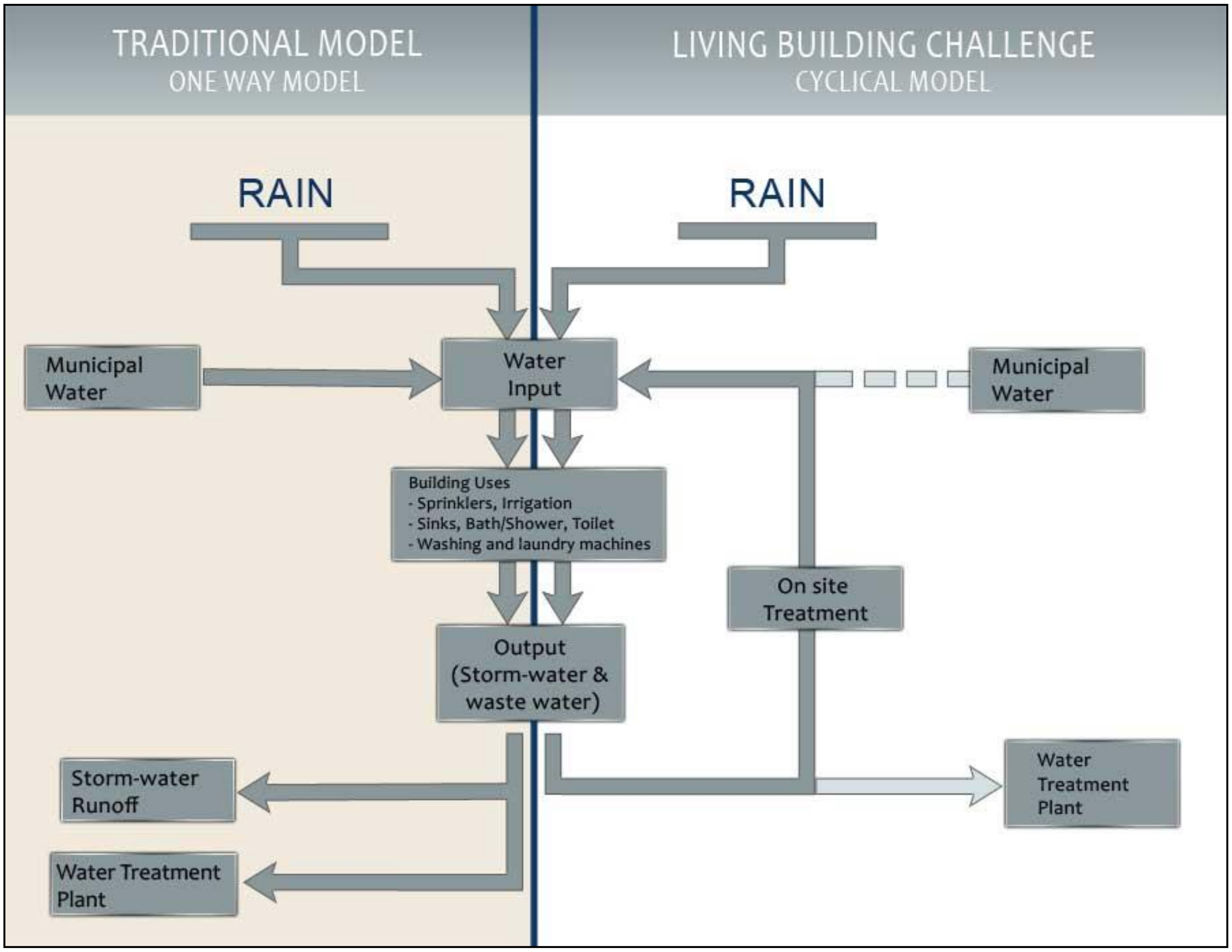
To receive Living Building Challenge certification, a building must demonstrate an on-site water management system that accounts for all components of water input and output. It should mimic the natural water cycle as shown in Figure 1.

Figure 1. Natural water cycle



All water inputs and outputs must be managed on-site for building use. The project can only be certified as a Net Positive Water site after twelve months of successfully demonstrating the on-site water managements. The figure below shows the differences between the traditional water cycle model and the cyclical (closed loop water system) model proposed by Living Building Challenge.

Figure 2 – Traditional (one way water system) vs. Living Building Model (closed loop water system)



The *Traditional model* is characterized by the following processes:

- Municipal potable comes in from watershed streams and reservoirs via New York City water treatment facilities[4].
- Municipal water can be used for 1) on-site irrigation and 2) potable uses (sinks, baths/showers, toilets, sprinklers)[5].

[4] http://www.nyc.gov/html/dep/pdf/wsstate13.pdf
[5] http://www.nyc.gov/html/dob/downloads/pdf/plumbing_code.pdf

- After use, water goes to the treatment plant. Storm water runoff goes to the sewer. During storms, sewers are often overloaded due to the absence of the separate lines for the storm water and waste water[6].

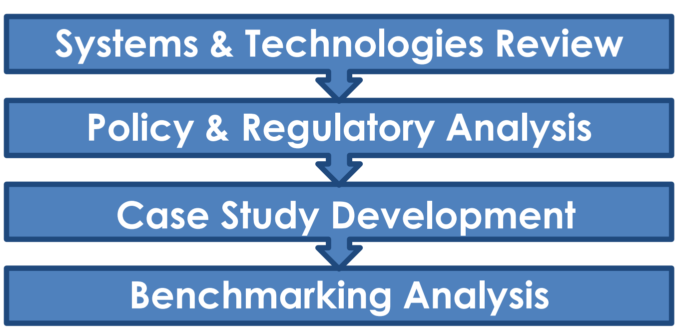
The *Living Building Challenge model* is a closed-loop (cyclical) water system model:

- The water input is based on 1) rain water harvesting, 2) on-site ground water, 3) condensate from the air 4) surface water sources (ponds recycled process water, grey and black water collected on site and treated). Water is purified in on-site using constructed wetlands or a Bio-Reactor to meet consumption standards. The purification process uses no chemicals[7].
- All water stored on site can be re-used for both irrigation and residential purposes[8].
- After use, water does not go the NYC wastewater plants, but stays on site and is returned as an input water source, completing the closed-loop system[9].

3 METHODOLOGY

3.1 Overview

Our methodology included system and technology review to determine precedents. We then reviewed NYC policy to determine which laws and policies applied to Net Positive Water systems. With this base, we developed our proof of concept study for Gowanus and benchmarked our results using case studies and interviews. The methodology flow is shown below.



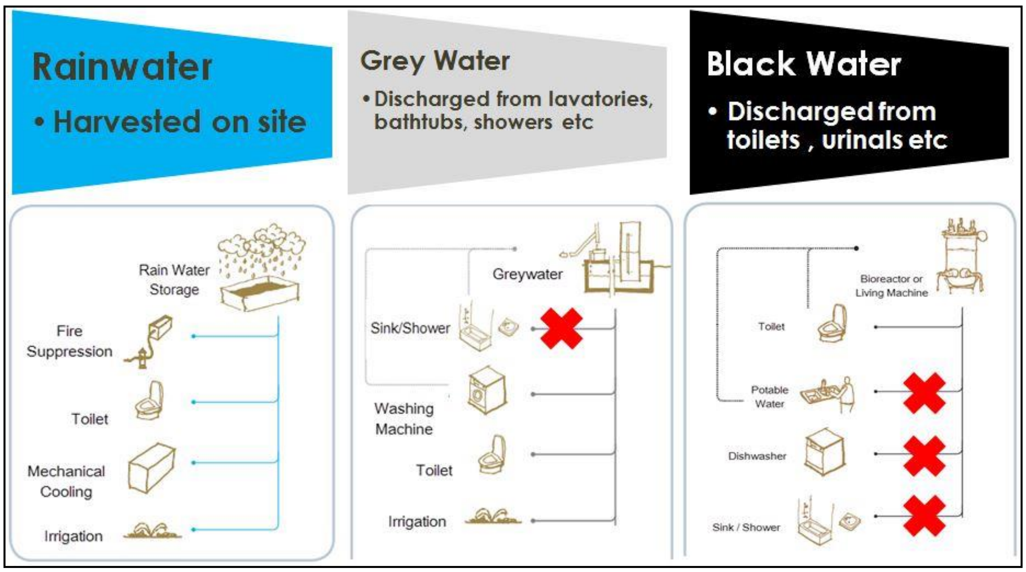
[6] http://www.nyc.gov/html/dob/downloads/pdf/plumbing_code.pdf
[7] http://www.dep.state.pa.us/dep/subject/advcoun/stormwater/Manual_DraftJan05/Section07-jan-rev.pdf
[8] Water Petal 3.0 handbook (White paper)
[9] Water Petal 3.0 handbook (White paper)

3.2 System and Technology Analysis

To develop our analysis model we defined the Net Positive Water system and determined the NYC applicable law for each system. This model was used as the basis of our proof of concept site design.

- Rainwater harvesting is the rain runoff captured from the roof and stored for future activities like watering a lawn (landscape irrigation), fire suppression, toilet usage and mechanical cooling.
- Grey water is defined by the NYS Department of Environmental Conservation as all water from bathtubs, showers, washing machines, dishwashers and sinks (excluding discharges from toilets, urinals and all industrial sources)[10]. It can be reused for the washing machine, toilet use and irrigation.
- Black water in NYC can only be reused for toilet flushing[11].

Figure 3: Net Positive Water Systems and Technology Analysis. NOTE: x means the process is not permitted in NYC



3.3 New York City Policy Analysis

To understand how New York City is applicable to Net Positive Water sites we reviewed the prevailing NYC regulation and governing bodies. Our findings are below:

[10] http://www.dec.ny.gov/docs/water_pdf/waterresue.pdf
[11] http://www.dec.ny.gov/docs/water_pdf/waterresue.pdf

- The Department of Health does not permit the use of non municipal water for potable use in NYC. All potable water in NYC is provided by the Department of Environmental Protection (DEP). DEP disinfects its water with chlorine and UV light, phosphoric acid, sodium hydroxide, fluoride[12].
- NYS Department of Environmental Conservation allows grey water reuse only for non-potable purposes to avoid potential pathogen risks. The City mandates monthly testing of the water for levels of pathogens and metals in the recycled water. All outlets must be labeled with signage reading “Non-potable water, do not drink” and the recycled water must be dyed blue or purple[13].
- The Innovation Review Board (IRB)[14] permits compositing toilets on site after a case by case site review.

These NYC policies work together with the exceptions permitted by the Living Building Challenge. (See Appendix Section 8.4) The Living Building Challenge exception applies when the City law requires, for public health reasons that the building maintain connections to the city and water and sewer supply.

Further in a high urban density environment like Gowanus, Living Building Challenge exceptions will allow you to manage less than 100% of the storm water on site if there are no direct waterways for discharge. In both cases you must demonstrate working with applicable agencies for solutions.

3.4 Benchmarking

We reviewed case studies in the USA and Canada to understand the systems and technologies used in Net Positive Water buildings. We also reviewed NYC case studies and performed interviews to understand existing recycling and treatments systems in NYC. We interviewed developers and architects to understand challenges to waste water recycling in NYC (Please see the Appendix - Table 8. Case Studies). This analysis formed the basis of our proof of concept

4 GOWANUS CASE STUDY

[12] http://www.nyc.gov/html/dep/pdf/wsstate13.pdf
[13] http://urbangreencouncil.org//sites/default/files/a15U0000000LreWIAS1388005219.pdf
[14] http://www.nyc.gov/html/dob/html/sustainability/sustainability_boards.shtml.

4.1 Scope

Overview

We selected Gowanus as our study neighborhood based on the increased residential development[15], particularly along the Gowanus canal. This case study can be used as a guide for buildings seeking Net Positive Water in Gowanus for a 3 story residential building.

A residential building was the proof-of-concept building as land use analysis showed that 26% of the buildings in Gowanus Canal are residential.

Figure 4: NYC flood zoning http://maps.nyc.gov/hurricane/#

We used spatial mapping together with site visits to select the building on 3rd and Bond streets as our proof of concept site. This block is a mixed-use zoning - both residential and commercial - and not far from the canal. The property (now demolished) was a residential building constructed in 1899 as a multifamily 3-story low-rise residential building, 2,380 square

[15] http://www.nytimes.com/2012/11/06/nyregion/gowanus-canal-flooding-brings-contamination-concerns.html?pagewanted=all&_r=0

foot (lot 1,574 sq ft)[16]. We purposely selected areas that were close to the Gowanus drainage in the event we could incorporate the canal into our site water management design.

Figure 5: Proof of Concept Site

Topology

Our proof-of-concept building is located in FEMA designated flood Zone 1 which requires immediate evacuation in the event of a flood. Any building in that area must comply with the NYC Flood Resiliency plan amendment. The building and mechanical systems must be one or two feet higher that the flood level. U.S. Geological Survey topographical maps show our proof of concept site at or less than 10 feet above sea level.

4.2 Proof-of-Concept

Overview

To determine the demand for water used for the residential building in Gowanus Brooklyn, we went through several steps outlined below:

1. Analyzed whether or not the building could supply its own water through rainwater harvesting and grey water recycling.
2. Determined which technology to implement to sufficiently meet the building demand.
3. Modeled the building on storm water management.

[16] http://www.trulia.com/homes/New_York/Brooklyn/sold/23613281-123-3rd-St-Brooklyn-NY-11231?sem=1.2.12.1.7.1.0.87&gclid=CPfIgNX-1L8CFTJp7AodgRcAyQ

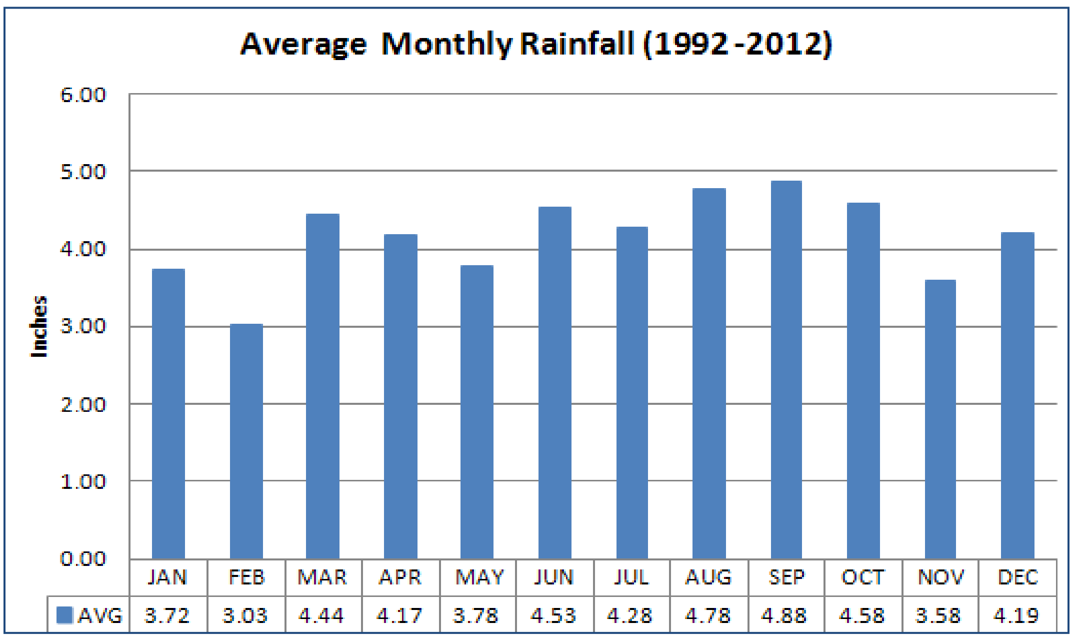
4. Determined how the building would meet Living Building Challenge certification with the existing NYC laws and policies mentioned in section 3.3 NYC Policy Analysis.
5. Calculated the economic viability of a building that supplies and manages its own water and storm water instead of the municipally provided water and wastewater management services;

Rainfall Analysis

Step 1:

A rainfall analysis for Brooklyn was necessary for the water input calculation. To determine season rainfall patterns we used the monthly rainfall data from Central Park and developed average monthly rainfall data. The data used was for the past twenty years 1992 –2012. This is shown in the Figure 6 below. The average annual rainfall is 50 inches.

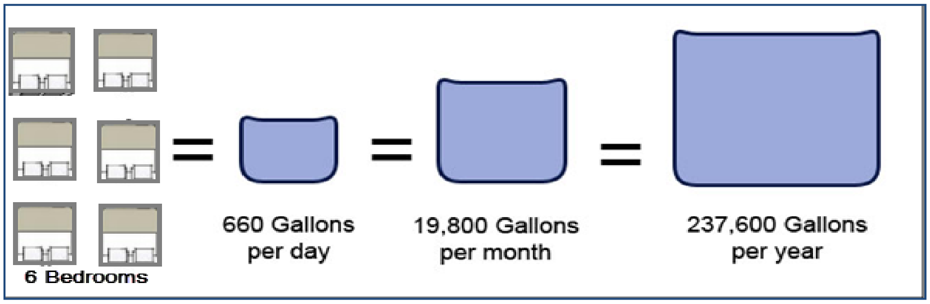
Figure 6: NYC Rainfall Analysis[17]



Step 2:

We developed a water demand relationship for our building to determine rainwater availability and needs for each season. The demand is based on NYC health regulations sizing of 110 gallons per bedroom[17]. We estimated the demand for twelve people (2 people per bedroom, in six bedrooms and three apartments in total) on the site for a total of 660 gallons needed for the site per day, this translates to 19,800 gallons per month based on a thirty day month. This relationship was used for a business as usual analysis for the building.

Figure 7: Water Demand Relationship



Step 3: To determine the amount of rainwater supplied on our site we used the water balance equation.

Supply >= Demand [18]

To determine supply, we assumed that 80% of the rainfall is collected for use on site. This is to account for water loss during the harvesting process. The rainfall used for the calculation was the monthly New York City rainfall averages for 1992 – 2012.

Table 1 below shows the calculated supply and demand for our site. The demand calculation assumes that rainwater will be used for all purposes inside the building. The supply is from our calculated demand relationship, (Figure 7), for a business as usual scenario.

[17] https://www.health.ny.gov/regulations/nycrr/title_10/part_75/appendix_75-a.htm
[18] Kinkade-Levario, Design for Water: Rainwater Harvesting, Stormwater Catchment, and Alternate Water Reuse 2007

Table 1: Water Balance for the Gowanus Residential Building

MONTH	AVERAGE RAINFALL (INCHES)	80% of PRECIPITATION OVER 1200 sq ft (GALLONS)	WATER DEMAND (GALLONS)	SURPLUS OR DEFICIT (GALLONS)	% DEFICIT
JAN	3.72	2,224.29	19,800	(17,576)	-89%
FEB	3.03	1,810.19	19,800	(17,990)	-91%
MAR	4.44	2,654.91	19,800	(17,145)	-87%
APR	4.17	2,492.85	19,800	(17,307)	-87%
MAY	3.78	2,261.88	19,800	(17,538)	-89%
JUN	4.53	2,711.30	19,800	(17,089)	-86%
JUL	4.28	2,561.49	19,800	(17,239)	-87%
AUG	4.78	2,859.96	19,800	(16,940)	-86%
SEP	4.88	2,916.07	19,800	(16,884)	-85%
OCT	4.58	2,739.78	19,800	(17,060)	-86%
NOV	3.58	2,141.41	19,800	(17,659)	-89%
DEC	4.19	2,508.80	19,800	(17,291)	-87%
ANNUAL	49.96	29,882.92	237,600	(207,717)	-87%

NOTE: 80% Coefficient was used for medium rain events > =1 inches. This was used based on Wahaso calculation for SolarOne [19]

Rainfall Analysis Results

The results below show that every month there is a shortfall of at least 85%t o meet the demand. Based on case study reviews we determined the demand can be reduced by implementing on-site water conservation and behavioral adaptations. Table 2, below, models a reduced demand based on different scenarios. On-site conservation included low flow toilets, showers, and kitchen and bathroom faucets[20]. For our study we included low water use dishwashing machines and laundry machines. We also considered behavior changes, and calculated reduced usage times for showers and faucets.[21]

[19] Tawengwa, Blessing; Kazakova, Veronika
[20] Data Source for Efficiency: http://www.nyc.gov/html/dep/html/residents/wateruse.shtml
[21] http://www.usgbc.org/sites/default/files/WEp1%20Additional%20Guidance%2004-01-2013%20v8-corrected.pdf

Table 2: Change in Shortfall Model

			1			2			3		
MONTH	AVERAGE RAINFALL (INCHES)	80% of PRECIPITATION OVER 1200 sq ft (GALLONS)	WATER DEMAND (GALLONS)	SURPLUS OR DEFICIT (GALLONS)	% DEFICIT	WATER DEMAND (GALLONS) W/ CONSERVATION	SURPLUS OR DEFICIT (GALLONS) W/ CONSERVATION	% DEFICIT	WATER DEMAND (GALLONS) W/ CONSERVATION &	SURPLUS OR DEFICIT (GALLONS) W/ COMPOSTING TOILET	% DEFICIT
JAN	3.72	2,224.29	19,800	(17,576)	-89%	15,685	(13,460)	-86%	13,349	(11,124)	-83%
FEB	3.03	1,810.19	19,800	(17,990)	-91%	15,685	(13,874)	-88%	13,349	(11,538)	-86%
MAR	4.44	2,654.91	19,800	(17,145)	-87%	15,685	(13,030)	-83%	13,349	(10,694)	-80%
APR	4.17	2,492.85	19,800	(17,307)	-87%	15,685	(13,192)	-84%	13,349	(10,856)	-81%
MAY	3.78	2,261.88	19,800	(17,538)	-89%	15,685	(13,423)	-86%	13,349	(11,087)	-83%
JUN	4.53	2,711.30	19,800	(17,089)	-86%	15,685	(12,973)	-83%	13,349	(10,637)	-80%
JUL	4.28	2,561.49	19,800	(17,239)	-87%	15,685	(13,123)	-84%	13,349	(10,787)	-81%
AUG	4.78	2,859.96	19,800	(16,940)	-86%	15,685	(12,825)	-82%	13,349	(10,489)	-79%
SEP	4.88	2,916.07	19,800	(16,884)	-85%	15,685	(12,769)	-81%	13,349	(10,433)	-78%
OCT	4.58	2,739.78	19,800	(17,060)	-86%	15,685	(12,945)	-83%	13,349	(10,609)	-79%
NOV	3.58	2,141.41	19,800	(17,659)	-89%	15,685	(13,543)	-86%	13,349	(11,207)	-84%
DEC	4.19	2,508.80	19,800	(17,291)	-87%	15,685	(13,176)	-84%	13,349	(10,840)	-81%
ANNUAL	49.96	29,882.92	237,600	(207,717)	-87%	188,215	(158,332)	-84%	160,183	(130,300)	-81%

Business as Usual – Scenario 1:This is a demand of 19,800 gallons per month. This represents a business as usual scenario, with no conservation or behavior changes. This results in an 87 % year shortfall.

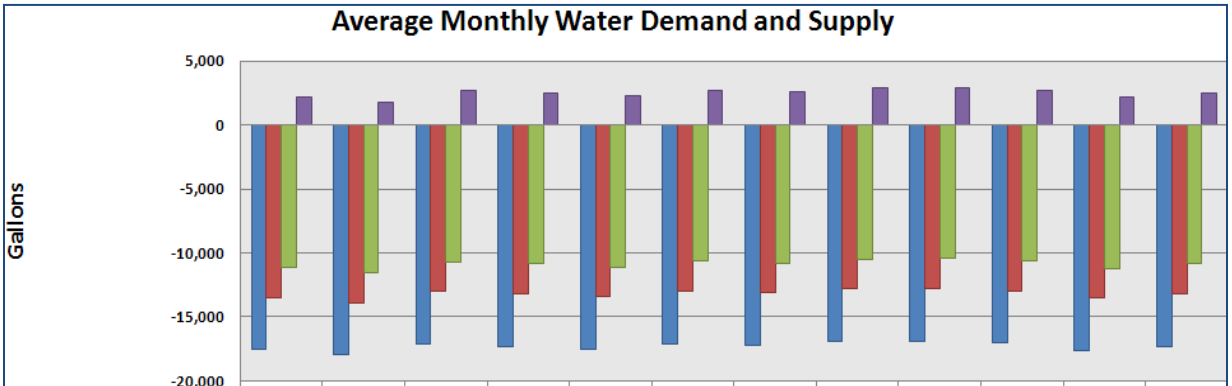
Efficient Demand - Scenario 2: This is a demand of 15, 685 gallons per month. This allows a 24% reduction in the shortfall from scenario 1 due to water efficient technologies. (See appendix Table 5: Efficiency Savings Conversion) for detail. This results in 84% shortfall.

Efficiency Demand + Composting Toilet - Scenario 3: This reduced demand of 13,349 gallons per month includes a composting toilet on site. The composting toilet reduced the demand by 28,032 gallons annually from Scenario 2 as water for flushing is no longer needed. (See appendix Table 6: Efficiency Savings Conversion) for detail. This allows a reduction in shortfall of 6% from scenario 1. This results in a scenario 3 shortfall of 81%.

Selecting the demand basis for study

The change in monthly shortfall based on the efficiency changes as described above is shown in Figure 7. Scenario 3 is the most efficient building water management system and is a step toward Net Zero Positive Water. We selected Scenario 3 as the demand base for the study.

Figure 8: Monthly Water Capture Analysis



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
*Business as Usual	-17,576	-17,990	-17,145	-17,307	-17,538	-17,089	-17,239	-16,940	-16,884	-17,060	-17,659	-17,291
*Efficiency	-13,460	-13,874	-13,030	-13,192	-13,423	-12,973	-13,123	-12,825	-12,769	-12,945	-13,543	-13,176
*Efficiency + Comp.Toilet	-11,124	-11,538	-10,694	-10,856	-11,087	-10,637	-10,787	-10,489	-10,433	-10,609	-11,207	-10,840
**Rainfall Harvested	2,224	1,810	2,655	2,493	2,262	2,711	2,561	2,860	2,916	2,740	2,141	2,509

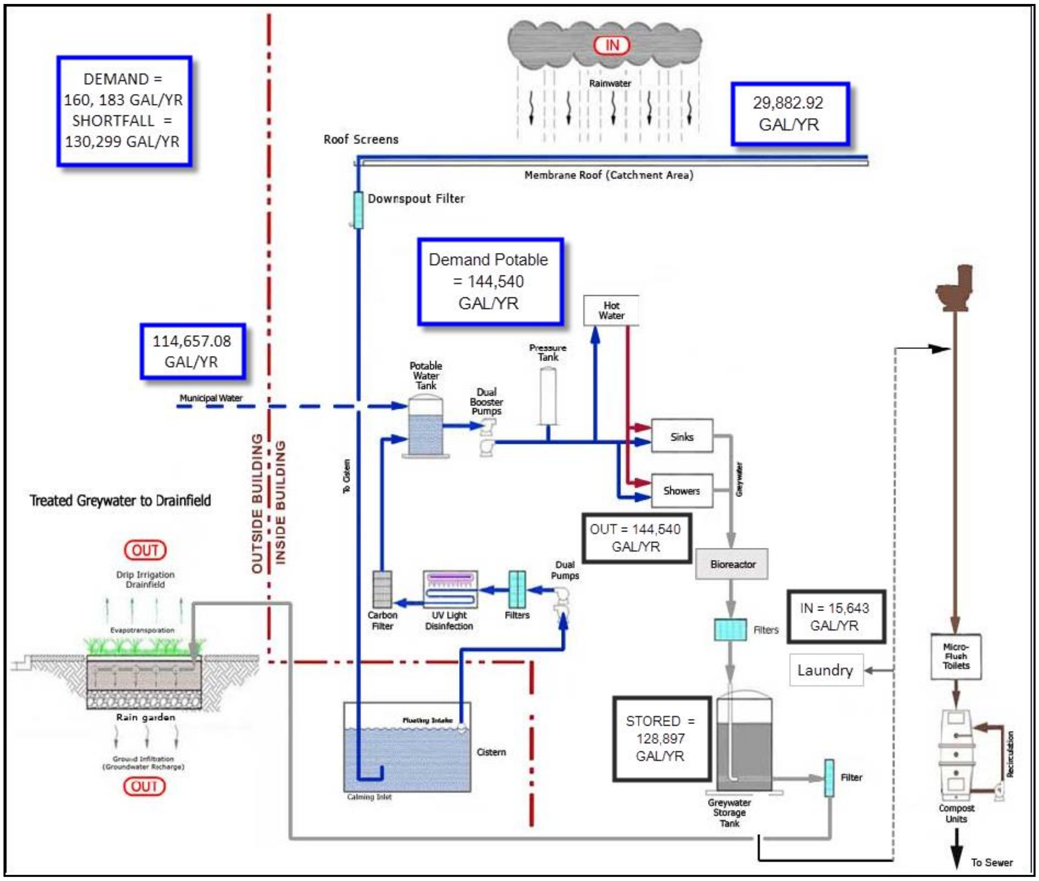
[22]

4.3 Building Design

We implemented a rainwater harvesting system to harvest the rain water from the roof. The rainwater is stored in a cistern, treated and used for faucets, sinks and showers. All the used water is then recycled and treated to remove harmful pathogens. Once treated, the water can be used for all potable purposes. New York City does not permit use of recycled water for potable uses, therefore in New York; this water will remain in the cistern and can be used for non-potable uses. A rain garden and flowers native to the area are part of the garden design. This is to allow for on-site water management in the event of a storm. A compost toilet is also part of the design. Compost toilets use little or no water and are suitable for areas where water supply or waste treatment facilities are not available, as happened with Hurricane Sandy in 2012. Figure 9 below shows the system model.

[22] Tawengwa, Blessing; Kazakova, Veronika

Figure 9: Systems Model

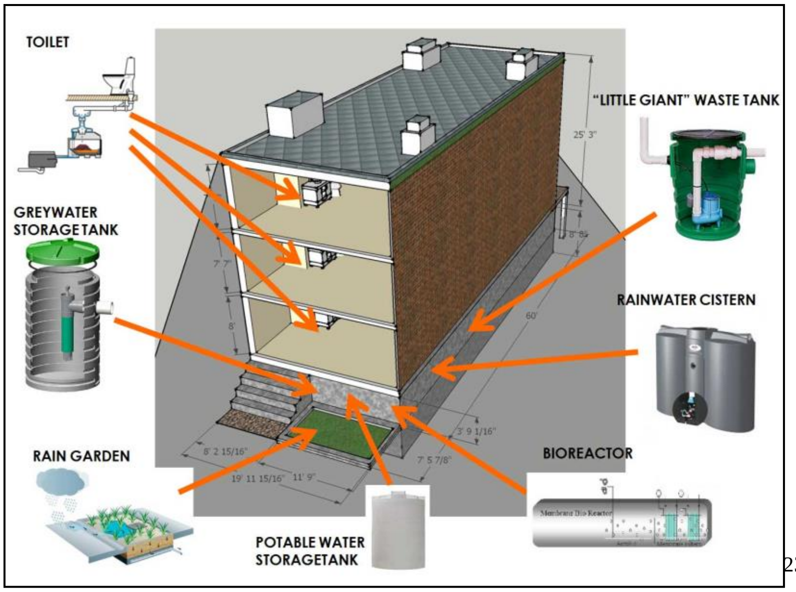


From the model we see:

- 29,882.92 of water is harvested from the rain.
- We have a shortfall of 130,299 gallons.
- To meet the shortfall we use 114,667 gallons from the city for our potable water needs calculated as 144,540 gallons. (See table 6 in the Appendix for a breakdown of uses.)
- From the potable water use we harvest 144,540 gallons of water from the grey water. This grey water is treated and stored in the grey water tank. The water is used for laundry. Currently NYC policy does not allow the use of recycled and treated water for any other uses.
- Any overflow is piped to the rain garden.

The rendering below shows all the individual systems and their placement in the building. Our building is in a flood zone and all equipment placed in the basement must be anchored to the floor.

Figure 10: Model Rendering



[23]

4.4 Financial Analysis

Cost Analysis

The cost analysis performed was from the perspective of a private developer filing for Living Building Certification. This approach allows ILFI, collaborators to understand the effect of cost on Living Building Certification in NYC and how this influences developer decisions.

Assumptions

All costs were estimated based on exiting case studies and literature review,

- Building costs were not factored into the analysis
- All costs are the current costs of the technology

Below is a table that lists the capital costs associated with the building in Gowanus.

[23] Tawengwa, Blessing; Kazakova, Veronika

Table 3: Capital Cost Analysis for Gowanus. NOTE: These costs are very rough estimates included to show rough capital cost.

Capital Costs (item)	Cost/ Item	# Units Needed	Total
Micro -Flush composting toilet	$1,000	4	$ 4,000.00
Membrane Bioreactor (MBR)	20 $ per gallon	1	$ 1,056.00
Rainwater Harvest System	80,000 based on 3920 sq feet	1	$ 24,489.80
Grand Total			**$ 29,545.80**

[24]

The cost for the selected technology for the site is $29,545.80. The annual monetary savings the developer will receive are from no longer paying a sewer bill and water bill. This is equal to $3,576 based on 2012 rate schedule[25] of $894 per apartment.

5 FINDINGS AND RECOMMENDATION

Our study showed that a Net Positive Water building is feasible in Gowanus with applicable Living Building Challenge Certification exceptions. The Living Building Challenge exception applies when the City law requires, for public health reasons that the building maintain connections to the city and water and sewer supply. The project team identified several barriers to Net Positive Water discussed below.

Regulatory

For the safety of the public, New York City Department of Health regulations require that all buildings maintain connection to the city for all potable water use and wastewater discharge. The

[24] Tawengwa, Blessing; Kazakova, Veronika
[25] http://www.nyc.gov/html/nycwaterboard/html/rate_schedule/index.shtml

Innovation Review Board (IRB)[26] permits compositing toilets on site after a case by case site review. The project team sees this as an opportunity to work with the New York City Department of Health and scientists for one time onsite water recycle and reuse certification system based on the technology used and the water purification level achieved.

Scale

Population density in Gowanus is 26,983 people per square mile. This is very high compared to the average 3,804 people per square mile for current Net Positive Water sites locations. This high density results in smaller building lots and limited roof size available for water harvesting.

The size of the project site limited our choice of technology and systems. For example, constructed wetlands, while ideal as they utilize little energy, were not feasible in an urban environment where there is no outdoor space. At first the team considered placing the wetland on the roof, as in the Bullitt center; however this design eliminated the roof for the rainwater harvesting.

A possible solution to the limited property size is sharing rooftop areas for water harvesting. This will be across property lines and will require the property owners to agree as well as the city regulation to change.

The Living Building Challenge allows this solution and calls it scale jumping. However NYC law does not allow water harvesting, recycling and reuse across property lines. This is due to public health concerns. The project team believes developer and practitioners can pursue regulation to allow scale jumping in NYC. Currently water harvesting across properties is not permitted in NYC.

Community

Current concerns among Gowanus community members were expressed at Bridging Gowanus, a June 25 2014 meeting the project team attended.[27] These include affordable housing, zoning and cleanup of the Gowanus Canal, as well as concerns about unmonitored construction sites. We see

[26] http://www.nyc.gov/html/dob/html/sustainability/sustainability_boards.shtml.
[27] http://bridginggowanus.org/updates/

this as an opportunity to build Net Positive Water Affordable housing in partnership with the community.

Perception

The city mandates that all recycled water sources are clearly labeled to protect the public from possible contamination. When we interviewed a local developer, he expressed a preference for a flushing toilet rather than using composting toilets. While this is one incident, we believe continued conversations with developers and community members will be needed to overcome reflexive objections to compost toilets and implement water management systems on their building sites.

Cost

The New York City Department of Health requires monthly testing of any water that is treated and reused on-site. The monthly water testing can run up to $200 a month[28]. This may be too high a cost for some developers but can be offset with incentives as part of City-wide resiliency planning. This high cost can also suggest that Net Positive Water is possible for larger new builds that can offset the price by factoring in the cost into the rent.

As the City develops a plan, we recommend it offer rebates equal to the money that would be saved on water delivery and infrastructure maintenance. The city can benefit from reduced stress on the city infrastructure. The cost to deliver water to the city in Fiscal Year 2011 was $.44 per 1000 gallons of water. These costs are estimated to increase by 3% from 2015 to 2016.[3] Net Positive Water systems will help DEP meet their conservation goals and reduce costs.

Additionally, the overall cost of the project may deter small residential buildings, like our building site, from pursing Net Positive Water certification through the Living Building Challenge. To determine if Net Positive Water is feasible from a financial standpoint a full cost-benefit analysis is required. We recommend the cost-benefit analysis include the willingness to pay higher rental prices to live in a building that practices water conservation. This analysis will show how developers can recover costs over a long term. The Solaire, a residential building in

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[28] http://inspectapedia.com/water/Water_Test_Choices_Fees.htm

Manhattan with onsite water recycle and reuse system, recovers its costs through this revenue stream.[29]

Technology

There are a multitude of technologies available for water recycling, and the performance of the technology requires implementation and testing. We looked at case studies to determine precedents. The absence of an easy-to-follow guide for design and technology performance can be a barrier to Net Positive Water implementation. The project team recommends a certification process to clarify the technology choices.

We recommend an independent body, an NGO like ILFI, take on the role of certifier for the technologies. Additionally, we recommend creating a centralized database that allows searching for best-fit local technologies for a project's specific location and size.

As a next step we recommend that ILFI work with the Mayor's office and practitioners and community groups to discuss the barriers and possible solutions we identified above. The outcome will be a user guide to facilitate NYC policy and LBC certification process for developers and home owners in NYC. The guide can be written by ILFI and shared as a resource on the Living Building Challenge website.

We believe this process will clarify, encourage, inform and inspire developers to take on the Living Building Challenge certification.

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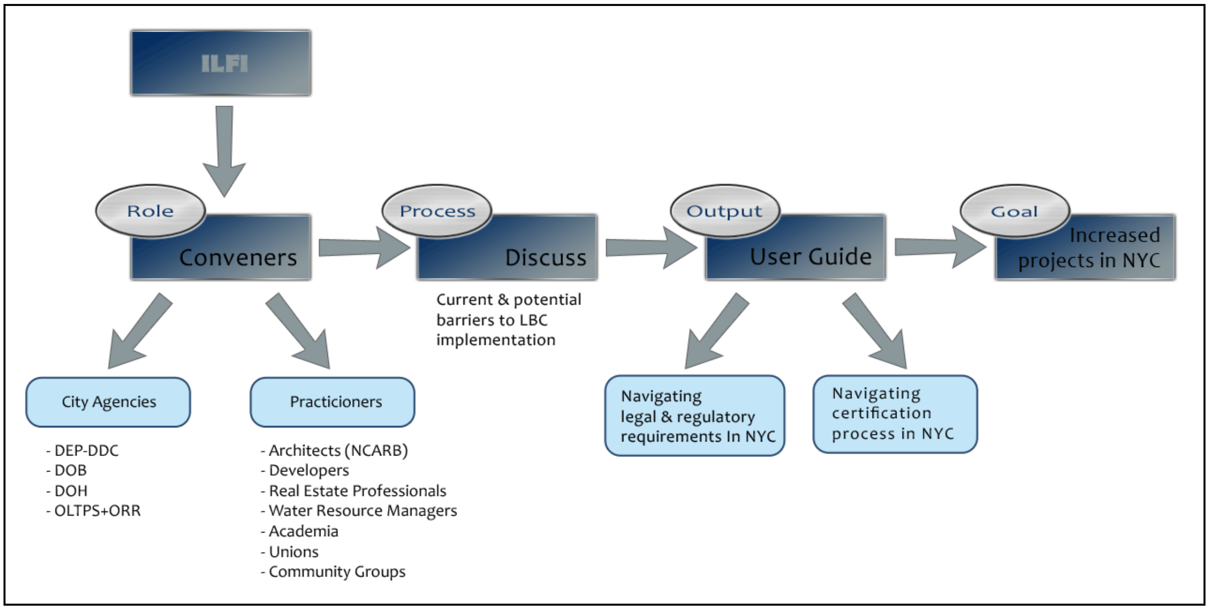
[29] https://www.werf.org/c/Decentralizedproject/Battery_Park.aspx

Figure 11: Recommendation Process



6 CONCLUSION

The study shows that Net Positive Water petal is feasible in NYC with the applicable Living Building Challenge exception. The exceptions allows certification if the City departments mandates that all buildings must connection to the city water and sewer for public health reasons. We demonstrated that the high urban density limited the area for collecting rainwater. We recommend that ILFI pursue the required regulatory changes to allow harvesting of water from other property sites as a solution to meet household water demands for a Net Positive Water multifamily building.

7 ACKNOWLEGMENTS

Our team, that conducted group research for Columbia University Summer 2014 Capstone, would like to express our gratitude to our Faculty Advisor, Professor Kizzy Charles-Guzman for her extensive guidance, expertise, feedback and support throughout the summer semester. We would also like to recognize Professor George Sarrinikolaou for his invaluable direction with our project. Lastly we would like to thank our Capstone Teacher's Assistant Marivi Perdomo Caba for her input and feedback on this report.

Thank you to Sean Meenan from Habana Outpost and Robert Scarano from Bright 'n Green for taking the time to answer our questions.

We would like to thank Living Building Challenge team for the remarkable work they are doing and for the opportunity to be a part of it during our research. Throughout this experience Living Building Research team has demonstrated their commitment to the environmental problems they are working on as well as their responsibility for the building environment that they creating.

Jennifer Preston, thank you for the opportunity to work with your team, it was a pleasure and a great chance to take part in such endeavor. JD Capuano, we are very grateful for your expertise and feedback on our work. We would like to acknowledge Clare Miflin at Kiss + Cathcart Architects, Hillary Mayhew at Living Building Challenge at International Living Future Institute, for their partnership, involvement and support. Also we would like to thank James Wilson at BKSK Architects, Casey Cullen at Cullen Outdoors and Abel B'Hahn at Viridian Future for the help, assistance and feedback throughout out meetings.

8 APPENDIX

8.1 Demand and Efficiency Details

Table 4: Scenario 2: Water Demand and Efficiency Calculation

*Appliance or Fixture	*Efficiency Savings	Gallons	**Duration (Sec)	**Uses per day	Daily usage Per Person (gallons)	Number of Bedrooms	Number of Residents (2 per bedroom)	Building Daily usage (Gallons)	Building Usage Per Month (Gallons)	Building Usage Per Year (Gallons)
High Efficiency Toilet ("HET"):	1.28 gallons per flush	1.28	na	5	6.4	6	12	77	2,304	28,032
Lavatory Faucet Faucet aerators reduce flow	2 gallon per minute	2	60	5	10	6	12	120	3,600	43,800
Kitchen Sink	1 gallon per minute	1	60	4	4	6	12	48	1,440	17,520
Low-flow showerheads use:	2 gallons per minute (or less)	2	480	2	32	6	12	48	1,440	17,520
Water-efficient washing machines use:	20 - 25 gallons per load (8.0 - 9.5 gals/cubic foot)	25	na	0.14	3.6	6	12	43	1,286	15,643
A dishwasher uses:	5 - 15 gallons per load	15	na	1	15	6	12	180	5,400	65,700
Total					71			516	15,470	188,215
* Data Source for Efficiency: http://www.nyc.gov/html/dep/html/residents/wateruse.shtml										
**Residential Fixture Use data:http://www.usgbc.org/sites/default/files/WEp1%20Additional%20Guidance%2004-01-2013%20v8-corrected.pdf										

Table 5: Scenario 3 – Water Demand and Efficiency Calculation

*Appliance or Fixture	*Efficiency Savings	Gallons	**Duration (Sec)	**Uses per day	Daily usage Per Person (gallons)	Number of Bedrooms	Number of Residents (2 per bedroom)	Building Daily usage (Gallons)	Building Usage Per Month (Gallons)	Building Usage Per Year (Gallons)
High Efficiency Toilet ("HET"):	1.28 gallons per flush	0	na	5	0	6	12	0	0	0
Lavatory Faucet Faucet aerators reduce flow	2 gallon per minute	2	60	5	10	6	12	120	3,650	43,800
Kitchen Sink	1 gallon per minute	1	60	4	4	6	12	48	1,460	17,520
Low-flow showerheads use:	2 gallons per minute (or less)	2	480	2	32	6	12	48	1,460	17,520
Water-efficient washing machines use:	20 - 25 gallons per load (8.0 - 9.5 gals/cubic foot)	25	na	0.14	3.6	6	12	43	1,304	15,643
A dishwasher uses:	5 - 15 gallons per load	15	na	1	15	6	12	180	5,475	65,700
Total					65			439	13,349	160,183
* Data Source for Efficiency: http://www.nyc.gov/html/dep/html/residents/wateruse.shtml										
**Residential Fixture Use data:http://www.usgbc.org/sites/default/files/WEp1%20Additional%20Guidance%2004-01-2013%20v8-corrected.pdf										

Table 6: Full Water Capture Analysis

*Appliance or Fixture	*Efficiency Savings	Gallons	**Duration (Sec)	**Uses per day	Daily usage Per Person (gallons)	Number of Bedrooms	Number of Residents (2 per bedroom)	Building Daily usage (Gallons)	Building Usage Per Month (Gallons)	Building Usage Per Year (Gallons)	Potable use	grey water reuse	Grey Water source (Gallons Per Year)	Total Water for Treatment and recycle (grey water + blackwater) (Gallons Per Year)
High Efficiency Toilet ("HET"):	1.28 gallons per flush	0	na	5	0	6	12	0	0	0			0	0
Lavatory Faucet Faucet aerators reduce flow	2 gallon per minute	2	60	5	10	6	12	120	3,650	43,800	43,800		43,800	43,800
Kitchen Sink	1 gallon per minute	1	60	4	4	6	12	48	1,460	17,520	17,520		0	17,520
Low-flow showerheads use:	2 gallons per minute (or less)	2	480	2	32	6	12	48	1,460	17,520	17,520		17,520	17,520
Water-efficient washing machines use:	20 - 25 gallons per load (8.0 - 9.5 gals/cubic foot)	25	na	0.14	3.6	6	12	43	1,304	15,643	0	15,643	15,643	15,643
A dishwasher uses:	5 - 15 gallons per load	15	na	1	15	6	12	180	5,475	65,700	65,700		0	65,700
Total					65			439	13,349	160,183	144,540	15,643	76,963	160,183

* Data Source for Efficiency: http://www.nyc.gov/html/dep/html/residents/wateruse.shtml
**Residential Fixture Use data:http://www.usgbc.org/sites/default/files/WEp1%20Additional%20Guidance%2004-01-2013%20v8-corrected.pdf

Table 7: Case Studies

Criteria	Tyson Living learning center (full certification)
1. where is it located – city/suburb / country, etc.	Outside of St. Louis metropolitan area - suburb
2. the building type	The site has been transformed from a degraded asphalt parking lot to an educational building with a native landscaped garden replete with pervious concrete, local stone pavers, and a central rain garden.
3. building size	2,000 acres (24,751sf.) outdoor laboratory/field station. Building area 2,968 sf.
4. regulations or barriers they had to overcome	St Louis County code - a barrier to the goal to use only captured rainwater for potable use, and treat and infiltrate the building's grey-water on-site. The project team and St Louis County Public Works Department reached an agreement to submit the project under the Alternate Compliance path. The path was successful and paves the way for future regional projects to implement the same strategies.
5. the NZW technology used and how it is installed	Collection strategies – chemical-free rainwater harvesting system via sloped standing seam metal roof. Lavatory & sink waste (grey water) is routed to a dosing basin/tank where particulates settle to the bottom. When about 35 gallons are accumulated, the water is flooded through a series of half-round polyethylene pipes buried no more that 12 inches below the soil surface - a leach field based treatment sources (infiltration garden). Black water is naturally broken down via

	the composting toilets system.
6. the cost for NPW technology	Total soft cost of the building is $169,513; no info of the NPW cost.
7. new build or retrofit	The Living Learning Center is a new building and was built in between existing buildings on the site of an existing parking lot and does not conflict with any site restrictions.
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Rainwater collection tools
10. water pressure at the site	No info
11. amount of water collected	Harvested on site 13,000 gal. Dependent on Rainfall & Usage, Potential for 50,000+ gallons/yr of harvested rainfall.
12. amount of water used	Annual water use 13,000 gal; 520 gal/yr water use per capita.
13. system used to clean the gray water/ black water	Grey water 13,000 gal/yr (system fed – irrigation), black water unknown amount (system fed – irrigation)
14. maximum number of occupants	Number of occupants – 10 per day, number of visitors 20 per week.

Criteria	**Omega Center for Sustainable living (full certification)**
1. where is it located – city/suburb / country, etc.	Outside of NYC metropolitan area, in Rhinebeck, NY.
2. the building type	Is a waste water filtration facility designed to use the treated water for garden irrigation and in a grey water recovery system as well an educational teaching tool to show the ecological impact of its campus.
3. building size	Building area 6,246sf
4. regulations or barriers	No info

they had to overcome	
5. the NZW technology used and how it is installed	Collection strategies – rainwater (toilets, washdown functions) collected in the underground cistern, on demand water is pumped from the cistern to a holding tank and UV sterilizer. From the holding tank rainwater is distributed to its usage location. Potable water comes from private ground well (lavatories, drinking fountain, sink).
6. the cost for NPW technology	No info
7. new build or retrofit	New built
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Rainwater collection tools
10. water pressure at the site	No info
11. amount of water collected	Harvested on site 16,476 gal rainwater
12. amount of water used	Annual water use 16,476 gal; 2,525 gal/visitor/yr
13. system used to clean the gray water/ black water	Grey & Black water – after use water is passed to the Eco Machine system for treatment, system fed – dispersal field that recharges groundwater.
14. maximum number of occupants	Number of occupants – 2, maximum number of visitors 30 per day.

Criteria	Bertschi Science Wing
1. where is it located – city/suburb / country, etc.	Seattle Capitol Hill, WA - city
2. the building type	Educational building
3. building size	Building area 1,225sf, building footprint 1,425sf
4. regulations or barriers they had to overcome	Currently Seattle Public Utilities will not permit another public drinking water system within their jurisdiction, which prohibits the Washington State Department of Health (DOH) from considering this system for permit. Because this system could serve over 25 people per day year round, it is considered a Public Group A Water System. A treatment system appropriate for treating the rainwater to potable levels has been installed for future use.
5. the NZW technology used and how it is installed	Rainwater is collected from the building's metal roof area as well as an adjacent building's roof area for indoor water needs. Stormwater collected from the green roofs along with the stormwater that overflows from the potable water cistern contributes to the irrigation cistern.
6. the cost for NPW technology	Project (hard) cost $935,000
7. new build or retrofit	Greyfield

8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Rainwater collection strategies
10. water pressure at the site	No info
11. amount of water collected	Rainwater, green roof stormwater and greywater
12. amount of water used	Utility supplied for portable water use due to regulatory requirements; 56.3 gal/day (assuming 20 students per day average)
13. system used to clean the gray water/ black water	Greywater from sinks is collected in two Aqua2Use filtration units, and pumped up to the indoor green wall for irrigation reducing the need for rainwater for irrigation purposes. Blackwater is collected and treated by a composting toilet.
14. maximum number of occupants	Number of occupants – 53

Criteria	**Bullitt Center**
1. where is it located – city/suburb / country, etc.	Northern edge of city's Central District in Seattle, Washington.
2. the building type	Commercial building
3. building size	Building area 52,000sf (4,800 m2)
4. regulations or barriers they had to overcome	Problems with local regulation, which require that water for consumption be chlorinated. The building will be connected to the municipal water supply as a back-up. So, although the Bullitt Center is fully plumbed to provide its own water, but until regulators give final approval, water will be from the municipal water source.
5. the NZW technology used and how it is installed	Aerobic composting system in a multi-story building. Composting foam flush toilets (save 96% more water than traditional flush toilets)
6. the cost for NPW technology	Building cost $18.5 million ($355 per sq.foot)
7. new build or retrofit	New built
8. was scale jumping implemented	Not sure
9. any of the water input/output touch points for the inventory	A new model for commercial development in dense urban settings.
10. water pressure at the site	No info
11. amount of water collected	Harvested on site 56,000 gal rainwater
12. amount of water used	500 gallons per day – "day-use tank"
13. system used to clean	Water from sinks and showers is stored in a greywater tank and cleaned in a

the gray water/ black water	constructed wetland. Clean greywater is infiltrated back into the soil to recharge the local aquifer. To create the potable water, the rainwater is "ultra-filtered" through three ceramic filters, with the finest removing viruses. The rainwater is also passed under ultraviolet light and through activated charcoal and a small amount of chlorine is added. While chlorine is a toxic chemical, research showed examples of people getting sick from bacterial growth on faucet heads, to the team decided to use a small amount of chlorine – then remove it at the faucet head with activated charcoal – to protect public health.
14. maximum number of occupants	85% of the Bullitt Center is leased and occupied by tenants, with very positive feedback about the experience of working in the building.

Criteria	**Eco Sense**
1. where is it located – city/suburb / country, etc.	Suburb, Victoria, BC, Canada
2. the building type	Residential building
3. building size	Building area 2500sf, building footprint 1800sf
4. regulations or barriers they had to overcome	Alternative Solution for a composting toilet - BC Building Code was passed on to the regional health authority. Flush toilet Ready (Pending) Municipal and Regional (CRD).
5. the NZW technology used and how it is installed	Solar thermal hot water, water conservation, composting (no flush) toilets, rain water harvesting, grey water reuse, living roof
6. the cost for NPW technology	Project (hard) cost $370,635
7. new build or retrofit	Brownfield site, new built
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Rainwater collection tools
10. water pressure at the site	No info
11. amount of water collected	Harvested on site 38,596 gal rainwater / 10,000 gal water cistern size
12. amount of water used	Annual water use 20,872 gal (grey water) = 401.4 gal per week; 3478 gal water used per capita
13. system used to clean the gray water/ black water	Rain water for garden irrigation, ground well for domestic use
14. maximum number of occupants	6 occupants/ 40 visitors per month

Criteria	**Hawaii Prep Academy Energy Lab**

1. where is it located – city/suburb / country, etc.	Country
2. the building type	Educational building
3. building size	Building area 5,902sf, building footprint 11,535sf
4. regulations or barriers they had to overcome	The project filed a rain water collection regulatory appeal with the State of Hawaii Department of Health to allow use potable water from rainwater collection**.**
5. the NZW technology used and how it is installed	No info
6. the cost for NPW technology	Project cost: $8,306,199 Soft cost: $1,314,569 Hard cost: $6,991,630
7. new build or retrofit	Previously bio waste site, new built
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Individual waste water system provides treatment on-site infiltration
10. water pressure at the site	No info
11. amount of water collected	Harvested on site 6,593 gal/yr (using local rain data) / 1,800 gal rainwater cistern size
12. amount of water used	4,932 gal. used in 1 year (158-740 gal per month)
13. system used to clean the gray water/ black water	No info
14. maximum number of occupants	Number of occupants – 25 / 10 visitors per day

Criteria	**Solaire** [30]
1. where is it located – city/suburb / country, etc.	City
2. the building type	Residential building, 27-story multi-family with 293 units
3. building size	357,000 sq.feet
4. regulations or barriers they had to overcome	The project filed a rain water collection regulatory appeal with the State of Hawaii Department of Health to allow use potable water from rainwater collection**.**
5. the NZW technology used and how it is	Stormwater runoff is collected in a 10,000-gallon basement storage tank with a sediment basin and treatment system and used for irrigating landscaping and

[30] https://www.nrdc.org/buildinggreen/casestudies/solaire.pdf

installed	operating the cooling tower. Central water filtration for entire building[33].
6. the cost for NPW technology	Project cost: $114,489,750 (without land) Greening Costs: $17,250,000 Potable water use: 4,440,000 gal/yr.
7. new build or retrofit	Previously bio waste site, new built
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	To help reduce potable water demand by 50% overall, the building uses recycled wastewater for its cooling tower, low-flow toilets and for irrigating landscaping. Waste water and storm water reuse system provides water for toilet flushing, landscape irrigation and cooling towers.[31]
10. water pressure at the site	No info
11. amount of water collected	No info
12. amount of water used	4,440,000 gal/yr.
13. system used to clean the gray water/ black water	On-site blackwater treatment system that recycles 100% of the building's wastewater for use in cooling towers, toilets and landscape irrigation. Plumbing is designed to accommodate graywater separation. Apartments feature water-efficient fixtures and toilets. Residents are encouraged to conserve water.
14. maximum number of occupants	293 units/ min 2 people per unit

Criteria	**Bright' n Green[32]**
1. where is it located – city/suburb / country, etc.	City
2. the building type	Residential building, 4-story multi-family with 6 units
3. building size	15,000 sq.feet
4. regulations or barriers they had to overcome	Attempt to avoid excessive runoff to municipal system.
5. the NZW technology used and how it is installed	50-foot deep geothermal on site wells for heating and cooling
6. the cost for NPW technology	No info
7. new build or retrofit	New built
8. was scale jumping implemented	No info
9. any of the water input/output touch points for the inventory	Rainwater harvesting – reclaimed rainwater

[31] http://www.thesolaire.com/documents/green_lifestyle.html
[32] http://brightngreen.com/

10. water pressure at the site	No info
11. amount of water collected	Harvested on site over 50,000 gal
12. amount of water used	No info
13. system used to clean the gray water/ black water	1 step - Pelican High-Flow Estate home whole house water folters (cleaning all water in the building: showers, dishwashers, washing machines). 2 step – 5-stage Reverse Osmosis water filter systems
14. maximum number of occupants	6 units/ min 1-2 people per unit

8.2 Gowanus Community Data

Gowanus community Demographic and Population maps.

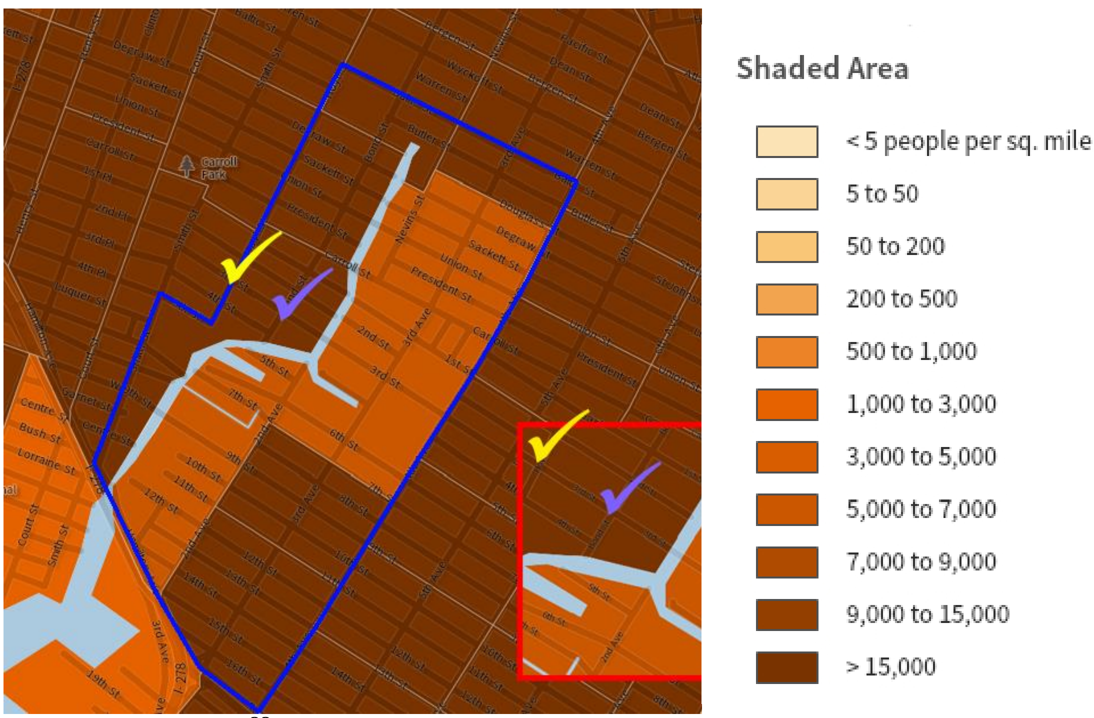


Figure 1. – Population[33].

As per the Census data as of 2010 the population density (Figure 1.) in the studied area of Gowanus canal is more than 9,000 - 15,000 people per square foot, which is a rather dense population[32]. From 1970 to 1990th the population in this area declined from 33,000 to 24,000 people (Figure 2 and 3) and the positive increase started only in recent years. In the past decade the amount of people with higher income allowed this neighborhood to gain the population back[34].

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[33] http://www.city-data.com/neighborhood/Gowanus-Brooklyn-NY.html
[34] http://www.baruch.cuny.edu/realestate/pdf/Reconsidering-Gowanus.pdf

Also, the number of area residents with four years of college increased 1.5% in 1970 to 20% in 2000. Additionally, in 1970, 7.5% of employed residents worked in management, business and finance and 3.2% worked as professionals in other fields. In 2000, nearly 16% worked in business and finance, and the number of people working in various other professional fields had increased tenfold to 33.1% (Figure 4.) [35]

Figure 2. Population of Gowanus (1970 – 2011)[36]

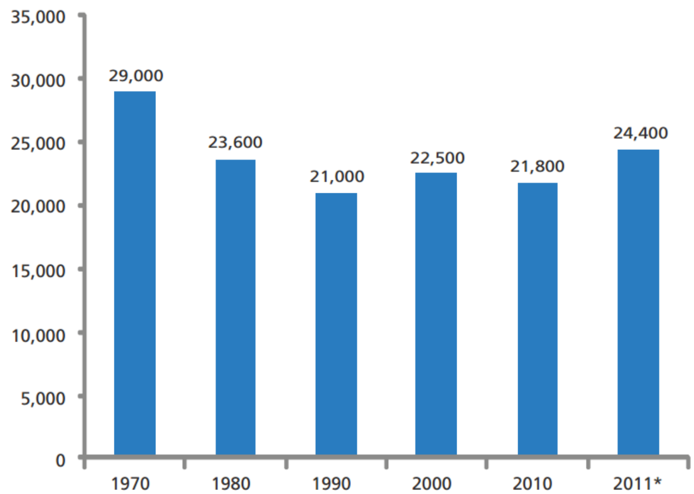


Figure 3. Age Distribution of Gowanus as Percentage of Total Population (1970–2010)[37]

[35] http://nypost.com/2010/05/11/study-says-gowanus-cleanup-will-lead-to-more-than-3000-units-of-new-housing/

[36] http://www.nycedc.com/sites/default/files/filemanager/Resources/Economic_Data/neighborhood_trends/Neighborhood_Trends_Gowanus_Sept.pdf

[37] http://www.nycedc.com/sites/default/files/filemanager/Resources/Economic_Data/neighborhood_trends/Neighborhood_Trends_Gowanus_Sept.pdf

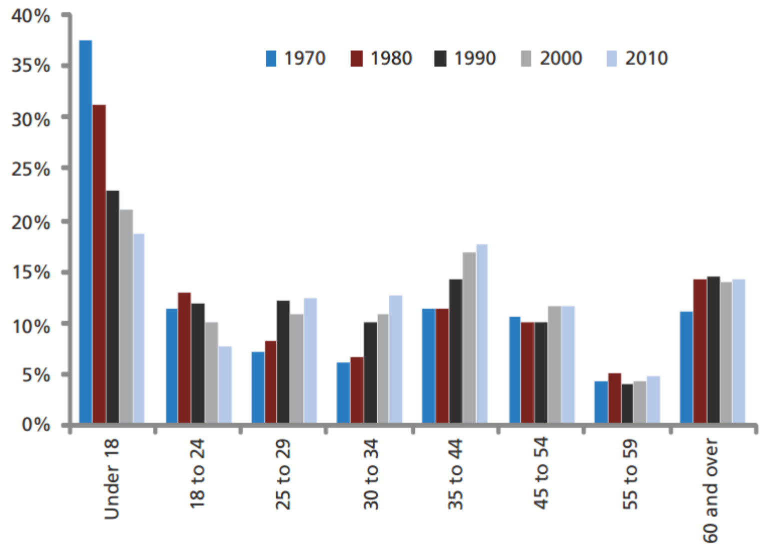


Figure 4. Data reflects civilian employment population fo Gowanus, 16 years and over. Source U.S. Census Bureau, 2007-2011 American Community Survey[35].

Industry	Employees
Professional, scientific, and technical services	2,001
Health care and social assistance	1,627
Educational services	1,531
Retail trade	1,194
Information	1,141
Finance and insurance	842
Arts, entertainment, and recreation	648
Manufacturing	523
Accommodation and food services	434

8.3 Gowanus Zoning Data collection.

Zoning research.

To develop a proof of concept study specific to a residential building in Gowanus, we used ZoLa for existing and proposed land used zones in the Gowanus. The study was to confirm that the selected building site in in a residential Zoned area as well as to ensure the proposed land use will keep it in a residential Zone. Additionally we undertook this study to ensure proposed land use percentages in Gowanus will still meet the project goal to impact change through residential buildings which are most prevalent land use in Gowanus.

Findings

The maps show the existing manufacturing zoning districts surrounding the Gowanus canal (Existing Land Use map). This area is formed by Bond Street to the west, Butler Street to the north, 3rd and 4th Avenues to the east, and Hamilton Avenue to the south. Existing zoning districts in this area include M1, M2, and M3 manufacturing neighborhood.

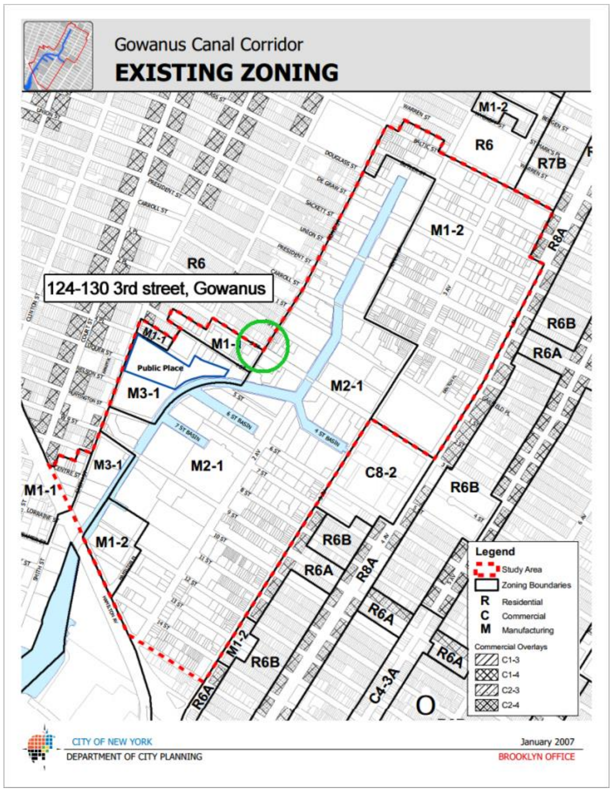


Figure 4. Existing Zoning Map - Gowanus

To the east and west of this area are primarily residential neighborhoods, Park Slope and Carroll Gardens. The commercial corridors of 4th Avenue and Smith Street run along or near the boundaries of the area. At the northern edge of the area are the New York City Housing Authority's Wyckoff Gardens and Gowanus Houses developments. To the south, beyond the southern boundary of Community District 6, is the Hamilton Avenue Bridge and the Gowanus Expressway, and industrial areas flank the Gowanus Creek[38].

Based on the proposed zoning by the Department of City Planning of New York there will be a future mixed use areas, as well as maintained areas for industrial and commercial use. The area

[38] http://www.nyc.gov/html/dcp/pdf/gowanus/4_gowanus_land_use.pdf

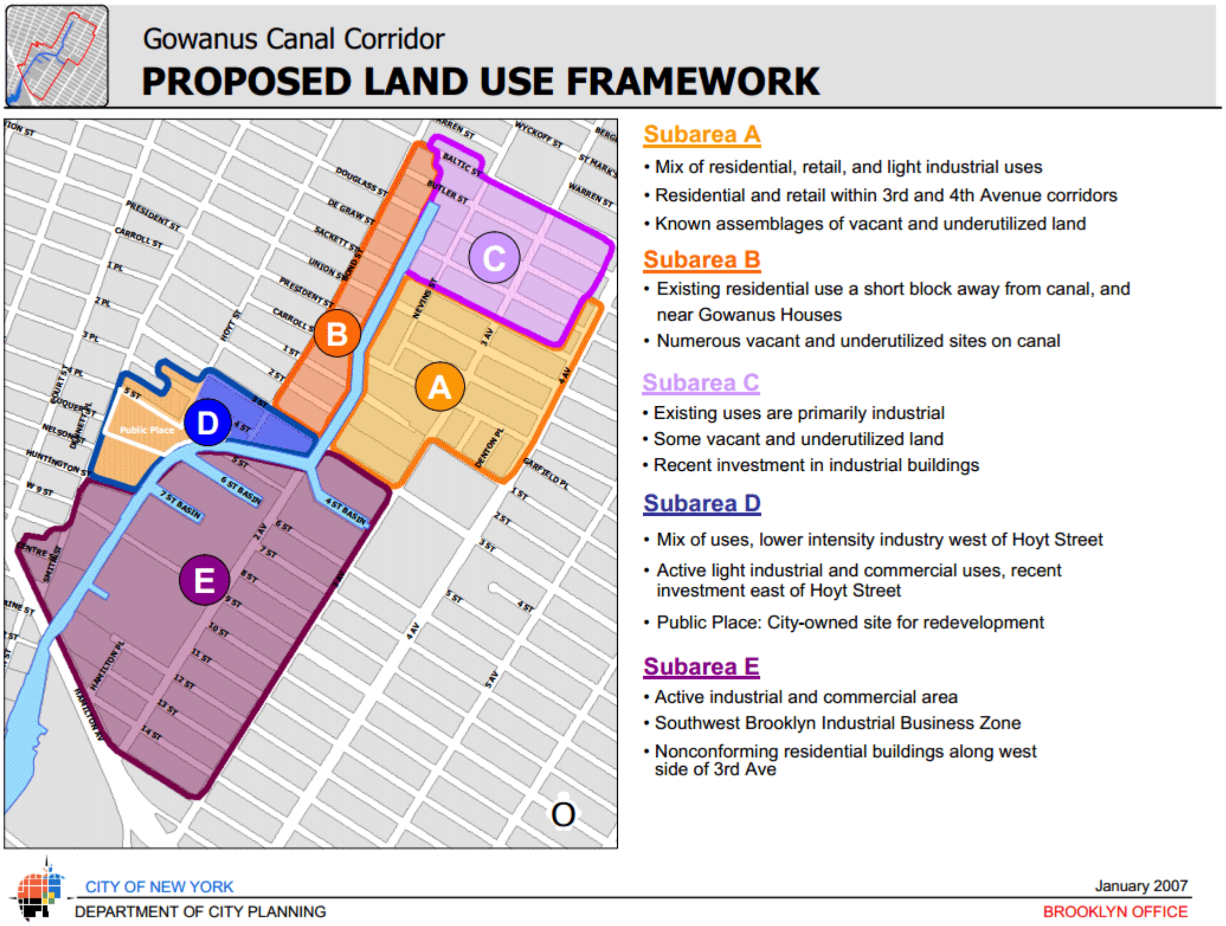
is presented as five subareas (A through E), within which different land use patterns exist. According to that the residential building that we are studying is on the boarder of Subarea B (existing residential) and Subarea D (mix of uses)[39].

The proposal by the Department of City Planning includes the following:

- Allowing for a mix of uses, including residential, in certain areas currently zoned for manufacturing uses - framework subareas A and B
- Maintaining areas for continued industrial as well as commercial uses
- Creating opportunities for public access at the canal's edge
- Enlivening the streetscape with pedestrian-friendly, active ground-floor uses
- Promoting affordable housing through the City's Inclusionary Housing Program
- Establishing limits for height and density that consider neighborhood context as well as other shared goals

Figure 6. Proposed Land Use – Gowanus

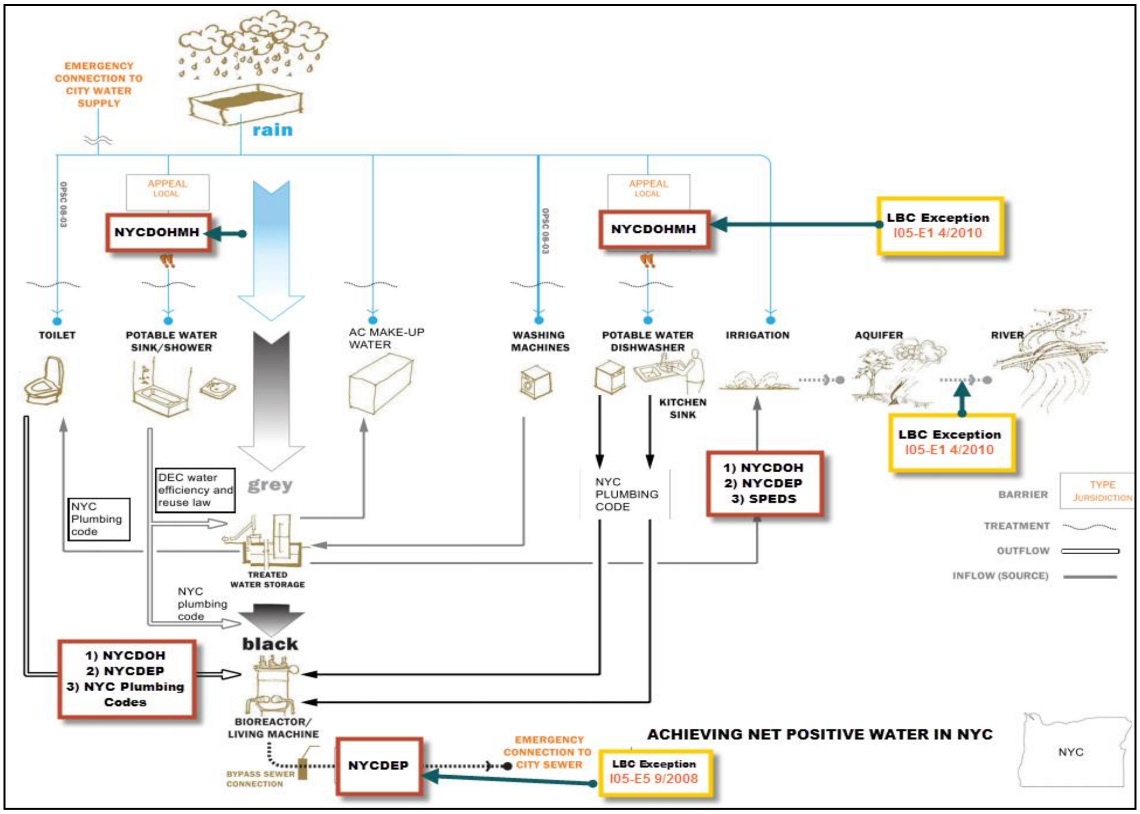
[39] http://www.nyc.gov/html/dcp/html/gowanus/gowanus4.shtml



8.4 Policy Roadmap

For public safety reasons, the New York Department of Health and New York Department of Environmental Protection still require connection to water and sewer supply in a building on a Net Positive Water site. The permitting process for installing Net Positive Water systems can be difficult to navigate and a barrier for adoption of Net Positive Water sites. The project team developed a roadmap to identify all city agencies and the Net Positive Water systems they oversee.

Policy Roadmap



New York City Department of Health (NYCDOHMH) requires the approved potable water to be supplied for the building uses. All the potable, grey and waste water system should have separate lines[40]. The definition of each area in the roadmap is defined in Table 9 below.

[40] http://www.nyc.gov/html/doh/downloads/pdf/radioh/water-potability-certificate-instr.pdf

Table 8: Policy Roadmap Definitions

New York State Departments	Department Name	Policy
NYCDOHMH	New York City Department of Health and Mental Hygiene	Oversees the Water harvesting and recycling on site
NYCDEP	New York City Department of Environmental Protection	Oversees the Sewer Systems on Site
NYC Plumbing Code	New York City Plumbing Code	Oversees the Pluming on site
SPDES	State Pollutant Discharge Elimination System (SPDES)	Overseas Stormwater discharge into the waterways
Living Building Challenge Exceptions	**Exception Description**	**Applicable NYC Law**
I05-E1 4/2010	Municipal Potable Water Supply	Allows Potable water use since NYC does not permit potable water use.
I05-E4 4/2010	Transects L5 and L6 - Municipal Storm water Connection	You can manage less than 100% of water on site if the is not possible way to discharge the water through natural mechanisms
I05-E5 9/2008	Municipal Sewer Overflow Connections	Allows connection if the City requires it.