Dutch Kills Green | Queens -- New York, NY
Methodology for Landscape Performance Benefits
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Environmental

Prevents over 20.2 million gallons of stormwater from entering the city's combined sewer system annually, avoiding a projected $3.4 million in future capital costs to upgrade stormwater infrastructure, such as constructing a larger combined sewer overflow tunnel.

Used biofiltration and infiltration equation[1]:

[annual precipitation (inches) * (feature area (sf) + drainage area (sf)] * % of rainfall captured] * 144 sq inches/sf * 0.00433 gal/cubic inch = total runoff reduction (gal)

Calculations:

Annual precipitation[2]: 49.92 inches
Features area[3]: 112,140.89 sf
Drainage Area[4]: 571,281.78 sf
% rainfall captured[5]: 95%

(49.94*(112,140.89+571,281.78)*0.95)*144*0.00433 = **20,216,776.67 gallons or ~20.2 million gallons**

New York City recognizes a cost avoidance for incorporating green infrastructure strategies. Green strategies offer an alternative approach to improving water quality that integrates green infrastructure features such as swales and green roofs. Unlike grey or traditional stormwater infrastructure strategies like sewers and wastewater treatment plants, green strategies optimize the existing system and build targeted, smaller-scale solutions.

Examining the cost per gallon of CSO (Combined Sewer Overflow) reduction for each respective alternative, the grey strategy (constructing a CSO tunnel) was estimated to be $0.62 per gallon

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[1] American Rivers, Center for Neighborhood Technology. 2011. The Value of GreenInfrastructure: A Guide to Recognizing Its Economic, Social and Environmental Benefits. http://www.cnt.org/repository/gi-values-guide.pdf
[2] "NowData - NOAA Online Weather Data". National Oceanic and Atmospheric Administration. Retrieved 2013-03-04.
[3] The feature area includes all the infiltration planters. It does not include any paving areas although the spaces between the motarless paving does provide some permeability.
[4] The drainage area includes all impermeable surfaces within the scope of work.
[5] This capture rate is based on personal communication with project landscape architect responsible for the project's storm water calculations. The team used the stormwater modeling software HydroCAD.

compared to $0.45 per gallon for the green strategy (green infrastructure). The cost per gallon of CSO reduced for the green infrastructure component is estimated to be considerably less than the cost per gallon of CSO reduced for the potential tanks, tunnels, and expansions of the grey strategy.

Green Infrastructure cost avoidance:

Cost of grey strategy:

> gallons reduced annually * cost of grey strategy = 20,208,679.99 gallons * $0.62/gallon = $12,529,381

Cost of green strategy:

> gallons reduced annually * cost of green strategy = 20,208,679.99 gallons * $0.45/gallon = $9,093,906

Cost Avoidance = Cost of Grey Strategy - Cost of Green Strategy

> $12,529,381 - $9,093,906 = **$3,435,475.60**

Limitations of Methodology:

- The multipliers are not site specific but based on averages for the City of New York
- Considering evaporation and other hard-to-estimate losses, the estimated % rainfall captured is difficult to accurately estimate.

Reduces irrigation needs by 786,500 gallons per year through a native and adapted plant palette, saving $3,500 in annual irrigation costs when compared to a standard lawn.

> Total potable water saved from avoiding irrigation costs = water needed for irrigation + water lost from evaporation – water from rainfall
>
> water lost from evaporation = average feet inches of evaporation per year * size of irrigation area
>
> 2.13 feet – average annual feet of evaporation per year[6]
> 112,140.89 sf – total irrigation area[7]
>
> Water lost from evaporation = 2.13 feet/year * 112,140.89 sqft = 238,860 cubic feet/year or **1,786,796 gallons/year**
>
> Water needed for irrigation (@ 20 weeks of irrigation at 1 inch per week) = total irrigation area * 20 weeks * 1 inch = 112,140.89 sqft * 20 week *1 in/sqft/week = 2,242,817 cf/year or **16,777,436 gallons/year**
>
> Water from rainfall = average annual rainfall * total drainage area = 49.92 in/year * 571,281.78 sf = **17,777,693 gallons/year**

[6] http://www.nrcc.cornell.edu/PET.pdf
[7] Total irrigation area includes all vegetated areas.

Total potable water saved from avoiding irrigation costs = **1,786,796 gallons/year + 16,777,436 gallons/year - 17,777,693 gallons/year = 786,539 gallons/year or ~ 786,500 gallons/year**

New York City Portable Water Cost[8] = $3.39 / CCF (hundred cubic feet)

786,500 gallons / 748 = 1051.52 CCF
1051.52 CCF * $3.39 = $3,564.66 or ~ $3500

Species numbers and percent of natives were pulled from the 100% construction drawing planting schedule.

Limitations of Methodology:

- This comparison assumes a typical irrigation need for a lawn of 1 inch/week
- Cost avoidance estimates are based on a 20-week irrigation period at 1 inch of rain per square feet per week. In reality this this will fluctuate in time and amount of rainfall based on weather conditions.
- Water loss through evaporation will fluctuate from year to year based on weather conditions.
-

Stores 4,698 lbs of carbon and sequesters 1079 pounds of carbon per year in 206 new trees on-site and adjacent to the site.

Utilized i-Tree Eco v5 and data collected on site. See table 1 for calculations. While all these new trees were included in the project's scope of work, "the site" refers to Dutch Kills Green while "adjacent to the site" refers to the surrounding streetscape improvement areas.

Limitations of Methodology:

- Carbon storage and sequestration estimates do not include non-tree vegetation
- Carbon storage and sequestration will vary with annual weather fluctuations

[8] http://www.nyc.gov/html/nycwaterboard/html/rate_schedule/index.shtml

Tree Characteristics in Dutch Kills Green by Species

Series: DKG, Time Period: 2013

	Tree Count		Canopy Cover (ft2)		Leaf Area (ft2)		Leaf Biomass (lb)		Carbon Storage (lb)		Gross Carbon Seq (lb/year)		Structural Tree Value ($)	
Species Name	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**	**Value**	**%**
Apple serviceberry	15	8.62	16.1	0.31	25.8	0.17	0.3	0.14	58.8	1.25	28.8	2.67	675.0	1.43
Eastern redbud	4	2.30	111.9	2.12	312.2	2.09	4.1	1.76	58.7	1.25	16.0	1.48	532.0	1.13
European hornbeam	62	35.63	1,810.5	34.26	5,035.0	33.79	62.5	27.05	1,807.0	38.46	449.7	41.69	14,632.0	30.97
Northern red oak	31	17.82	1,201.3	22.73	3,668.2	24.62	60.1	26.03	1,327.2	28.25	235.9	21.87	14,473.0	30.63
Staghorn sumac	24	13.79	671.7	12.71	1,872.9	12.57	36.5	15.81	467.5	9.95	121.8	11.29	4,016.0	8.50
Swamp white oak	5	2.87	193.8	3.67	454.8	3.05	9.1	3.96	146.4	3.12	37.9	3.52	1,840.0	3.89
Sweetbay	9	5.17	348.8	6.60	955.2	6.41	28.0	12.11	262.3	5.58	65.3	6.05	2,790.0	5.90
Sweetgum	13	7.47	503.8	9.53	1,319.5	8.85	12.3	5.34	261.7	5.57	46.4	4.30	5,473.0	11.58
Tulip tree	3	1.72	116.3	2.20	409.1	2.75	5.0	2.15	75.6	1.61	18.8	1.75	930.0	1.97
Yellowwood	8	4.60	310.0	5.87	849.1	5.70	13.1	5.65	233.2	4.96	58.0	5.38	1,888.0	4.00
TOTAL	**174**	**100**	**5,284**	**100**	**14,902**	**100**	**231**	**100**	**4,698**	**100**	**1,079**	**100**	**47,249**	**100**

Social

Increased bicycle traffic by 12% since the project was completed in 2011 with an average of 3,416 cyclists using the bicycle path per day. On average 7% of these users stop to use either the green or median seating areas.

Bicycle traffic over the Queensboro Bridge has steadily increased since 2007. Between 2007 and 2010 alone, bicycle traffic increased 147% compared to 50% on the Brooklyn Bridge. Since the streetscape improvements were completed in July 2011, traffic increased another 12%. Over the same period, bicycle traffic over the Brooklyn Bridge increased on 2%.

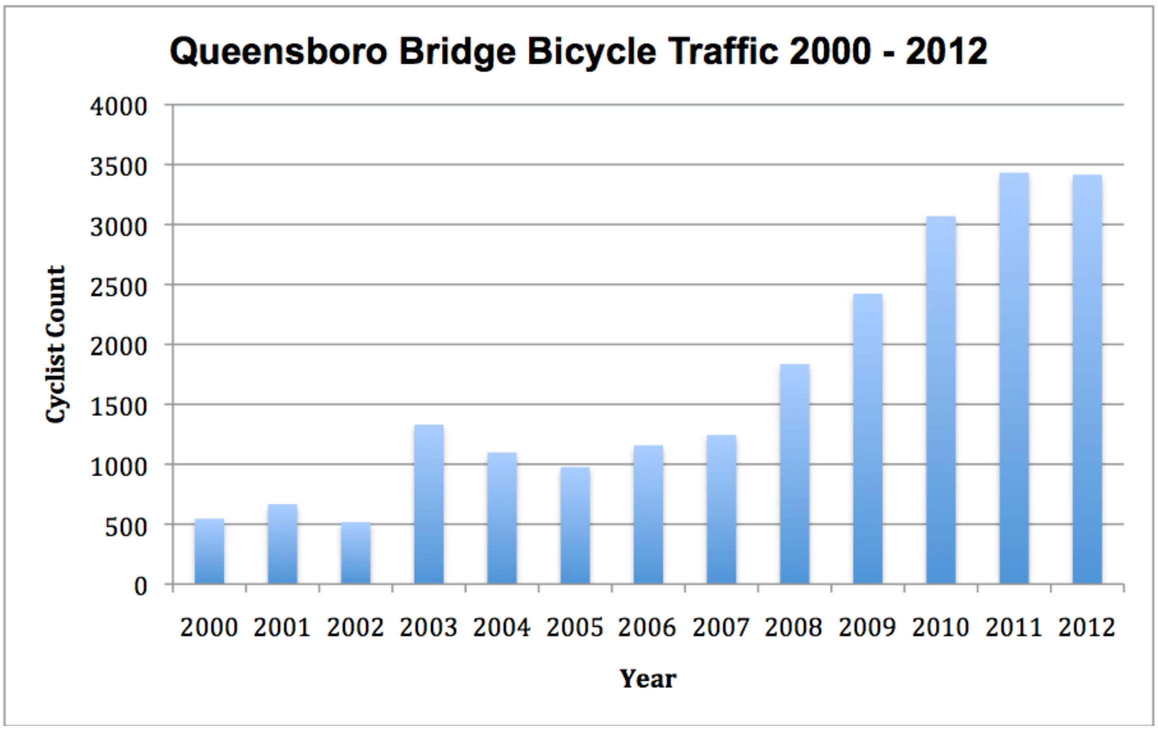

Figure 1. Queensboro Bridge Bicycle Traffic (daily users in a 12-hour period) 2000 - 2012

2000 through 2012 cycling data for the Queensboro and Brooklyn Bridges (figure 3) comes from the NYC DOT[9]. Counts are based on a 12-hour count performed between 7am and 7pm in August.

To determine how many cyclists stopped to use the green or median seating areas, the City's cyclists counts were adjusted to use seating data collected on site:

Average number of Cyclists= 3416[10]*(5/12)[11] = 1423

Percent cyclists using Green or Median Seating Areas = Number of Cyclists Using Median Seating / Average number of Cyclists

= 98 / 1423 = 6.9% or ~7%

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[9] http://www.nyc.gov/html/dot/downloads/pdf/2012-nyc-bicycle-screen-count.pdf

[10] Number of cyclists counted in 12-hour period in August 2012

[11] Average number of cyclists adjusted for 5-hour period (seating data was counted on-site over a five hour period)

Data	Number of Cyclists Using Median Seating	Number of Cyclists
7/24/13	107	1423
7/25/13	77	1423
7/27/13	109	1423
Average	**98**	**1423**

Table 4. Results of Cyclists using Seating areas (includes Dutch Kills Green and Median Seating Areas)

Benefits of methodology:

- Offers potentially compelling metrics about social performance
- Accepted as rigorous method by professional and academics
- Does not require IRB review
- Offers valuable learning for research assistants
- Results are objective

Limitations of Methodology:

- Absence of baseline data means data from such a short-term study has questionable statistical power
- Data collection is time intensive (although this can be reduced through group work)
- Objective outcomes are not always positive (i.e. – benefits)

Helped reduce pedestrian and cyclist fatalities. Thanks to safety improvements like new pedestrian countdown signals, 2011 marked the first year that no deaths were recorded along Queens Boulevard, infamously known for many years as the "Boulevard of Death."[12] This is down from a high of 18 pedestrian deaths in 1997.

Data based on statistics reported by NYC DOT[13]. These statistics are for a 7.2-mile stretch of Queens Boulevard, 0.43 miles of which are included in the project's scope of work.

- Between 1993 and 2000, 72 pedestrians were killed[14] – an average of over 10 per year
- Between 2001 and 2012, 26 pedestrians were killed[15] [16] –an average of 2.4 pear year
- Comparing the period 1993 through 2000 to the period 2000 through 2012, reveals a 76% decrease in fatalities (10.1 pedestrians per year compared to 2.4 pedestrians per year)

2001	4
2002	2
2003	5
2004	1
2005	2

[12] http://abclocal.go.com/wabc/story?section=news/local&id=6752538
[13] http://www.nyc.gov/html/dot/html/pr2012/pr12_04.shtml
[14] http://www.nytimes.com/2006/10/04/nyregion/04boulevard.html?pagewanted=print
[15] http://wiki.answers.com/Q/How_many_pedestrians_are_killed_on_Queens_Boulevard_each_year
[16] http://www.nyc.gov/html/dot/html/pr2012/pr12_04.shtml

2006	2
2007	1
2008	2
2009	2
2010	4
2011	0
2012	1
Average	2.4

Table 2. Pedestrian Fatalities along Queens Boulevard 2001 to 2012

Limitations of Methodology:

- Data was not readily available for the section of Queens Boulevard in question and is based on the full length of the road of 7.2 miles.
- It is unclear how much of the improved safety can be directly attributed to improvement that formed part of the Queens Plaza Bicycle and Pedestrian Landscape Improvement Project.

Reduces average ambient noise within the green by 23%. By removing two lanes of traffic that formerly bisected the space and adding lush vegetation, noise from traffic and the elevated rail lines decreased from a typical range of 85-101dB to 69-75dB.

Sampled 3 locations using the "Decibel Meter Pro" application for the Apple iphone[17]. Two location were within the green itself and, to mimic former conditions, the third was at the edge of the green. The average ambient noise level, based on three minutes of monitoring, was recorded for each location three times on three separate days at 9am, noon, and 5pm. The two locations within the green were then averaged and compared against the location at the edge of the green. The average ambient noise at the edge of the green was 93dB with range between 85dB and 101dB. The average ambient noise within the green was 72dB with range between 69dB and 75dB.

Limitations of Methodology:

- Pre-project noise measurements were not available for comparison and had to be simulated.
- The precision and accuracy of the application is limited by the sensitivity of the iphone microphone. Professional equipment might produce more accurate results.

Attracts an average of 125 people per day during summer months (June through September). Of these visitors, 92% engaged in recreational activities, 57% of which were also social activities.

User data was collected on site in summer 2013 using the Public Space, Public Life (PSPL) survey method developed by Jan Gehl[18]. The PSPL survey method includes both bicycle/pedestrian counts and a stationary survey. Park users were observed on three separate site visits during summer 2013 (two week days and one weekend day) collecting information about use duration and time, user age, gender, purpose (recreation or work), type of activity (necessary, optional, social), position (sit/stand), location within the space, in/out patient/visitor

[17] https://itunes.apple.com/us/app/decibel-meter-pro/id382776256?mt=8
[18] Gehl, Jan. 1971. Life Between Buildings: Using Public Space. Arkitektens Forlg.

status. By the survey's definition, optional and necessary activity are mutually exclusive, while social activities are potentially inclusive.

Necessary activities include those things that people would do regardless of the quality of the space. For example the mail carrier will deliver the package, the business executive will walk to her office. Optional activities these are those activities that people choose to do and—importantly—where they choose to do them. For example sitting in a sunny place to eat their lunch or reading a book. Social activities occur when people interact spontaneously when they are engaging in necessary or optional activities. Gehl shows that more successful public spaces have a higher number of optional and social activities.

Results of stationary survey are summarized below:

Date	User Count	Average Length of Stay (minutes)	Type of Use (Count)		
			Necessary	Optional	Social
7/24/13	138	8	15	123	62
7/25/13	93	7	9	84	42
7/27/13	147	12	7	140	96
Average	**125**	**9**	**10**	**115**	**66**

Percent of Optional Users	92%
Percent of Necessary Users	8%
Percent of Social Users	52%

Table 3. Results of Stationary Survey (includes Dutch Kills Green and Median Seating Areas)

Economic

Saves the city between $20,000 and $37,000 annually from reduced energy consumption, CO2 storage and sequestration, and air quality improvements.

The NYC Department of Environmental Protection estimated and compared long-term operations and maintenance (O&M) costs to the City under both Green and Grey Strategy scenarios. DEP's modeled the annual net benefit from vegetated sources in 2030. The model included benefits such as reduction energy consumption, CO2 storage and sequestration, improvements to air quality, and improvement to surrounding property value. Depending on the health of the vegetation (either 100% healthy or 50% healthy), the DEP estimated this value to be between $7,771 and $14,457 per acre annually by 2013.[19]

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[19] R.M. Roseen, T.V. Janeski, J.J. Houle, et al. Forging the Link: Linking the Economic Benefits of Low Impact Development and Community Decision. University of New Hampshire Stormwater Center, Virginia Commonwealth University, and Antioch University New England. July 2011 http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/docs/FTL_Chapter3%20LR.pdf in American Rivers, the Water Environment Federation, the American Society of Landscape Architects and ECONorthwest. 2012. Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide. http://www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banking%20on%20Green%20HighRes.pdf

Projected value (according to NYC DEP) of the annual benefits from vegetated courses in 2030:

Features area[20]: 112,140.89 sf or 2.574 acres
Annual benefits of fully vegetated sources in 2030 ($/acre) = $14,457/acre
Annual benefits of partially vegetated sources in 2030 ($/acre) = $7,771/acre

2.574acres * $14,457 = $37,212
2.574acres * $7,771 = $20,002

Limitations of Methodology:

- The benefit estimates are not site specific and based on averages for the City of New York

Increases property value of surrounding properties. Between 2006 and 2013 – a period when the real estate value in the six largest U.S. Metro markets (including NYC metro) grew by only 8% – the estimated market value of properties surrounding Dutch Kills Green increased 37%.

Figure 2. Dutch Kills Green Economic Assessment Area

Using an assessment boundary definition[21] of half a block (see figure 1), we used assessors' data from the City of New York[22] to determine for the site property and the adjacent property (within a half black radius). Using data from 2006 through 2013, Figure 2 shows the results of the analysis. These were benchmarked against Moody's/RCA United States Commercial Property Price Index

[20] The feature area includes all the infiltration planters. It does not include any paving areas although the spaces between the motarless paving does provide some permeability.
[21] http://gis.nyc.gov/taxmap/map.htm
[22] http://nycprop.nyc.gov/nycproperty/nynav/jsp/stmtassesslst.jsp

(CPPI)[23] which tracks real estate values in the six largest US real estate metro markets including NYC metro[24]. Over the same period (2006 through 2013) the US real estate market shrunk 1%.[25]

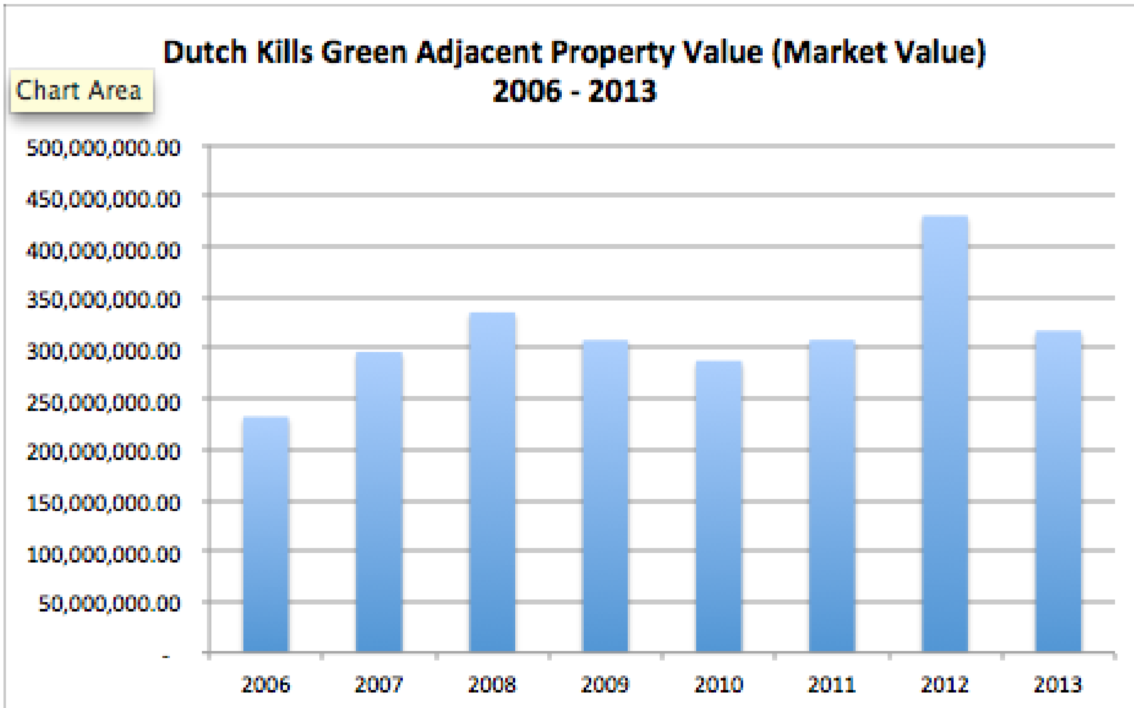

Figure 3. DKG Adjacent Property Value 2006 - 2013

Limitations of Methodology:

- The dataset is based on the period 2006 through 2013. This is a relatively short period for a statistically powerful economic analysis.
- The project period coincided with a greatest economic downturn in over 40 years, making an objective analysis more challenging.
- A more thoughtful analysis might also include an analysis using a larger assessment area or breaking down changes in property value by real estate type (retail, commercial, home).

Cost Comparison Methodology

To create the median "No-Go" barriers, 32,145 sf (803 tons) of concrete were reused. Paving this area with 214 tons of new concrete would have cost $135,000. An equivalent area of permeable paving would have cost $270,000. Reusing concrete on-site also avoided adding over 30 tons of carbon dioxide to the atmosphere through the production of new cement, as well as the transportation and tipping fees associated with removal of the debris after demolition. Tipping fees for the demolished material would have come to over $75,000 and transporting this material to a nearby transfer station would have cost close to

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[23] https://www.rcanalytics.com/public/rca_cppi.aspx

[24] The six major metro real estate markets included in the index are Boston, Chicago, Los Angeles, New York, San Francisco and Washington DC

[25] http://www.google.com/finance?cid=2055260

$400,000. As a result the total cost avoided from this design solution is estimate to be $500,000-$630,000.

Analysis of Reuse of Sidewalk Concrete in Median "No-Go" Areas

Availability of Concrete for Reuse:

Concrete from Jersey barriers and sidewalks found on site was available for the new median "No-Go" barrier that allows for stormwater infiltration but directs pedestrians and bicyclists toward safe passage through the new crosswalk and bike path system.

Yield of Demolished sidewalks for reuse: 73,309 sf
(each 25 SF of sidewalk yields 6.67 sf area in "standing up" placement)[26],
this will yield: 73,309 / 25 = 2932.36
2932.36 * 6.67 = 19,558 sf

Area of Median "No-Go" Areas: 8575.93 sf needed. Remainder (10,982.91 sf) available for modulating height and "filling in gaps"

Cost Avoidance

Reusing concrete for the new median "No-Go" areas avoided a number of costs including installing new concrete sidewalk or permeable paving. Since the cost of demolition would have occurred irrespective, the figure is only included for reference.

Median "No-Go" Areas: 8575.93 sf

Demolished concrete needed = 8575.93 sf * (25sf/6.67sf)[27] = **32,143.62 sf**

32,143.62 sf * $3.50/sf = $112,502.69
cost to demolish needed concrete: $112,502.69

8575.93 sf * $15.75/sf = $135,070.90
if new concrete sidewalk: $135,070.90

8575.93 sf * $31.50/sf = $270,141.80
if permeable pavement: $270,141.80

Greenhouse gas emission avoided by reusing concrete:

Concrete Weight: 150 lbs/cf[28] *
Median "No-Go" Areas: 8575 sf

If new concrete sidewalk had been poured @ 4" depth:

8575 sf * (4/12) = 2858.64 cf
x 150 lbs/cf

428796 lbs or 214.4 tons of new concrete

[26] Tobiah Horton, landscape architect, personal communication
[27] Each 25 SF of sidewalk yields 6.67 sf area in "standing up" placement
[28] http://www.lafarge-na.com/wps/portal/na/en/3_A_11_4-Concrete_Yield__Unit_Weight_&_Suspected_Shortages (depends on mix)

2858.64 cf = 105.87 cubic yard

x 630 lbs CO2/cubic yard (emissions from production of concrete[29])

66,701.59 lbs CO2

33.35 tons CO2 for new concrete surfaced medians

Avoided Tipping fees[30]:

A tipping fee is a cost paid for disposing of construction waste in a landfill. The closest landfill for this project would have been in Newark, NJ. Since so much concrete was reused, this was a significant cost avoidance.

$93.92/ton

32,143.62 sf * (4/12) *150/lbs/sf = 1,607,181/41 lbs or 803.59 tons

803.59 @ $93.92/ton = **$75,473.17**

Transportation:

Site to transfer Station in Newark, NJ: 20 miles
Cost: $25 per ton per mile[31]

803.59 tons * 20 miles * $25/ton/mile = **$401,795.00**

Total Cost Avoided = Cost of new paving + cost of tipping fees + cost of transportation to transfer station – cost to demolish needed concrete

With new concrete paving:

$135070.90 + $75,473.17+ $401,795.00- $112,502.69 = $499,836.37

With new permeable paving:

$270,141.80 + $75,473.17+ $401,795.00- $112,502.69 = $634,907.27

[29] http://psccsi.org/article-01/
[30] http://mcmua.com/sw_ts_tippingfees.asp
[31] http://news.thomasnet.com/green_clean/2012/10/31/used-concrete-once-for-the-landfill-now-heads-to-recycling-facilities/