LANDSCAPE PERFORMANCE SERIES

Nova Southeastern Oceanographic Center: Phase I Landscape – Hollywood, FL
Methodology for Landscape Performance Benefits

Figure 1 & 2.Before and after images of *Nova Southeastern University Oceanographic Center*. Courtesy of EDSA, Inc

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This document is a supplemental worksheet that elaborates on the environmental, social, and economic performance benefits of the *Nova Southeastern University Oceanographic Center: Phase I Landscape* that were identified through case study research conducted between March and August of 2014. The research was part of the 2014 Case Study Investigation (CSI) Program funded by the Landscape Architecture Foundation (LAF). The complete findings of the research are published as a brief in the *Case Study Briefs* database of LAF's *Landscape Performance Series*. This worksheet lists all performance benefits identified and specifies the methods employed in their determination and/or calculation.

Environmental

Performance Benefit 1

Sequesters approximately 5.6 tons of carbon and intercepts 47,800 gallons of stormwater in 209 new trees.

Methodology

Some of the plant materials on the landscape architect's planting plan were replaced after the completion of the project. We crosschecked the plants listed on the planting plan to determine what exists now. Then we used the dbh values on the landscape architect's planting plan. The site includes 43 silver buttonwoods, 21 green buttonwoods, 31 live oaks, 27 seagrapes, 26 gumbo limbos, 17 royal palms, and 44 cabbage palms equaling to a total of 209 newly planted trees.

Figure 1. On-site taking measurements of dbh.

Nova Southeastern University Oceanographic Center : Phase I				Individual	Overall
Quantity	Latin Name	Common Name	(D) Diameter (Inches)	Total CO2 Sequestered (lbs)	Total CO2 Sequestered (lbs)
Canopy Trees					
4	*Bursera simaruba*	Gumbo Limbo	3"	48	192
10	*Bursera simaruba*	Gumbo Limbo	4"	72	720
5	*Bursera simaruba*	Gumbo Limbo	6"	127	635
7	*Bursera simaruba*	Gumbo Limbo	5"	98	686
14	*Conocarpus erectus*	Green Buttonwood	4"	41	574
7	*Conocarpus erectus*	Green Buttonwood	5"	59	413
14	*Conocarpus erectus'sericeus'*	Silver Buttonwood	4"	41	574
14	*Conocarpus erectus'sericeus'*	Silver Buttonwood	6"	81	1134
6	*Conocarpus erectus'sericeus'*	Silver Buttonwood	5"	59	354
9	*Conocarpus erectus'sericeus'*	Silver Buttonwood	3"	28	252
5	*Coccoloba uvifera*	Seagrape	4"	59	295
7	*Coccoloba uvifera*	Seagrape	5"	76	532
15	*Coccoloba uvifera*	Seagrape	3"	43	645
5	*Quercus virginiana*	Live Oak	3"	27	135
26	*Quercus virginiana*	Live Oak	4"	39	1014
Total:					8155
Palms					
9	*Roystonea regia*	Royal Palm	9"	53	477
8	*Roystonea regia*	Royal Palm	8"	48	384
33	*Sabal palmetto*	Cabbage Palm	8"	48	1584
11	*Sabal palmetto*	Cabbage Palm	9"	53	583
Total:					3028
				Grand Total	11183
				Overall Total throughout site	
				Overall Total	11183
				11183 lbs =	5.5915 tons annually
				Total Number of trees:	209

Table 1. Tree potential for carbon sequestration.

We used the National Tree Benefit Calculator (http://www.treebenefits.com/calculator/) to calculate the annual carbon sequestration amount shown on the above table.

For example: A single *Gumbo Llimbo* tree of 4" DBH sequesters 72 lbs of CO2. There are total (10) *Gumbo Limbo* trees with a 4" DBH. Thus, the total amount of CO2 sequestered by (10) *Gumbo Limbo* trees would be:

72 lbs x 10 = 720 lbs

One metric ton comprises of 2204 lbs. Thus, the total CO2 sequestered with the help of all the trees would be:

11183 / 2204 ~ 5.07 metric tons

Nova Southeastern University Oceanographic Center : Phase I				Individual Tree	Overall Trees
Quantity	Latin Name	Common Name	(D) Diameter (Inches)	Stormwater intercepted per gallon	Total Stormwater intercepted per gallon
Canopy Trees					
4	*Bursera simaruba*	Gumbo Limbo	3"	221	884
10	*Bursera simaruba*	Gumbo Limbo	4"	324	3240
5	*Bursera simaruba*	Gumbo Limbo	6"	559	2795
7	*Bursera simaruba*	Gumbo Limbo	5"	436	3052
14	*Conocarpus erectus*	Green Buttonwood	4"	147	2058
7	*Conocarpus erectus*	Green Buttonwood	5"	196	1372
14	*Conocarpus erectus'sericeus'*	Silver Buttonwood	4"	147	2058
14	*Conocarpus erectus'sericeus'*	Silver Buttonwood	6"	249	3486
6	*Conocarpus erectus'sericeus'*	Silver Buttonwood	5"	196	1176
9	*Conocarpus erectus'sericeus'*	Silver Buttonwood	3"	102	918
5	*Coccoloba uvifera*	Seagrape	4"	252	1260
7	*Coccoloba uvifera*	Seagrape	5"	337	2359
15	*Coccoloba uvifera*	Seagrape	3"	182	2730
5	*Quercus virginiana*	Live Oak	3"	105	525
26	*Quercus virginiana*	Live Oak	4"	162	4212
Total:					32125
Palms					
9	*Roystonea regia*	Royal Palm	9"	274	2466
8	*Roystonea regia*	Royal Palm	8"	249	1992
33	*Sabal palmetto*	Cabbage Palm	8"	249	8217
11	*Sabal palmetto*	Cabbage Palm	9"	274	3014
Total:					15689
				Grand Total	47814
				Overall Total throughout site	
				Overall Total	47814
				Total Number of trees:	209

Table 2. Trees' potential for stormwater interception

We used the National Tree Benefit Calculator (http://www.treebenefits.com/calculator/) to calculate the annual stormwater interception amounts shown on the above table.

For example: A single G*umbo Limbo* tree of 4" DBH intercepts 324 gallons of stormwater. There are total (10) *Gumbo Limbo* trees with a 4" DBH in the planting plan of the Nova Southeastern University Oceanographic Center. Thus, the total amount of stormwater intercepted by (10) *Gumbo Limbo* trees would be:

324 gallons x 10 = 3,240 gallons

Limitations of methodology

- The online calculator doesn't list all tree species used in the project. Therefore the calculations may include the values calculated using generic species of similar kind.
- Carbon sequestration calculations do not include non-tree vegetation such as groundcovers.
- Carbon storage and sequestration may vary with yearly weather fluctuations.

Performance Benefit 2

Reduces annual potable water consumption by 82,750 gallons or 54% through the use of a water-efficient irrigation system compared to a conventional system.

Methodology

We calculated the difference between a water-efficient irrigation system and a conventional system shown in the table below:

Nova Southeastern University Oceanographic Center			
Native Landscape Irrigation Usage			
Plant Type	Irrigation Type	Irrigated Area (sf)	TWA (gal)
Shrub	MP Rotators	10681	13812.91
Shrub	MP Rotators	1965	977.38
Trees	Bubblers	2044	3151.68
Shrub	Drip	1171	1304.04
Trees	Bubblers	2008	2211.55
Turf	MP Rotators	13055	26715.99
Trees	Bubblers	1809	2789.33
Turf	MP Rotators	11245	19176.65
Average (gals):		43978	70139.53

Nova Southeastern University Oceanographic Center			
Conventional Landscape Irrigation Usage			
Plant Type	Irrigation Type	Irrigated Area (sf)	TWA (gal)
Shrub	Spray	10681	33942.5
Shrub	Spray	1965	3174.15
Trees	Spray	2044	9244.94
Shrub	Spray	1171	4918.08
Trees	Spray	2008	6487.22
Turf	Spray	13055	50611.97
Trees	Spray	1809	8182.04
Turf	Spray	11245	36329.1
Average (gals):		43978	152890.00
		Difference (gals):	82750.47

Table 3. Irrigation comparison of water efficient & conventional irrigation

Limitations of methodology

- The information provided above comes from secondary sources and may have some factual errors that cannot be detected or confirmed by our research team.

Performance Benefit 3

Reduces average air temperatures on portions of the site by 1.7°F when compared to nearby areas that closely resemble what was there before redevelopment.

Methodology

In order to measure air temperatures at the same time at parallel locations, we set up digital thermometer pairs. We used Acu-Rite Wireless #00782 indoor/outdoor thermometer:

Air temperatures were measured by placing each thermometer about 2-feet above ground hanging inside a milk crate, shaded from direct sunlight with a 1-inch-thick wood board:

Figure 2. Affordable temperature measurement system created using milk crates.

Figure 3. The locations sampled are marked on the above aerial:

1- Air temperatures on concrete sidewalk (partial-shade)
2- Air temperatures on asphalt paving in parking lot (shade)
3- Air temperatures on textured paving near understory planting materials located on the marina dock (no-shade)
4- Air temperatures on mixed coral reef particle paving near building entrance (no-shade)
Weather in Dania Beach on July 7, 2014 was mostly sunny with a mean temperature of 84 degrees and a maximum temperature of 90 degrees.

(http://www.wunderground.com/history/airport/KFLL/2014/7/7/MonthlyHistory.html?req_city=NA&req_state=NA&req_statename=NA).

We recorded values at each hour between 9:00 am to 1:00 pm on July 7, 2014. Temperature data were recorded during the time specified and can be seen in the table below. Temperature differences between surfaces were calculated by finding the difference in temperature each hour:

astern University Oceanographic Center : Phase I			Monday- July 7, 2014	
	1	3	(°F)	(%)
Weather Condition	Concrete sidewalk	Marina Dock	Difference in Temperature	Difference in Temperature
Sunny	92.3	88.3	4.0	4.43%
Mostly Cloudy	91.9	93	1.1	-1.19%
Mostly Cloudy	94.5	95.9	1.4	-1.47%
Mostly Cloudy	94.5	89.8	4.7	5.10%
Rain	87.1	88.5	1.4	-1.60%
	92.1	91.1	1.0	1.05%

astern University Oceanographic Center : Phase I			Monday- July 7, 2014	
	2	4	(°F)	(%)
Weather Condition	Parking lot	Coral Reef mixed paving	Difference in Temperature	Difference in Temperature
Sunny	87.8	88.3	0.5	-0.56%
Mostly Cloudy	91.9	88.3	3.6	4.07%
Mostly Cloudy	93.9	93.4	0.5	0.53%
Mostly Cloudy	93.4	86.9	6.5	7.48%
Rain	88.7	86.9	1.8	2.07%
	91.2	88.8	2.38	2.72%

Table 4. Air temperature differences of tree shaded and non-shaded areas.

We measured air temperatures of a tree shaded area and not shaded area of a walkway that connects the entry, parking lot, and the building. We have taken measurements of two specific areas, parking lot and coral reef mixed paving areas. We extrapolated given temperatures through the Acu-Rite device to represent the air temperature change across the entire site.

Limitations of methodology

- Due to the high cost of more accurate thermometers, we used Acu-Rite Wireless #00782 which was relatively inexpensive. This may not be the most accurate device for such a temperature study.
- Since the project was recently completed in 2012, the planted trees are not yet fully matured. It is expected that the tree canopy densities (and also canopy coverage) will significantly increase within the next several years, providing more coverage and better shade.

Social

Performance Benefit 4, 5, 6, 7

Improves quality of life for 72% of the 15 faculty, staff, and student survey respondents; providing a place to be outdoors, improving perception of the area, and reducing stress were the main reasons cited.

Provides a space for outdoor educational activities for 60% of survey respondents; 87% consider the incorporation of fragments of coral and glass into site materials to be educational.

Methodology

To measure the social benefits of Nova Southeastern University Oceanographic Center: Phase I Landscape, we developed a voluntary survey for all on-campus participants. The administration of Nova Southeastern University informed us that we could not conduct the surveys ourselves, but rather, the administration could conduct the survey for us on the private institution's campus grounds. We were requested to provide printed survey material and appropriate instructions. The administration kindly located our survey material on the reception desk, and informed the faculty, staff, and students about its

presence. The surveys were conducted on campus during the week of July 14 – 18. A total of 15 surveys were retrieved, which included 6 students, 8 faculty/staff, and 1 participant of unknown description.

Figure 5. Survey set-up on reception desk

Survey findings:

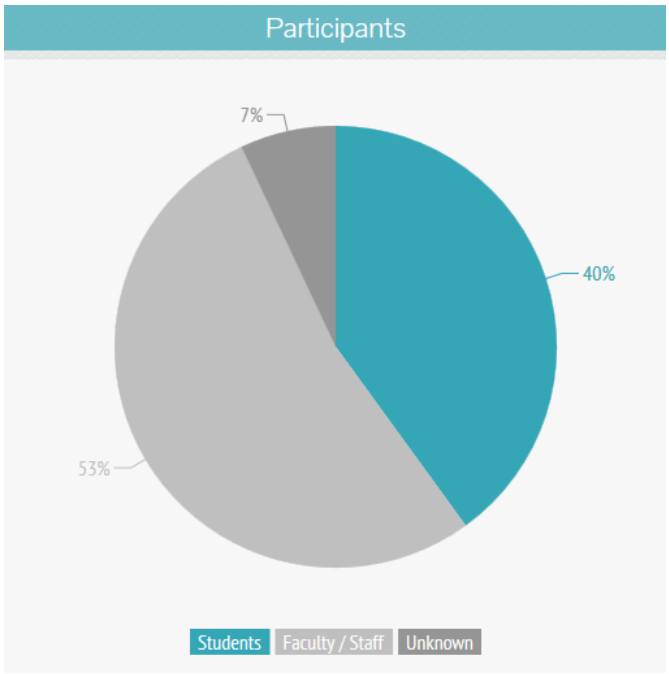

Table 5. 53% of the survey participants were faculty and staff, while 40% were students, and 7% were of unknown description.

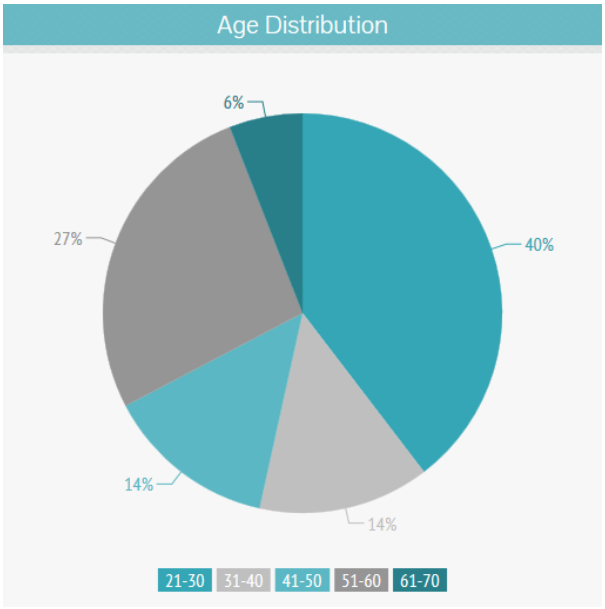

Table 6. 40% of the survey participants were between the ages of 21-30, while 27% were between the ages of 51-60, 14% were between the ages of 31-40 and 41-50, and 6% between the ages of 61-70.

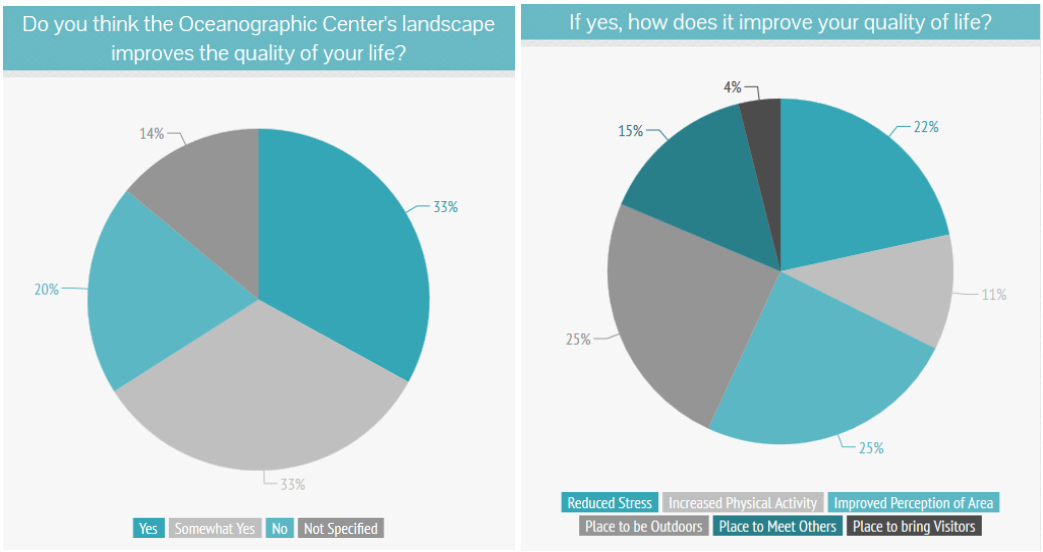

Table 7. 72% of the survey participants felt that through newly redesigned Campus and its incorporated landscape environment reduces mental stress and provides a sense of place and comfort of being outdoors.

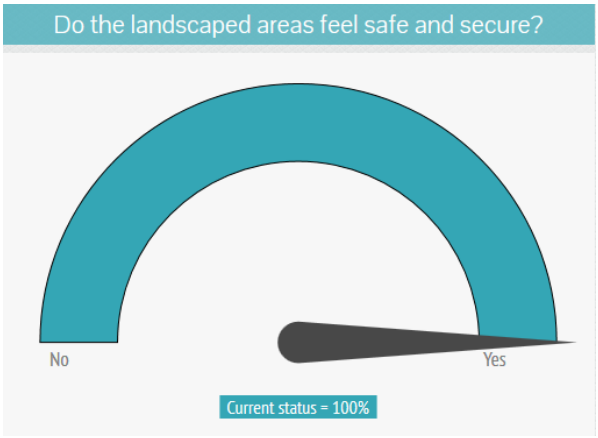

Table 8. 100% of the survey participants felt safe and secure in landscaped areas.

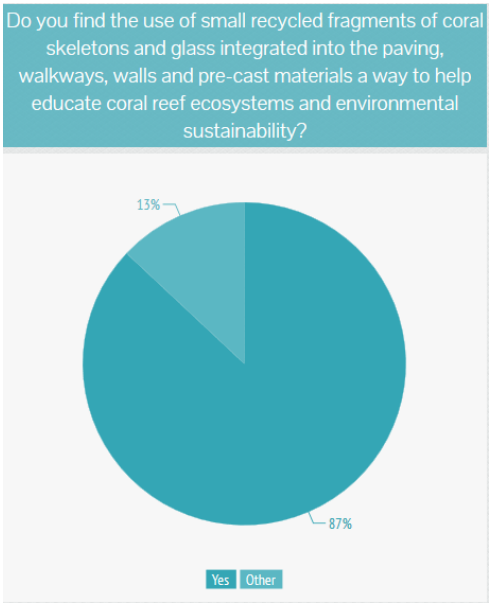

Table 9. 87% of survey participants find the use of small recycled fragments of coral skeletons and glass integrated into the paving, walkways, walls and pre-cast materials helps educate coral reef ecosystems and environmental sustainability.

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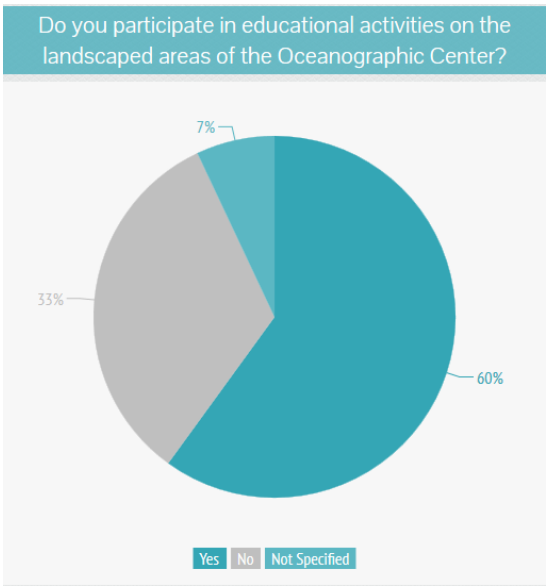

Table 10. 60% of the survey participants in educational activities on the landscaped areas.

Limitations of methodology

- Due to limited amount of participants and partially completed surveys, the results of the survey may or may not reflect the views of all participants.
- The CSI program runs through the campus' summer term semester, which has the lowest enrollment of students and fulltime faculty and staff.

Sources:

1. http://www.nova.edu/ocean/forms/ocean_graduate_calendar.pdf

Economic

Performance Benefits 8

Contributed to the creation of 300 jobs during construction and after project completion, including 44 full-time positions and 50 graduate student assistantships related to oceanographic research.

Methodology

Vice President of Facilities shared employment data. It is also found on the University's website, under press releases, linked to other websites such as SunSentinel, Miami Herald, and Biz Journals.

Sources:

1- http://www.advancedaquarist.com/blog/americas-largest-coral-reef-research-center-to-open-its-doors-on-september-27
2- http://www.miamiherald.com/2012/09/27/3023921/nova-southeastern-opens-50-million.html
3- http://www.bizjournals.com/southflorida/blog/morning-edition/2012/09/nsu-coral-reef-research-center-to-open.html

Limitations of methodology

- The information provided above comes from secondary sources and may have some factual errors that cannot be detected or confirmed by our research team.

SUSTAINABLE FEATURES IDENTIFIED & METHOGOLOGIES UTILIZED

Sustainable Feature 1

The site design increased functional open space by approximately 34% with roughly 2 acres of landscape that has easy pedestrian access to conduct research, host events, and sit.

Methodology

We measured the area of Phase I and its open spaces from master map. Phase I, included approximately 260,991 sf, while designated to conduct research, host events, and site take up roughly 88,369 sf of the site.

We calculated:

88,369 / 260,991 = 0.34 x 100 = 34% of open space

Limitations of methodology

- None.

Sustainable Feature 2

Runoff from roof, road, parking lot, and hardscape surfaces is collected and managed through a network of catch basins and infiltration trenches. When the quantity of rainfall is large, or the duration of storm is extended, the runoff can be stored in two detention basins, where it slowly percolates into the soil, or evaporates.

Methodology

Figure 9. Stormwater management and flow diagram.

We obtained drainage drawings and related information from Craven & Thompson Associates, Inc., who took part in the stormwater management system implemented on site.

Nova Southeastern University Oceanographic Center: Phase I					
Pre-development vs Post-development					
	Coefficient of Runoff	Intensity of the Storm	Area	Flowrate (cfs)	Improvement
Pre-development					
100-year, 24-hr rainfall event	0.10	13.50 / 24 hr	6.00	0.36	
Post-development					
100-year, 24-hr rainfall event	0.30	13.50 / 24 hr	6.00	1.08	
Average (gals):			Difference	0.72	33%

Table 11. Pre-development and post-development stormwater runoff discharge flow rates

Limitations of methodology

- None.

Sustainable Feature 3

The center contains 8,354 sf of secured outdoor land-based coral nursery areas. Corals are cultured in 18 tanks ranging from 80 gal to 1000 gal. When specimens grown on site reach an appropriate size and age, they are then transplanted to reefs in the ocean. Coral reefs play an important role as natural barriers that help protect coastal cities from the impacts of storm surge. They also support an estimated 25% percent of all marine life.

Figure 6: Nova Southern University Oceanographic Center: Coral Reef Tank Research Area

Methodology

On one of our visits on Campus, we were able to speak with some of the graduate students working on their thesis in the 8,354 sf Coral Reef Tank research area. We were able to familiarize ourselves with what exactly each area of tanks were designated for. We took measurements of existing tanks throughout the designated space using a Fiberglass long tape ruler.

Limitations of methodology

- We were not permitted to uncover sheets placed on top of the coral tanks while they were undergoing experimentation, without some assistance. In the image below, you can see a zoomed-in image of one of the student experimental tanks with the assistance of one of the graduate students found on site during our visit.

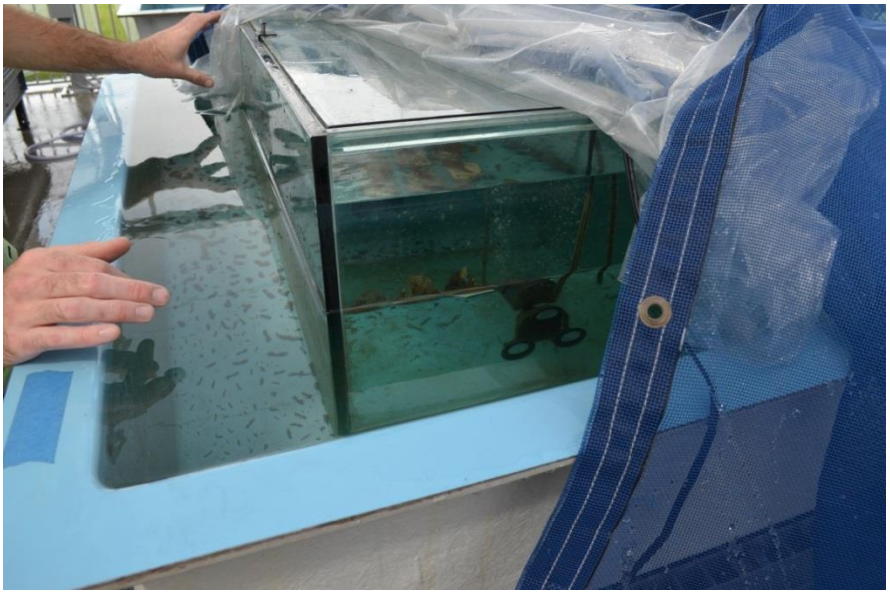

Figure 7: Nova Southern University Oceanographic Center: Coral Reef Tank Research Area

Sustainable Feature 4

209 new trees were added in a variety of native species, including gumbo limbos, cabbage palms, silver buttonwoods, and live oaks. 45 existing trees were removed to thier poor condition.

Limitations of methodology

- With given information by the Landscape Architect on the 'existing' planting plan, the trees that were removed due to poor conditions during the pre-development stages are not considered 'replaced' since the same tree specimen were not installed in the same areas. We are not able to consider these trees as 'replaced' but as 'removed'.

Sustainable Feature 5

The design incorporates small recycled fragments of coral skeletons and glass into walkways, walls, and pre-cast materials. These cover 15,100 sf or 5.8% of the site and serve both decorative and educational purposes.

Methodology

We took measurements from the site plan. We measured the area of Phase I from master map. We calculated:

15,076 / 260,991 = 0.0577
0.0577 x 100 = 5.8%

Sustainable Feature 6

Durable materials such as reinforced concrete paving, 14 steel benches, and an aluminum bike rack were chosen to withstand ocean salt spray, winds, and the severe weather events that periodically affect South Florida's coastal areas. These materials will not corrode or degrade quickly.

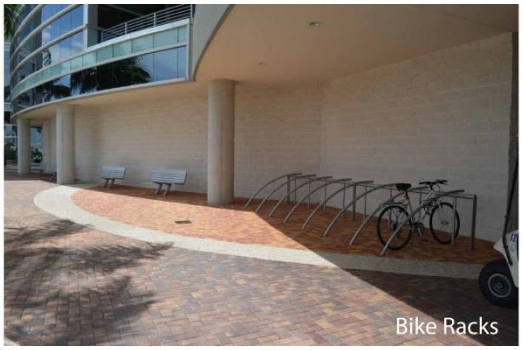

Figure 8: Nova Southern University Oceanographic Center: Furnishings

Sustainable Feature 7

The parking lot provides spaces for both the university and state park visitors. Becasue peak demand for each occurs at different times, the shared parking allowed the total number of parking spaces to be reduced.

Cost Comparison Methodology

Cost Comparison 1

The use of an efficient irrigation system reduces potable water consumption by 82,750 gallons annually as compared to a conventional irrigation system. This saves approximately $800 in annual irrigation water costs.

Methodology

Nova Southeastern University Oceanographic Center			
Native Landscape Irrigation Usage			
Plant Type	Irrigation Type	Irrigated Area (sf)	TWA (gal)
Shrub	MP Rotators	10681	13812.91
Shrub	MP Rotators	1965	977.38
Trees	Bubblers	2044	3151.68
Shrub	Drip	1171	1304.04
Trees	Bubblers	2008	2211.55
Turf	MP Rotators	13055	26715.99
Trees	Bubblers	1809	2789.33
Turf	MP Rotators	11245	19176.65
Average (gals):		43978	70139.53

Nova Southeastern University Oceanographic Center			
Conventional Landscape Irrigation Usage			
Plant Type	Irrigation Type	Irrigated Area (sf)	TWA (gal)
Shrub	Spray	10681	33942.5
Shrub	Spray	1965	3174.15
Trees	Spray	2044	9244.94
Shrub	Spray	1171	4918.08
Trees	Spray	2008	6487.22
Turf	Spray	13055	50611.97
Trees	Spray	1809	8182.04
Turf	Spray	11245	36329.1
Average (gals):		43978	152890.00
		Difference (gals):	82750.47

Table 12. Water-efficient vs Conventional irrigation (TWA)

Nova Southeastern University Oceanographic Center : Phase I				Individual
Turf Grass Lawn				
Typical Maintenance	Year One	Year Two	Year Three	Annual Expense Beyond 3 Years
Installing Seed, Mulch, & Fertilizer	$2,000	$2,000	$2,000	Consistancy
Mowing	$26,000	$26,000	$26,000	Consistancy
Replacement of Irrigation Nozzles	$2,000	$2,000	$2,000	Consistancy
Annual Expense	$30,000	$30,000	$30,000	
After 3 Years	-	-	-	Consistancy

Table 13. Maintenance of the native landscape

Irrigation savings:

Information was provided by ACAI Associates, Inc., who took part in irrigation design and implementation. We calculated given areas with set irrigation type nozzles used for water-efficiency specified as opposed to spray type of nozzle used primarily on conventional landscapes.

We calculated the difference in gallons of total water applied (TWA) between water-efficient and conventional irrigation usage:

152,890.00 - 70,139.53 = 82,750.47 gals = TWA

Average cost per 100 CCF (centum cubic feet) of Utility Rates and Charges in irrigation is $7.23 with flow rates ranging from 3,600 cf (cubic feet) to 4,900 cf. We obtained this information from the city of Hollywood which provides cost for residential and non-residential flow charges.

We needed to convert from gallons to cubic feet in order to get overall cost:

82,750.47 gal = 11,062.066 cf
11,062.066 / 100 ccf = 110.620666
110.620666 x $7.23 (average cost per ccf) = $799.79 = $800 savings water-efficient system

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Sources:

1. http://www.hollywoodfl.org/DocumentCenter/Home/View/35 (Irrigation only)

Maintenance savings:

Information was provided by Nova Southeastern University Oceanographic Center's department of maintenance. We compared the current costs of water-efficient maintenance and compared it to conventional irrigation.

Cost Comparison 2

By creating a shared parking lot, Nova Southeastern University Oceanographic Center and the State Park save on installation and maintenance costs. If a second 127-space parking lot were needed, it would cost approximately $381,000 to install and $38,100 to maintain with a surface asphalt overlay ever 8-15 years.

Shared parking system savings:

Through the use of shared parking lot system, both Nova Southeastern University and the state park save in no need of an expansion. We were able to calculate the cost of each parking space implemented into the site equaling to a total 127 spaces of what is currently existing in the shared parking lot system.

For example:

127 (existing parking spaces) x $3000 (construction per space) = $381,000 (not including maintenance)

The hours of operation for the Campus is Monday through Friday, while the State Park hours of operation run 365 days a year from 8:00 am until sundown. Both the Campus and State Park will utilize the spaces at different times of the day, week, month or year.

Maintenance savings:

An average cost for maintenance per parking space in a surface lot alone can be anywhere from $200-$400. Having the parking lot design constructed recently, normally parking lots will require maintenance for an average pavement overlay lifespan of 8-15 years depending on how the thickness of the new asphalt layer.

For example, we calculated the median number between $200 and $400:

$300 x 127 (parking space) = $38,100 (cost of maintenance only)

Sources:

1. www.vtpi.org (Miami Parking)
2. http://ebpave.com/hello-world/ (Maintenance)

References:

National Tree Benefit Calculator

1- http://www.treebenefits.com/calculator/treeinfor.cfm?zip=33004&city=DANIA&state=FL&climatezone=Tropical&country=US

LAF-Landscape Architecture Foundation Case Study Briefs

1- https://lafoundation.org/research/landscape-performance-series/case-studies/

Nova Southeastern University Oceanographic Center receives BP money to research oil spill's impact

1- http://articles.sun-sentinel.com/2012-04-22/news/fl-oil-oped0422-20120422_1_deepwater-horizon-oil-spill-oil-drilling
2- http://blogs.scientificamerican.com/guest-blog/2012/04/20/the-bp-oil-spill-anniversary-opportunities-to-learn/
3- http://www.icyte.com/system/snapshots/fs1/2/b/3/d/2b3d7089fabaab6b06852d90ac4290d1285bf8f5/index.html

Nova Southeastern University Oceanographic Center receives federal grant for educational opportunities

1- http://nsunews.nova.edu/nsu-receives-287-million-federal-grant-create-educational-opportunities-hispanic-students/
2- http://www.gflalliance.org/index.php?src=news&submenu=InformationCenter_data_workforce_highern&srctype=detail&category=Higher%20Education%20News&refno=1237&print=y
3- http://www.hispanicbusiness.com/2012/6/12/nsu_awards_most_doctoral_degrees_nationally.htm
4- http://www.hispanicgrants.net/2-87-million-title-v-grant-increases-academic-opportunities-for-hispanic-students.html

Weather in Dania Beach, Fl.

1- http://www.wunderground.com/history/airport/KFLL/2014/7/7/MonthlyHistory.html?req_city=NA&req_state=NA&req_statename=NA&MR=1

Nova Southeastern University Oceanographic Center creates job opportunities

1- http://www.nova.edu/ocean/excellence/
2- http://articles.sun-sentinel.com/2010-01-10/news/fl-nova-coral-20100110_1_healthy-reefs-national-coral-reef-institute-new-center
3- http://www.advancedaquarist.com/blog/americas-largest-coral-reef-research-center-to-open-its-doors-on-september-27

4- http://www.engexp.com/engineering-express-glass-galore-and-the-nova-southeastern-center-of-excellence/
5- http://www.eurekalert.org/pub_releases/2010-01/nsu-nsu010810.php
6- http://www.miamiherald.com/2012/09/27/3023921/nova-southeastern-opens-50-million.html
7- http://www.bizjournals.com/southflorida/blog/morning-edition/2012/09/nsu-coral-reef-research-center-to-open.html

Victoria Transport Policy Institute Transportation Cost and Benefit Analysis II – Parking Costs

1- www.vtpi.org [5.4-2 to 5.4-4] (Miami Parking)
2- http://ebpave.com/hello-world/ (Maintenance)

City of Hollywood, FL: Utility Rates and Charges for Water, Irrigation and Sewer Service Inside the City

1- http://www.hollywoodfl.org/DocumentCenter/Home/View/35 (Irrigation only)

Nova Southeastern University Oceanographic Center: Phase I Landscape

1- http://www.nova.edu/ocean/forms/ocean_graduate_calendar.pdf