Downtown Cocoa Beach Community Redevelopment Plan

Volume IV

Appendices (continued)

Prepared for:

Downtown Cocoa Beach Community Redevelopment Agency

City of Cocoa Beach, Florida

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Cocoa Beach, Florida 32931

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Acknowledgements

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Vice Mayor:	Skip Williams
Commissioner:	Kenneth Griffin
Commissioner:	Dave Netterstrom
Commissioner:	Kevin Pruett

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MILLER LEGG

Stormwater Master Plan

Miller Legg Project No. 10-00119

March 2011

"Improving Communities ...

... Creating Environments"

Prepared for:

City of Cocoa Beach Downtown
Community Redevelopment Agency
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Banana River Lagoon
Basin Management Action Plan
June 2010

Allocation Calculations for Total Nitrogen (TN) and Total Phosphorus (TP)

Background

In establishing the detailed allocations for the Banana River Lagoon (BRL) Basin Management Action Plan (BMAP) and the reductions required by the total maximum daily load (TMDL) for total nitrogen (TN) and total phosphorus (TP), the Florida Department of Environmental Protection (FDEP) considered the best approach to allocate to the appropriate stakeholders in a manner that is reasonable and equitable. Section 403.067(7)(a)(1), Florida Statutes (F.S.), includes the following guidance for preparing BMAPs:

> In developing and implementing the total maximum daily load for a water body, the department, or the department in conjunction with a water management district, may develop a basin management action plan that addresses some or all of the watersheds and basins tributary to the water body. Such a plan must integrate the appropriate management strategies available to the state through existing water quality protection programs to achieve the total maximum daily loads and may provide for phased implementation of these management strategies to promote timely, cost-effective actions as provided for in s. 403.151. The plan must establish a schedule for implementing the management strategies, establish a basis for evaluating the plan's effectiveness, and identify feasible funding strategies for implementing the plan's management strategies.

In addition, Section 403.067(6)(b) provides the following guidance for allocations:

> Allocation of total maximum daily loads. The total maximum daily loads shall include establishment of reasonable and equitable allocations of the total maximum daily load between or among point and nonpoint sources that will alone, or in conjunction with other management and restoration activities, provide for the attainment of the pollutant reductions established pursuant to paragraph (a) to achieve water quality standards for the pollutant causing impairment. The allocations may establish the maximum amount of the water pollutant that may be discharged or released into the water body or water body segment in combination with other discharges or releases. Allocations may also be made to individual basins and sources or as a whole to all basins and sources or categories of sources of inflow to the water body or water body segments. An initial allocation of allowable pollutant loads among point and nonpoint sources may be developed as part of the total maximum daily load. However, in such cases, the detailed allocation to specific point sources and specific categories of nonpoint sources shall be established in the basin management action plan pursuant to subsection (7). The initial and detailed allocations shall be designed to attain the pollutant reductions established pursuant to paragraph (a) and shall be based on consideration of the following…

This paper outlines the process and considerations that FDEP used in calculating the allocations for the BRL BMAP.

Calculating Baseline Loads

To determine the allocations for the BRL BMAP, FDEP clipped and erased the Pollutant Loading Screening Model (PLSM) Geographic Information System (GIS) shapefile according to the procedure outlined in the document *Detailed Allocation Procedure for the Banana River Lagoon*, with one exception. The zero event mean concentration (EMC) acres were included, except the land use land cover code 5400 (used to identify the BRL surface area), in the total allocated acres because this is the same way the TMDL was calculated. Based on the clipped files, the PLSM used to establish the TMDL was run to determine the baseline loads (loads based on the 2000 land uses in the model) for each entity. The model was run according to the procedures used by the St. Johns River Water Management District (SJRWMD) to calculate the baseline loads. The calculations for TN and TP total loads agree with the adopted baseline loads. The baseline loads for each entity and total loads compared with the current loads adopted in the TMDL Report are presented in Table 1.

Table 1. Baseline TN and TP Loads for Each Entity in BRL

Entity	Area (acres)	TN (lbs)	TN (lbs/acre)	TP (lbs)	TP (lbs/acre)
Agriculture	231	1,363	5.90	340	1.472
Brevard County	10,470	75,489	7.21	14,741	1.408
Cape Canaveral	856	8,945	10.45	1,957	2.287
Cape Canaveral Air Force Station (AFS)	13,795	53,007	3.84	10,790	0.782
Cocoa Beach	1,857	18,759	10.10	3,781	2.036
Florida Department of Transportation District 5 (FDOT 5)	386	3,741	9.69	1,076	2.788
Indian Harbour Beach	1,251	11,908	9.52	2,092	1.673
Kennedy Space Center	18,540	70,816	3.82	8,576	0.463
Melbourne	4	29	8.23	5	1.533
Patrick Air Force Base (AFB)	2,134	28,994	13.59	7,500	3.515
Port Canaveral	344	1,474	4.29	199	0.580
Satellite Beach	1,488	13,952	9.38	2,462	1.655
U.S. Army Corps of Engineers (USACE)	30	167	5.49	31	1.655
Total	**51,385**	**288,644**	**5.62**	**53,552.1**	**1.042**
TMDL Baseline (2000) Loads	**-**	**289,117**	**-**	**54,981.0**	**-**
% Difference	-	0.0%	-	-0.7%	-

Note: TMDL loads taken from the Indian River Lagoon (IRL) TMDL Table 4.9, which does not include atmospheric deposition or point sources.

***De Minimus* Calculations**

The data from Table 1 were then sorted for TN and TP loads, from highest to lowest, to determine whether any entity had loads low enough that reductions from these areas would have essentially no significant impact on the required reductions in the first phase of the BMAP. Tables 2 and 3 present the sorted data.

Table 2. Entity Baseline TN Loads Sorted from Highest to Lowest

Entity	TN (lbs)	% of Total Load	Cumulative Load (lbs)	Cumulative % of Total Load
Brevard County	75,489	26.15%	75,489	26.15%
Kennedy Space Center	70,816	24.53%	146,305	50.69%
Cape Canaveral AFS	53,007	18.36%	199,312	69.05%
Patrick AFB	28,994	10.04%	228,306	79.10%
Cocoa Beach	18,759	6.50%	247,065	85.60%
Satellite Beach	13,952	4.83%	261,017	90.43%
Indian Harbour Beach	11,908	4.13%	272,925	94.55%
Cape Canaveral	8,945	3.10%	281,870	97.65%
FDOT 5	3,741	1.30%	285,611	98.95%
Port Canaveral	1,474	0.51%	287,085	99.46%
Agriculture	1,363	0.47%	288,448	99.93%
USACE	167	0.06%	288,615	99.99%
Melbourne	29	0.01%	288,644	100.0%

Note: Highlighted entities signify de minimus *load contributions*

Table 3. Entity Baseline TP Loads Sorted from Highest to Lowest

Entity	TP (lbs)	% of Total Load	Cumulative Load (lbs)	Cumulative % of Total Load
Brevard County	14,741	27.53%	14,741	27.53%
Cape Canaveral AFS	10,790	20.15%	25,531	47.68%
Kennedy Space Center	8,576	16.02%	34,107	63.69%
Patrick AFB	7,500	14.01%	41,608	77.70%
Cocoa Beach	3,781	7.06%	45,389	84.76%
Satellite Beach	2,462	4.60%	47,851	89.35%
Indian Harbour Beach	2,092	3.91%	49,943	93.26%
Cape Canaveral	1,957	3.65%	51,900	96.92%
FDOT 5	1,076	2.01%	52,976	98.92%
Agriculture	340	0.64%	53,317	99.56%
Port Canaveral	193	0.37%	53,516	99.93%
USACE	31	0.06%	53,547	99.99%
Melbourne	5	0.01%	53,552	100.0%

Note: Highlighted entities signify de minimus *load contributions*

Four entities each contributed less than 1% of the total load: Agriculture, Port Canaveral, USACE, and the City of Melbourne. These entities are thus considered to be *de minimus.* Combined they contribute approximately 1% of the total load and therefore will not be assigned an allocation for either TN or TP for the first phase of the BMAP. It is important to note that the *de minimus* status is only for the first BMAP iteration and will be reviewed with each BMAP cycle. In future phases of the BMAP, TN and TP reductions may be needed from the *de minimus* entities; therefore, although they do not currently have a reduction responsibility, this does not prevent these entities from having reduction requirements in future BMAPs. Any actions taken by these entities during this first phase of the BMAP that result in TN or TP reductions should be documented by those entities for credit against any reduction requirements allocated in subsequent BMAP iterations.

BMAP Considerations

The BRL BMAP will be phased, meaning that 33% of the allocated reductions will need to be met in the first five years of implementation. However, in the second phase of the BMAP, the TMDL will be updated with more current land use and water quality data. These revisions may result in a change to required reductions in future BMAP iterations. In addition, stakeholders have expressed concern over uncertainties they feel exist in the TMDL, such as the relationship between TN and TP reductions and the seagrass target, salinity and algae influences on the system, and basin-specific data for model calibration. Recognizing these issues, FDEP is opting to use the flexibility available in the BMAP process to set allocations for Phase 1 of the BMAP by selecting an interim target for TN (as described below). This phased approach helps to ensure that FDEP does not ask the stakeholders to reduce more than is necessary by using adaptive management principles to evaluate progress towards the TMDL seagrass target. It must be noted that the TMDL requirements have not changed; however, for the purposes of the first phase of this BMAP, FDEP is selecting a higher interim target while certain issues are further examined. Additional reductions may be required in subsequent iterations of the BMAP to meet the TMDL target.

Calculating the Target Loads per Acre

The target loads per acre were calculated by dividing the TMDL target load by the total non-lagoon area in the BRL system. A large portion of the basin is comprised of water, and in the model most of those areas contribute no load.

Table 4. Calculated Target Loads per Acre for TN and TP

	TN	TP
Non-lagoon acres (from Table 1)	51,385	51,385
TMDL Target Load (lbs)	104,642	17,697
Target Load (lbs/acre)	**2.04**	**0.344**

Note: Target loads summed from TMDL Table 6.3a are for the WBIDs 3044A, 3057A and 3057B, and 3057C and do not include atmospheric deposition or point sources.

The target nonpoint source loads are thus 2.04 lbs/acre and 0.344 lbs/acre for TN and TP, respectively. This target differs from the TMDL target of 2.18 lbs/acre for TN and 0.374 lbs/acre for TP because the TMDL includes atmospheric deposition and point sources. The point sources were already assigned allocations in the TMDL and their permits. Subtracting atmospheric deposition and point source loads from the allowable loading results in the calculated target loads per acre shown in Table 4.

Allocations

A preliminary calculation of the required load reductions for each entity, based on the targets in Table 4, is included in Tables 5 and 6.

Table 5. Preliminary TN Load Allocations by Entity

Entity	Area (acres)	TN Target (lbs/acre)	TN Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	Resulting Load (lbs)
Brevard County	10,470	2.04	21,322	75,489	54,167	71.8%	21,322
Cape Canaveral	856	2.04	1,742	8,945	7,203	80.5%	1,742
Cape Canaveral AFS	13,795	2.04	28,092	53,007	25,915	47.0%	28,092
Cocoa Beach	1,857	2.04	3,781	18,759	14,978	79.8%	3,781
FDOT 5	386	2.04	786	3,741	2,955	79.0%	786
Indian Harbour Beach	1,251	2.04	2,547	11,908	9,361	78.6%	2,547
Kennedy Space Center	18,540	2.04	37,756	70,816	33,060	46.7%	37,756
Patrick AFB	2,134	2.04	4,345	28,994	24,649	85.0%	4,345
Satellite Beach	1,488	2.04	3,030	13,952	10,922	78.3%	3,030
de minimus	609	-		3,033	-	0.0%	3,033
Total	**51,385**	**-**	**103,402**	**288,644**	**182,209**	**63.1%**	**106,435**

Note: The resulting load is higher than the target load because the de minimus *entities are not required to reduce loads in the first iteration of the BMAP.*

Table 6. Preliminary TP Load Allocations by Entity

Entity	Area (acres)	TP Target (lbs/acre)	TP Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	Resulting Load (lbs)
Brevard County	10,470	0.344	3,606	14,741	11,135	75.5%	3,606
Cape Canaveral	856	0.344	295	1,957	1,663	84.9%	295
Cape Canaveral AFS	13,795	0.344	4,751	10,790	6,039	56.0%	4,751
Cocoa Beach	1,857	0.344	640	3,781	3,141	83.1%	640
FDOT 5	386	0.344	133	1,076	943	87.6%	133
Indian Harbour Beach	1,251	0.344	431	2,092	1,662	79.4%	431
Kennedy Space Center	18,540	0.344	6,385	8,576	2,191	25.5%	6,385
Patrick AFB	2,134	0.344	735	7,500	6,766	90.2%	735
Satellite Beach	1,488	0.344	512	2,462	1,949	79.2%	512
de minimus	609	-		576	-	0.0%	576
Total	**51,385**	**-**	**17,487**	**53,552**	**35,489**	**66.3%**	**18,063**

Note: The resulting load is higher than the target load because the de minimus *entities are not required to reduce loads in the first iteration of the BMAP.*

In examining these tables, the required TN reduction for Kennedy Space Center appeared large given the high proportion of undeveloped lands within this facility. To determine why this might be occurring, FDEP calculated the required reductions for TN per built-up acre for each entity. As highlighted in Table 7, the required reduction for TN per built-up acre is significantly higher for Kennedy Space Center than the other entities.

Table 7. TN Required Reduction per Built Up Acre by Entity

Entity	TN Required Reduction (lbs)	Undeveloped Acres	Built-Up Acres	TN Required Reduction per Built-Up Acre	% Undeveloped
Brevard County	54,167	4,793	5,677	9.5	45.8%
Cape Canaveral	7,203	247	609	11.8	28.9%
Cape Canaveral AFS	24,915	11,103	2,691	9.3	80.5%
Cocoa Beach	14,978	134	1,723	8.7	7.2%
FDOT 5	2,955	44	342	8.6	11.4%
Indian Harbour Beach	9,361	144	1,107	8.5	11.5%
Kennedy Space Center	33,060	16,788	1,752	18.9	90.5%
Patrick AFB	24,649	113	2,021	12.2	5.3%
Satellite Beach	10,922	207	1,281	8.5	13.9%
de minimus	0	295	314	-	-

As a comparison, FDEP also calculated the average TN loads for the undeveloped areas for the overall BRL Basin, as well as for Kennedy Space Center (Tables 8 and 9). As shown in these tables, the average loading from the undeveloped land for Kennedy Space Center is higher than the basin average.

Table 8. TN and TP Loads for Undeveloped Acres in Banana River Lagoon

FLUCCS	Definition	Area (acres)	TN (lbs)	TP (lbs)	TN (lbs/acre)	TP (lbs/acre)
3100	Herbaceous (Dry Prairie)	3,799	20,305	1,079	5.34	0.284
3200	Shrub and Brushland	5,768	26,057	1,379	4.52	0.239
3300	Mixed Rangeland	346	1,489	78	4.30	0.224
4100	Upland Coniferous Forests	52	187	24	3.57	0.458
4110	Pine Flatwoods	1,985	6,928	890	3.49	0.448
4130	Sand Pine	15	18	2	1.23	0.157
4200	Upland Hardwood Forests	370	893	116	2.41	0.312
4210	Xeric Oak	6,343	12,299	1,580	1.94	0.249
4340	Hardwood - Coniferous Mixed	961	2,085	269	2.17	0.280
4370	Australian Pines	60	143	19	2.39	0.309
4430	Forest Regeneration Areas	24	74	10	3.12	0.400
5100	Streams and Waterways	1,008	6,777	562	6.72	0.557
5200	Lakes	27	90	16	3.39	0.618
5300	Reservoirs	387	1,062	182	2.74	0.470
5340	Reservoirs less than 10 acres (4 hectares) which are dominant features	53	144	28	2.74	0.527
5430	Embayments not opening directly into the Atlantic Ocean	2,171	-	-	-	-
6120	Mangrove Swamps	1,730	-	-	-	-
6150	Streams and Lake Swamps (Bottomland)	0	-	-	-	-
6170	Mixed Wetland Hardwoods	1,250	-	-	-	-
6181	Willow and Elderberry	72	-	-	-	-
6182	Willow and Elderberry	286	-	-	-	-
6210	Cypress	16	-	-	-	-
6300	Wetland Forested Mixed	427	-	-	-	-

FLUCCS	Definition	Area (acres)	TN (lbs)	TP (lbs)	TN (lbs/acre)	TP (lbs/acre)
6410	Freshwater Marshes	2,082	-	-	-	-
6420	Saltwater Marshes	1,909	-	-	-	-
6430	Wet Prairies	268	-	-	-	-
6440	Emergent Aquatic Vegetation	15	-	-	-	-
6460	Treeless Hydric Savanna	2,431	-	-	-	-
6500	Non-Vegetated	11	-	-	-	-
	Overall	**33,869**	**78,551**	**6,234**	**2.32**	**0.184**

Note: In the BRL, approximately 66% of the acres in the basin are undeveloped areas, and the majority of these areas (82%) occur on Kennedy Space Center and Cape Canaveral AFS.

Table 9. TN and TP Loads for Undeveloped Acres on Kennedy Space Center

FLUCCS	Definition	Area (acres)	TN (lbs)	TP (lbs)	TN (lbs/acre)	TP (lbs/acre)
3100	Herbaceous (Dry Prairie)	2,935	17,226	918.0	5.87	0.313
3200	Shrub and Brushland	3,835	20,845	1,108.3	5.44	0.289
3300	Mixed Rangeland	155	892	46.9	5.76	0.303
4100	Upland Coniferous Forests	52	187	24.0	3.57	0.458
4110	Pine Flatwoods	1,906	6,698	860.7	3.51	0.451
4200	Upland Hardwood Forests	280	732	94.9	2.61	0.339
4210	Xeric Oak	31	92	12.0	2.95	0.385
4340	Hardwood - Coniferous Mixed	379	802	103.1	2.12	0.272
4370	Australian Pines	7	9	1.2	1.24	0.165
4430	Forest Regeneration Areas	24	74	9.5	3.12	0.400
5100	Streams and Waterways	59	341	27.9	5.76	0.471
5200	Lakes	2	9	1.5	3.69	0.614
5300	Reservoirs	87	239	34.2	2.76	0.394
5340	Reservoirs less than 10 acres (4 hectares) which are dominant features	48	138	25.9	2.87	0.538
5430	Embayments not opening directly into the Atlantic Ocean	483	-	-	-	0.000
6120	Mangrove Swamps	623	-	-	-	0.000
6150	Streams and Lake Swamps (Bottomland)	0	-	-	-	0.000
6170	Mixed Wetland Hardwoods	1,145	-	-	-	0.000
6181	Willow and Elderberry	39	-	-	-	0.000
6182	Willow and Elderberry	286	-	-	-	0.000
6210	Cypress	16	-	-	-	0.000
6300	Wetland Forested Mixed	297	-	-	-	0.000
6410	Freshwater Marshes	1,948	-	-	-	0.000
6420	Saltwater Marshes	410	-	-	-	0.000
6430	Wet Prairies	197	-	-	-	0.000
6440	Emergent Aquatic Vegetation	2	-	-	-	0.000
6460	Treeless Hydric Savanna	1,534	-	-	-	0.000
6500	Non-Vegetated	8	-	-	-	0.000
	Overall	**16,788**	**48,284**	**3,268**	**2.88**	**0.195**

From Table 8, the average loading (2.32 lbs/acre) from the undeveloped acres in the BRL Basin is greater than the nonpoint source TMDL target load (2.04 lbs/acre). Due to the large percentage of undeveloped area in this basin, FDEP decided to use the average loading from the undeveloped acres as the interim target for TN in the first phase of the BMAP. Therefore, a target load of 2.32 lbs/acre of TN will be used in this BMAP. However, the average loading from undeveloped acres on Kennedy Space Center is greater than the basin-wide average. Since Kennedy Space Center has such a large portion of their area (approximately 91%) as undeveloped land, FDEP determined that the average undeveloped area load per acre of 2.88 will be used as the target for Kennedy Space Center. Using this target puts the required reductions for TN per built-up acre on Kennedy Space Center in line with the other entities (see Table 10). The TMDL nonpoint target for TP of 0.344 lbs/acre will be applied for all stakeholders. It is important to note that the TMDL requirements have not changed; however, FDEP is using an interim target for the purposes of allocating reduction requirements in this first phase of the BMAP. Additional reductions may be required in later iterations of the BMAP to meet the TMDL targets.

Table 10. TN Required Reduction per Built Up Acre by Entity Using the Interim Target

Entity	TN Required Reduction (lbs)	Undeveloped Acres	Built-Up Acres	TN Required Reduction per Built-Up Acre	% Undeveloped
Brevard County	51,206	4,793	5,677	9.0	45.8%
Cape Canaveral	6,960	247	609	11.4	28.9%
Cape Canaveral AFS	21,013	11,103	2,691	7.8	80.5%
Cocoa Beach	14,452	134	1,723	8.4	7.2%
FDOT 5	2,846	44	342	8.3	11.4%
Indian Harbour Beach	9,007	144	1,107	8.1	11.5%
Kennedy Space Center	17,492	16,788	1,752	10.0	90.5%
Patrick AFB	24,046	113	2,021	11.9	5.3%
Satellite Beach	10,501	207	1,281	8.2	13.9%
de minimus	0	295	314	-	-

BMAP Phase 1 Allocations

Using the target loads discussed above, the final allocations for Phase 1 of the BRL BMAP are shown in Tables 11 and 12.

Table 11. BRL BMAP Phase 1 Required TN Reductions for the BRL BMAP

Entity	Area (acres)	TN Target (lbs/acre)	TN Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	BMAP 1 Required Reduction (lbs)
Brevard County	10,470	2.32	24,283	75,489	51,206	67.8%	17,068.7
Cape Canaveral	856	2.32	1,985	8,945	6,960	77.8%	2,320.2
Cape Canaveral AFS	13,795	2.32	31,994	53,007	21,013	39.6%	7,004.4
Cocoa Beach	1,857	2.32	4,307	18,759	14,452	77.0%	4,817.5
FDOT 5	386	2.32	895	3,741	2,846	76.1%	948.5
Indian Harbour Beach	1,251	2.32	2,901	11,908	9,007	75.6%	3,002.4
Kennedy Space Center	18,540	2.88	53,324	70,816	17,492	24.7%	5,830.7
Patrick AFB	2,134	2.32	4,948	28,994	24,046	82.9%	8,015.3
Satellite Beach	1,488	2.32	3,451	13,952	10,501	75.3%	3,500.3
de minimus	609	-	2,954	2,954	0	0.0%	0.0
Total	**51,385**	**-**	**128,087**	**288,565**	**157,524**	**54.6%**	**52,508.0**

Table 12. BRL BMAP Phase 1 Required TP Reductions for the BRL BMAP

Entity	Area (acres)	TP Target (lbs/acre)	TP Target (lbs)	Base Load (lbs)	Required Reduction (lbs)	Required Reduction (%)	BMAP 1 Required Reduction (lbs)
Brevard County	10,470	0.344	3,606	14,741	11,135	75.5%	3,711.8
Cape Canaveral	856	0.344	295	1,957	1,663	84.9%	554.2
Cape Canaveral AFS	13,795	0.344	4,751	10,790	6,039	56.0%	2,013.0
Cocoa Beach	1,857	0.344	640	3,781	3,141	83.1%	1,047.2
FDOT 5	386	0.344	133	1,076	943	87.6%	314.4
Indian Harbour Beach	1,251	0.344	431	2,092	1,662	79.4%	553.8
Kennedy Space Center	18,540	0.344	6,385	8,576	2,191	25.5%	730.4
Patrick AFB	2,134	0.344	735	7,500	6,766	90.2%	2,255.2
Satellite Beach	1,488	0.344	512	2,462	1,949	79.2%	649.8
de minimus	609	-	566	566	0	0.0%	0.0
Total	**51,385**	**-**	**18,053**	**53,543**	**35,489**	**66.3%**	**11,829.7**

Comparison to the TMDL

Tables 13 and 14 provide a summary of the total BMAP loading in the basin, using the target loads for nonpoint sources described above, compared to the TN and TP loading required by the TMDL.

Table 13. Comparison of TN Loading in the BMAP Allocations to the TMDL

Source	BMAP TN Loading (lbs/yr)	TMDL TN Loading (lbs/yr)	Difference in Loading (lbs/yr)	% Difference in Loading
Nonpoint sources	128,087	104,642	25,626	22.4%
Wastewater treatment facilities	7,387	7,387	0	0.0%
Atmospheric Deposition	179,727	179,727	0	0.0%
Total	**315,201**	**291,756**	**25,626**	**8.0%**

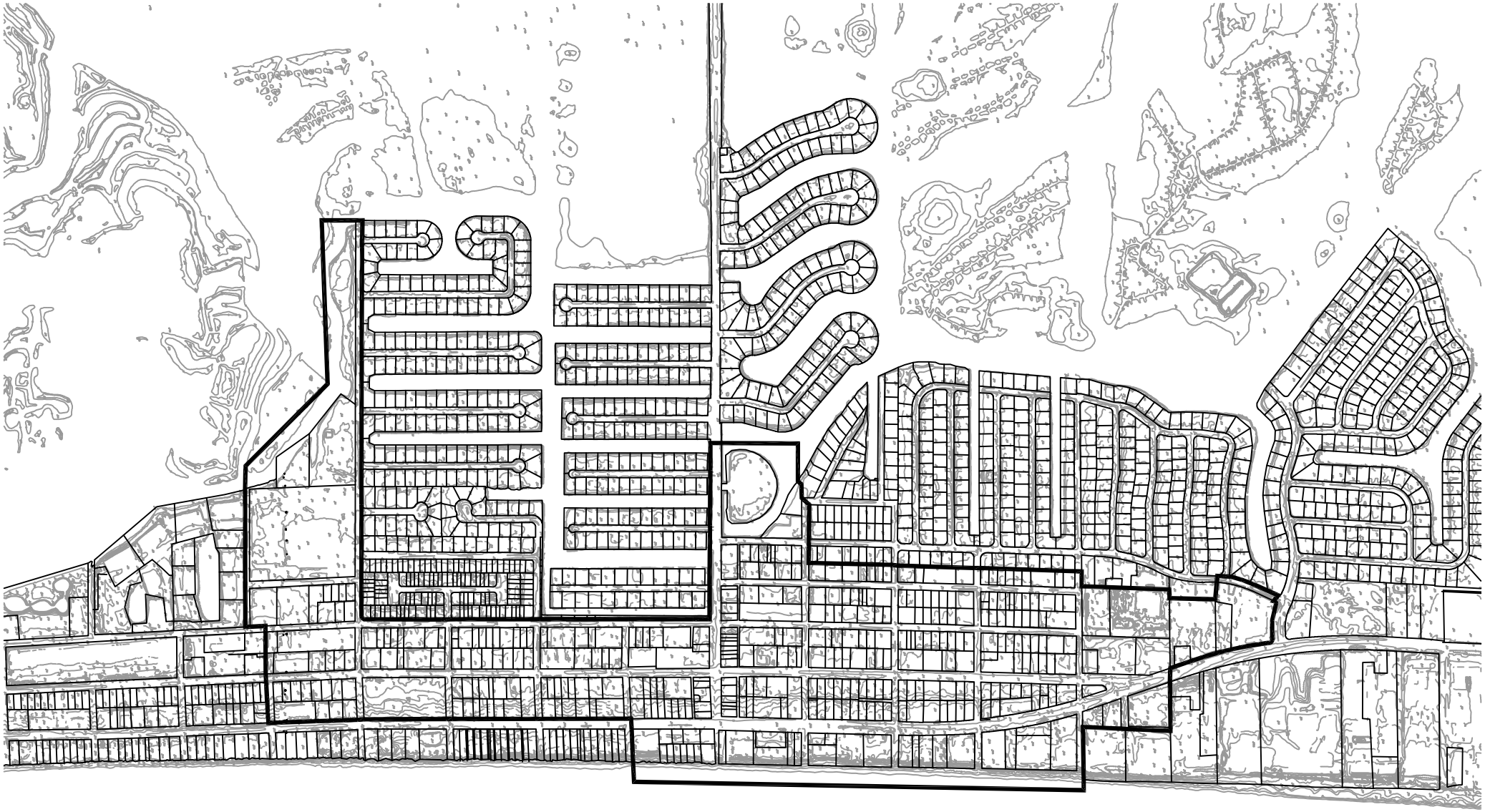
Table 14. Comparison of TP Loading in the BMAP Allocations to the TMDL

Source	BMAP TP Loading (lbs/yr)	TMDL TP Loading (lbs/yr)	Difference in Loading (lbs/yr)	% Difference in Loading
Nonpoint sources	18,053	17,697	356	2.0%
Wastewater treatment facilities	1,523	1,523	0	0.0%
Atmospheric Deposition	4,033	4,033	0	0.0%
Total	**23,609**	**23,253**	**356**	**1.5%**

Next Steps

During the July 9, 2010 BRL BMAP meeting, FDEP will discuss the next steps in the BMAP process with the stakeholders. FDEP will present TN and TP removal efficiencies for standard stormwater best management practices (BMPs), the method for project collection for credit towards TN and TP reductions, and timelines for submitting projects. Additionally, the monitoring meetings will continue to determine the objectives of the monitoring plan and monitoring station locations for data collection. The information from the monitoring plan discussions will also be brought to the technical meetings for discussion to help identify key unknowns in the basin, which should be addressed in the TMDL update for the second phase of the BMAP.

APPENDIX B



APPENDIX C

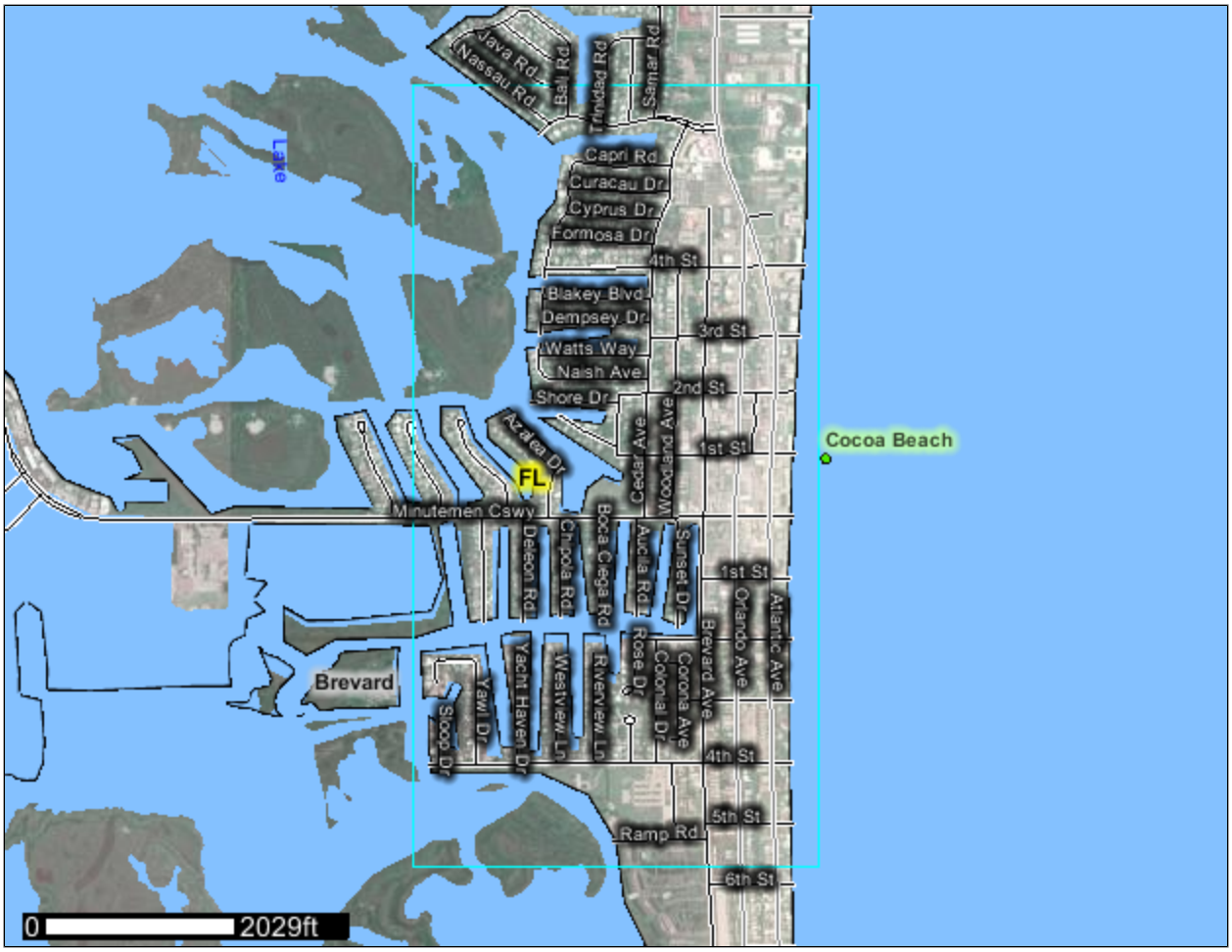
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Brevard County, Florida



July 14, 2010

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

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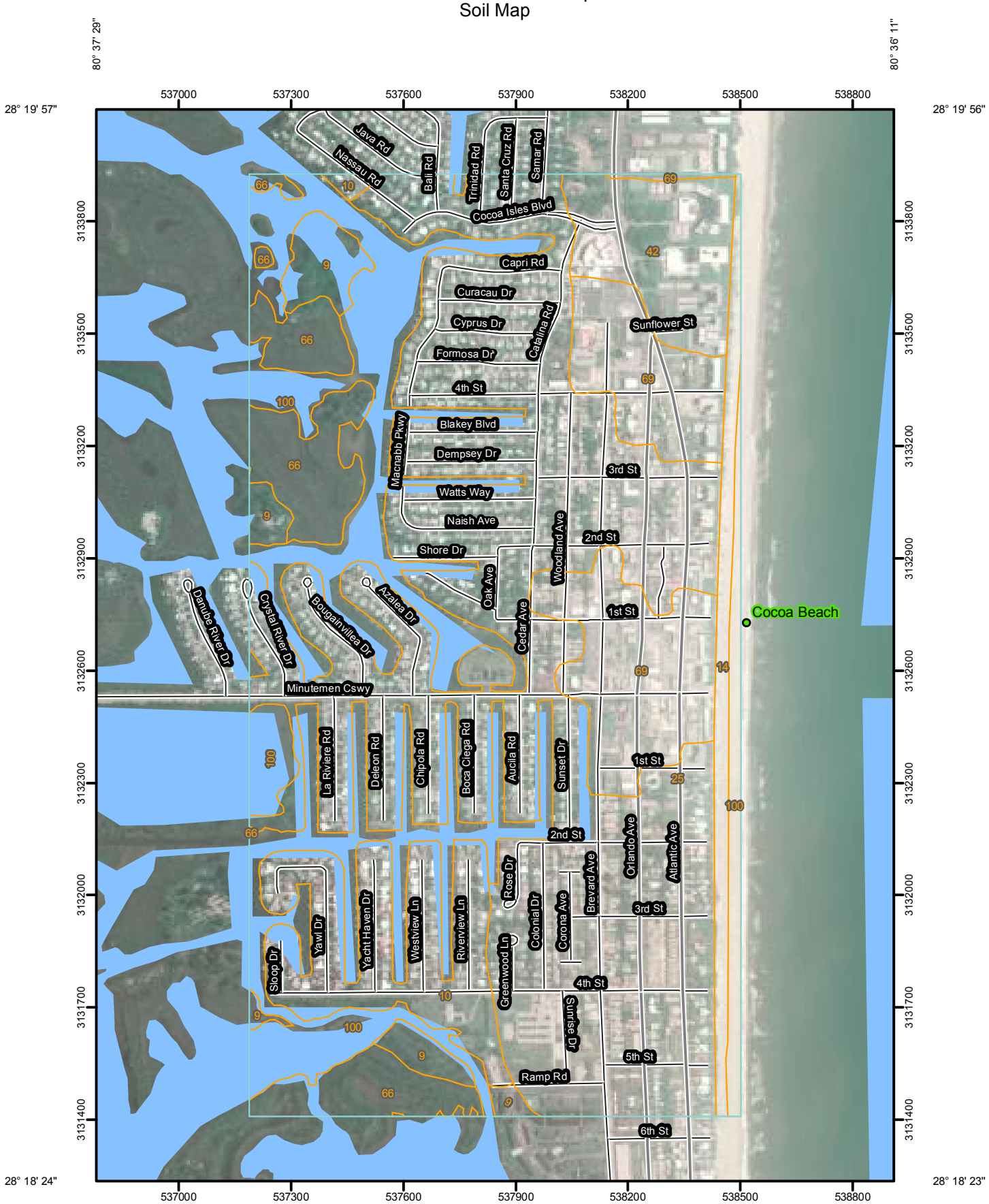
Soil Map.....6
Legend.....7

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:13,700 if printed on A size (8.5" x 11") sheet.

N

Meters
0 100 200 400 600

Feet
0 500 1,000 2,000 3,000

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:13,700 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brevard County, Florida
Survey Area Data: Version 8, Jan 13, 2010

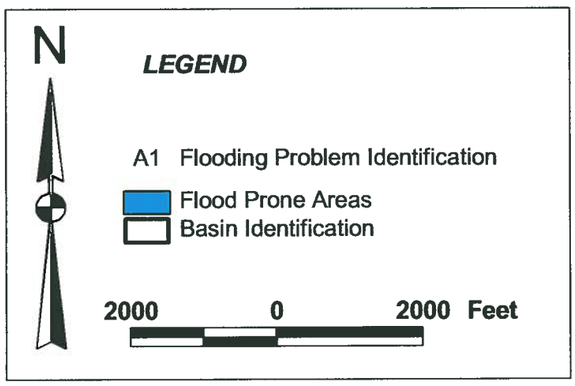
Date(s) aerial images were photographed: 6/20/2007

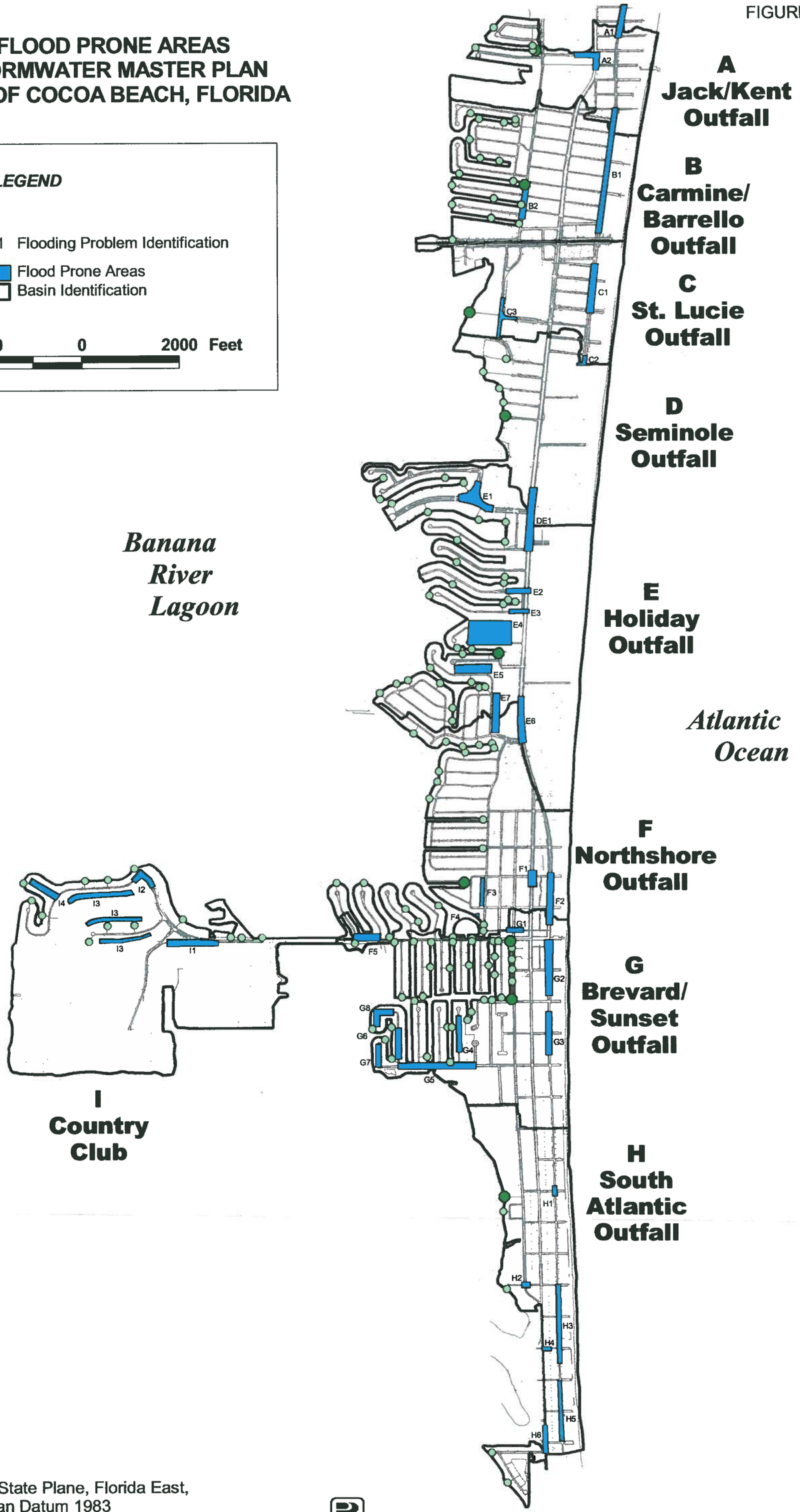
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

APPENDIX D

FIGURE 3.1

FLOOD PRONE AREAS
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA





Note:
Map is in US State Plane, Florida East,
North American Datum 1983

PARSONS ENGINEERING SCIENCE, INC.

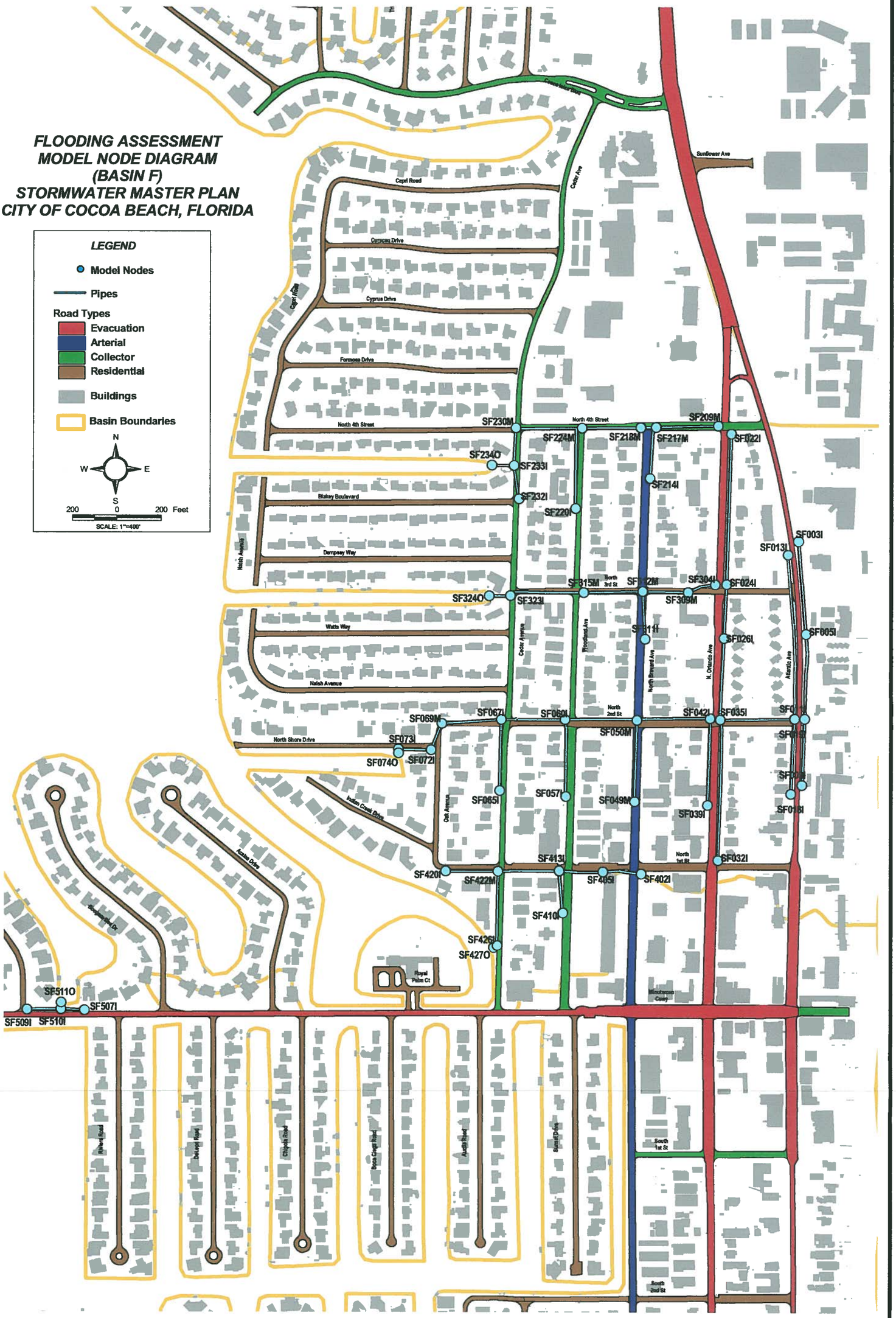
TABLE 3.4
FLOODING PROBLEM ASSESSMENT RESULTS EVALUATION
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

Problem ID	Problem Location	Problem Description	Area Modeled ?	Lowest LOS in Area	Comments	Carry Forward ?
A1	Ocean Beach Blvd.and Harding Ave., Barlow Ave., and Young Ave.,	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
A2	Intersection of A1A and Shepard Dr. to A1A and Meade Ave.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
A3	***Model Node SA025I - Ridgewood Avenue***	***Modeling indicates possible deficiency***	***Yes***	***C***	***Evaluate BMP options / corrective actions***	***Yes***
A4	***Model Node SC125M - Belt Road***	***Modeling indicates possible deficiency***	***Yes***	***D***	***Evaluate BMP options / corrective actions***	***Yes***
B1	Ocean Beach Blvd.from California Ave.to E. Columbia La. (incl. Basin A area near SA015I and SA016I)	Nuisance flooding, standing water	Yes	F	Evaluate BMP options / corrective actions	Yes
B2	N. Banana River Blvd and W. Suwannee La. (Barrello La.), W. Volusia La., and Angelo La.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
C1	Ocean Beach Blvd. and Hernando La., Marion La., Brevard La., and Palm La.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
C2	Intersection of Ocean Beach Blvd. and Wakula La.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
C3	S. Banana River Blvd.and intersection of St. Lucie La.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
DE1	A1A and S. Banana River Blvd. and Bimini Rd.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
E1	Intersection of S. Banana River Blvd. and Banana River Blvd.	Nuisance flooding, standing water	Yes	D	Evaluate BMP options / corrective actions	Yes
E2	Intersection of A1A and Bahama Blvd. and west	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
E3	Intersection of A1A and Antigua Dr.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
E4-A	Area between Antigua Dr. and June Dr.	Nuisance flooding, fences and structures impeding swale flow	Yes	A	Modeling indicates acceptable LOS for flood stage, but model indicates long duration standing water. Drainage path inhibited due to structures and other obstructions. Evaluate for maintenance and/or grading improvements, possible structural upgrades and/or BMP imlementation.	Yes
E4-B	Area between June Dr. and Esther Dr.	Nuisance flooding, fences and structures impeding swale flow	Yes	A		Yes
E5	Area Between Holiday La. and Samar Rd.	Nuisance flooding, fences and structures impeding swale flow	Yes	A		Yes
E6	A1A north from Cocoa Isles Blvd.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
E7	Between Samar and A1A	Nuisance flooding in yards behind businesses	No	n/a	Evaluate BMP options / corrective actions	Yes
F1	Intersection of N. Orlando Ave. and 2nd St. N.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
F2	A1A and 2nd St. N. and 1st St. N.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
F3	West of Cedar Ave. between 2nd St. N. and 1st St. N	Nuisance flooding, standing water, grading	Yes	B	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
F4	Lookout Point Apts.1st St. N. and Cedar Ave.	Stormwater from apts. causing flooding at residents to west	No	n/a	Evaluate BMP options / corrective actions	Yes
F5	Minutemen Between Crystal River and Danube River Dr.	Nuisance flooding, standing water	Yes	D	Evaluate BMP options / corrective actions	Yes
F6	***Model Node SF024I - N. Orlando Ave.***	***Modeling indicates possible deficiency***	***Yes***	***D***	***Evaluate BMP options / corrective actions***	***Yes***
F7	***Model Node SF057I Woodland, Yard/Open Space***	***Modeling indicates possible deficiency***	***Yes***	***C***	***Evaluate BMP options / corrective actions***	***Yes***
F8	***Model Node SF050M - N. Brevard, N. 2nd St, Yard/Open Space***	***Modeling indicates possible deficiency***	***Yes***	***D***	***Evaluate BMP options / corrective actions***	***Yes***
G1	N. Brevard Ave. and the alley north of Minutemen Cswy.	Nuisance flooding, standing water	Yes	B	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G2	A1A at Minutemen Cswy. and 1st St. S.	Nuisance flooding, standing water	Yes	F	Evaluate BMP options / corrective actions	Yes
G3	A1A near 3rd St. S.	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
G4	Riverview La.	Nuisance flooding, standing water	Yes	B	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G5	4th St. S. atGreenswood La., Riverview La., Westview La., Yachthaven Dr., and Yawl Dr.	Nuisance flooding, standing water	Yes	B	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G6	Yawl Dr. at 4th St. S.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G7	Sloop Dr.	Nuisance flooding, standing water	Yes	B	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G8	Yawl Dr.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
G9	***Model Node SG077I - N. Brevard, S. 2nd St, Yard/Open Space***	***Modeling indicates possible deficiency***	***Yes***	***D***	***Evaluate BMP options / corrective actions***	***Yes***
G10	***Model Node SG076M - N. Brevard, S. 2nd St, Yard/Open Space***	***Modeling indicates possible deficiency***	***Yes***	***E***	***Evaluate BMP options / corrective actions***	***Yes***
H1	A1A and 8th St. S.	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
H2	11th St. S. and Brevard Ave.	Nuisance flooding, standing water	Yes	E	Evaluate BMP options / corrective actions	Yes
H3	A1A and 11th St. S., 12th St. S., and 13th St. S.	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
H4	13th St. S. and S. Orlando Ave.	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
H5	A1A and 14th St. S., 15th St. S., and 16th St. S.	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
H6	S. Orlando Ave. and 16th St. S. and Indian Village Trail	Nuisance flooding, standing water	No	n/a	Evaluate BMP options / corrective actions	Yes
I1	Minutemen Cswy. Near public works	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
I2	Country Club Rd. and Minutemen Cswy.	Nuisance flooding, standing water	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
I3	South of Fairway Rd.	Nuisance flooding, golf course grading	Yes	A	Evaluate for maintenance and/or grading problems, secondary BMP impact	No
I4	Willowgreen Dr.	Nuisance flooding, constricted pipe (12" HDPE pipe in outfall end)	Yes	A based on original pipe	Retrofit with new pipe being completed by City.	No

Notes: Refer to Flood Prone Area Figure for problem identification and physical location
NA - Not applicable

Bold/Italic type indicates that this problem was not originally specified, rather indicated by modeling and LOS assessment.
Shading indicates problem carried forward for further evaluation.

FLOODING ASSESSMENT
MODEL NODE DIAGRAM
(BASIN F)
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA



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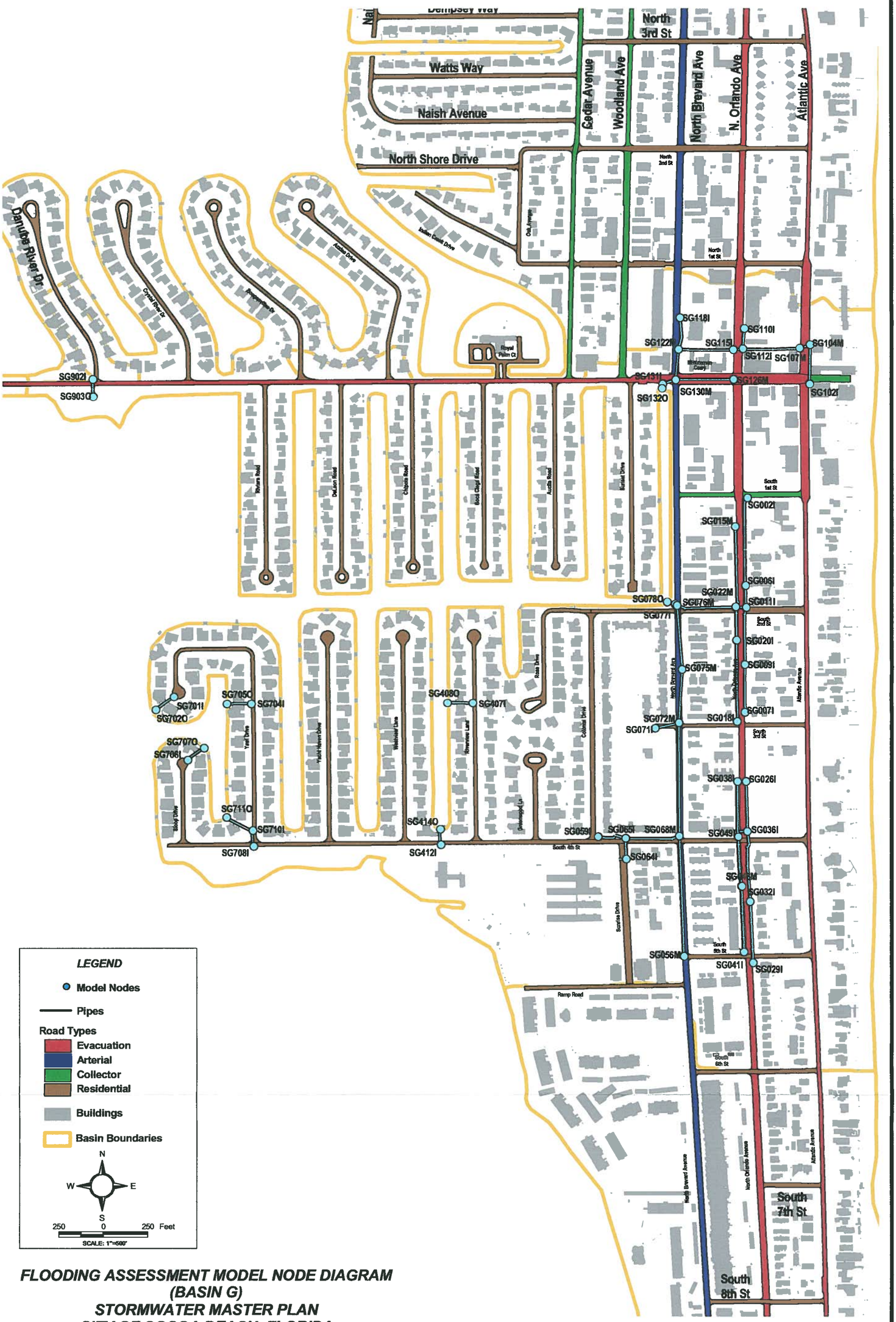


LEGEND

- Model Nodes
- Pipes

Road Types

- Evacuation
- Arterial
- Collector
- Residential

- Buildings
- Basin Boundaries

N W E S

250 0 250 Feet

SCALE: 1"=500'

FLOODING ASSESSMENT MODEL NODE DIAGRAM
(BASIN G)
STORMWATER MASTER PLAN
CITY OF COCOA BEACH, FLORIDA

PARSONS ENGINEERING SCIENCE, INC.

APPENDIX E

Item	Unit Cost	B-1 Quantity	B-1 Cost	B-2 Quantity	B-2 Cost	B-3 Quantity	B-3 Cost	B-4 Quantity	B-4 Cost	B-5 Quantity	B-5 Cost	B-6 Quantity	B-6 Cost	B-7 Quantity	B-7 Cost	B-8 Quantity	B-8 Cost	B-9 Quantity	B-9 Cost	B-10 Quantity	B-10 Cost	B-11 Quantity	B-11 Cost	B-12 Quantity	B-12 Cost	B-13 Quantity	B-13 Cost	B-14 Quantity	B-14 Cost
Demolition																													
Existing Pavement Removal (asphalt & base)	$2.25 /SY	0	$0.00	0	$0.00	2,667	$6,000.75	0	$0.00	722	$1,624.50	1,067	$2,400.75	1,067	$2,400.75	1,600	$3,600.00	1,600	$3,600.00	0	$0.00	3,200	$7,200.00	0	$0.00	0	$0.00	0	$0.00
Existing Sidewalk/Concrete Driveway Removal	$3.50 /SY	0	$0.00	0	$0.00	207	$724.50	0	$0.00	0	$0.00	990	$3,465.00	990	$3,465.00	2,000	$7,000.00	2,000	$7,000.00	0	$0.00	3,067	$10,734.50	0	$0.00	0	$0.00	0	$0.00
Existing Curb Removal	$4.00 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,220	$8,880.00	2,220	$8,880.00	0	$0.00	0	$0.00	0	$0.00	2,400	$9,600.00	0	$0.00	0	$0.00	0	$0.00
Demolition Subtotal			***$0.00***		***$0.00***		***$6,725.25***		***$0.00***		***$1,624.50***		***$14,745.75***		***$14,745.75***		***$10,600.00***		***$10,600.00***		***$0.00***		***$27,534.50***		***$0.00***		***$0.00***		***$0.00***
Construction																													
Rain Tank System	$8.00 /CF	0	$0.00	0	$0.00	24,695	$197,560.00	0	$0.00	8,980	$71,840.00	40,486	$323,888.00	40,486	$323,888.00	74,272	$594,176.00	74,272	$594,176.00	0	$0.00	35,988	$287,904.00	4,049	$32,392.00	0	$0.00	0	$0.00
Bio-Swale	$25.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	1,727	$43,175.00	1,727	$43,175.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,680	$67,000.00	2,267	$56,675.00	0	$0.00
Dry Retention Area	$18.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	333	$5,994.00
Pavement (asphalt, base, & subgrade)	$20.00 /SY	0	$0.00	0	$0.00	2,667	$53,340.00	0	$0.00	0	$0.00	1,067	$21,340.00	1,067	$21,340.00	1,600	$32,000.00	1,600	$32,000.00	0	$0.00	1,067	$21,340.00	0	$0.00	0	$0.00	0	$0.00
Mill & Resurface existing Pavement	$15.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,133	$31,995.00	2,133	$31,995.00	4,800	$72,000.00	4,800	$72,000.00	0	$0.00	2,667	$40,005.00	0	$0.00	0	$0.00	0	$0.00
Sidewalk/Concrete Driveways	$22.00 /SY	0	$0.00	0	$0.00	207	$4,554.00	0	$0.00	409	$8,998.00	1,620	$35,640.00	1,620	$35,640.00	4,600	$101,200.00	4,600	$101,200.00	0	$0.00	3,067	$67,474.00	0	$0.00	0	$0.00	0	$0.00
Type D Curb	$9.50 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,220	$21,090.00	2,220	$21,090.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00
Type F Curb	$12.50 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	320	$4,000.00	0	$0.00	0	$0.00	3,600	$45,000.00	3,600	$45,000.00	0	$0.00	2,400	$30,000.00	0	$0.00	0	$0.00	0	$0.00
Ribbon Curb (6"x12")	$9.00 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	200	$1,800.00	0	$0.00	0	$0.00	1,200	$10,800.00	1,200	$10,800.00	0	$0.00	800	$7,200.00	0	$0.00	0	$0.00	0	$0.00
Header Curb (6"x6")	$7.50 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	200	$1,500.00	0	$0.00	0	$0.00	420	$3,150.00	1,800	$13,500.00	0	$0.00	750	$5,625.00	0	$0.00	0	$0.00	0	$0.00
Pervious Pavers	$125.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	722	$90,250.00	0	$0.00	0	$0.00	2,597	$324,625.00	6,745	$843,125.00	0	$0.00	3,544	$443,000.00	0	$0.00	0	$0.00	0	$0.00
Striping	$0.80 /LF	0	$0.00	0	$0.00	2,500	$2,000.00	0	$0.00	320	$256.00	0	$0.00	0	$0.00	3,600	$2,880.00	3,600	$2,880.00	0	$0.00	6,000	$4,800.00	0	$0.00	0	$0.00	0	$0.00
Construction Subtotal			***$0.00***		***$0.00***		***$257,454.00***		***$0.00***		***$178,644.00***		***$477,128.00***		***$477,128.00***		***$1,185,831.00***		***$1,714,681.00***		***$0.00***		***$907,348.00***		***$99,392.00***		***$56,675.00***		***$5,994.00***
Maintenance																													
Rain Tank Annual Maintenance Cost	$0.03 /CF		$0.00		$0.00		$740.85		$0.00		$269.40		$1,214.58		$1,214.58		$2,228.16		$2,228.16		$0.00		$1,079.64		$121.47		$0.00		$0.00
Bio-Swale Annual Maintenance Cost	$0.50 /SY		$0.00		$0.00		$0.00		$0.00		$0.00		$863.50		$863.50		$0.00		$0.00		$0.00		$0.00		$1,340.00		$1,133.50		$0.00
Dry Retnetion Area Annual Maintenance Cost	$0.50 /SY		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$166.50
Pervious Pavement Annual Maintenance Cost	$0.25 /SY		$0.00		$0.00		$0.00		$0.00		$180.50		$0.00		$0.00		$649.25		$1,686.25		$0.00		$886.00		$0.00		$0.00		$0.00
Total Annual Maintanance Cost			*$0.00*		*$0.00*		*$740.85*		*$0.00*		*$449.90*		*$2,078.08*		*$2,078.08*		*$2,877.41*		*$3,914.41*		*$0.00*		*$1,965.64*		*$1,461.47*		*$1,133.50*		*$166.50*
Maintenance Subtotal (present value, 10 years @ 5%)			***$0.00***		***$0.00***		***$5,720.65***		***$0.00***		***$3,474.01***		***$16,046.38***		***$16,046.38***		***$22,218.60***		***$30,226.04***		***$0.00***		***$15,178.15***		***$11,285.08***		***$8,752.59***		***$1,285.67***
Capital Costs (as % of construction cost)																													
Rain Tank System	45%		$0.00		$0.00		$88,902.00		$0.00		$32,328.00		$145,749.60		$145,749.60		$267,379.20		$267,379.20		$0.00		$129,556.80		$14,576.40		$0.00		$0.00
Bio-Swale	30%		$0.00		$0.00		$0.00		$0.00		$0.00		$12,952.50		$12,952.50		$0.00		$0.00		$0.00		$0.00		$20,100.00		$17,002.50		$0.00
Dry Retention Area	40%		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$2,397.60
Pervious Pavement	40%		$0.00		$0.00		$0.00		$0.00		$36,100.00		$0.00		$0.00		$129,850.00		$337,250.00		$0.00		$177,200.00		$0.00		$0.00		$0.00
Capital Cost Subtotal			***$0.00***		***$0.00***		***$88,902.00***		***$0.00***		***$68,428.00***		***$158,702.10***		***$158,702.10***		***$397,229.20***		***$604,629.20***		***$0.00***		***$306,756.80***		***$34,676.40***		***$17,002.50***		***$2,397.60***
TOTALS			**$0.00**		**$0.00**		**$358,801.90**		**$0.00**		**$252,170.51**		**$666,622.23**		**$666,622.23**		**$1,615,878.80**		**$2,360,136.24**		**$0.00**		**$1,256,817.45**		**$145,353.48**		**$82,430.09**		**$9,677.27**
COST PER LB OF REDUCED POLLUTANT LOADING		**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**
TP Reduction		0.00	N/A	0.00	N/A	46.72	$7,679.84	0.00	N/A	43.16	$5,842.69	83.26	$8,006.51	83.26	$8,006.51	148.71	$10,865.97	167.12	$14,122.40	0.00	N/A	73.14	$17,183.72	11.57	$12,562.96	32.41	$2,543.35	6.17	$1,568.44
TN Reduction		0.00	N/A	0.00	N/A	9.42	$38,089.37	0.00	N/A	9.73	$25,916.80	16.78	$39,727.19	16.78	$39,727.19	32.97	$49,010.58	36.99	$63,804.71	0.00	N/A	16.61	$75,666.31	2.33	$62,383.47	6.53	$12,623.29	1.24	$7,804.25

Item	Unit Cost	B-15 Quantity	B-15 Cost	B-16 Quantity	B-16 Cost	B-17 Quantity	B-17 Cost	B-18 Quantity	B-18 Cost	B-19 Quantity	B-19 Cost	B-20 Quantity	B-20 Cost	B-21 Quantity	B-21 Cost	B-22 Quantity	B-22 Cost	B-23 Quantity	B-23 Cost	B-24 Quantity	B-24 Cost	B-25 Quantity	B-25 Cost	B-26 Quantity	B-26 Cost	B-27 Quantity	B-27 Cost	B-28 Quantity	B-28 Cost
Demolition																													
Existing Pavement Removal (asphalt & base)	$2.25 /SY	0	$0.00	1,867	$4,200.75	933	$2,099.25	2,411	$5,424.75	3,920	$8,820.00	3,200	$7,200.00	2,133	$4,799.25	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	1,333	$2,999.25
Existing Sidewalk/Concrete Driveway Removal	$3.50 /SY	0	$0.00	1,333	$4,665.50	500	$1,750.00	1,722	$6,027.00	3,547	$12,414.50	2,000	$7,000.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	1,000	$3,500.00
Existing Curb Removal	$4.00 /LF	0	$0.00	2,400	$9,600.00	1,200	$4,800.00	3,100	$12,400.00	2,940	$11,760.00	3,600	$14,400.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,400	$9,600.00
Demolition Subtotal			***$0.00***		***$18,466.25***		***$8,649.25***		***$23,851.75***		***$32,994.50***		***$28,600.00***		***$4,799.25***		***$0.00***		***$0.00***		***$0.00***		***$0.00***		***$0.00***		***$0.00***		***$16,099.25***
Construction																													
Rain Tank System	$8.00 /CF	0	$0.00	26,911	$215,288.00	11,225	$89,800.00	52,336	$418,688.00	66,136	$529,088.00	47,264	$378,112.00	108,065	$864,520.00	25,840	$206,720.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	40,487	$323,896.00
Bio-Swale	$25.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	4,800	$120,000.00	0	$0.00	6,933	$173,325.00	3,214	$80,350.00	0	$0.00	0	$0.00	311	$7,775.00	0	$0.00	0	$0.00
Dry Retention Area	$18.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,511	$45,198.00	0	$0.00	0	$0.00	0	$0.00
Pavement (asphalt, base, & subgrade)	$20.00 /SY	0	$0.00	0	$0.00	0	$0.00	0	$0.00	1,307	$26,140.00	1,200	$24,000.00	2,133	$42,660.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	1,067	$21,340.00
Mill & Resurface existing Pavement	$15.00 /SY	0	$0.00	2,933	$43,995.00	1,467	$22,005.00	4,722	$70,830.00	4,280	$64,200.00	3,200	$48,000.00	6,400	$96,000.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	3,200	$48,000.00
Sidewalk/Concrete Driveways	$22.00 /SY	0	$0.00	1,467	$32,274.00	733	$16,126.00	1,894	$41,668.00	3,757	$82,654.00	2,400	$52,800.00	3,200	$70,400.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,933	$64,526.00
Type D Curb	$9.50 /LF	0	$0.00	2,400	$22,800.00	1,200	$11,400.00	3,100	$29,450.00	0	$0.00	3,600	$34,200.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,400	$22,800.00
Type F Curb	$12.50 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,940	$36,750.00	0	$0.00	4,800	$60,000.00	4,800	$60,000.00	2,225	$27,812.50	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00
Ribbon Curb (6"x12")	$9.00 /LF	0	$0.00	800	$7,200.00	400	$3,600.00	800	$7,200.00	960	$8,640.00	0	$0.00	1,600	$14,400.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	800	$7,200.00
Header Curb (6"x6")	$7.50 /LF	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	900	$6,750.00	0	$0.00	0	$0.00
Pervious Pavers	$125.00 /SY	0	$0.00	667	$83,375.00	333	$41,625.00	667	$83,375.00	800	$100,000.00	0	$0.00	1,333	$166,625.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,553	$319,125.00	0	$0.00	6,000	$750,000.00
Striping	$0.80 /LF	0	$0.00	2,400	$1,920.00	1,200	$960.00	5,000	$4,000.00	3,480	$2,784.00	7,200	$5,760.00	7,200	$5,760.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	2,400	$1,920.00
Construction Subtotal			***$0.00***		***$406,852.00***		***$185,516.00***		***$655,211.00***		***$850,256.00***		***$662,872.00***		***$1,320,365.00***		***$440,045.00***		***$108,162.50***		***$0.00***		***$45,198.00***		***$333,650.00***		***$0.00***		***$1,239,682.00***
Maintenance																													
Rain Tank Annual Maintenance Cost	$0.03 /CF		$0.00		$807.33		$336.75		$1,570.08		$1,984.08		$1,417.92		$3,241.95		$775.20		$0.00		$0.00		$0.00		$0.00		$0.00		$1,214.61
Bio-Swale Annual Maintenance Cost	$0.50 /SY		$0.00		$0.00		$0.00		$0.00		$0.00		$2,400.00		$0.00		$3,466.50		$1,607.00		$0.00		$0.00		$155.50		$0.00		$0.00
Dry Retnetion Area Annual Maintenance Cost	$0.50 /SY		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$1,255.50		$0.00		$0.00		$0.00
Pervious Pavement Annual Maintenance Cost	$0.25 /SY		$0.00		$166.75		$83.25		$166.75		$200.00		$0.00		$333.25		$0.00		$0.00		$0.00		$0.00		$638.25		$0.00		$1,500.00
Total Annual Maintanance Cost			*$0.00*		*$974.08*		*$420.00*		*$1,736.83*		*$2,184.08*		*$3,817.92*		*$3,575.20*		*$4,241.70*		*$1,607.00*		*$0.00*		*$1,255.50*		*$793.75*		*$0.00*		*$2,714.61*
Maintenance Subtotal (present value, 10 years @ 5%)			***$0.00***		***$7,521.59***		***$3,243.13***		***$13,411.34***		***$16,864.89***		***$29,480.97***		***$27,606.75***		***$32,753.28***		***$12,408.83***		***$0.00***		***$9,694.64***		***$6,129.13***		***$0.00***		***$20,961.50***
Capital Costs (as % of construction cost)																													
Rain Tank System	45%		$0.00		$96,879.60		$40,410.00		$188,409.60		$238,089.60		$170,150.40		$389,034.00		$93,024.00		$0.00		$0.00		$0.00		$0.00		$0.00		$145,753.20
Bio-Swale	30%		$0.00		$0.00		$0.00		$0.00		$0.00		$36,000.00		$0.00		$51,997.50		$24,105.00		$0.00		$0.00		$2,332.50		$0.00		$0.00
Dry Retention Area	40%		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$18,079.20		$0.00		$0.00		$0.00
Pervious Pavement	40%		$0.00		$33,350.00		$16,650.00		$33,350.00		$40,000.00		$0.00		$66,650.00		$0.00		$0.00		$0.00		$0.00		$127,650.00		$0.00		$300,000.00
Capital Cost Subtotal			***$0.00***		***$130,229.60***		***$57,060.00***		***$221,759.60***		***$278,089.60***		***$206,150.40***		***$455,684.00***		***$145,021.50***		***$24,105.00***		***$0.00***		***$18,079.20***		***$129,982.50***		***$0.00***		***$445,753.20***
TOTALS			**$0.00**		**$563,069.44**		**$254,468.38**		**$914,233.69**		**$1,178,204.99**		**$927,103.37**		**$1,808,455.00**		**$617,819.78**		**$144,676.33**		**$0.00**		**$72,971.84**		**$469,761.63**		**$0.00**		**$1,722,495.95**
COST PER LB OF REDUCED POLLUTANT LOADING		**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**	**Annual Loading Reduction (lb)**	**Unit Cost of Loading Reduction ($/lb)**
TP Reduction		0.00	N/A	94.00	$5,990.10	39.84	$6,387.26	91.22	$10,022.29	114.21	$10,316.13	97.20	$9,538.10	267.98	$6,748.47	41.16	$15,010.20	26.49	$5,461.55	0.00	N/A	35.56	$2,052.08	29.27	$16,049.25	0.00	N/A	81.29	$21,189.52
TN Reduction		0.00	N/A	18.95	$29,713.43	8.03	$31,689.71	18.39	$49,713.63	24.59	$47,913.99	19.59	$47,325.34	56.69	$31,900.78	11.36	$54,385.54	5.34	$27,092.95	0.00	N/A	7.17	$10,177.38	5.90	$79,620.61	0.00	N/A	16.39	$105,094.32

APPENDIX F

RainTank

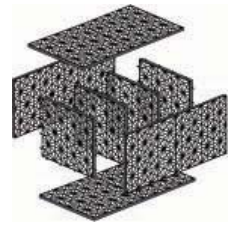
Storm Water Detention/Retention/Harvesting

Environmental ACF

Atlantis
Water Management for Life

RainTank

D-RainTank™ storm water detention and infiltration systems provide underground storage of storm water. After a rain event fills the RainTank, storm water will either infiltrate into the ground, drainage system, or be recycled for irrigation. This system provides an alternative to storm water basins and a more efficient alternative to other underground systems.



Applications

RainTank can be used for a variety of applications including:

- Storm Water Retention/Infiltration
- Storm Water Detention
- Dry Wells
- Leach Fields
- Bioretention
- Storm Water Recycling/Harvesting

RainTank is a modular system and can be assembled to a variety of heights from 9 1/2" to over 7'. It is extremely strong and can be placed beneath a variety of surfaces including:

- Parking Lots
- Streets and Access Roads
- Driveways
- Landscaping
- Athletic Fields/Playgrounds
- Swales and Channels

Benefits

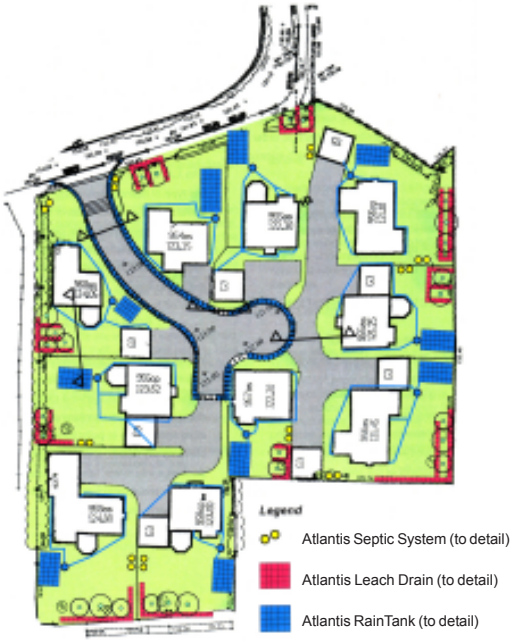
- High Capacity
  - 95% void internal area
- Modular Design
  - Can be placed in any shape to efficiently use space
  - Stack to depths of more than 7 feet
- High Strength
  - May be used under parking lots and roads
- Increased Infiltration
  - Reduces post-construction runoff
- Easy to Transport
  - Can be supplied unassembled for reduced delivery costs
- Lightweight and Quick to Install
  - Can be put in place by hand; no cranes required
  - Reduces site access delays

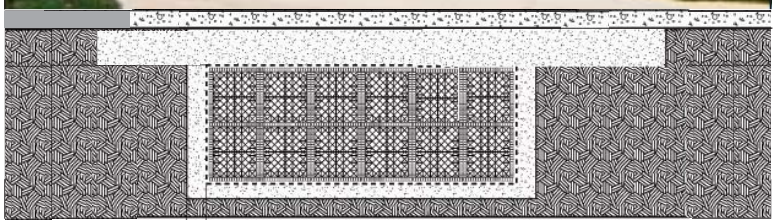
RainTank - Solving Tough Problems

Arlington, Virginia - Residential Area

12 residential homes...each house includes approximately 1,000 cf of storm water storage.

Large homes on small lots created enough storm water runoff to threaten the permitting of this Northern Virginia development. Changing the design to incorporate RainTanks beneath all the driveways solved the runoff problem without affecting the affordability of the homes.





Minimum excavation was required to prepare the area for the RainTank system.

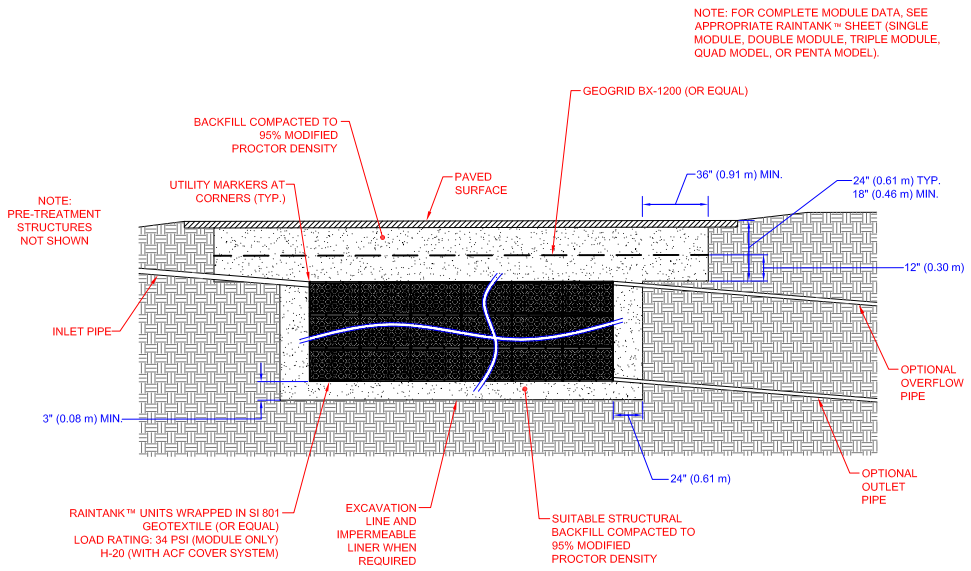
Approximately 1,000 cf of RainTank was installed at each residence.

With only two feet of cover above the RainTank, a geogrid helps disperse the traffic load.

Design Considerations

Many factors will determine the depth of the RainTank System and the corresponding amount of cover material, including:

1. RainTank Strength
2. Backfill Materials
3. Outlet Elevation
4. Depth of Water Table / Hardpan
5. Static & Dynamic Surface Loads
6. Construction Loads
7. Lateral Loads



1. RainTank Strength

Independent testing has shown RainTank can withstand up to 34 psi. By considering the full range of factors used to design a project, the system will easily support H20 loads with an adequate factor of safety. (See sample calculation on page 5.)

Compression Test

Fail @ 34 psi

2. Backfill Materials

If the area above the RainTank will be used for vehicular traffic, then the fill materials should be of granular nature and should be reinforced with Tensar BX-1200 (or a performance equivalent) to spread point load impact. Otherwise, cover material should be free flowing clean sand or granular material. SOIL THAT CAN ABSORB LARGE QUANTITIES OF WATER SUCH AS CLAY SHOULD NOT BE USED.

Backfill materials should be compacted to at least 90% for each 12" layer.

3. Outlet / Overflow Elevation

Many designs incorporate an Outlet to drain the system at a controlled rate and/or an Overflow to prevent flooding in an extreme event. The elevation of these elements may be restricted, and should be considered when determining the elevation of the RainTank.

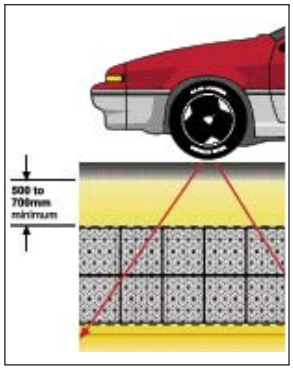
4. Elevation of Water Table or Hardpan

While placing the RainTank below the water table will not cause the system to fail, it will limit its ability to function by reducing the space available to store stormwater. In these situations the RainTank may be placed at a shallow depth, or a liner may be used to prevent groundwater from entering the tanks. A shallow hardpan will limit the depth of excavation that is practical, which will also limit the designer's options for RainTank elevations.

Design Considerations

5. Surface Loads

RainTank is a structural unit which does not rely on properly compacted backfill to support a load, as other systems do. Its 34 psi ultimate bearing capacity was derived from unconfined testing (pictured on page 4).



To determine the load (psi) applied to the RainTank and the resulting factors of safety, use the tire contact area and the distribution angle of the cover material to calculate the area of applied load on the RainTank (A´). Then, using the wheel load (W) modified with a dynamic factor to account for the movement of the wheel, divide by the area of applied load (A´) and add the weight of the saturated fill.

This equation can be written as:

$$\sigma_{va} = (W\ F_d\ /\ A') + dy$$

W = Wheel Load
F_d = Dynamic Factor for Moving Wheel Load
A´ = Area of Applied Load on RainTank
dy = Total Weight of Fill Materials

Sample Calculation

W = 8,000 lbs (32,000 lb axle / 4 wheels/axle)
F_d = 1.2
A´ = 1661 si (18" cover w/45 degree angle)
dy = 1.35 psi (18 ci saturated sand @ 130 lbs/cf)

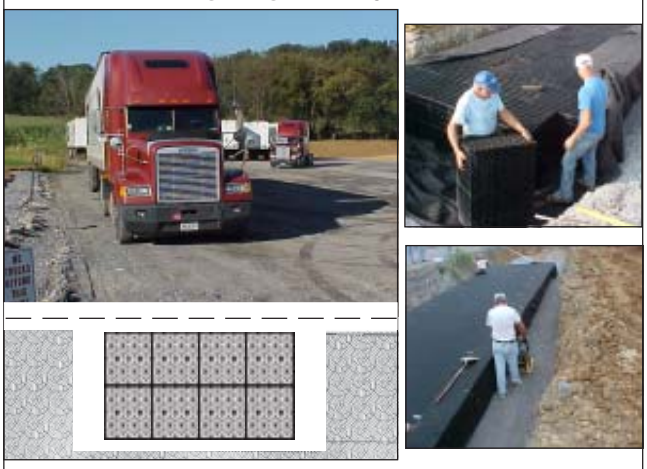
$$\sigma_{va} = (8{,}000 \text{ lbs} \times 1.2 / 1661 \text{ si}) + 1.35 \text{ lbs}$$

$$\sigma_{va} = 7.13 \text{ psi}$$

Safety Factor = 4.77

(34 psi ultimate bearing capacity / 7.13 psi applied load)

Harrisonburg, Virginia - Wynco Distribution



This project required approximately 5,000 cf of storage volume under heavy loads

6. Construction Loads

While achieving proper compaction of the fill materials is critical, the type of compaction equipment used must be carefully considered to avoid localized high impact and penetration of the fill and/or RainTanks. Whenever possible, LIGHT WEIGHT EQUIPMENT SHOULD BE USED.

7. Lateral Loads

The pressure acting on the sides of the units should also be considered, particularly when the bottom elevation of the RainTanks is more than 9½ feet below final grade.

RainTank Project

Villa Riva Condominiums - Jacksonville, Florida

Storm Water Detention beneath grass firelane

RainTank Installation Procedures

Wendy's Restaurant - Morgantown, West Virginia

4,700 cubic feet of storage

Minimum excavation was required to prepare the area for the RainTank system. 3" to 4" of stone was placed on the excavated floor. A footprint of the system was marked to determine the geotextile boundaries.

One person can easily handle a 4' deep tank module. Approximately 4,700 cf of RainTank was installed in this project.

This design incorporated a multi-level discharge system.

The installed modules were wrapped with a geotextile and then proper backfill and compaction were performed.

An initial 1' of cover was placed . Next the geogrid reinforcement along with a final 1' of cover were placed.

Completed job.

Installation of Atlantis Tank Modules

1. Excavate the site to the proper depth (accounting for 3"-4" of base and specified depth of cover material), length and width, allowing adequate room to compact backfill around the perimeter (typically 12" – 24"). If using a liner (optional) to reuse water in the system, install that now. Mark the footprint of the RainTank in the excavation to allow placement of Geotextile and the tanks.

2. Put the geotextile in place and begin installing tanks in the excavation over the filter fabric, butting them tightly against each other. After placement of the tanks, bring geotextile up the sides and over the top of the structure, connecting joints as recommended. Fold excess fabric at corners to lay flat against the structure and secure using tape.

3. Identify locations of inlet, outlet, inspection ports, and any other penetrations. To secure pipe to system, cut X into geotextile, and secure fabric to the pipe with a band clamp. If butting the pipe to the RainTank is not satisfactory, the exterior plate of the RainTank may be cut with a reciprocating saw and the pipe inserted into the tank.

4. Place backfill around RainTanks carefully, and use a powered mechanical compactor to compact backfill around perimeter, being careful to avoid damage to geotextile and (optional) liner. Support pipe in trenches to prevent damage to the pipe.

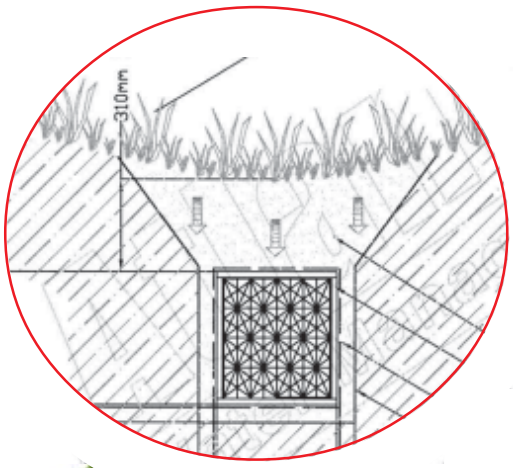
5. Place a sandy gravel backfill material over wrapped tank (typically between 1' and 3', with 2' typical for traffic applications), compacting with lightweight equipment to a minimum of 90%. Take care when placing backfill on top of the structure to avoid damage to the fabric and tanks.

6. Geogrids should be installed on traffic areas. The geogrid layer is preferably placed 12 inches over the top of the structure, so that it extends beyond the edge of the structure for at least 1 1/2 ft. Joints must be overlapped by a minimum of 1 ft.

7. Place surfacing materials, such as groundcovers, shrubs (do not plant trees above the tank), or paving material over the structure with care.

Ecological Road

The Atlantis philosophy is to resolve water management at the source. That's the concept behind the Ecological Road. This holistic system captures surface runoff from roads and, instead of transporting it to a central storage pond, provides short-term localized storage so that stormwater can be either infiltrated to recharge groundwater, released at a controlled rate, or recycled for irrigation. RainTank provides benefits for everyone, including the developer, the municipality, and the community.



Managing stormwater close to the source.

Benefits for the Developer – Economic

- Less expensive than traditional techniques
- Replaces curb & gutter, inlet structures, drainage pipe, and stormwater ponds
- Frees up valuable space

Benefits for the Municipality – Environmental

- Removes a variety of pollutants and nutrients from hydrocarbons to phosphorous
- Encourages infiltration
- Reduces total runoff in detention applications

Benefits to the Community – Quality of Life

- Eliminates breeding grounds for mosquitoes and other vermin
- Completely maintenance-free

Economically sensible, environmentally friendly, and completely sustainable, the Ecological Road is a better way to manage storm water.

Design Options

Santa Monica, CA - Installation of 750 cf of RainTanks installed

There are many ways to incorporate the principles of the ecological road into a project design, as demonstrated by this project.

Excavation of the area.

Placement of tanks.

Backfill on top of structure.

Completed job.

Horizontal & Vertical Drainage

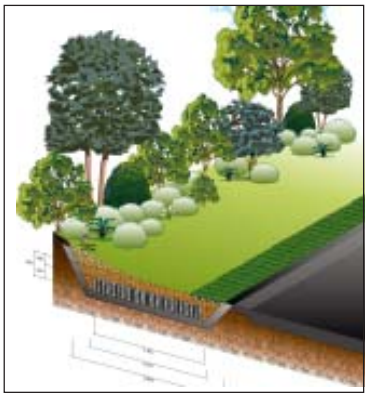
Ecological Road

RainTank solves three major issues.

1. *Safety*
2. *Environmental...eliminating water contamination*
3. *Aesthetic*

Safety *- A RainTank channel could have prevented this accident.*

Environmental *- Standing water can lead to poisonous green algaes or other environmental hazards in road drainage.*



Aesthetic *- Replacing concrete ditches with shallow grass swales beautifies the landscape.*

LEED™ Points

Using RainTank in a project design can earn as many as 11 LEED credits for your project.

Sustainable Sites – 4 Credits

By temporarily storing large volumes of water in a small footprint, RainTank allows you to maximize open space (credit 5.1) while minimizing the development footprint (credit 5.2). This will also reduce the total quantity of stormwater runoff (credit 6.1). Incorporating RainTank as part of a bioretention system can help remove pollutants from runoff, as well (credit 6.2).

Water Efficiency – 5 Credits

RainTank can be wrapped with a liner, allowing rain water or gray water stored in the system to be reused to irrigate the landscaping (credits 1.1, 1.2 and 2), resulting in reduced demand on the building's potable water resources (credits 3.1 and 3.2).

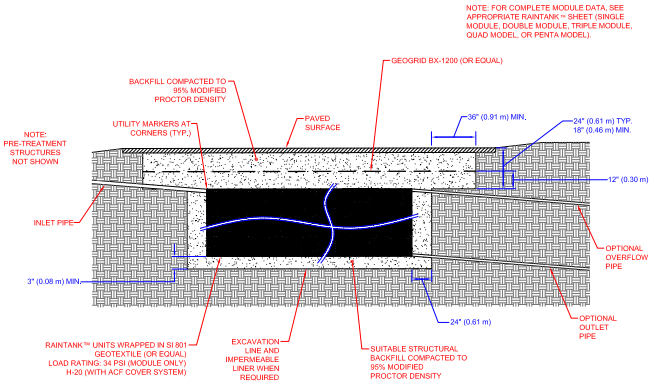
Materials and Resources – 2 Credits

RainTanks are always made from 100% post-consumer recycled plastics (credits 4.1 and 4.2).

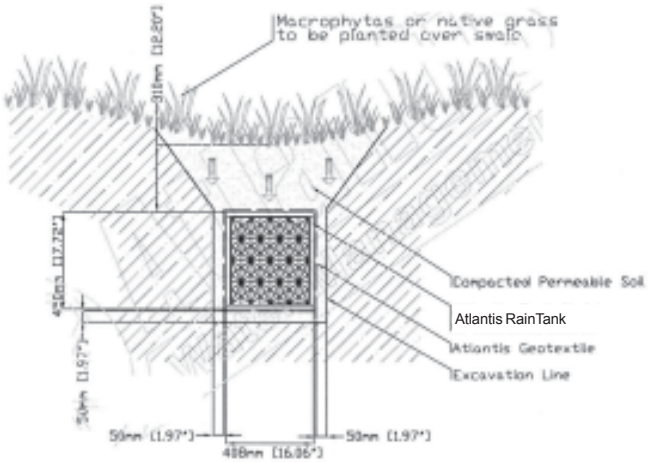
Typical Design

Additional CAD Drawings Available

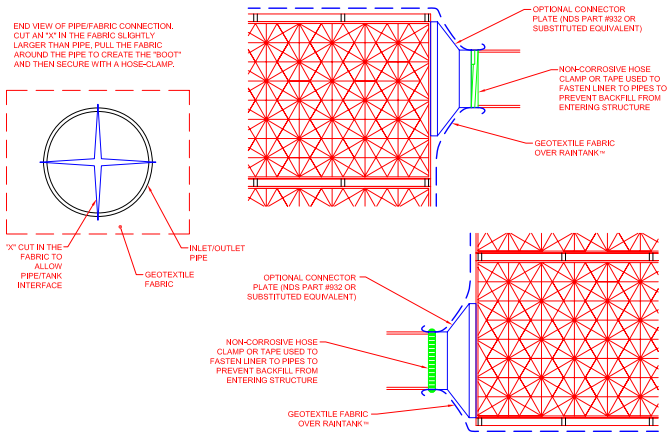
Parking Lots / H20 Loads



Typical Swale Infiltration Design



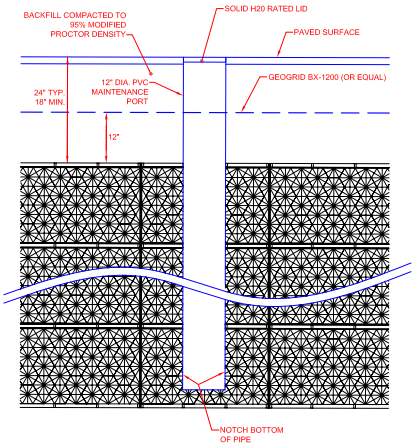
Inlet / Outlet Pipe Connections



Maintenance Port

MAINTENANCE PORT

THIS PORT IS USED TO PUMP WATER INTO THE SYSTEM AND RE-SUSPEND ACCUMULATED SEDIMENT SO THAT IT MAY BE PUMPED OUT. MINIMUM REQUIRED MAINTENANCE INCLUDES A QUARTERLY INSPECTION DURING THE FIRST YEAR OF OPERATION AND A YEARLY INSPECTION THEREAFTER. FLUSH AS NEEDED.



Specifications

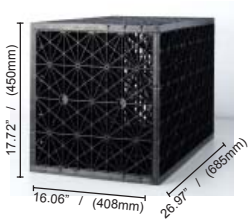
RainTank Dimensions

Module (Units)	Width (mm)	Width (inches)	Length (mm)	Length (inches)	Height (mm)	Height (inches)
Mini (1/2)	408	16.06	685	26.97	240	9.45
Single (1)	408	16.06	685	26.97	450	17.72
Double (2)	408	16.06	685	26.97	880	34.65
Triple (3)	408	16.06	685	26.97	1310	51.57
Quad (4)	408	16.06	685	26.97	1740	68.50
Pent (5)	408	16.06	685	26.97	2170	85.43

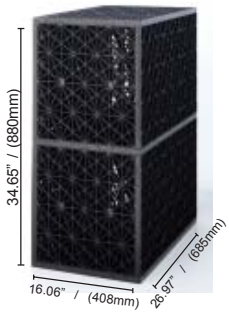
Module (Units)	Tank Volume (cf)	Tank Volume (gal)	Water Storage Volume (cf)	Water Storage Volume (gal)	Number of Plates Large / Small	Tank Weight (lbs)
Mini (1/2)	2.4	17.96	2.27	17.06	2 / 4 / 2*	10
Single (1)	4.44	33.22	4.22	31.56	4 / 4	14
Double (2)	8.69	64.97	8.25	61.72	7 / 8	26
Triple (3)	12.93	96.72	12.28	91.88	10 / 12	38
Quad (4)	17.17	128.47	16.31	122.03	13 / 16	50
Pent (5)	21.42	160.21	20.35	152.19	16 / 20	62

*Requires 3 different plates

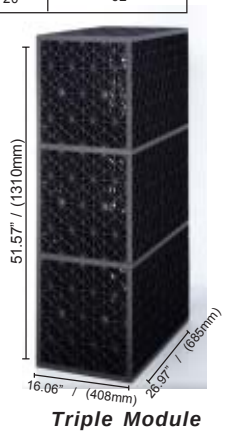
Conversions
1 cf = 7.4805195 gallon
1 liter = 0.2641721 gallon
1 mm = 0.0393701 inches
1 cf = 0.0283168 cm



Single Module



Double Module



Triple Module

RainTank Specifications

Void Ration	**95%**
Material	85% recycled Polypropylene + 10% Atlantis proprietary selected materials.
Biological & Chemical Resistance:	Unaffected by molds and algae, soil-bourne chemicals,bacterial and bitumen.
Unconfined Crush Load	34 psi

Long-Term Unconfined Creep Test: 90 Day Dead Load Creep Test

	Metric	English
Load Applied	2.85 t/m^2	4.06 psi
Displacement (90 Days)	1.7 mm	0.067”
Total Strain After 90 Days	2.30%	2.30%
Creep Sustained After 90 Days	0.40%	0.40%
Temperature	20° (= 3)	68°F (≐ 37.4)

Atlantis Water Management Solutions

Wall Panel Installation

Road Edge Drainage

Turf / Gravel Cell

Strip Filter Pipe™

Drainage Swales

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1/07

StormTech®

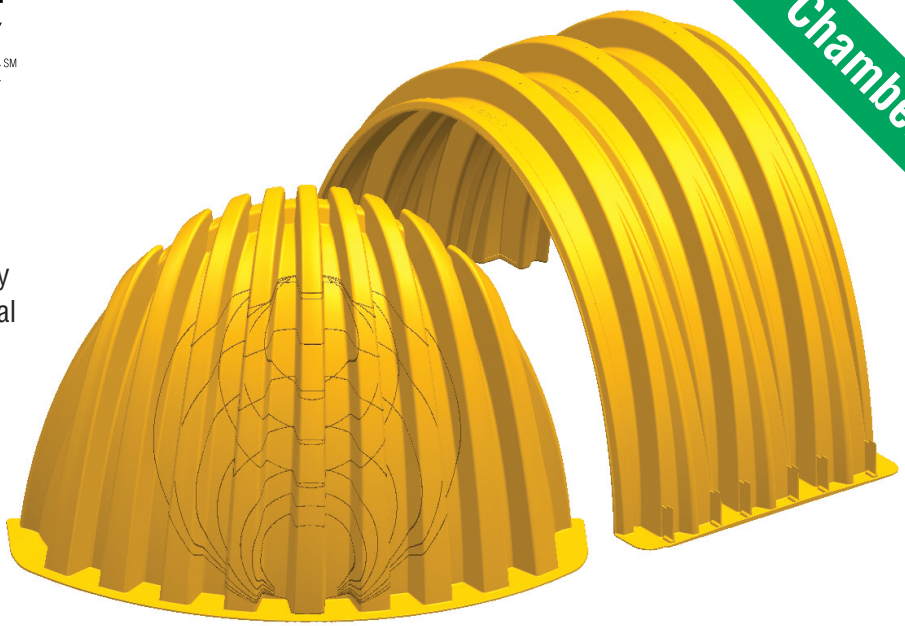
Detention • Retention • Water Quality

Subsurface Stormwater Management℠

MC-4500 Chamber

StormTech™ MC-4500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



StormTech MC-4500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	52" (1321 mm) x 100" (2540 mm) x 60" (1524 mm)
Chamber Storage	106.5 ft^3 (3.01 m^3)
Min. Installed Storage*	162.6 ft^3 (4.60 m^3)
Nominal Weight	120 lbs (54.4 kg)

* This assumes a minimum of 12" (305 mm) of stone above, 9" (229 mm) of stone below chambers, 9" (229 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-4500 End Cap (not to scale)

Nominal End Cap Specifications

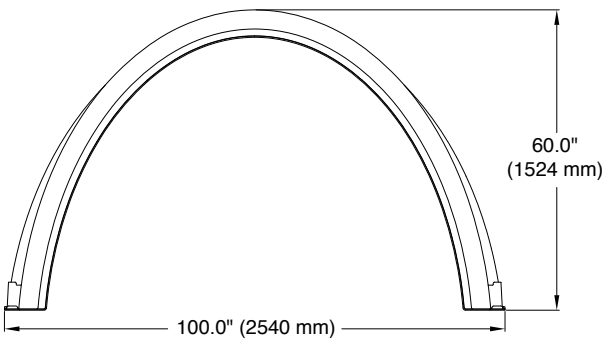
Size (L x W x H)	35.1" (891 mm) x 90.2" (2291 mm) x 59.4" (1509 mm)
End Cap Storage	35.7 ft^3 (1.01 m^3)
Min. Installed Storage*	108.7 ft^3 (3.08 m^3)
Nominal Weight	120 lbs (54.4 kg)

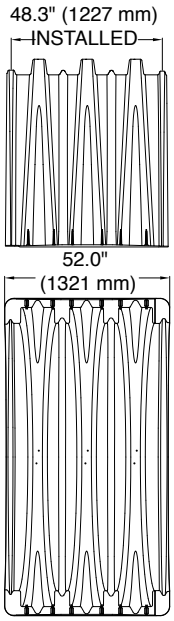
*This assumes a minimum of 12" (305 mm) of stone above, 9" (229 mm) of stone below, 12" (305 mm) of stone perimeter, 9" (229 mm) of stone between chambers/end caps and 40% stone porosity.

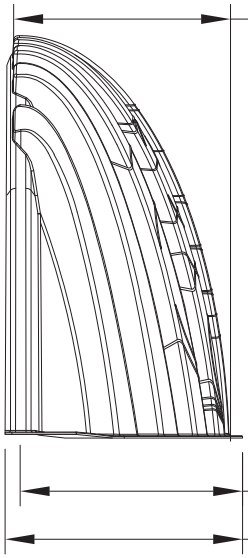
Shipping

8 chambers/pallet

11 pallets/truck







30.7"
(781 mm)
INSTALLED

32.8" (832 mm)

35.1" (891 mm)

Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
Chamber	106.5 (3.02)	162.6 (4.60)	166.3 (4.71)	169.9 (4.81)	173.6 (4.91)
End Cap	35.7 (1.01)	108.7 (3.08)	111.9 (3.17)	115.2 (3.26)	118.4 (3.35)

NOTE: Assumes 9" (229 mm) min. row spacing, 12" (305 mm) min. of stone above, 40% stone porosity and includes the bare chamber/end cap volume. End cap volume assumes 12" (305 mm) min. stone perimeter.

Volume of Excavation Per Chamber/End Cap in yd³ (m³)

	Stone Foundation Depth			
	9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
Chamber	10.5 (8.0)	10.8 (8.3)	11.2 (8.5)	11.5 (8.8)
End Cap	9.3 (7.1)	9.6 (7.3)	9.9 (7.6)	10.2 (7.8)

NOTE: Assumes 9" (229 mm) min. of separation between chamber rows, 12" (305 mm) min. of perimeter in front of end caps, and 24" (610 mm) of cover. The volume of excavation will vary as the depth of cover increases.

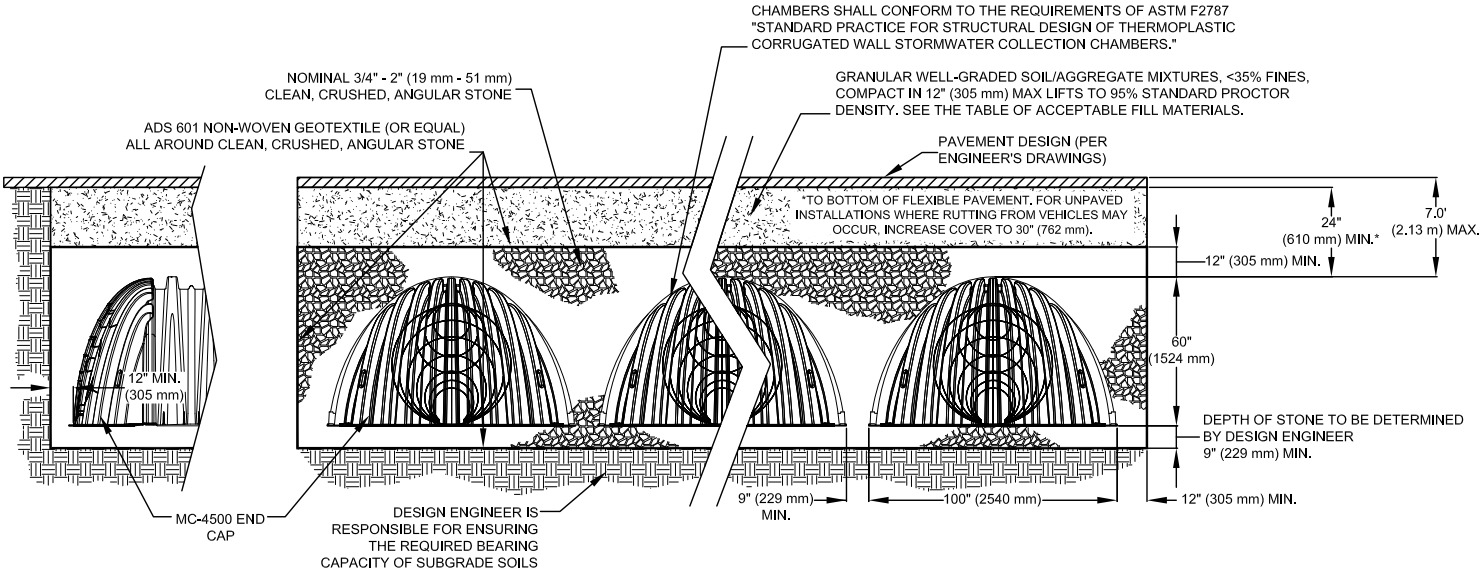
Amount of Stone Per Chamber

ENGLISH tons (yds³)	Stone Foundation Depth			
	9" (229 mm)	12" (305 mm)	15" (381 mm)	18" (457 mm)
Chamber	7.4 (5.2)	7.8 (5.5)	8.3 (5.9)	8.8 (6.2)
End Cap	9.6 (6.8)	10.0 (7.1)	10.4 (7.4)	10.9 (7.7)
METRIC kg (m³)	**229 mm**	**305 mm**	**381 mm**	**457 mm**
Chamber	6681 (4.0)	7117 (4.2)	7552 (4.5)	7987 (4.7)
End Cap	8691 (5.2)	9075 (5.4)	9460 (5.6)	9845 (5.9)

NOTE: Assumes 12" (305 mm) of stone above, 9" (229 mm) min. row spacing, and 12" (305 mm) min. of perimeter stone in front of end caps.

General Cross Section

**Contact your local StormTech representative or visit www.stormtech.com for a copy of the latest installation instructions.



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

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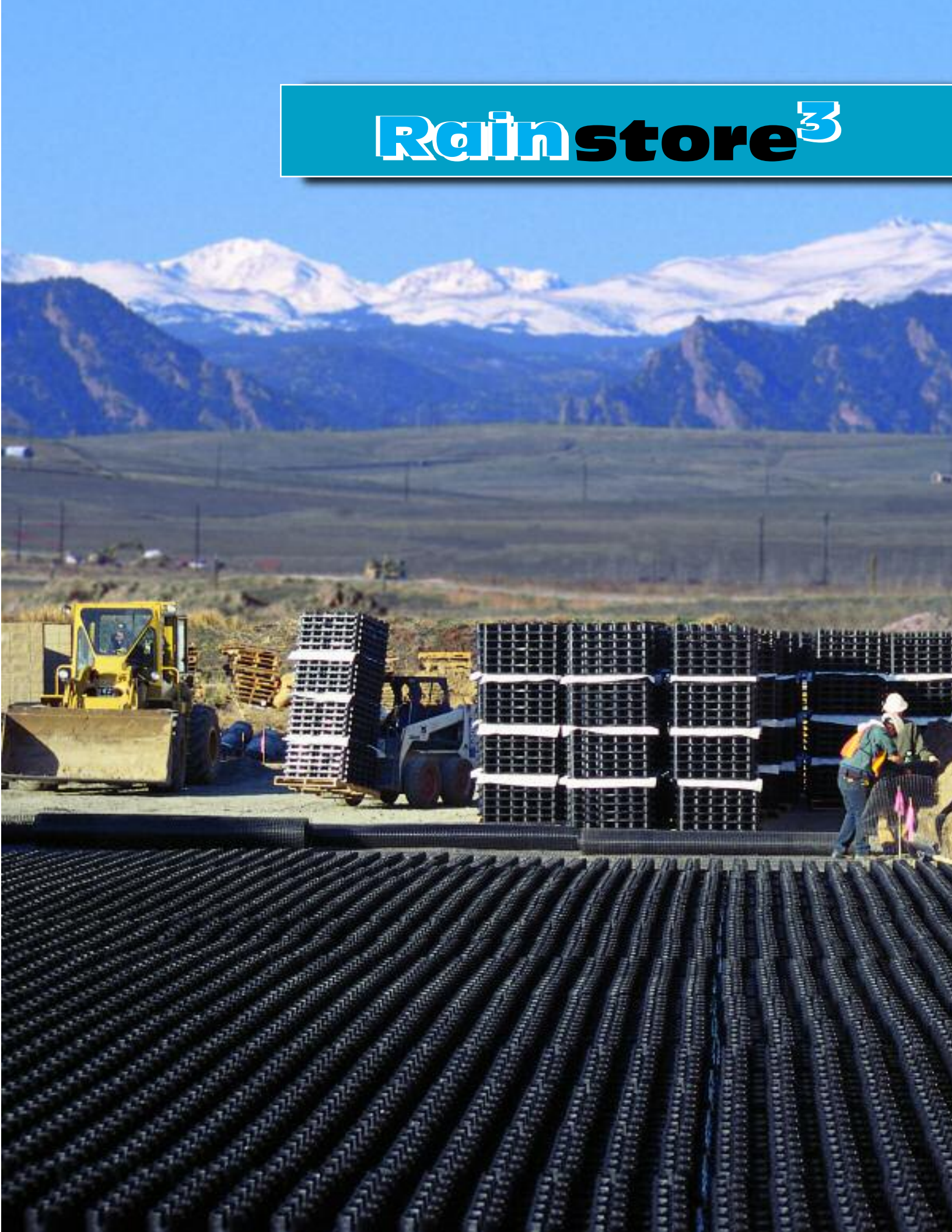
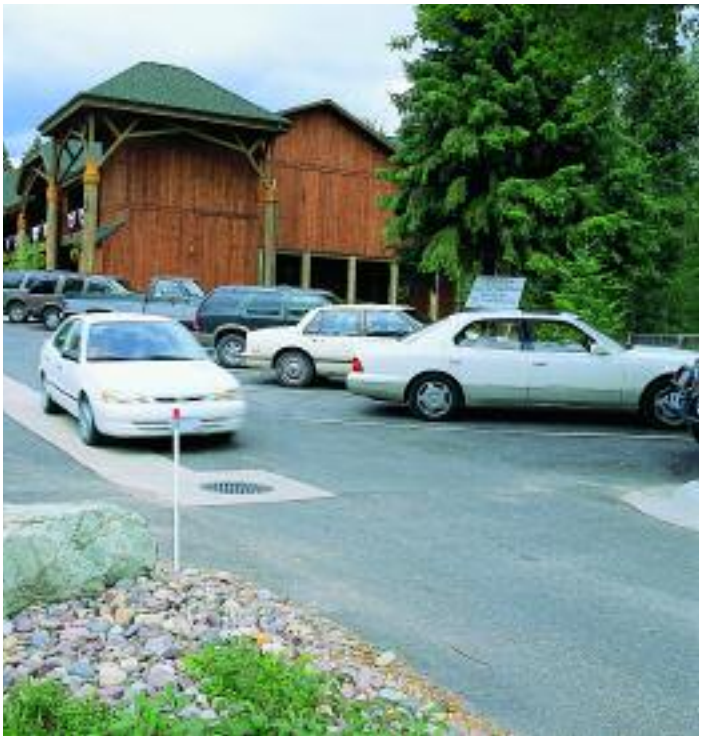
Rainstore^3

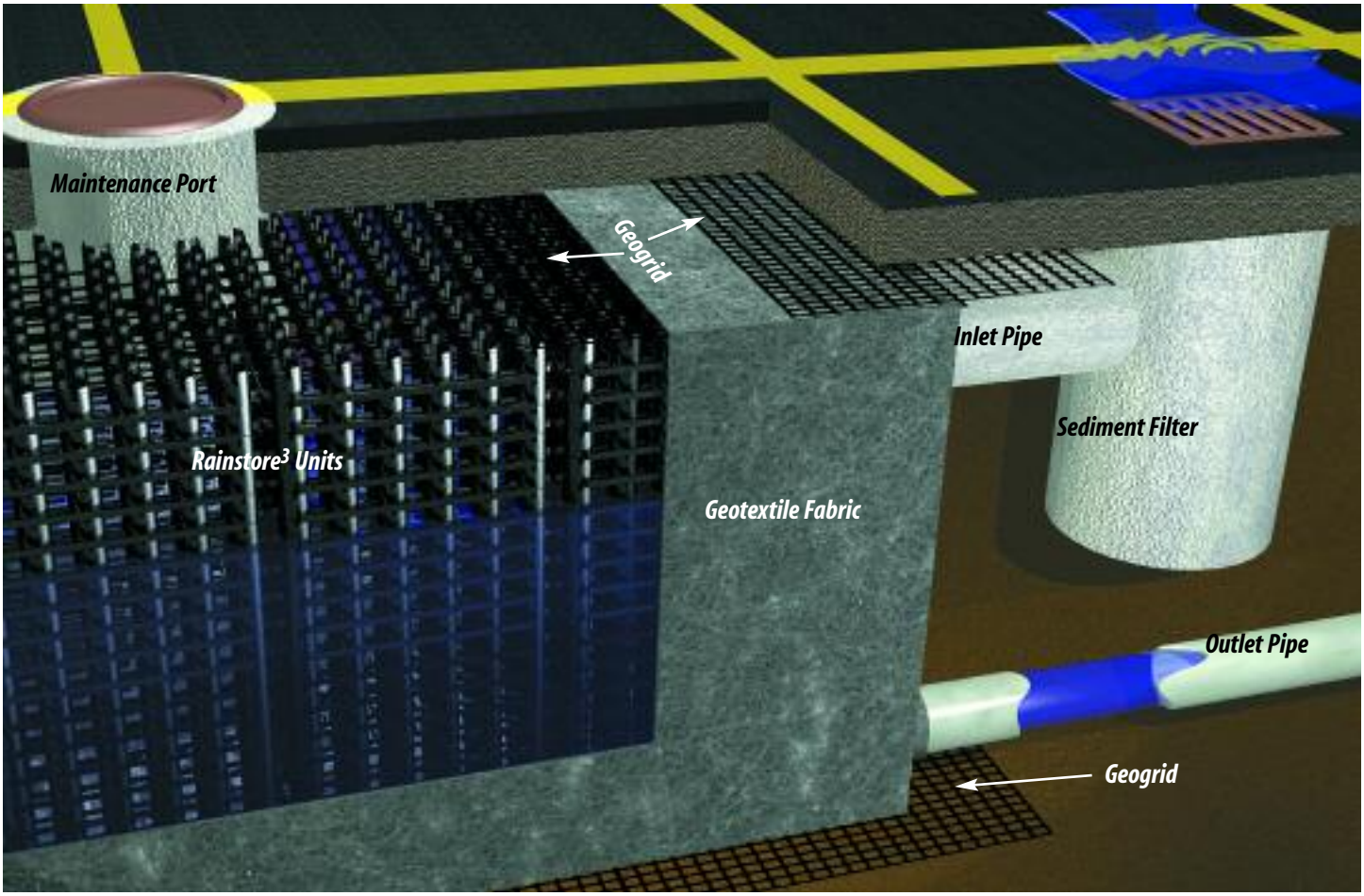




On the cover: Rainstore^3 chamber under parking lot, Broomfield, CO. Without Rainstore^3's high water storage capacity at shallow depths, the flexibility in design, and the convenience of exfiltration, the owners of this site would have been unable to develop this site and would have been forced to find a different location for their new construction.

Above: Two views of a completed RS^3 install under a parking lot in Big Fork, MT. Parking lot and off-street bays for approximately 48 cars, drains into a 26,250-gallon Rainstore^3 stormwater detention structure. Diagonal parking is graded toward the center concrete strip, which drains toward the catch basin.

Below: Graphic representation of asphalt parking lot with Rainstore^3 detention showing individual components. Drawing not to scale.



NOW IT IS POSSIBLE!

Invisible Structures, Inc., (ISI) has created a new class of subsurface water storage system, Rainstore^3 (RS^3). It is not pipe or arched chamber, but a structure with strength throughout its shape. The unique design places the plastic entirely in compression rather than bending or tension, resulting in an excess of H-20 loading, and high void storage volume of 94%! Minimum cover is only 0.3 meter (12″).

The structure can be as shallow as 0.1 meter (4″) or as deep as 2.5 meters (94″), and with any length and width in 1 m (40″) increments. Rainstore^3 eliminates site restrictions by conforming to custom project requirements.

RS^3 does not require any stone backfill between structures. Calculating the void (storage) volume is as simple as dividing storage demand by 94%. This means significant savings in amount of excavation, soil transport, imported stone, installation time, and labor.

Rainstore^3 can be utilized for long-term water storage for irrigation, fire protection, and potable applications by encasing the structures in an impervious liner.

Porous lining materials around RS^3 offer 100% surface area coverage for water infiltration/exfiltration.

Above: Nearly completed installation of a stormwater detention system at a gas station in Nampa, ID. This site has three separate Rainstore^3 chambers to provide the necessary water storage. This photo shows the catch basin and curbing for one of the chambers. Asphalt will cover the visible gravel base.

Below: Installation of a water harvesting application in Santa Fe, NM at the Santa Fe Greenhouse. Rain water is captured and re-used for irrigating the greenhouse plants - saving on the cost of using city water.

STORMWATER QUALITY IS OLD BUSINESS

Company Background and Product Line

Invisible Structures, Inc., has been in the stormwater management business since 1982 with our porous paving systems Grasspave^2 and Gravelpave^2, ring and grid structures for grass and gravel drivable surfaces. Large rolls sizes cover areas quickly while either protecting grass roots from compaction or containing small gravel to eliminate gravel migration. These products have extensive design brochures that cover all aspects from project photographs to latest technology and specifications. Check our web site www.invisiblestructures.com for a full display of information and downloadable details.

Draincore^2 (DC^2) collects excess irrigation and rainfall from recreational grass surfaces such as lawns, sports fields, and bio-swales, and transports filtered water to RS^3. This water may be recycled for irrigation or other uses. Draincore^2 conveys water in a shallow horizontal plane, eliminating trenching and backfill requirements of pipe.

Slopetame^2 (ST^2) is a three dimensional soil, vegetation, pre-vegetation containment mat used to reduce soil loss due to water erosion on slopes, river banks, channels, and bio-swales. Crossbars between rings serve to prevent rill erosion. ST^2 provides support for grasses and a variety of plant material whose roots furnish natural fibrous anchorage. ST^2 bio-swales will help clean debris and pollutants from stormwater prior to entering Rainstore^3.

RS^3 evolved from the ring and grid concept by allowing stackability to greater depths, and increased lateral compressive strength to resist deep soil pressures. The 94% void capacity was attained for RS^3 while satisfying structural criteria.

Water Quality Background

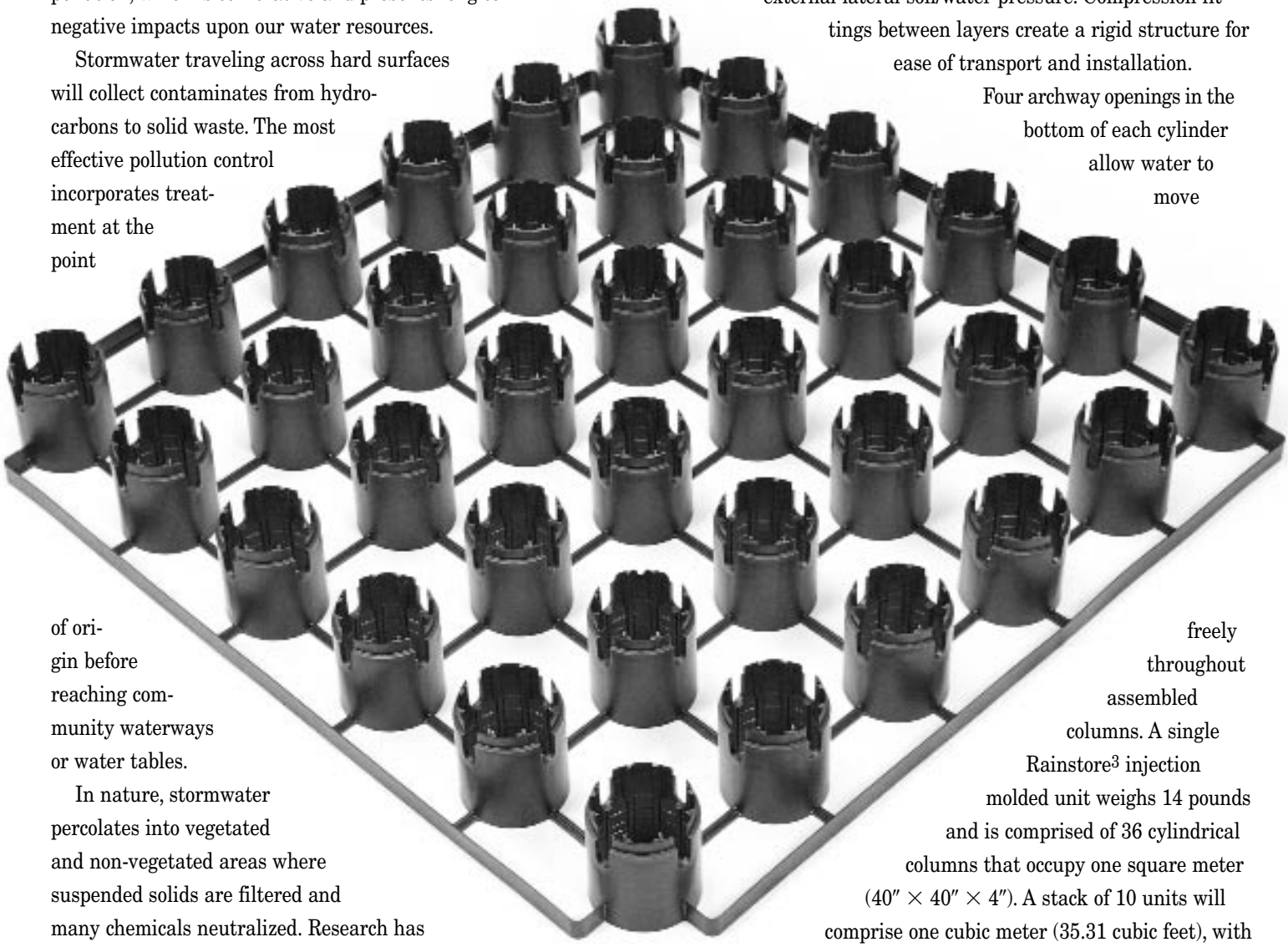
Water quality is critical and must be considered when dealing with stormwater management. In the past, point-source pollution (contaminates from a concentrated source) was of primary concern. Today, non-point source pollution (contaminates from a large area such as a parking lot) is important due to its magnitude and frequency.

The EPA has regulated point source pollution for years and is now implementing strict regulations to control non-point source pollution, which is cumulative and presents long term negative impacts upon our water resources.

Stormwater traveling across hard surfaces will collect contaminates from hydrocarbons to solid waste. The most effective pollution control incorporates treatment at the point of origin before reaching community waterways or water tables.

In nature, stormwater percolates into vegetated and non-vegetated areas where suspended solids are filtered and many chemicals neutralized. Research has shown that hydrocarbons are consumed by bio-organisms found in the root zone without killing the vegetation.

Invisible Structures' porous pavement and bio-swale products provide one of the most effective means of removing pollutants at the source. Refer to Sand-Bio Filter Inlet Detail for ways to reduce or eliminate catch basins and elaborate cleaning systems. Rainstore^3 in combination with ISI's other outstanding products provide a complete stormwater management package.



PRODUCT DESCRIPTION

Basic Structure

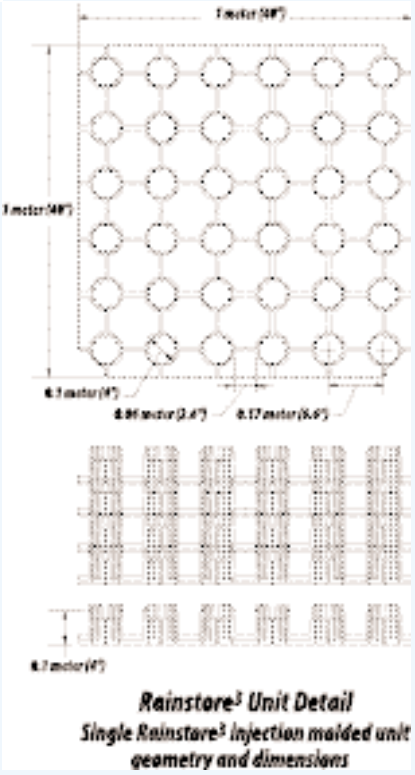
Rainstore^3 is a structure of thin-walled cylindrical columns injection molded of recycled resins of either high impact polypropylene (HIPP), or high density polyethylene (HDPE) plastic for strength, durability, and green industry benefit. For potable water storage, virgin plastic is used. Cylinders are 10 cm (4″) diameter, 5mm (0.2″) average wall thickness, 10 cm (4″) tall, and spaced 16.7 cm (4.6″) apart. T-shaped beams connect the cylinders and resist external lateral soil/water pressure. Compression fittings between layers create a rigid structure for ease of transport and installation.

Four archway openings in the bottom of each cylinder allow water to move freely throughout assembled columns. A single Rainstore^3 injection molded unit weighs 14 pounds and is comprised of 36 cylindrical columns that occupy one square meter (40″ × 40″ × 4″). A stack of 10 units will comprise one cubic meter (35.31 cubic feet), with approximately 250 gallons of net water storage.

RS^3 allows for water containment depths from 10 cm to 2.5 meters (4″ to 94″ or 8.2′). The following standard depths are stocked: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9). Custom depths are also available.

Side bumpers provide foolproof, accurate spacing. Structures may be moved by hand. A layer of geogrid, below the cells and above the existing subsoil, provides a stable surface and will insure proper alignment.

RS³ withstands repeated freeze-thaw cycles, will not rust, break down, crack, is not affected by chemicals, extremes of pH, oils, salts, or fertilizers. Ethylene plastics have a projected service life in excess of 100 years provided they are not exposed to UV light.



Rainstore³ Unit Detail
Single Rainstore³ injection molded unit geometry and dimensions

Overall System

RS³, wrapped with a geotextile filter fabric or geomembrane, and placed side by side in an excavated void create a variety of water storage structures. Inflow, outflow, visual inspection pipes, catch basins, pumps and water filters are installed as needed. Backfilling and compacting the sides, geogrid, base course, and surfacing complete the system.

STORMWATER MANAGEMENT APPLICATIONS

Land development significantly affects the natural course of stormwater. Prior to development, land is semi-porous enabling rainfall to directly infiltrate, which filters pollutants, recharges subsurface water tables, and reduces flooding. Sealing the earth's surface with parking lots, roads, walks, and roofs, results in rapid runoff to storm sewers and rivers, causing flooding and unacceptable pollution of valuable water resources.

To combat these serious problems, national (EPA) and regional regulatory agencies require all or a portion of stormwater to be managed on site.

Surface detention basins and ponds are common, but often occupy valuable real estate and create safety hazards, insects, weeds, and odor problems. Increasingly, the most economical and convenient solution is an "underground pond," where the water may be stored temporarily before it is released to a storm sewer (detention), stored until it exfiltrates (retention), or stored for reuse (harvesting).

Porous Paving

The most direct stormwater management technique is to allow the rain to penetrate the surface where it falls. This can be done with Grasspave² or Gravelpave² porous paving. The base course below these plastic reinforcement structures will typically store at least 2.5″ of rain, or more, if subsoils are porous. Firelanes and overflow parking areas are frequently used as infiltration basins.

Rainstore³ Detention

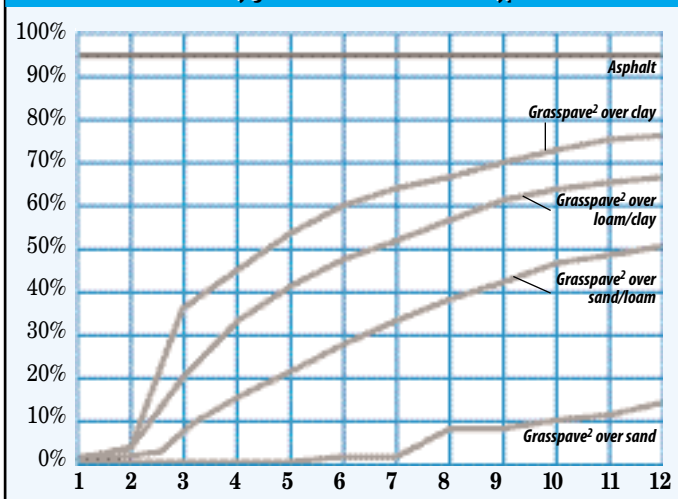
Short term storage and releasing stormwater at a predetermined rate through the use of small outlet pipes or pumps is detention. Downstream stormwater facilities may exist but have a limited flow rate capacity. While the water is held awaiting gradual release, it may or may not be allowed to exfiltrate into the site soils. A porous non-woven geotextile is used to encase RS³. Geomembranes are used when exfiltration must be avoided.

Rainstore³ Retention

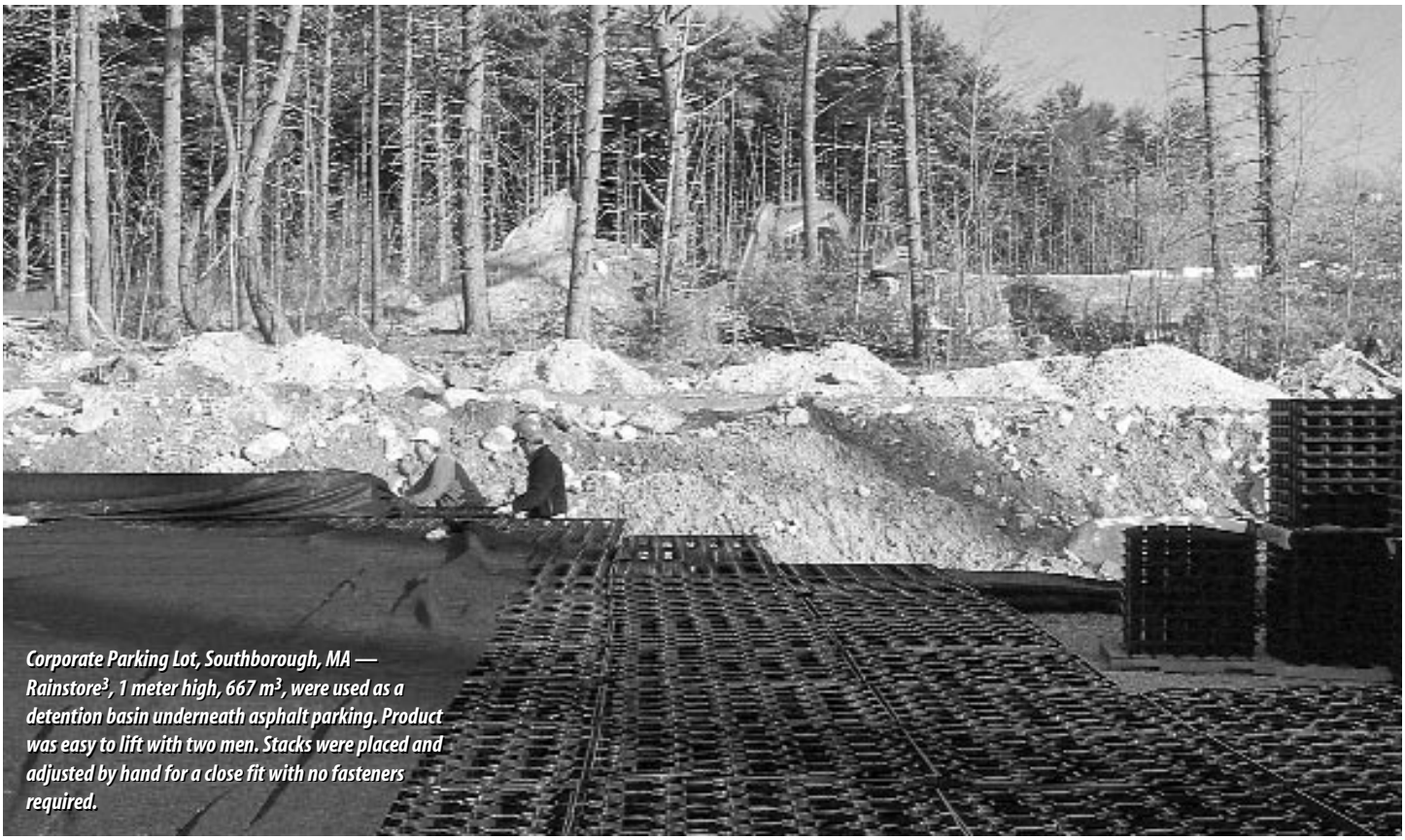
When downstream stormwater facilities do not exist or the amount of water released from a site is limited for some other reason, stormwater retention is utilized. Typically, there are no outflow pipes. RS³ is encased in non-woven geotextile and placed above porous soil. Replenishing existing aquifers is a benefit.

Runoff Comparison Chart

Runoff coefficients, Grasspave² or Gravelpave² and sandy gravel base over various soil types.



Calculations include Grasspave² or Gravelpave² placed over 6″ of sandy gravel base course, laid over native soils indicated.



Corporate Parking Lot, Southborough, MA — Rainstore³, 1 meter high, 667 m³, were used as a detention basin underneath asphalt parking. Product was easy to lift with two men. Stacks were placed and adjusted by hand for a close fit with no fasteners required.

Water Harvesting

As population centers expand in arid climates, traditional water sources such as rivers and aquifers have been significantly depleted. With increased water prices, it becomes more economical to harvest rainfall with Rainstore³. Also, demands upon ground resources are reduced, making some water critical projects possible. The choice for long term storage with Rainstore³ is influenced by site opportunities and constraints, access to community infrastructure (water, sewer, fire protection), government regulations, and owner principles and guidelines.

Stormwater falling on a site is collected from roofs, bio-swales, and parking areas. A strong impermeable liner surrounding the

Product Performance Analysis

Performance Criteria	Rainstore³ 2.5 meter (8.2′) height	Arched Chambers (34″ × 75″ × 16″)	Corrugated Plastic Pipe (60″ dia.)	Corrugated Metal Pipe (72″ dia.)	Concrete Pipe (72″ dia.) Non-perforated
% of excavated volume available for water storage	~75%*	~40%*	~60%*	~53%*	~38%*
% of storage volume occupied by stone	0%	~59%	~60%	~70%	0%
Maximum water storage volume/ surface area	8.2 ft^3 water storage/ft^2 surface area	~1.4 ft^3 water storage/ft^2 surface area	3.8 ft^3 water storage/ft^2 surface area	4.7 ft^3 water storage/ft^2 surface area	3.2 ft^3 water storage/ft^2 surface area
Chamber depth design flexibility	4″ min., 98″ max., in 4″ increments	12″ min., 30.5″ max.	12″ dia. min., 60″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments
Cover depth required	12″	18″	12″ – 30″ based on diameter	12″ – 24″ based on diameter	6″
On-site handling and manual installation	Easy	Easy	Difficult	Difficult	Difficult
Maintenance, inspection, clean-out	Moderate	Moderate	Easy	Easy	Easy
% of chamber surface area available for infiltration	100%	~75%, including side cuts	~15%, based on perforation area to pipe surface area	~15%, based on perforation area to pipe surface area	0%

*Calculations based on an average sized (10 meter × 10 meter) footprint installed per manufacturer's specifications.

chamber prevents evaporation and contamination. The water may be used for landscape irrigation, fire protection, potable applications, and industrial processes, such as water for heating and cooling with geothermal energy transfer. For long term storage, water may require chemical treatment or oxygenation to preserve water quality.

PRODUCT PERFORMANCE COMPARISON

Crushed rock wrapped in geotextile, concrete, corrugated metal or plastic pipe, and plastic arch chambers have been historical subsurface water storage options available to designers. Invisible Structures closely studied the performance of these systems and obtained feedback from engineers and contractors as to what they liked and disliked about available solutions.

With this information, ISI designers developed Rainstore^3 which boasts a highly efficient excavated volume, economical installation, reduced stone requirements, improved design flexibility, safety, strength, and exceptional longevity.

DESIGNING WITH RAINSTORE^3

Design Steps

1. *Choose system application:* Determine whether porous paving, detention, retention, and/or water harvesting methods will be used. Function will determine whether outflow pipes will be needed, and choice of liner to encase the structures.

2. *Determine the location and quantity of storage systems:* Pick the most appropriate site location to minimize excavation, grading, and piping — usually downhill from runoff sources. Use soil boring information to determine subsoil conditions and water table depth. Exfiltration requires porosity. Rainstore^3 can be located below most landscaped or paved surfaces. It may be desirable to use more than one location for storage.

3. *Choose surfacing to be placed above storage structure:* RS^3 allows for many different surfacing options — parking, green space, recreation, landscaping, and light weight buildings. Landscaping directly above a storage structure should be restricted to shallow rooted materials such as grasses, groundcovers, and low growing shrubs. Long term chemical root barrier materials are available if RS^3 must be kept root free.

If parking is the surface use, then choose between porous paving and hard surface options. Grasspave^2 and Gravelpave^2 filter stormwater directly by allowing percolation through the parking surface and base course into RS^3 without the use of pipe.

4. *Determine required capacity:* Local regulating agencies establish rainfall storage requirements. Calculate by multiplying the hard surface area (roads, parking lots, walks, roofs, etc.) by the "design rainfall" required, then by the runoff coefficient (refer to Runoff Comparison Chart on page 3). Determine supplemental storage requirements for irrigation, process, fire safety, or potable uses, and add to regulated storage demand.

5. *Determine quantity of Rainstore^3:* Convert the storage requirement to cubic meters, divide by 0.94 to determine volume of Rainstore^3 in cubic meters. Gallon storage reference is 1 m^3 of water = 264 gallons $\times$ .94 = 250 gallons/m^3 RS^3.

6. *Depth of Rainstore^3:* Factors such as depth of water table, bedrock and available excavation area affect the optimal depth of retention/ detention capability. Choose a RS^3 bottom elevation that is higher than the water table maximum level. In cases where surface area is very limited and storage volume is great, deeper structures are usually more cost effective. Include 12″ of gravel fill and surfacing cover in the decision. The Rainstore^3 cells are assembled to the desired depth prior to shipment. The following depths are available to avoid additional shipping costs: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4), *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9).

Provide an appropriate safety factor when depth of structure is near the maximum water table level because water rising into RS^3 reduces storage volume. Please refer to the Product Description section for standard and custom depths.

7. *Choose the length and width of Rainstore^3:* Having already chosen RS^3 depth, pick the length and width that occupies the required volume of RS^3 (L $\times$ W = V/height). Adjust length or width as necessary to meet site criteria. The length and width must be in full meter increments.

8. *Determine catch basin and inflow locations:* **All water entering the Rainstore^3 structure must be reasonably silt and debris free to minimize maintenance and extend the system's useful life.**

Typical Soil Permeabilities

Soil Group	Typical Coefficient	Inches /Day	Description	Suitable for Exfiltration
GW	2.5 EE-2	850.4	well graded, clean gravels, gravel-sand mixtures	Yes
GP	5 EE-2	170.1	poorly graded clean gravels, gravel-sand mixtures	Yes
SW	>5 EE-4	17.0	well-graded clean sands, gravelly sands	Yes
SP	>5 EE-4	17.0	poorly graded clean sands, sand-gravel mix	Yes

Note: The following soil groups are not suitable for exfiltration (silty, clayey soils): GM, GC, SM, SM-SC, SC, ML, ML-CL, CL, OL, MH, CH, OH.

The preferred filtration method is a sand or bio-filter constructed with Gravelpave^2 or Grasspave^2 (refer to Sand/Bio-Filter Inflow Detail). A catch basin or other structural means may also be used. Choose an inflow location that best suits site conditions and minimizes waterborne debris. Standard pipe made of PVC, HDPE, steel, concrete, tile, copper, or any other material may be used to convey water to or away from Rainstore^3.

9. *Determine outflow locations (if necessary):* For gravity fed outflow, ensure that site topography allows the outflow pipe to travel to a lower elevation stormwater facility. Size the pipe to limit outflow to the desired rate. If gravity outflow is not possible, pumps may be used (refer to Water Harvest or Maintenance Port Details). **A fail safe power supply is essential if outflow pumps are used.**

10. *Select Rainstore^3 liner:* First, choose between permeable and impermeable. Non-woven filter fabrics are typically used except when water harvesting or stormwater exfiltration is prohibited by regulation.

Acceptable impermeable liners are at least 40 mil PVC or equal. Permeable liners must be at least 8 ounce non-woven. Properly match fabric pore sizes to surrounding soils to prevent clogging and blinding. **Fabric seams must have a 24″ minimum overlap unless sewn.**

To make pipe connections to geotextile fabric, cut an "X" in the fabric, insert the pipe, gather fabric, and fasten tightly with a pipe clamp. If using a geomembrane, construct a "boot" of material and bond it to the circular opening. Insert the pipe through the boot and fasten with two pipe clamps (refer to the Water Harvest Detail).

11. *Determine quantity of geogrid:* **Three layers of geogrid (Tensar BX1200, Tenax MS330, Huesker Fornit 30 or equivalent) must be placed. One layer on the soil below the RS^3 (see step 12), one layer directly on top of the RS^3 cells — to stabilize with adjacent cells and to provide a walking surface — and the final layer placed on fabric-encased chamber and extended 0.5 meter (20″) beyond the sides of the structure.**

12. *Compute length, width, and depth of excavation:* **Excavation must extend at least 0.5 meter (20″) beyond all sides of RS^3 structures to allow for ease of product installation and backfill compaction with powered compactor. Soil below RS^3 must be leveled with minimal compaction. A layer of geogrid (Tensar BX1200, Tenax MS330, Huesker Fornit 30 or equivalent) must be placed on the subsoil and extended 0.5 meter (20″) beyond the sides of the structure.** Large and deep storage volumes may demand a drivable access route for excavation, leveling, compaction and placing Rainstore^3 structures.

0.3 meters (12″) minimum, 0.9 meters (36″) maximum, structural base course (no greater than 1″ particle size) must cover the geogrid and extend past all RS^3 sides by 0.5 meter (20″). Compact this layer to a minimum of 95% modified Proctor density.

Native excavated soil or imported structural backfill may be used along the sides of the structure as long as a 95% modified Proctor density is achieved. Compact in lifts as needed to attain proper compaction. Water saturated backfill should not be used as it is difficult to compact and creates excessive hydrostatic pressure on bottom sides of RS^3.

Warning: Take extreme care when driving and/or compacting over the chamber and do not drive over exposed Rainstore^3 units — wait until ALL the units are installed, the side backfill is complete, fabric and geogrid layers are completed, and an adequate amount of cover material is placed. Mark area to identify chamber location.

13. *Choose maintenance port locations:* Check local regulations proper size and placement of maintenance ports. An inside corner section of Rainstore^3 may be removed to create a suitable opening for inspection and inserting cleanout pumps. (Refer to the Maintenance Port Detail.)

MAINTENANCE OF A RAINSTORE^3 STORMWATER STORAGE CHAMBER

Invisible Structures, Inc. recommends that stormwater be pretreated prior to discharging into the chambers to avoid foreign matter accumulation inside the chamber. This can be accomplished by a variety of techniques or products. Some examples are:

Short Term Storage (Detention Basin)

"Zero" Maintenance — the Preferred Method

Use a natural, or "Bio-Filter," inlet device — essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore^3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

Water passing through the filter section can pass directly into the top of a Rainstore^3 chamber, or be collected and transported over larger distances via Draincore^2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall remain suspended, or be easily re-suspended by the next rain event for removal. Long-term accumulations to a depth affecting exfiltration rates can be measured in decades, not years.

Trash pickup from the surface requires that Zero be in quotes. Also be aware that grass surface porous pavements (Grasspave^2) offer greater biological activity, but at a higher surface maintenance cost — mowing, fertilization and irrigation. Gravel surface porous pavements (Gravelpave^2) still provide biological activity at a level lower than with grass, but with lower maintenance required.

Short Term Storage (Detention Basin)

Low, but Periodic, Maintenance

Use a structural form of catch basin with a deep sump prior to use of a hooded elbow inlet into the chamber. Whether standard catch basins or sophisticated cyclonic flow devices are used, the objective is to remove any coarse debris and sediment (sand and larger) from entering the Rainstore^3 chamber. Periodic maintenance will be required to remove trash and sediment that accumulates in the device. Frequency shall depend upon the physical nature of sediments carried and allowed into the "screening" device.

Fine sediments may still be transported into the chamber via the inlet pipe and will likely be dispersed rather evenly over the entire chamber bottom surface area, where they will then settle to the bottom — depending upon the duration of time water is left in the chamber and the size of the particle. Particles smaller than the AOS of the porous fabric liner will pass through the liner and continue migration until stopped by underlying soils. Particles larger than the AOS shall remain inside the chamber, and can be periodically re-suspended by injecting high-pressure water into a Maintenance Port, with removal of the sediment laden water via sump pump from the same, or other, port.

Eventually, especially if maintenance is too infrequent, the bottom of the chamber may develop a thick sediment layer sufficient to obstruct exfiltration through the bottom of the chamber. The sides of the chamber shall continue to function, but time for total water evacuation will increase.

This approach is most closely related to more traditional design responses, but is not the best solution long term for the client. Standard catch basins are lowest initial cost, but much higher in maintenance cost. Commercial cyclonic devices may have lower maintenance cost, but offer higher levels of cleaning efficiency at much higher initial investment cost.

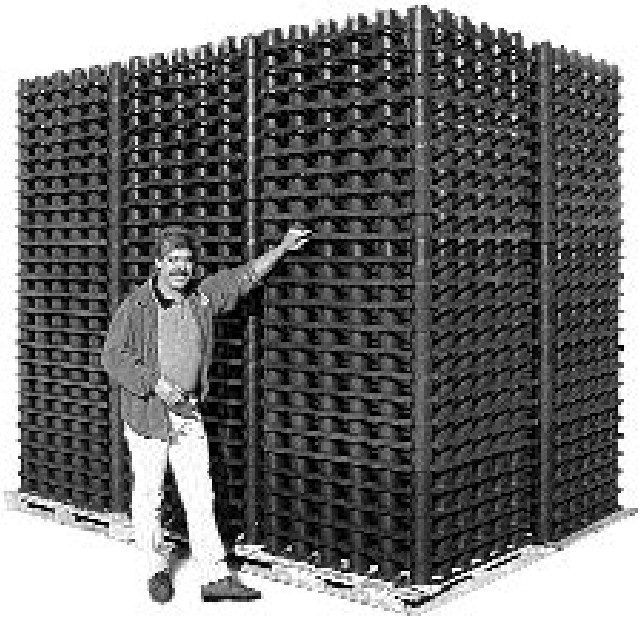
Long Term Storage (Water Harvest Basin)

"Zero" Maintenance — the Preferred Method

Again, use a natural, or "Bio-Filter", inlet device – essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore^3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

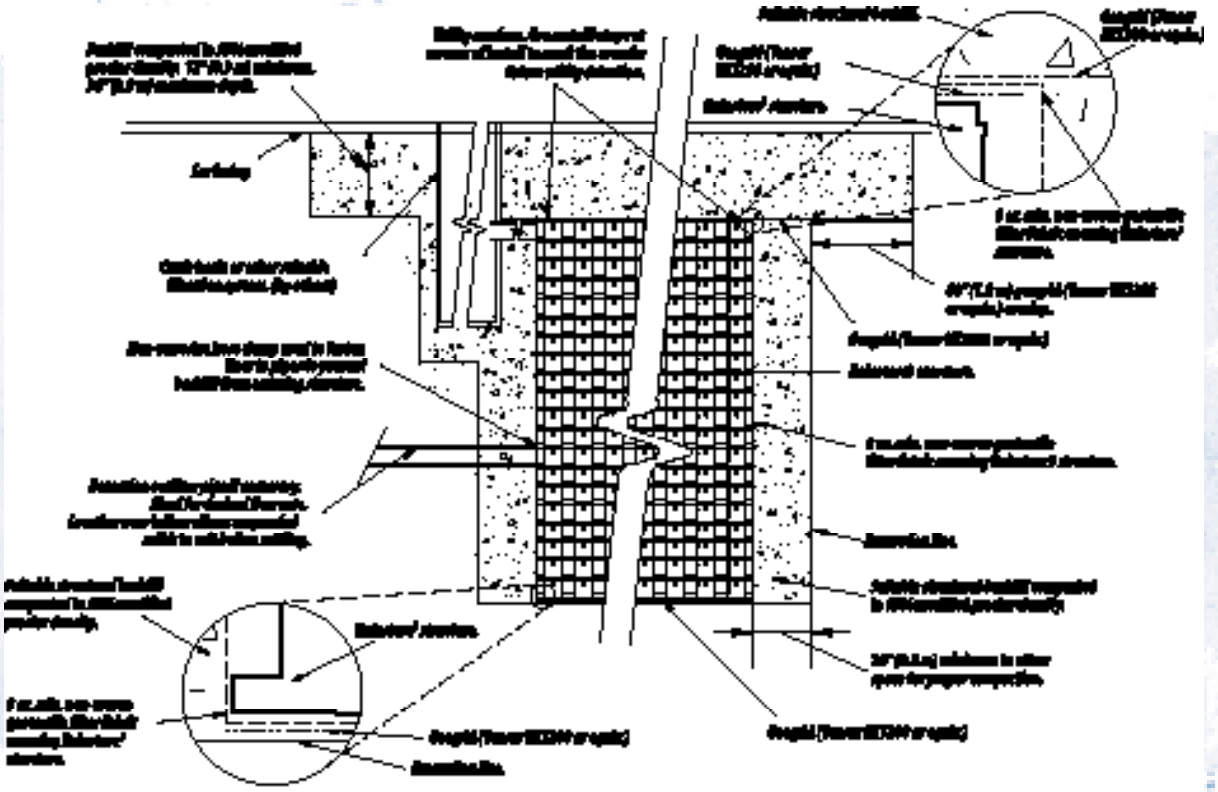
Water passing through the filter section can pass directly into the top of a Rainstore^3 chamber, or be collected and transported over larger distances via Draincore^2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall be easily re-suspended by the next rain event for removal. This level of sediment can be safely captured and transported via pumps for water reuse in irrigation or gray water applications, or further filtered by an automatic sand filter device with "back-flush" capabilities.

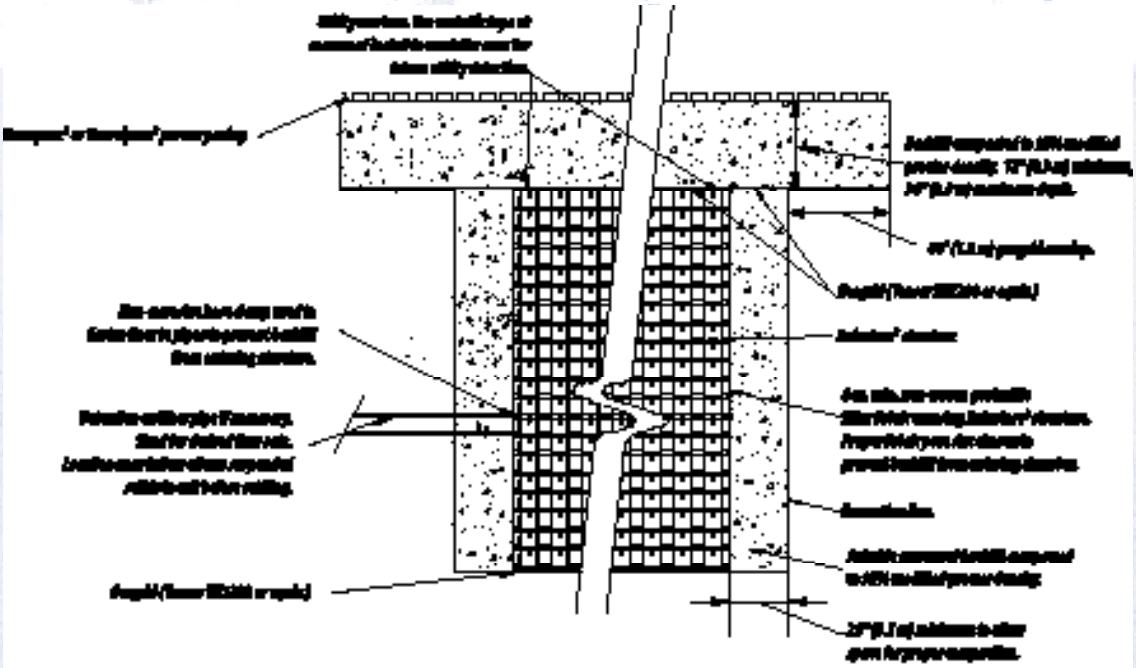


Below: Taller can be better for your design with 8.2 feet or 2.5 meters high versatility. H-20 loading capability allows use underneath all parking lots and a variety of structures.

DESIGN DETAILS

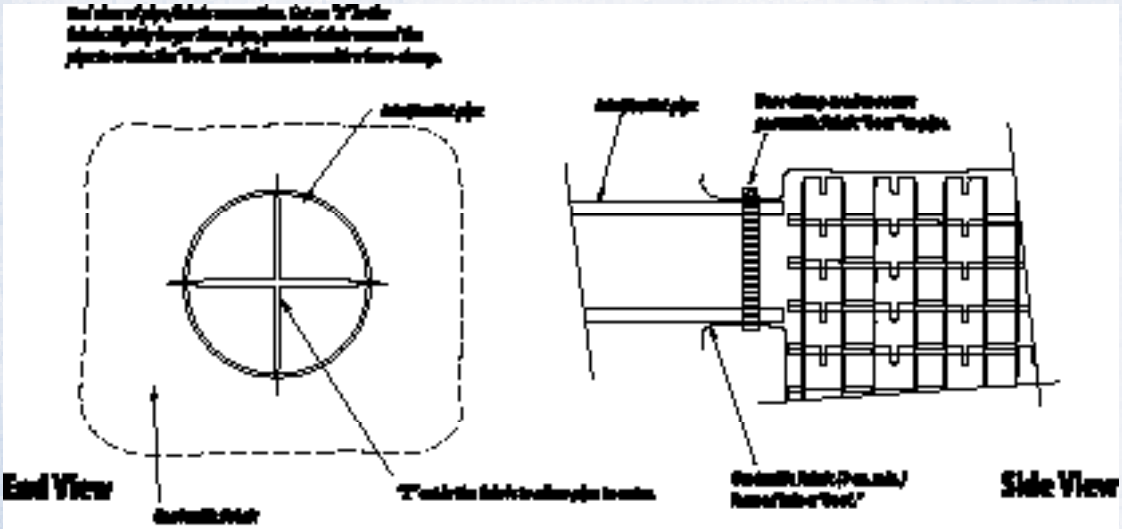


Rainstore² System



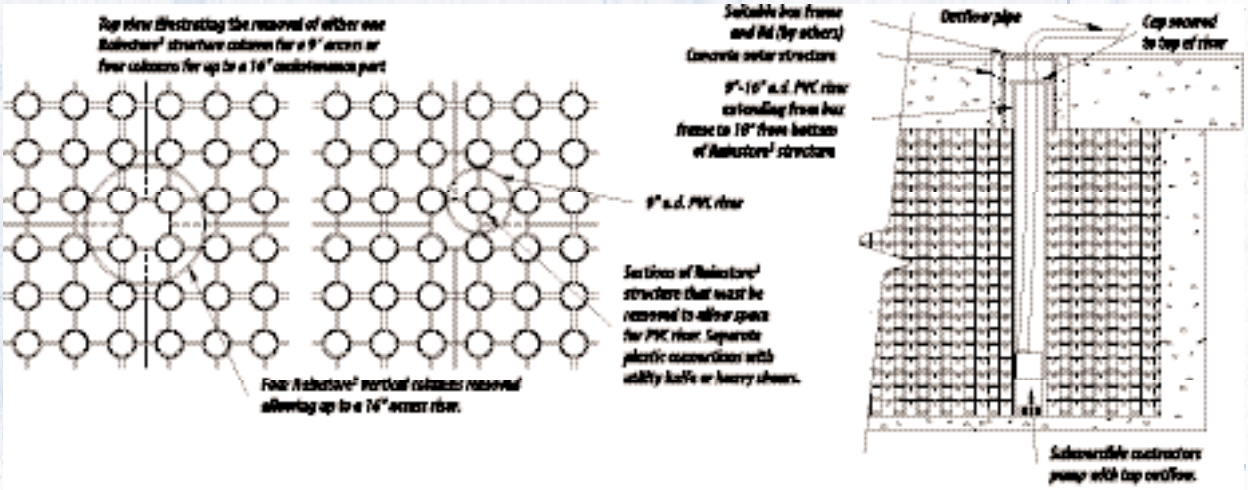
Porous Paving Inflow Method

DESIGN DETAILS



Rainstore³ Inlets/Outlets With Fabric

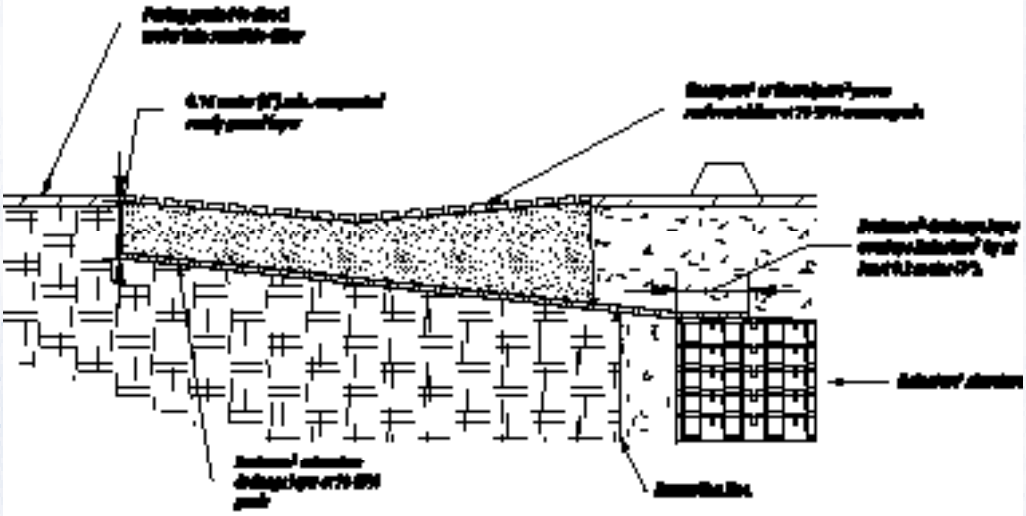
Connecting pipe to the Rainstore³ structure



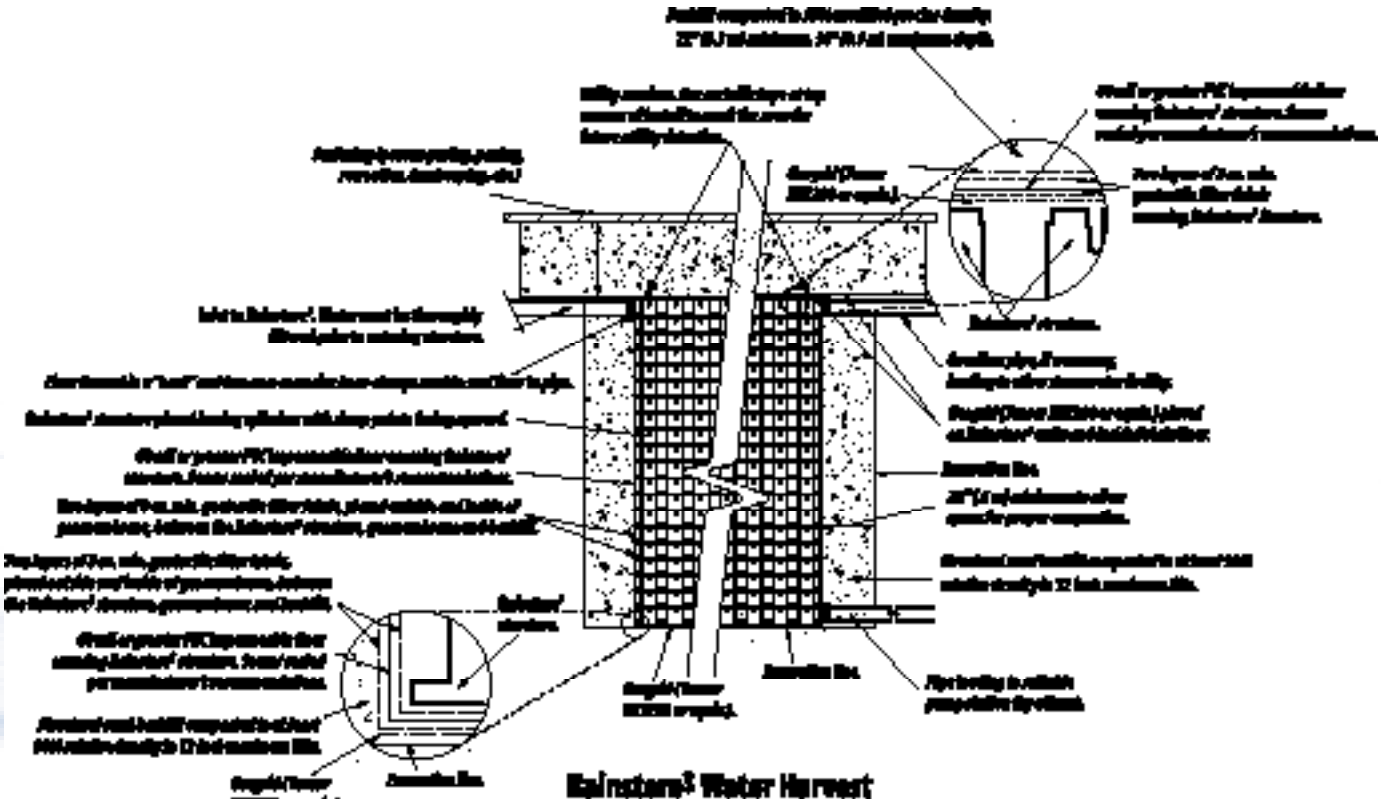
Rainstore³ Maintenance Port

Method for providing inspection and cleanout access

DESIGN DETAILS



Rainstore³ Sand-tile Filter Inlet



Rainstore³ Water Harvest

Rainstore^3 Materials and Budgeting Worksheet

Online version of the materials estimator available at: http://www.invisiblestructures.com/RS3/estimator.htm

Item	Description	Formula	Quantity	Unit	$/Unit	Budget Total $	Notes
1	Required Water Volume (V_w)	–		m^3	N/A	N/A	Minimum agency requirements+client/site requirements
2	RS^3 Storage Volume (V_r)	$V_r = V_w/.94$		m^3			RS^3 is 94% void
3	Depth RS^3 (D)	see note		m	N/A	N/A	in meters (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) in feet (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9)
4	Length RS^3 (L)	$L=V_r/H \times W$		m	N/A	N/A	Site dimensions, round up to nearest meter
5	Width RS^3 (W)	$W=V_r/H \times L$		m	N/A	N/A	Site dimensions, round up to nearest meter
6	Geotextile Fabric Area (A_f) for detention†	$A_f=2.1 \times ((L \times W)+(L \times D+W \times D))$		m^2			Top+bottom+sides+5%, 8 oz. min., includes labor
7	Geogrid Area (A_g)	$A_g=((L+1\ m) \times (W+1\ m)/0.95) \times 3)$		m^2			RS^3 area+1 meter on each side+5%, includes labor
8	**Total Materials**	Add items 1-8	N/A	$	N/A		
9	Excavation Volume (V_e)	$V_e=(D+0.4\ m) \times (L+1\ m) \times (W+1\ m)$		m^3			Equipment, labor and hauling included
10	RS^3 installation labor (L_r)	$L_r=V_r/15$		man-hours			Estimation assuming installation of 15m^3/man-hour
11	**Total***	Add items 9-11	N/A	$	N/A		

† For harvesting applications, budget for twice the fabric area (A_f) and include cost for 40 mil PVC liner = A_f
*Overhead and contingency expenses not included

USEFUL CONVERSIONS

1 gallon = .1337 ft^3	1 ft^2 = .0929 m^2	1 m^3 = 264.15 gallons
1 gallon = .003785 m^3	1 m^2 = 10.76 ft^2	1 m^3 = 35.314 ft^3
1 gallon = 3.7854 liters	1 m^2 = 1.196 yd^2	1 m^3 = 1.308 yd^3
1 inch = 2.54 cm	1 acre = 43,560 ft^2	1 yd^3 = .8361 m^3
1 cm = .3937 inches	1 acre = 4,047 m^2	1 ton @ 125/ft^3 = 16 ft^3
1 foot = .3048 m	1 acre foot = 1,233.5 m^3	1 ton @ 125/ft^3 = .593 yd^3
1 meter = 3.28 ft	1 ft^3 = .0283 m^3	1 ton @ 125/ft^3 = .453 m^3
	1 ft^3 = 7.48 gallons	

DESIGN AND TECHNICAL SUPPORT

Invisible Structures welcomes the opportunity to review project designs and answer technical questions. AutoCAD design details may be downloaded from our website. ISI staff is available for on-site construction guidance.

See a comprehensive list of project profiles with photos, project sizes, descriptions, locations, and designs on the web at www.invisiblestructures.com

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Rainstore^3 Patent No. 6,095,718. International Patents Apply

LIMITED WARRANTY — RAINSTORE^3

INVISIBLE STRUCTURES, INC., warrants to the Owner the structural integrity of Rainstore^3 structures themselves when installed in accordance with Invisible Structures' written specifications at the time of installation. This warranty applies against defective materials for two (2) years from the date of purchase.

This warranty shall be the sole and exclusive warranty granted by Invisible Structures, Inc., and shall be the sole and exclusive remedy available to Owner. INVISIBLE STRUCTURES, INC., DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, THAT ARISE BY THE OPERATION OF LAW, SPECIFICALLY INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. INVISIBLE STRUCTURES, INC., SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES WHICH MAY HAVE RESULTED FROM ANY ALLEGED BREACH OF WARRANTY.

SPECIFICALLY EXCLUDED FROM WARRANTY COVERAGE ARE DAMAGES ARISING FROM ORDINARY WEAR AND TEAR; ALTERATION, ACCIDENT, MISUSE, ABUSE, OR NEGLECT, THE RAINSTORE^3 STRUCTURE BEING SUBJECTED TO USES OTHER THAN THOSE PRESCRIBED IN INVISIBLE STRUCTURES, INC.'S WRITTEN SPECIFICATIONS, OR ANY OTHER EVENT NOT CAUSED BY INVISIBLE STRUCTURES, INC.

Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Neither the sales personnel of the seller nor any other person is authorized to make any warranties other than those described herein or to extend the duration of any warranties beyond the time period described herein on behalf of Invisible Structures, Inc.

Should a defect appear in the warranty period, the Owner must inform Invisible Structures, Inc. of the defect in writing within ten (10) days of the discovery of the defect to the following address:

Kevin F. Wright, President
Invisible Structures, Inc.
1600 Jackson Street, Suite 310
Golden, CO 80401

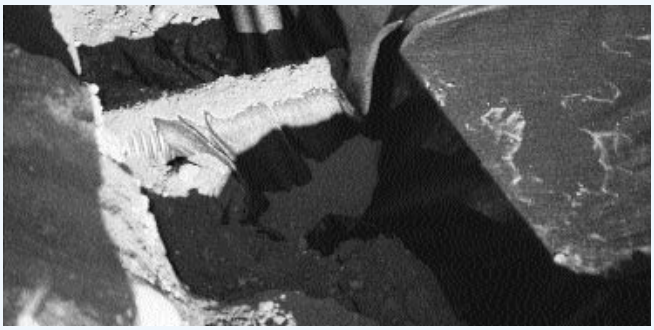
Invisible Structures, Inc., agrees to supply replacement Rainstore^3 structures for those parts found by Invisible Structures, Inc., to be defective. THE COST OF REMOVAL OR INSTALLATION, OR A COMBINATION THEREOF, OF THE RAINSTORE^3 STRUCTURE IS SPECIFICALLY EXCLUDED FROM THIS WARRANTY. Shipping costs shall be the responsibility of the Owner.

Under no circumstances shall Invisible Structures, Inc. be liable to the Owner or to any third party for claims arising from the design of the Rainstore^3 structure, shipment of the components of the Rainstore^3 structure, or installation of the Rainstore^3 structure.

This warranty may not be amended except by a written instrument signed by an officer of Invisible Structures, Inc., at its corporate headquarters in Golden, Colorado. This warranty does not apply to any party other than to the Owner.

California Industrial Resources, Monroe, WA — Installation of Rainstore^3

Moving stacks of product



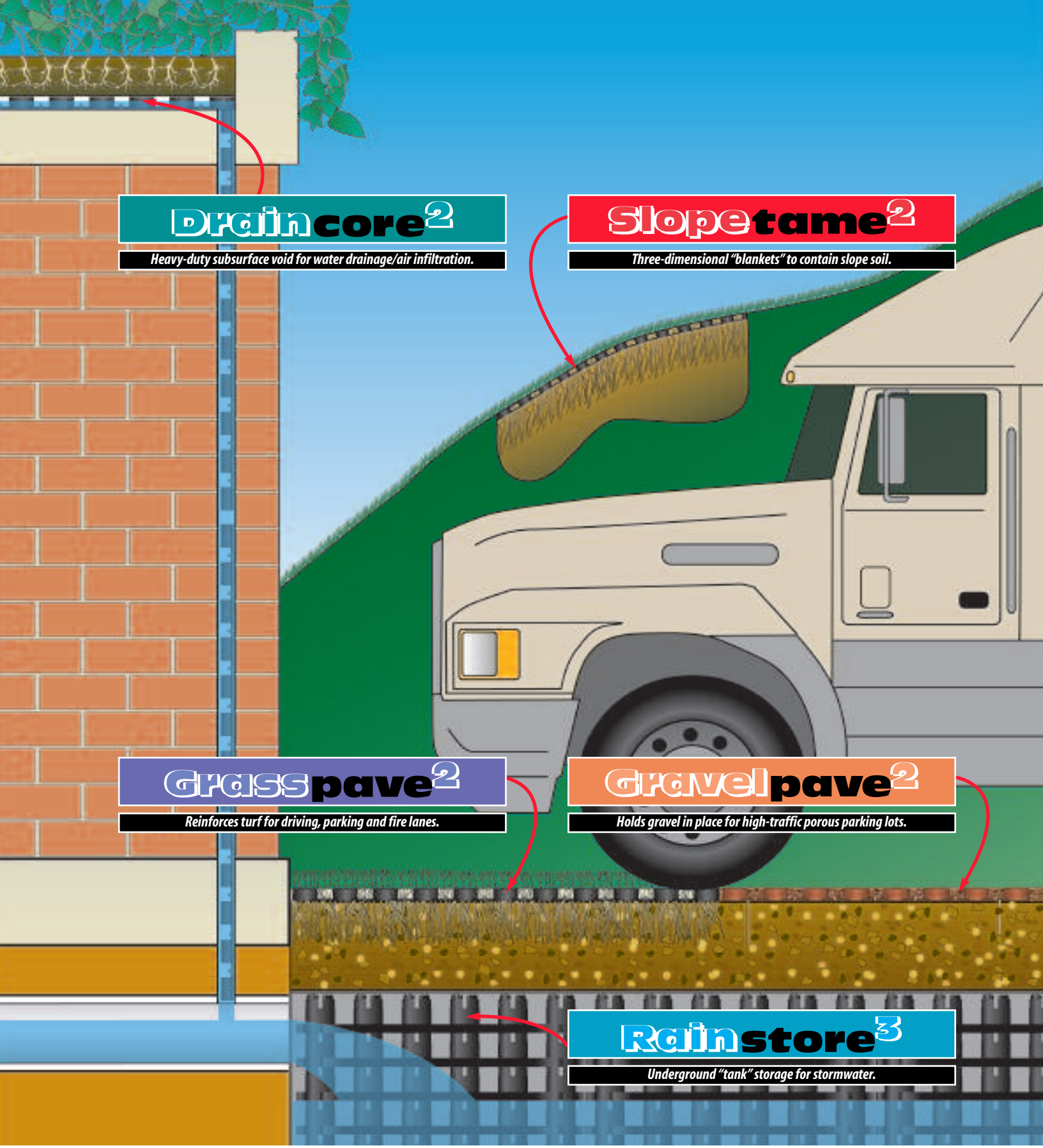
Inlet boot connection detail

Filter fabric with geogrid placed on top

Backfill with roadbase prior to operating heavy machinery on Rainstore^3 units

Left: Heavy equipment begins to put the cover material over an installed Rainstore³ chamber. Take extreme care when driving and/or compacting over the chamber and do not drive over exposed Rainstore³ units — wait until ALL the units are installed, the side backfill is complete, fabric and geogrid layers are completed, and an adequate amount of cover material is placed.

Below: A completed Rainstore³ installation at a chemical plant's loading dock in Chicago Heights, IL. Stormwater drains via multiple inlets to a Rainstore³ retention area beneath a concrete loading dock pad. The out-flow into the city system is controlled by a shut off valve on a single 6" pipe. For safety, if there is a chemical spill, the valve can be closed, the contents can be pumped out, and the spill cleaned up.



Invisible Structures, Inc.

1600 Jackson Street, Suite 310, Golden, CO 80401
800-233-1510 • Fax: 800-233-1522
Overseas and locally: 303-233-8383 • Fax: 303-233-8282
www.invisiblestructures.com

CD-ROM

CADD DISK

IECA MEMBER

Rainstore3 Patent No. 6,095,718.
International Patents Apply

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Turf Cell®

The Only Porous Paver designed specifically for use with rhizomatous grasses.

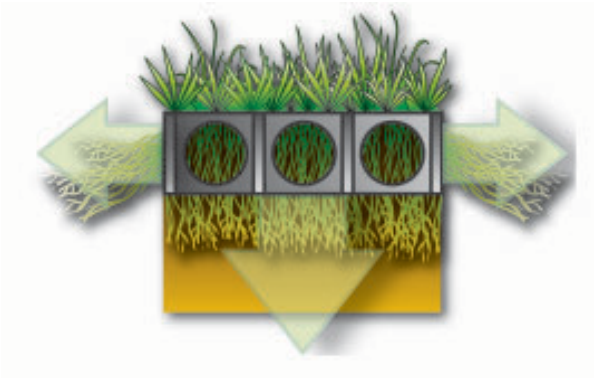
Environmental ACF

Atlantis
Water Management for Life

Turf Cell

Introducing Turf Cell, the latest innovation in porous paving technology. Turf Cell allows occasional use impervious pavements to be converted to pervious, drivable grass surfaces.

But Turf Cell goes a step further. With lateral openings within the structure, Turf Cell not only protects roots against compaction, it allows the roots of rhizomatous grasses to spread through the block within the protected soil layer. This creates a living, self-healing system which is not only resilient, but looks great year round.



Turf Cell® grass reinforcement structure allows horizontal and vertical root growth.

Why use Porous Pavements?

- Convert impervious pavements to pervious, drivable surfaces
- Reduce storm water runoff
- Reduce heat island effect
- Encourage infiltration to improve water quality
- Improve aesthetics

Why is Turf Cell Different?

- Lateral openings within the block allow roots to spread within the protected soil layer

Reducing Runoff as much as 90%

Using the rational method to calculate peak runoff flows:

$$Q = CiA$$

Where:

Q = Peak Rate of Runoff
C = Runoff Coefficient
i = Intensity of the Event
A = Area of the Contributing Basin

Turf Cell modifies the Runoff Coefficient (C). Typical pavements use a coefficient of .70 - .95, meaning that they shed 70% - 95% of the storm water that falls on them.

Grass areas use a much lower coefficient, typically between .05 - .35, meaning they only contribute 5% - 35% of their rainfall to runoff. This reduction of 35% - 90% is infiltrated or consumed by the vegetation, and can drastically improve site hydrology.

Doctor's Office Parking Lot Jacksonville, FL

Patients arriving at this Doctor's Professional Building can park in the grass lot whenever the paved lot is full. Even during wet weather when grass fields can become sloppy and muddy, Turf Cell keeps this lot stable, making it pedestrian and vehicle friendly. It was construction friendly, too, as the entire 25,000 sf lot was constructed over a single weekend. The lateral openings of the Turf Cell will work extremely well with the rhizomatous St. Augustine Grass to keep the lot looking great.

Installation Guide

1. *Excavate* - Excavate area to the proper depth, accounting for the thickness of the base materials (per engineer's specifications, typically +/- 6") and Turf Cell (2.05"). Top of Turf Cell should be at least .25" below any adjacent paved surfaces. Base of excavation should be flat and relatively level (per engineer's specifications, typically < 6%).

2. *Prepare Base* - Use of a woven monofilament geotextile is recommended as a separation layer between the subgrade and base. Although not required, this will help maintain long-term porosity of the pavement. Base materials should be a blend of open-graded stone (AASHTO #5) and topsoil. The topsoil content must not exceed the void space of the stone (typically < 40%). Place base materials into excavation and compact.

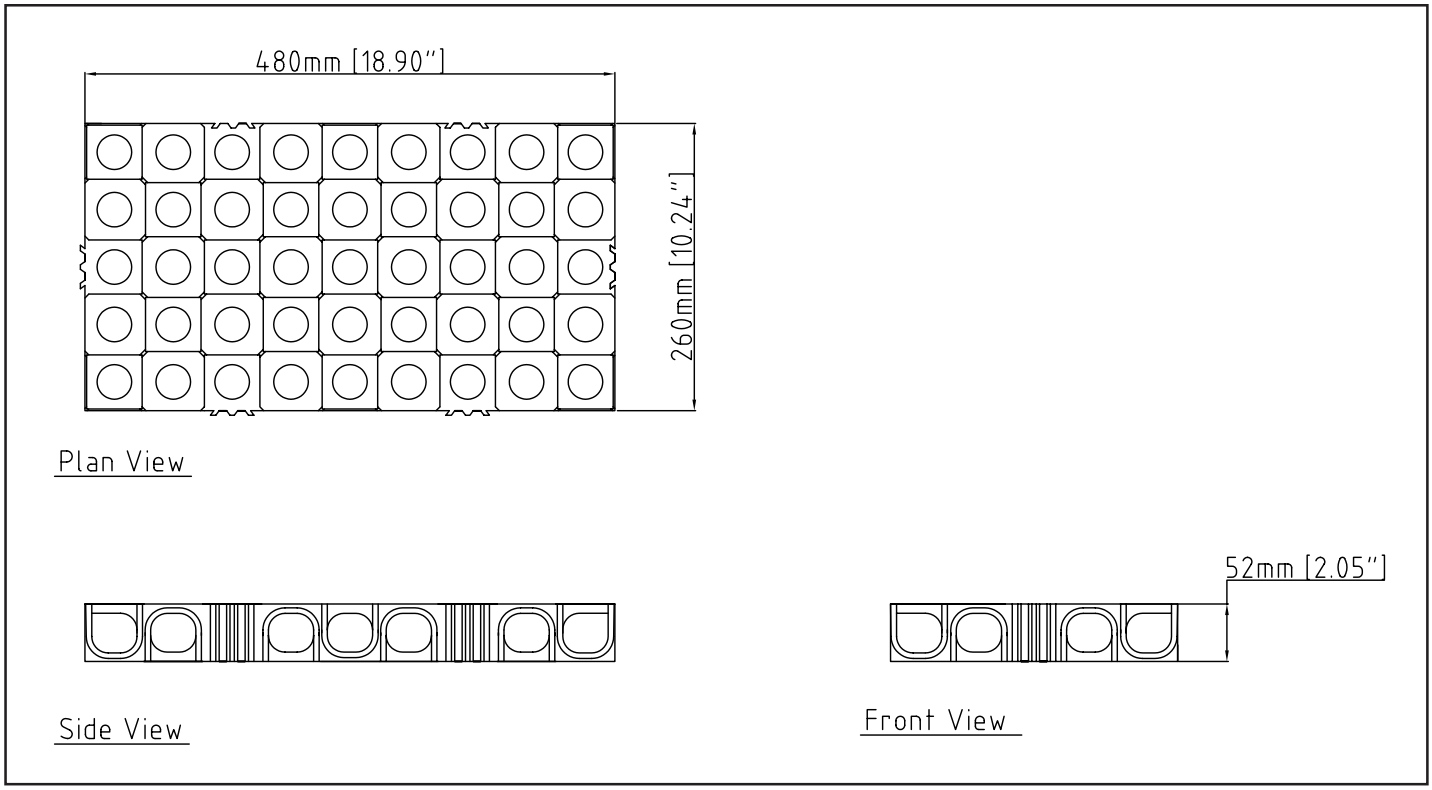
3. *Install Turf Cell* - Turf Cell units are palletized in panels of nine blocks. These panels measure 2.56' x 4.73' and are 12.1 sf/panel. Turf Cell panels are joined using a dove tail slip joint. Begin installation at intersection with paved areas to ensure correct elevation (see above). If units do not butt against any paved areas, use a string line to square the area. Working from this line, attach panels and fill-out installation area. Turf Cell units can be cut around obstacles such as light posts and sprinkler heads.

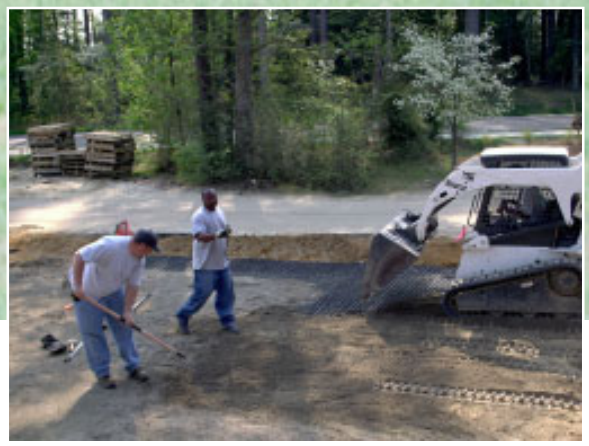
4. *Backfill & Seed/Sod* - Fill Turf Cell units with a mixture of sand & topsoil or compost (per engineer's specifications, typically a 70/30 mix). Lime may be added during mixing to ensure long-term porosity of the system. Equipment to dump or spread infill materials may drive on filled units. Backfill should completely cover Turf Cell units, with an additional 1/2" - 3/4" over the blocks to allow mix to settle. When available, water may be used to encourage backfill to settle into units. Backfilled units may be seeded or sodded (preferably with a rhizomatous variety) in a manner consistent with regional guidelines. Seed or sod must be watered frequently until established. All pedestrian and vehicular traffic must be diverted around the installation until grass is established (typically 4-6 weeks for seed, 3-4 weeks for sod).

Turf Cell Specifications

Material	100% Post Consumer Recycled Polypropylene
Chemical Resistance	Excellent
Unit Dimensions	10.24" x 18.9"
Panel Dimensions	(9 assembled units) - 2.56' x 4.73'
Unit Depth	2.05"
Cells per Unit	45
Nominal Cell Size	2.1" x 2"
Nominal Weight	0.94 lbs/sf
Compressive Strength - Filled	6030 psi Ultimate
Compressive Strength - Unfilled	166 psi Ultimate
Service Temperature - Unfilled	-22° to 248° F

CAD Design





Jamestown Visitor Center
Jamestown, VA

To get ready for a major tourism boom for the 400 year anniversary of the first permanent English settlement in the United States, establishing overflow parking without creating a visual eyesore - or additional runoff - was paramount. Of the many available options, Turf Cell was selected for it's lateral openings that allow grass roots to spread within the protected topsoil zone. This allows damaged areas - or areas that get frequent traffic during the tourism boom - to repair themselves without additional over seeding, creating a self-healing system.

Off-Street Parking Improvements
Ponte Verdra, FL

Road and storm sewer improvements in this high-end neighborhood included an opportunity for the city to offer residents attractive, environmentally friendly off-street parking. To accomplish this goal, Turf Cell was extended from the edge of the road nearly 13 feet into home owners' front yards. Once sodded, parking blends seamlessly into the landscape, providing beautiful off-street parking that cleans and infiltrates storm water rather than discharging contaminated runoff.

Bachelor Enlisted Quarters (BEQ)
Yorktown Naval Weapon Station - Yorktown, VA

The military demanded that their new Bachelor Enlisted Quarters (BEQ) be designed and built as a LEED Silver project. That meant strict limits on the amount of impervious area that could be created. Instead of a traditional fire-lane, a porous Turf Cell road was created, reducing the impervious area and improving the aesthetics of the finished project.

Atlantis Water Management Solutions

Wall Panel Installation

Road Edge Drainage

Storm Water Detention

Strip Filter Pipe™

Drainage Swales

Order Line 1-800-448-3636
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Water Management for Life
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GEOSYSTEMS
GLOBAL LEADER • GLOBAL PARTNER

creating
sustainable
environments™

GEOWEB®

cellular confinement system

PRODUCT CATALOG

our commitment:
providing the highest quality
products/solutions

solving challenging soil stabilization problems

GEOWEB®
MADE IN THE USA

For the most advanced soil stabilization technology today, rely on the proven Presto Geosystems' Geoweb® cellular confinement system for solving challenging soil stability problems.

genuine GEOWEB®

THE ORIGINAL CELLULAR CONFINEMENT SYSTEM

Presto Geosystems is the original developer of the geocell technology and leads the industry in research and development. The result is meaningful product improvements, innovative features, advanced engineering methodologies and proven field results that provide the most cost-effective and long-term solutions to soil stabilization problems. Innovations continue today to provide you with sustainable, high-performing and lowest-cost solutions.

HIGH-QUALITY PRODUCTS AND SOLUTIONS

With Presto Geosystems, you'll receive the same high quality products, solutions and support that you did over 30 years ago. Geoweb® sections are manufactured from high-quality polyethylene to achieve consistent and maximum seam strength and overall system performance. Quality is assured because the complete manufacturing process adheres to a quality management system that is certified to ISO 9001:2000 and CE standards.

HIGH PERFORMANCE SOIL STABILIZATION

The Geoweb® system significantly improves the performance of soils by confining and stabilizing them in the system's high-strength network of interconnected cells. The three-dimensional system is an economic and effective solution to challenging soil stability problems in load support, slope, channel, and shoreline protection, and vegetated retaining wall/earth retention applications.

PRESTO'S VALUE SERVICES

- DESIGN SUPPORT: A complementary project evaluation service is available to support your project designs.
- CONSTRUCTION SUPPORT: Contractor training or site supervision is available to support your project installations.

INFILL OPTIONS

A variety of infill materials can be used based upon details of the specific project/problem:

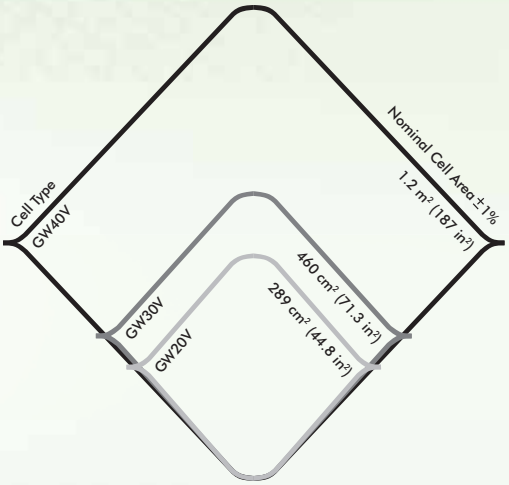
- topsoil with various selected vegetation
- aggregates from sand and gravel to larger rock or stone
- concrete of various strengths and surface finishes
- on-site available fill
- combinations of the above to meet project conditions

GEOWEB® *system standard sizes*

Geoweb® sections are available in various cell types and depths, and section lengths to most economically meet project requirements.

Cell Type	Section Width	Section Length Range Cells Long: 18, 21, 25, 29, 34	
	Variable	Minimum	Maximum
GW20V	7.7 ft–9.2 ft (2.3 m–2.8 m)	12.0 ft (3.7 m)	27.3 ft (8.3 m)
GW30V		15.4 ft (4.7 m)	35.1 ft (10.7 m)
GW40V		25.4 ft (7.7 m)	58.2 ft (17.8 m)

Available cell depths	3 in (75 mm), 4 in (100 mm), 6 in (150 mm), 8 in (200 mm)
Cell size and depth are determined by the details of the application, problem or desired solution. Refer to the Geoweb® material specification for more information.	



GEOWEB CELL SIZES

system components & contractor tools

The following components may be part of the overall Geoweb® solution to meet engineering requirements and to facilitate and expedite construction:

TENDONS

Tendons may be required and are available in various tensile strengths to meet design requirements.

- Provide additional stability against gravitational, hydrodynamic, and buoyancy forces.
- Effective with high flows, or when a geomembrane underlayer or hard soil/rock prevents anchoring with stakes.

ATRA® ANCHORS

Contractor-friendly ATRA® Anchors reduce time and material costs during installation of the Geoweb system. (1)

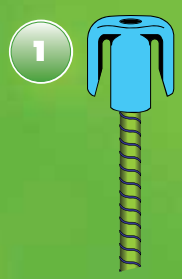
- Easier to drive than J-hook stakes; improves installation productivity and uses less material.
- The ATRA® Driver makes driving anchors easy and fast, and causes less stress on workers. (2)
- Tendons and an ATRA® Anchor array provide additional anchoring to resist sliding and/or uplift forces. (3)

ATRA® CLIP

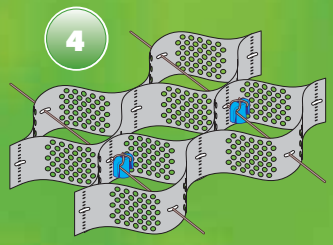
The ATRA® Clip is an efficient load-transfer mechanism when connected to tendons at load-transfer points. (4)

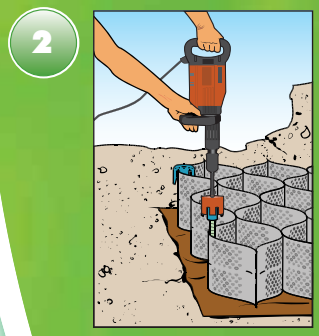
ATRA® KEY CONNECTION DEVICE

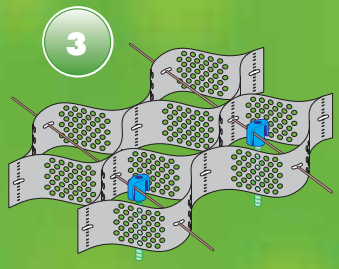
Designed for quicker connection of Geoweb sections, the exclusive ATRA® key device reduces contractor installation cost and provides three-times-stronger connections than staples. (5)



1. ATRA® Anchor
2. ATRA® Driver
3. ATRA® Anchor with tendon
4. ATRA® Clip
5. ATRA® Key







GEOWEB®
CHANNEL PROTECTION

The Geoweb® system provides a wide variety of economical, flexible protection treatments for open channels and hydraulic structures. The system provides stability and protection of channels exposed to erosive conditions ranging from low-to-high flows either intermittent or continuous.

- Greatly improves the hydraulic performance of conventional protection materials such as aggregate, rip-rap and vegetation by confining them within the cellular structure.
- With concrete infill, is a flexible and long-lasting armored channel lining, at a lower cost than articulating block systems.
- Can be designed for specific site conditions based upon compatibility with local environmental, ecological and aesthetic requirements, maximum anticipated flow, and associated hydraulic stresses.
- Surface roughness and hydraulic efficiency of the lining system can be changed to control flow.
- Subgrade drainage requirements and deformation potential within the structure can be addressed.

TYPICAL APPLICATIONS

- swales and drainage ditches
- storm water diversion or containment
- process water channels or containment
- spillways/down chutes/drop structures
- culvert outfalls
- intermittent or continuous/low-to-high flow channels

environmental benefits

- With permeable infill, the Geoweb® system is a natural Low Impact Development (LID) / Best Management Practice (BMP) solution to stormwater challenges, reducing runoff and managing stormwater on-site.

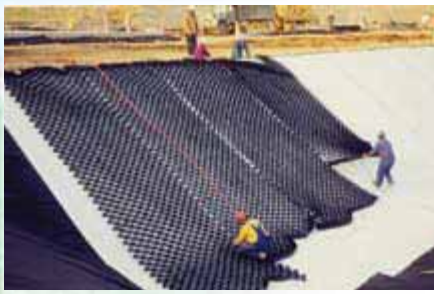
GEOWEB®
SLOPE & SHORELINE PROTECTION

The Geoweb® slope and shoreline protection system confines, reinforces and restrains the upper soil layer and infill controlling down-slope movement and slippage due to hydrodynamic and gravitational forces.

- Provides effective slope protection and structural confinement of topsoil/vegetation and granular materials such as sand, gravel and larger rock or stone.
- Becomes a flexible concrete mat with built-in expansion joints when cells are infilled with concrete.
- Creates additional stability by integrating tendons on steeper slopes and shoreline embankments or when a geomembrane or hard soil/rock surface prevents anchoring with stakes.
- Allows embankments to be steeper than when unconfined, reducing use of valuable land space.

TYPICAL APPLICATIONS

- cut or fill embankment slopes
- shoreline revetments
- abutment protection
- storm water/waste water lagoons
- containment dikes and levees
- geomembrane protection
- landfill linings and covers
- dam faces and spillways



LEED® green building credits

- The Geoweb® system is an eco-friendly product that contributes to USGBC LEED® green building credits in the categories for reducing site disturbance, stormwater quantity and quality control, reducing the heat island effect (non-roof) and regional materials (varies by application).

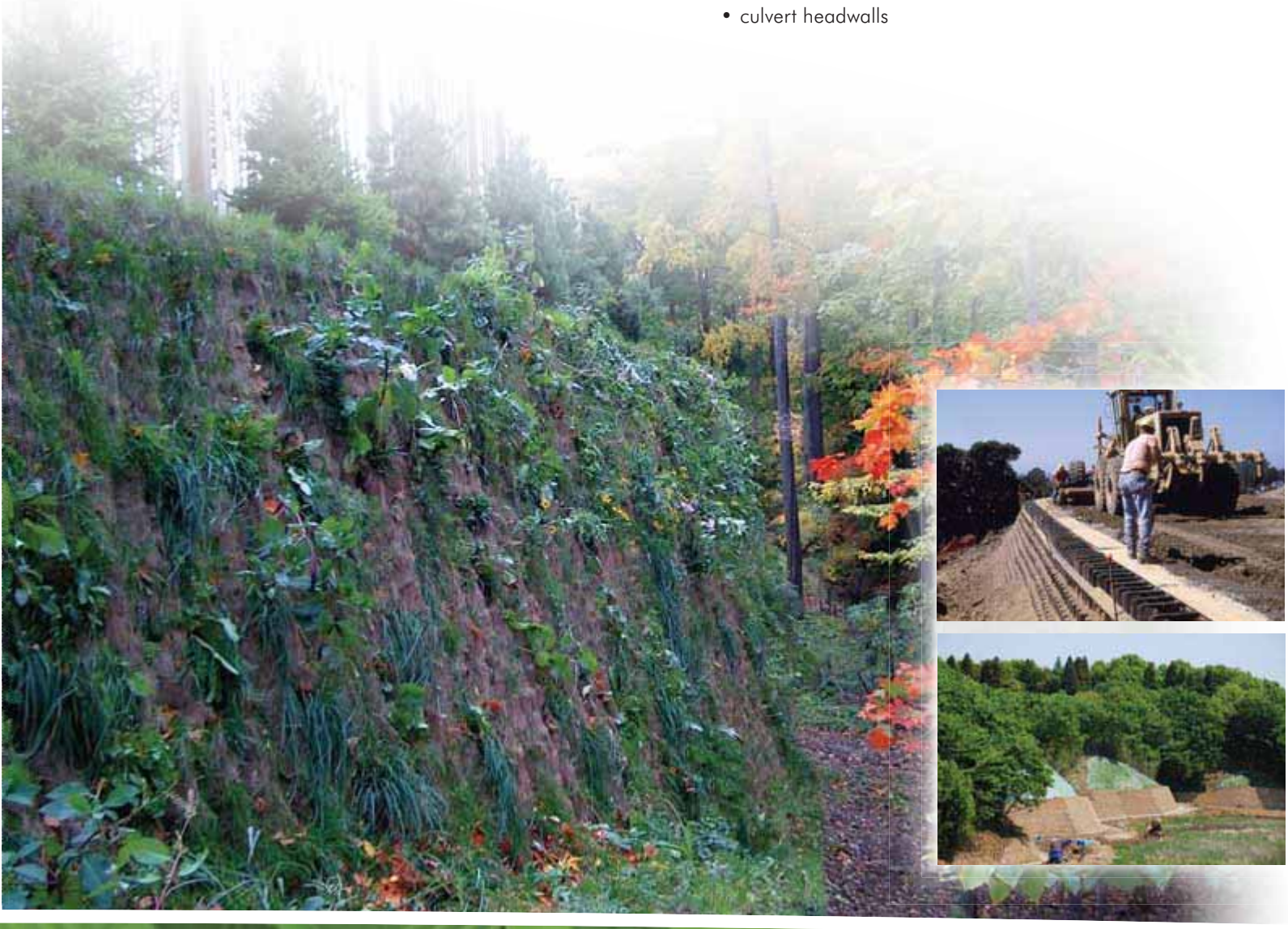
GEOWEB®
RETAINING WALLS/EARTH RETENTION

The Geoweb® system, when layered, becomes an economical retaining wall system meeting all project-specific structural requirements. The system allows for construction flexibility and provides aesthetics through a completely vegetated face. Horizontal terraces are formed where vegetation can flourish in the exposed outer cell infill. The system captures rainwater and controls groundwater evaporation, creating a more natural environment for vegetation.

- Maintains structural stability against all loading through its mass and frictional values of the infill, even in soft soil environments.
- Meets site challenges when subgrade soils are compressible or construction is in difficult-to-access locations.
- Creates blending with any environment through use of tan, green or special-colored facia panels.

TYPICAL APPLICATIONS

- bioengineered walls
- steepened embankments
- dike and levee protection
- culvert headwalls
- landscape development walls
- vegetated channel structures
- sound barriers



low-impact development

- The highly permeable Geoweb® wall surface is a natural low impact development (LID) solution by allowing stormwater collection through the vegetated outer fascia and reducing runoff.

GEOWEB®
LOAD SUPPORT

The Geoweb® load support system stabilizes the selected infill and provides economical solutions to unstable surface or base problems in three key areas: 1) a load distribution system over weak soils, 2) base stabilization for paved surfaces and 3) surface stabilization for unpaved surfaces.

- Significantly minimizes surface rutting.
- Distributes loads laterally and reduces vertical deflection and subgrade contact pressures.
- Controls shearing and lateral movement of the coarse and permeable infill material.
- With open aggregate infill, reduces storm water runoff and creates on-site water detention/ retention basin.
- In most cases, the Geoweb® system doubles the effective structural number for load support, reducing base requirements by half.

TYPICAL APPLICATIONS

- site access roads
- permeable, load-supporting surfaces
- roadway shoulders
- intermodal/port facilities
- transportation/storage yards
- stabilized drainage layer
- trails and walkways
- track ballast and subballast structures
- stabilized base for asphalt or modular block pavements
- boat ramps/low water crossings
- foundation mattresses and pipeline protection

stormwater benefits

- With permeable aggregate, the Geoweb® system reduces the need and costs for additional stormwater collection/storage systems or stormwater ponds by performing as an on-site stormwater storage "basin".

comprehensive tools and services

Presto Geosystems and its distributors/representatives offer the most-complete services in the industry to support project design and installation requirements.

TOOLS:

- Technical resources binder
- Engineering analysis/technical overviews
- SPECMaker® specification development tool
- Project case studies
- Detailed construction instructions

SERVICES:

Project Evaluation Service: We analyze specific project needs and provide recommended preliminary designs for each project.

Construction Services: Qualified on-site field support specialists can be available for construction training, and start-up installation supervision.

PRESTO GEOSYSTEMS' COMMITMENT — *To provide the highest quality products and solutions.*

Presto Geosystems is committed to helping you apply the best solutions to your soil stabilization problems. Our solutions-focused approach to solving problems adds value to every project. Rely on the leaders in the industry when you need a solution that is right for your application. Contact Presto Geosystems or our worldwide network of knowledgeable distributors/representatives for assistance.

UNSURPASSED QUALITY

Presto's commitment to quality begins with manufacturing and continues through final installation.

- Quality management system certified to ISO 9001:2000 and CE certification.
- Sections manufactured from high-quality polyethylene provide consistent and maximum seam weld strength.
- Materials engineered to established geosynthetic industry guidelines.
- Sections backed by a 10-year limited warranty.

PRESTO GEOSYSTEMS
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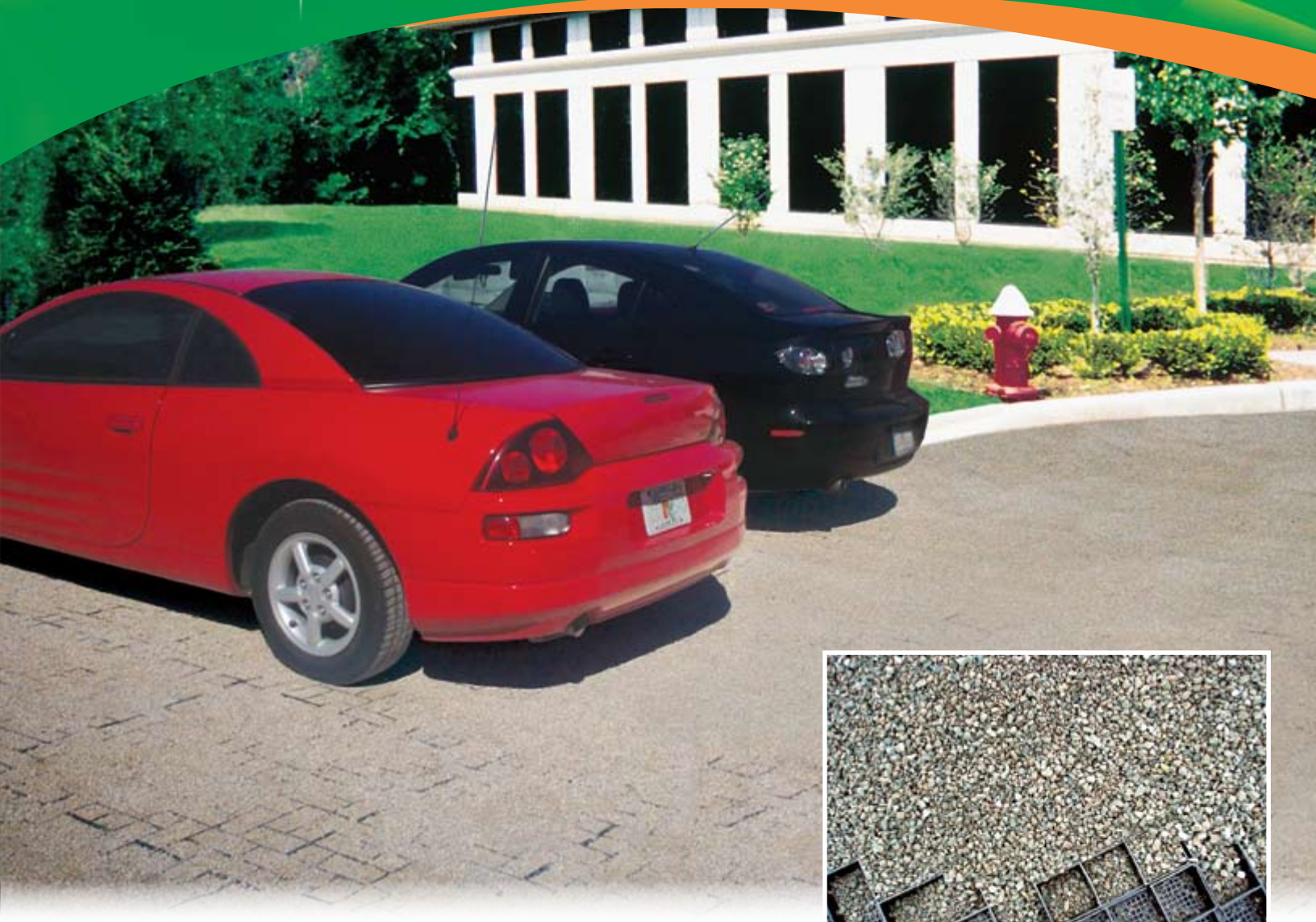


GEOPAVE™

porous pavement system

APPLICATION OVERVIEW

GEOPAVE™ POROUS PAVEMENT SYSTEM

The GEOPAVE System is the latest evolution in porous pavements for creating low-cost, long-lasting and sustainable permeable surfaces.

The GEOPAVE system is a structural framework specifically designed for confining and stabilizing porous infill materials. The system increases the bearing capacity for pedestrian or vehicular traffic, providing long-term performance with minimal maintenance.

The economical pavement system is made from recycled materials, effectively addressing today's stringent stormwater regulations in an eco-friendly way.

the eco-economic way to manage stormwater

GEOPAVE™
MADE IN THE USA

the GEOPAVE™ *system*

LOW-COST POROUS PAVEMENT SOLUTIONS

The GEOPAVE™ units are well-suited for developing economical porous pavements with either an aggregate or a vegetated surface. The finished GEOPAVE pavement system forms a uniformly connected, visually appealing porous pavement system.

full-range load capability

With one of the highest true load ratings in the industry, the GEOPAVE™ system can be designed to accommodate light to heavy loads with appropriate infill and base materials. The system supports aggregate infill, or an aggregate/topsoil mix for vegetated surfaces.

PERFORMS TO AN H-20 RATING

with an open-graded aggregate infill, for repeated traffic loads.

PERFORMS TO AN H-10 RATING

with an engineered topsoil/aggregate infill for vegetated, drivable surfaces and infrequent or occasional traffic loads.

applications

The GEOPAVE™ system is ideal for a variety of porous pavements where stabilized, permeable surfaces are desired:

- utility/emergency access lanes
- parking lots/auxiliary parking
- cart paths and driveways
- trails/walkways

innovative features and advantages

The GEOPAVE™ system is specifically designed for long-lasting, problem-free performance, offering advantages over other rolled or small-unit porous pavement systems.

UNIQUE CELL-WALL DESIGN AND UNIFORM SURFACE

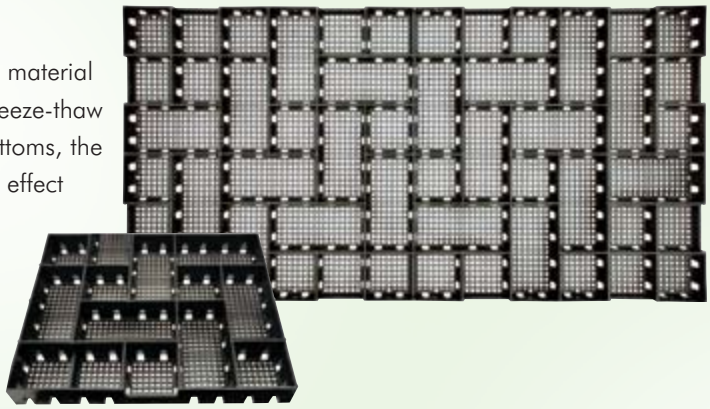
When filled with aggregate, the herringbone cell design offers randomized-pattern aesthetics of a decorative pavement. Strong GEOPAVE paving units hold up to repeated traffic and torsional loading. The interconnected units create a semi-rigid pavement surface that better resists subgrade undulations and imperfections than more flexible systems.

HIGH STRUCTURAL STRENGTH & LOAD DISTRIBUTION

The GEOPAVE unit's ample stiffness and large size offers high structural strength and maximum load distribution. As a result, less depth of base material is required for all loading requirements than with many other light-weight porous pavement systems, equating to significant material and construction cost savings.

INHERENT BOTTOM KEEPS MATERIAL IN-GROUND

The monolithic mesh bottom encapsulates aggregate infill preventing material loss from the unit's bottom when exposed to repeated loading and freeze-thaw cycles. Unlike porous systems with light-weight and bonded fabric bottoms, the GEOPAVE system's strong inherent mesh bottom creates a snowshoe effect that contributes to maximum load distribution. The GEOPAVE system will not lift up like other systems as material drops through, and will stay in-ground for decades of use.



CELL-WALL VENTS

Inherent multiple cell-wall vent openings provide:

- better cell-to-cell interlock of the aggregate or topsoil/aggregate infill
- lateral drainage of the complete pavement system
- locations for placement of anchors, when required.

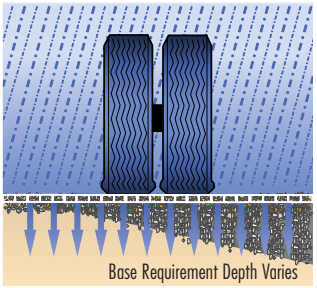
FLEXIBLE LAYOUT OPTIONS

Three layout patterns – offset, bricklayer and herringbone – can be configured to address specific traffic needs. Strong U-CLIP connection devices are used to quickly join adjacent GEOPAVE units together in the desired pattern, forming the fully-integrated "locked-in-place" pavement system.

the GEOPAVE™ *system environmental benefits*

CONTRIBUTES TO U.S. GREEN BUILDING LEED™ CREDITS

- Reduced Site Disturbance
- Stormwater Management: Quality & Quantity
- Reduced Heat Island Effect
- Recycled Material Content



HIGHLY PERMEABLE DESIGN

- with a high percentage open area and with permeable infill, the system virtually eliminates surface runoff typically associated with stormwater discharge from paved areas.
- minimizes site disruption and the development footprint by reducing or eliminating the need for larger, on-site stormwater detention facilities.

ADDRESSES STORMWATER STORAGE NEEDS

- functions as a stormwater detention/retention layer storage "basin" and can complement underground storage systems. Additional depth of base can be added when the pavement system is designed over a low-permeable base.

IMPROVES STORMWATER QUALITY

- increases water infiltration and reduces non-point source pollution.

PROVIDES A COOLER SURFACE

- cooler pavements reduce the heat island effect related to traditional hard pavements.

CONTAINS HIGH RECYCLED MATERIAL CONTENT

- manufactured from up to 97% recycled polyethylene.

PRESTO'S COMMITMENT

The GEOPAVE™ system is powered by the GEOSYSTEMS® technology and manufactured with the same quality materials and process as the GEOBLOCK® and GEOBLOCK2® systems. Presto offers a full line of porous paving systems with available engineering and construction support on all Geosystems products.

PRESTO GEOSYSTEMS®
P.O. Box 2399
670 North Perkins Street
Appleton, Wisconsin 54912-2399, USA

P: 920-738-1328
TF: 800-548-3424

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E: info@prestogeo.com

www.prestogeo.com

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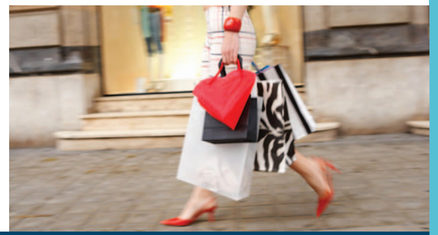

Aquaflow is compliant with ADA design standards (Americans with Disabilities Act) for paved surfaces and is safe for disabled pedestrians and wheelchairs, making it ideal for shopping centers and other high traffic, public areas.

Hanson HEIDELBERGCEMENT Group
Hanson Hardscapes

Hanson Building Products North America is comprised of Hanson Pipe & Precast, Hanson Pressure Pipe, Hanson Structural Precast, Hanson Brick, Hanson Hardscapes and Hanson Roof Tile. Based in Irving, Texas, Hanson Building Products North America employs approximately 5,000 people and operates 150 facilities with products available throughout the U.S. and Canada. To learn more about Hanson's quality products, services and building technology, please visit www.hanson.com.

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Naples, FL 34109
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Hanson HEIDELBERGCEMENT Group
Hanson Hardscapes

Aquaflow®
Permeable Paving
Sustainable Urban Drainage System

Aquaflow® Permeable Paving

Sustainable Urban Drainage System

Over the past 15 years, the Hanson Aquaflow System has become the premier system for permeable paving in the UK. The introduction of Aquaflow to the Florida market provides an environmentally sensitive paving solution that cleans pollutants from run-off and supports groundwater recharge or water harvesting.

Hanson Hardscapes is a premier manufacturer in the hardscape products industry, with 12 manufacturing and distribution facilities in Ontario, Michigan, Virginia and Florida.

Hanson Building Products North America and its divisions are part of the HeidelbergCement Group, the global leader in aggregates with leading positions in cement, concrete and heavy building. The company employs approximately 57,000 people across five continents.

Our goal is to be the market leader in the provision of sustainable products and services. We believe that the Aquaflow permeable paving system is an important advancement toward achieving this goal.

Aquaflow® Permeable Paving System: a modern stormwater management solution

Urban expansion and rapid storm water run-off is placing tremendous strain on conventional storm water drainage systems. Existing storm drains, sewers and culverts are becoming overloaded during periods of heavy rain, resulting in contamination of natural water resources.

Heavy metals, hydrocarbons, rubber dust, silts and other pollutants are all deposited on impermeable surfaces during dry periods. These contaminants are scoured off surfaces during periods of heavy rain and transported either to sewer treatment facilities or directly into our rivers and streams. In addition to severe environmental damage, this results in:

- **Pollution**
- **Overtaxed Sewer Systems**
- **Poor Groundwater Quality**
- **Expensive Treatment Plant Upgrades**

The Aquaflow® System

The Aquaflow sustainable drainage system allows heavy rains to infiltrate through a permeable interlocking concrete paver surface into a unique sub-base, before being released in a controlled manner into the ground below, directed to sewers, or captured for water harvesting and re-use.

Hanson's Aquaflow sustainable urban drainage systems are ideal for industrial and commercial retail centers and parking lots, pedestrian plazas and walkways, residential developments, driveways and service areas, and for many other heavy duty applications.

LEED

Incorporate the Aquaflow system into your project and earn up to 10 LEED (Leadership in Energy and Environmental Design) credits. Contact Hanson Hardscapes for more information.

Aquaflow® reduces and eliminates:

- **Stormponds**
- **Infiltration trenches**
- **Inlets & piping**
- **Bioswales**
- **Runoff pollutants**
- **Puddles**
- **Sheet Flow**
- **Eutrophication**

The Aquaflow® Paver

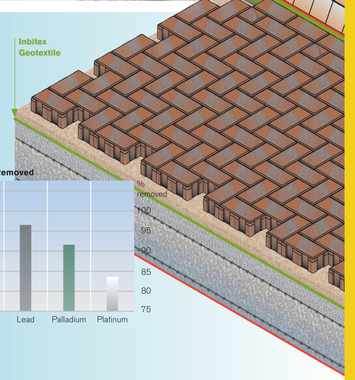
The Aquaflow paver is highly attractive and suitable for all forms of vehicular and pedestrian traffic. With small joints and no loose aggregates on the surface, Aquaflow pavers provide a safe, comfortable and ADA compliant surface for the elderly or disabled, and those using wheelchairs, pushing baby carriages and shopping carts or wearing high heels.

The unique design of Aquaflow pavers incorporates slight chamfers with gaps less than 1/2 inch wide (13mm) to direct water through 6 vertical channels that allow water to pass through the pavement surface. These features allow water to pass through the pavement surface at a rate of approximately 354 in./hour (9000 litres per m²/hr), regulated to 177 in./hour (4,500 litres per m²/hr) with the Inbitex geotextile in place.

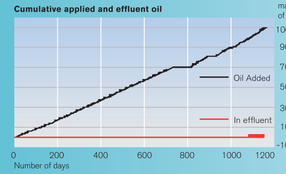
Aquaflow pavers are available in a range of colors and integrate seamlessly with other non-permeable pavers available from Hanson Hardscapes.

Pollution Control

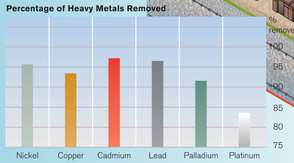
The unique Aquaflow Permeable Paving System offers multiple stages of water management: water first passes through the permeable paving and is then cleaned by the Inbitex® geotextile layer without requiring a separate oil and silt interceptor. This clean water is then stored in the sub-base to enable controlled discharge as required.



Cumulative applied and effluent oil



Percentage of Heavy Metals Removed



Data provided by the kind permission of: Cumulative applied and effluent oil, Stephen Coupe, University of Coventry.
Percentage of Heavy Metals Removed, Dr Chris Jefferies and Fiona Napier, Urban Water Technology Centre, University of Abertay, Dundee.

The Aquaflow system has been designed with an extended service life, providing the same superior performance as a regular interlocking concrete paver.

Projected Average Annual Pollutant Removal Capability of Infiltration Areas (in %)

Pollutant	0.5" (13mm) of runoff per impervious acre	1.0" (25mm) of runoff per impervious acre	2 year design storm treatment
Total suspended solids	60 - 80	80 - 100	80 - 100
Total phosphorous	40 - 60	40 - 60	60 - 80
Total nitrogen	40 - 60	40 - 60	60 - 80
Biological oxygen demand	60 - 80	60 - 80	80 - 100
Bacteria	60 - 80	60 - 80	80 - 100
Metals	60 - 80	60 - 80	80 - 100

Base Stabilization with SC Intergrid™

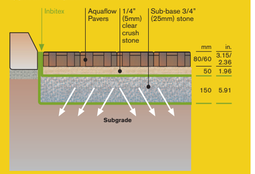
In areas with low bearing capacity soil or where construction depth is limited, the unique design of Aquaflow's open graded sub-base reduces construction depth and improves base stabilization with the optional use of SC Intergrid. SC Intergrid is a 'flexurally stiff and rigid' geogrid, designed to resist horizontal shear by providing mechanical interlock and confinement of granular particles. The level of base stabilization by geogrid reinforcement is increased through dispersion of force with the use of the SC Intergrid.

Trials undertaken at the Transport Research Laboratory using a wetted sub-base validated the sub-base design for heavy duty use.

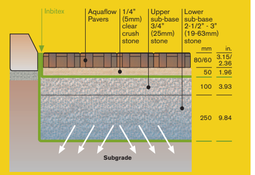
Typical Systems and Exfiltration Options

Design capabilities range from pedestrian to commercial vehicular applications. Designs must be modified to site conditions.

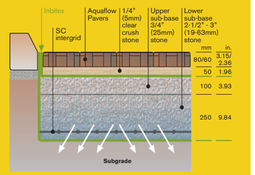
Typical footpath construction

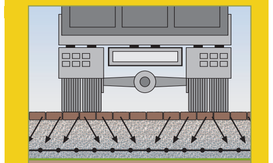


System with a sub-grade CBR of 5% or greater



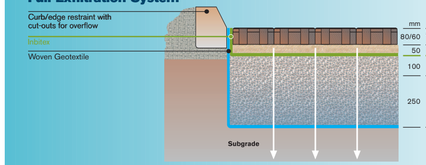
System with a sub-grade CBR of between 2-5%



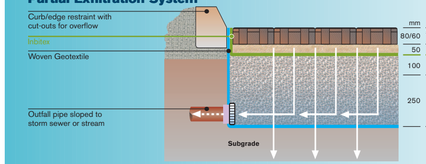


SC Intergrid stiffens the aggregate, eliminating paver deformation.

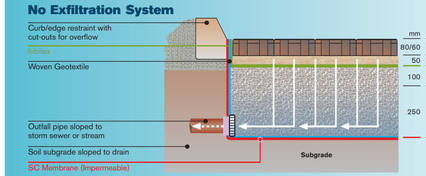
Full Exfiltration System



Partial Exfiltration System



No Exfiltration System



Aquaflow® Water Harvesting

The Aquaflow system can be designed to collect water run-off from surrounding impermeable surfaces. This water is directed into the Aquaflow base where it is cleaned by the Inbitex geotextile before storage. Stored water is pumped out for re-use in non-potable, exterior uses.

Engineering Services

Hanson offers free technical advice and design services for your individual project requirements, including site-specific design support for our Aquaflow Permeable Paving System. Contact us at 800.273.7084 for assistance with your project.

FIGURE 1

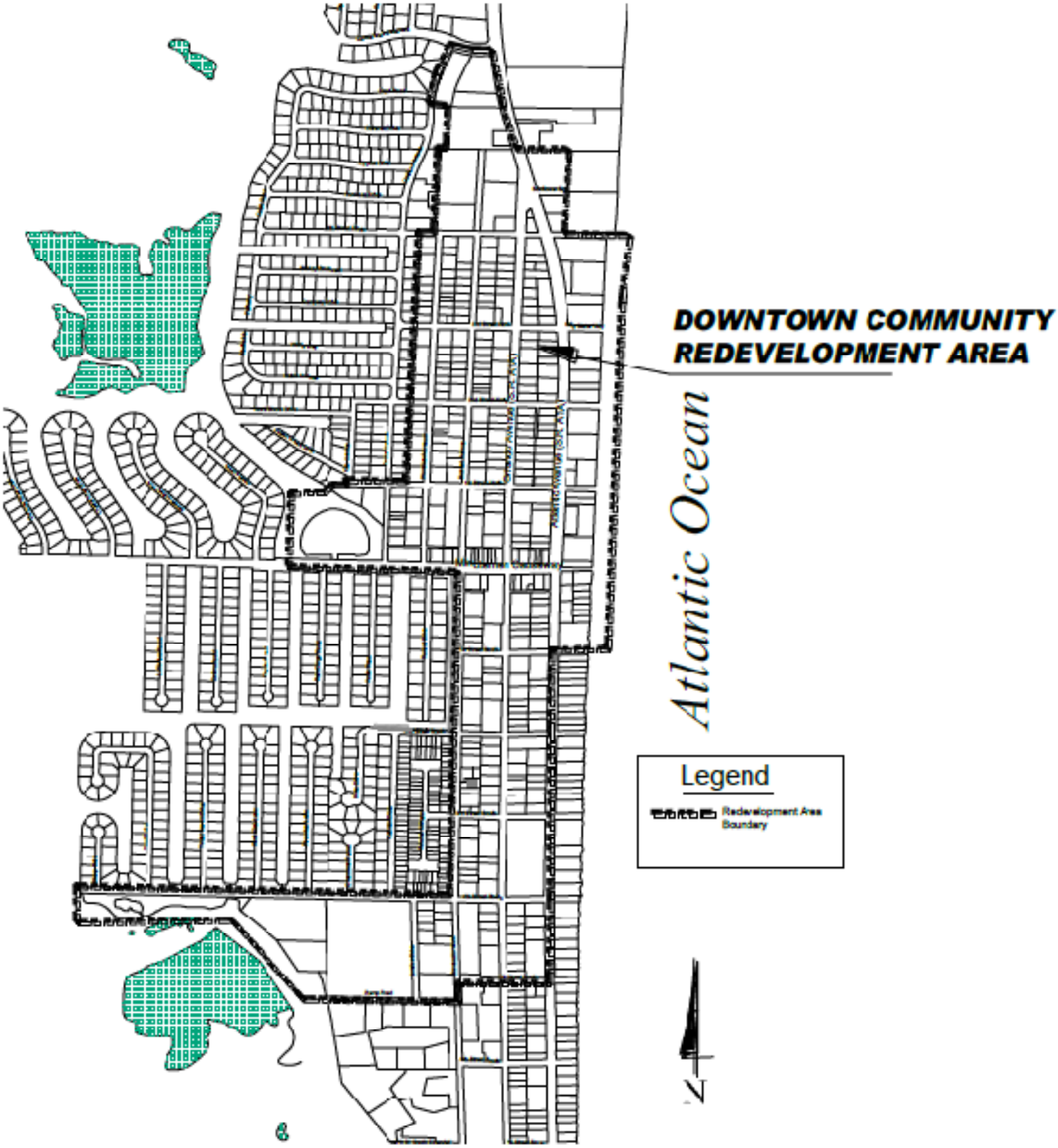

DOWNTOWN COMMUNITY
REDEVELOPMENT AREA
Atlantic Ocean
Legend
Redevelopment Area
Boundary

FIGURE 2

THE CITY OF COCOA BEACH
EXISTING LAND USE MAP 1999

EXISTING LAND USE MAP LEGEND

- Residential
- Condos/Townhouse
- Commercial
- Recreation
- Conservation
- Education
- Public Facilities
- Private Institutional
- Vacant

FIGURE 3

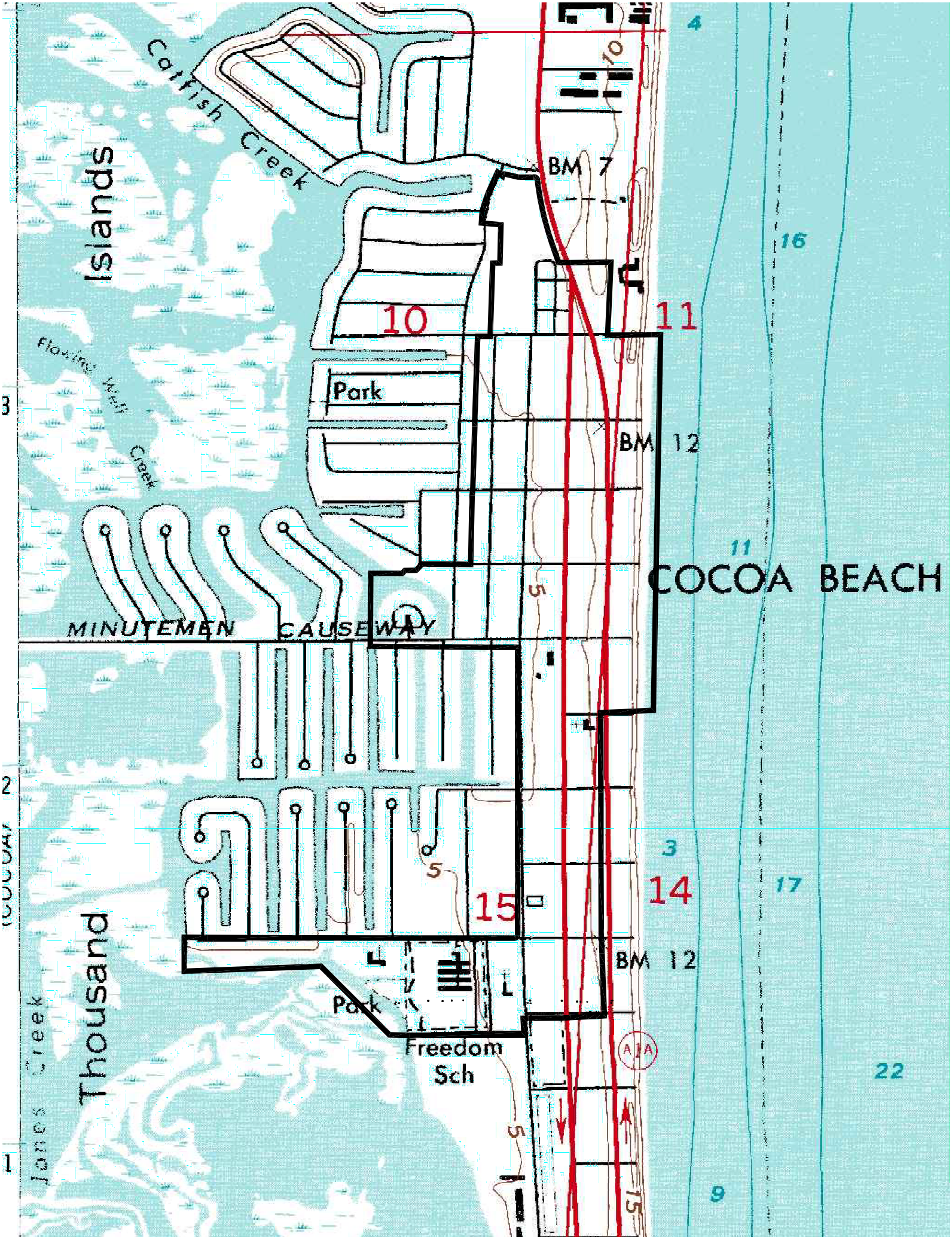

Catfish Creek
Islands
Flowing Well Creek
Thousand
James Creek
Park
Park
Freedom Sch
MINUTEMEN CAUSEWAY
COCOA BEACH
BM 7
BM 12
BM 12
10
11
14
15
A1A
4
16
11
3
17
22
9
5
5
5
15
10
3
2
1

FIGURE 4

MILLER LEGG
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Winter Park, Florida · 32789-7122
407-628-8880 · Fax: 407-628-7883
www.millerlegg.com
Certificates of Authorization: EB7318, LB6680, LC0337

MASTER STORM WATER STUDY
DOWNTOWN REDEVELOPMENT AREA
COCOA BEACH, FLORIDA

OVERALL KEY

V:\PROJECTS\2010\10-00119 - COCOA BEACH LID SW PLAN\DRAWINGS\10-00119 ANALYSIS.DWG 03 8/3/2010 8:44A by JGRANT

COCOA BEACH CRA POLLUTANT LOADING REDUCTION SUMMARY

					FDOT LAND AREA SUMMARY								COCOA BEACH LAND AREA SUMMARY								OVERALL LAND AREA SUMMARY				
Basin	Future Land Use	CRA Acreage (ac)	FDOT Acreage (ac)	Total Acreage (ac)	Ex. TP Loading (lbs)	Allowable TP Loading (lbs)	Req'd TP Reduction (lbs)	TP Reduction (lbs)	Ex. TN Loading (lbs)	Allowable TN Loading (lbs)	Req'd TN Reduction (lbs)	TN Reduction (lbs)	Ex. TP Loading (lbs)	Allowable TP Loading (lbs)	Req'd TP Reduction (lbs)	TP Reduction (lbs)	Ex. TN Loading (lbs)	Allowable TN Loading (lbs)	Req'd TN Reduction (lbs)	TN Reduction (lbs)	Req'd TP Reduction (lbs)	TP Reduction (lbs)	Req'd TN Reduction (lbs)	TN Reduction (lbs)	Total Storage Provided (cf)
Area 1	Right-of-Way	0.513	0	0.513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.18	1.19	3.99	0.00	1.04	0.18	0.87	0.00	3.99	0.00	0.87	0.00	-
Area 2	Civic/Semi-Public	3.114	0	3.114	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.45	7.22	24.23	0.00	6.34	1.07	5.27	0.00	24.23	0.00	5.27	0.00	-
Area 3	Civic/Semi-Public	9.008	0	9.008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.93	20.89	70.04	46.72	18.33	3.10	15.23	9.42	70.04	46.72	15.23	9.42	24,695.00
Area 4	Civic/Semi-Public	4.51	0	4.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.55	10.46	35.09	0.00	9.18	1.55	7.63	0.00	35.09	0.00	7.63	0.00	-
Area 5	Civic/Semi-Public	3.435	1.449	4.884	14.04	3.36	10.68	10.68	4.04	0.50	3.54	3.54	34.69	7.97	26.72	32.48	6.99	1.18	5.81	6.19	37.40	43.16	9.35	9.73	23,076.00
Area 6	Cottage Row Res.	9.318	0	9.318	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	94.11	21.62	72.49	83.26	18.97	3.21	15.77	16.78	72.49	83.26	15.77	16.78	40,486.00
Area 7	Cottage Row Res.	9.661	0	9.661	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	97.58	22.41	75.16	83.26	19.67	3.32	16.35	16.78	75.16	83.26	16.35	16.78	40,486.00
Area 8	Cottage Row Com.	13.134	4.213	17.347	40.82	9.77	31.05	31.05	11.75	1.45	10.30	10.30	132.65	30.47	102.18	117.66	26.74	4.52	22.22	22.67	133.23	148.71	32.52	32.97	80,011.00
Area 9	Oceanside District	14.18	4.648	18.828	45.04	10.78	34.26	34.26	12.96	1.60	11.36	11.36	143.22	32.90	110.32	132.86	28.87	4.88	23.99	25.63	144.58	167.12	35.35	36.99	94,179.00
Area 10	Park Lands	12.621	0	12.621	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	127.47	29.28	98.19	0.00	25.70	4.34	21.35	0.00	98.19	0.00	21.35	0.00	-
Area 11	Downtown Core	5.293	2.627	7.92	25.46	6.09	19.36	19.36	7.32	0.90	6.42	6.42	53.46	12.28	41.18	53.78	10.78	1.82	8.96	10.19	60.54	73.14	15.38	16.61	44,777.00
Area 12	Right-of-Way	1.298	0	1.298	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.11	3.01	10.10	11.57	2.64	0.45	2.20	2.33	10.10	11.57	2.20	2.33	7,289.00
Area 13	Civic/Semi-Public	3.8	0	3.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.38	8.82	29.56	32.41	7.74	1.31	6.43	6.53	29.56	32.41	6.43	6.53	20,280.00
Area 14	Cottage Row Res.	1.263	0	1.263	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.76	2.93	9.83	6.17	2.57	0.43	2.14	1.24	9.83	6.17	2.14	1.24	3,000.00
Area 15	Artisian District	3.026	0	3.026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.56	7.02	23.54	0.00	6.16	1.04	5.12	0.00	23.54	0.00	5.12	0.00	-
Area 16	Artisian District	9.55	0	9.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	96.46	22.16	74.30	94.00	19.44	3.29	16.16	18.95	74.30	94.00	16.16	18.95	29,811.00
Area 17	Artisian District	4.231	0	4.231	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.73	9.82	32.92	39.84	8.61	1.46	7.16	8.03	32.92	39.84	7.16	8.03	12,635.00
Area 18	Downtown Core	10.434	0	10.434	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	105.38	24.21	81.18	91.22	21.24	3.59	17.65	18.39	81.18	91.22	17.65	18.39	55,156.00
Area 19	Downtown Core	11.332	2.211	13.543	21.42	5.13	16.30	16.30	6.16	0.76	5.40	5.40	114.45	26.29	88.16	97.91	23.07	3.90	19.17	19.19	104.46	114.21	24.58	24.59	69,520.00
Area 20	Cottage Row Res.	11.004	0	11.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	111.14	25.53	85.61	97.20	22.40	3.79	18.62	19.59	85.61	97.20	18.62	19.59	47,264.00
Area 21	Cottage Row Res.	25.501	3.762	29.263	36.45	8.73	27.73	27.73	10.49	1.29	9.19	9.19	257.56	59.16	198.40	240.26	51.92	8.77	43.15	47.50	226.12	267.98	52.34	56.69	130,945.00
Area 22	Right-of-Way	0	4.322	4.322	41.88	10.03	31.85	31.85	12.05	1.49	10.56	10.56	0.00	0.00	0.00	9.31	0.00	0.00	0.00	0.80	31.85	41.16	10.56	11.36	26,880.00
Area 23	Right-of-Way	3.021	0	3.021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.51	7.01	23.50	26.49	6.15	1.04	5.11	5.34	23.50	26.49	5.11	5.34	16,688.00
Area 24	Park Lands	3.241	0	3.241	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.73	7.52	25.21	0.00	6.60	1.11	5.48	0.00	25.21	0.00	5.48	0.00	-
Area 25	Civic/Semi-Public	4.232	0	4.232	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.74	9.82	32.92	35.56	8.62	1.46	7.16	7.17	32.92	35.56	7.16	7.17	22,250.00
Area 26	Park Lands	2.862	0	2.862	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.91	6.64	22.27	29.27	5.83	0.98	4.84	5.90	22.27	29.27	4.84	5.90	12,375.00
Area 27	Civic/Semi-Public	10.411	0	10.411	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	105.15	24.15	81.00	0.00	21.20	3.58	17.62	0.00	81.00	0.00	17.62	0.00	-
Area 28	Artisian District	9.485	0	9.485	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.80	22.01	73.79	81.29	19.31	3.26	16.05	16.39	73.79	81.29	16.05	16.39	43,307.00
Sub-Totals		199.47	23.23	222.71	225.12	53.90	171.22	171.22	64.77	7.99	56.78	56.78	2014.68	462.78	1551.90	1442.51	406.13	68.62	337.51	285.00	1723.12	1613.73	394.29	341.78	845,110.00
Public Education Pollutant Loading Reduction Credit (TP-6% / TN-6%):								0.00				0.00				120.88				24.37		0.00		0.00	
Street Sweeping Pollutant Loadign Reduction Credit (TP-7% / TN-7%):								15.76				4.53				141.03				28.43		120.88		24.37	
																						156.79		32.96	
Sub-Totals								15.76				4.53				261.91				52.80		277.67		57.33	
Total								186.98				61.31				1704.42				337.80	1723.12	1891.39	394.29	399.11	

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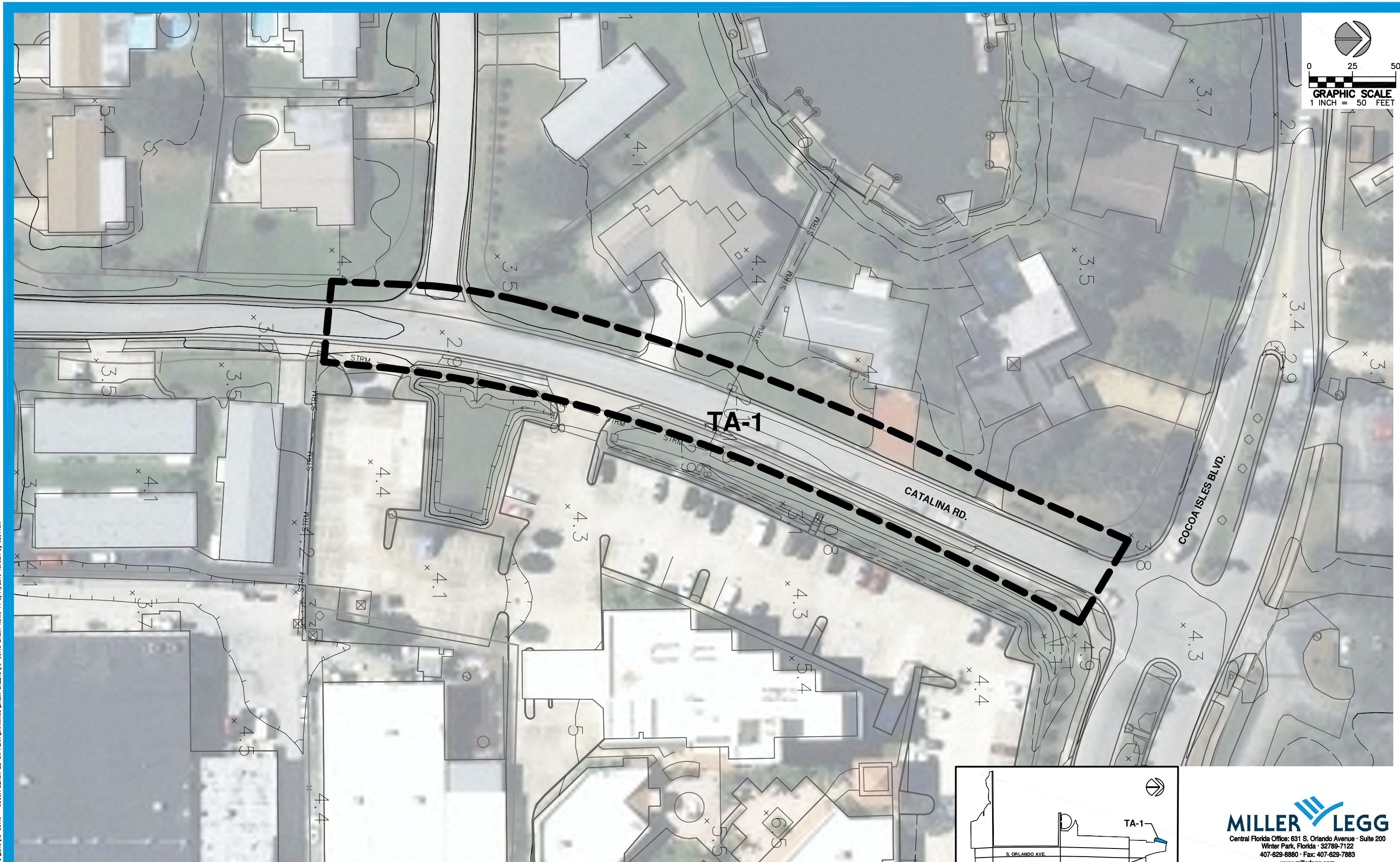
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 1



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NO IMPROVEMENTS PROPOSED

Treatment Area: 1

Area Description: An existing roadway with approximately 450 LF of 50-foot right-of-way containing a 20-foot two lane road with miami curb and gutter and sidewlak on the east side. An exisitng 2-3 foot deep swale retention facility exisits on the east side. There is no room for additional surface treatment with the exception of a minor swale system that could be installed on the east side. No treatment facilities are proposed for this basin.

Proposed Land Use:	Right-of-Way	
Major Soil Hydrological Group:	A	
CRA Area Acreage	0.513	acres
FDOT Area Acreage	0	acres
Total Area Acreage	0.513	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	78	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.24	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	0.513	acres	x	10.10	lbs/ac	=	**5.18**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**5.18**	**lbs**
TN CRA:	0.513	acres	x	2.036	lbs/ac	=	**1.04**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.04**	**lbs**

ALLOWABLE LOADING:

TP CRA:	0.513	acres	x	2.32	lbs/ac	=	**1.19**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**1.19**	**lbs**
TN CRA:	0.513	acres	x	0.344	lbs/ac	=	**0.18**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**0.18**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**3.99**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**3.99**	**lbs**
TN CRA:	**0.87**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**0.87**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet
Area Treated:	0.00	Acres

TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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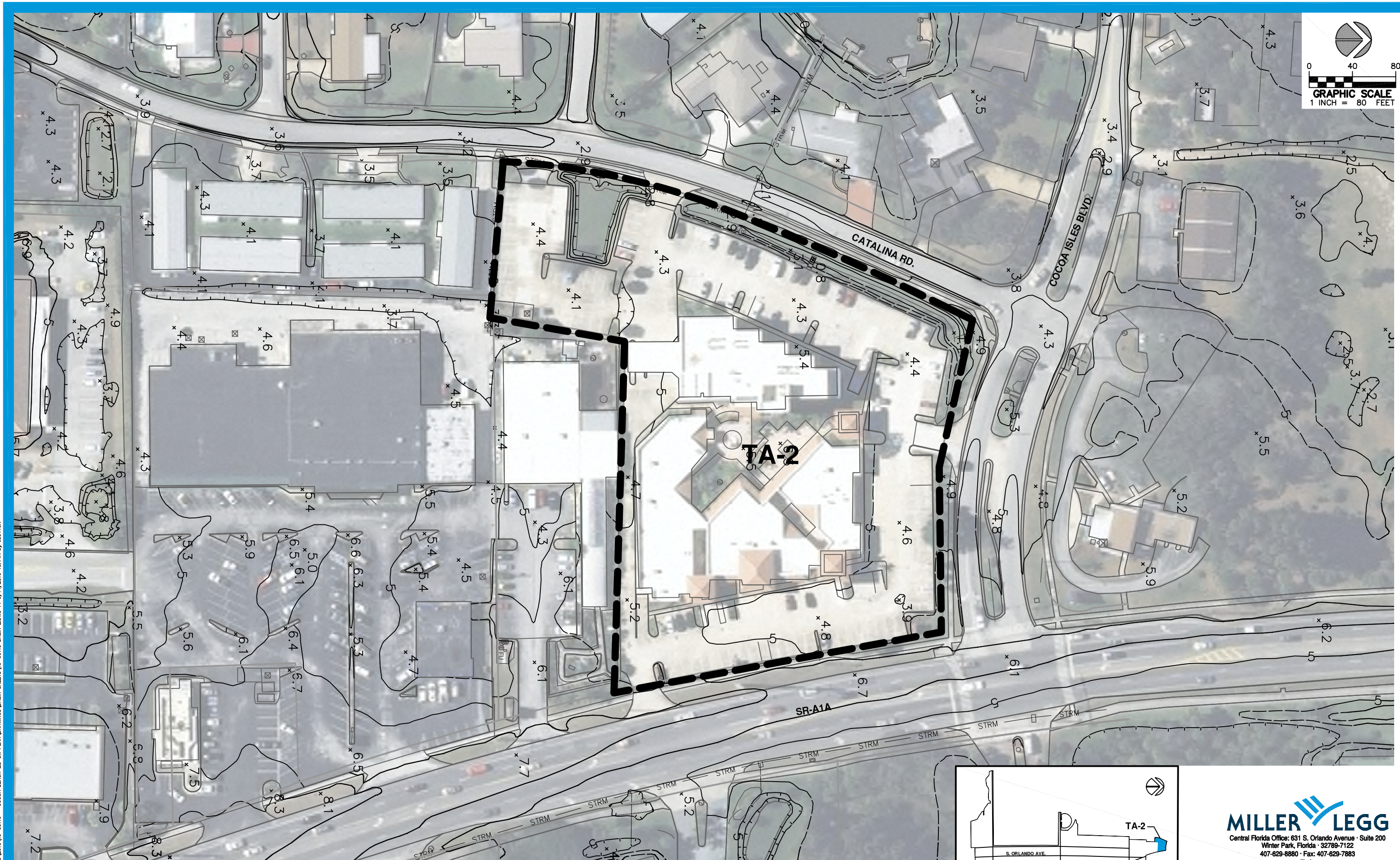
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 2



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NO IMPROVEMENTS PROPOSED

Treatment Area: 2

Area Description: Fully developed commercial site with very limited open space opportunities for above ground treatment facilities. Site would require significant redevelopment in order to provide treatment facilities. As such, no treatment facilities are proposed for this basin.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	A	
CRA Area Acreage	3.114	acres
FDOT Area Acreage	0	acres
Total Area Acreage	3.114	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	76	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.25	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.114	acres	x	10.10	lbs/ac	=	**31.45**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**31.45**	**lbs**
TN CRA:	3.114	acres	x	2.036	lbs/ac	=	**6.34**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**6.34**	**lbs**

ALLOWABLE LOADING:

TP CRA:	3.114	acres	x	2.32	lbs/ac	=	**7.22**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**7.22**	**lbs**
TN CRA:	3.114	acres	x	0.344	lbs/ac	=	**1.07**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.07**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**24.23**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**24.23**	**lbs**
TN CRA:	**5.27**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**5.27**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet	
Area Treated:	0.00	Acres	
TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 2

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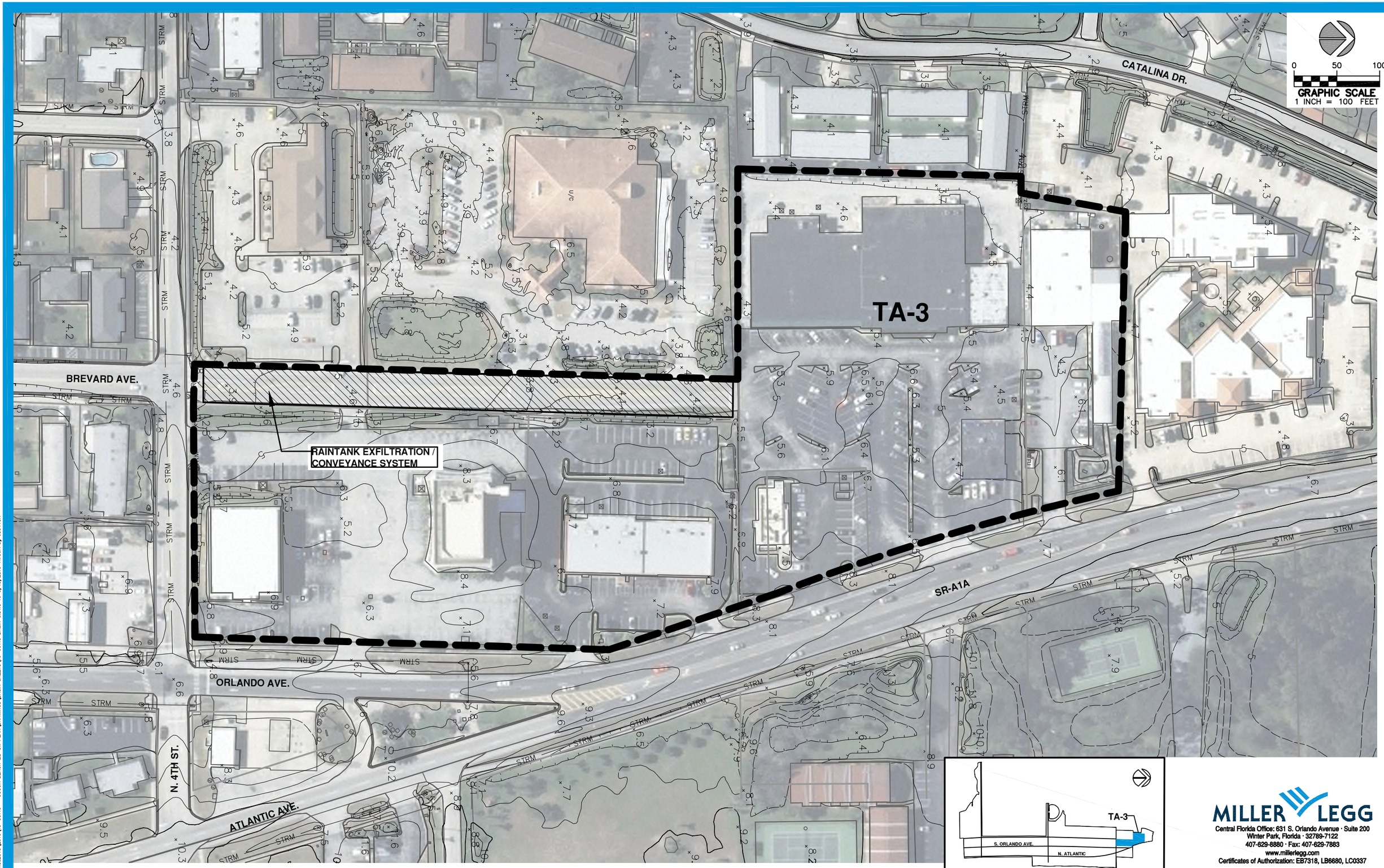
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 3



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Treatment Area: 3

Area Description: Fully developed commercial site and almost entirely impervious. No open space available for surface treatment facilities without significant site redevelopment. As such, no treatment facilities are proposed for this basin. It is anticipated that under a redevelopment scenario, up to 100% of the nutrient removal would be accomplished on-site.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	A	
CRA Area Acreage	9.003	acres
FDOT Area Acreage	0	acres
Total Area Acreage	9.003	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	76	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.25	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	9.003	acres x	10.10	lbs/ac	=	**90.93**	**lbs**
TP FDOT:	0	acres x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**90.93**	**lbs**
TN CRA:	9.003	acres x	2.036	lbs/ac	=	**18.33**	**lbs**
TN FDOT:	0	acres x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**18.33**	**lbs**

ALLOWABLE LOADING:

TP CRA:	9.003	acres x	2.32	lbs/ac	=	**20.89**	**lbs**
TP FDOT:	0	acres x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**20.89**	**lbs**
TN CRA:	9.003	acres x	0.344	lbs/ac	=	**3.10**	**lbs**
TN FDOT:	0	acres x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**3.10**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**70.04**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**70.04**	**lbs**
TN CRA:	**15.23**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**15.23**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	24695	Cubic-Feet
Area Treated:	5.44	Acres

TP Load Reduction:	**46.72**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**9.42**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

FINAL BREVARD AVENUE RIGHT-OF-WAY CROSS SECTION IS UNDETERMINED AND WILL BE BASED UPON REDEVELOPMENT PLAN FOR AREAS TA-2, TA-3, AND TA-4. THEREFORE, CALCULATION BELOW NOTES QUANTITY OF RAINTANK SYSTEM REQUIRED TO ACHIEVE TREATMENT REQUIREMENTS. LOCATION OF EXFILTRATION SYSTEM WILL VARY WITH FINAL ROAD DESIGN.

ROAD SECTION IS APPROXIMATELY 600 LF WHICH ALLOWS FOR 266 UNITS ALONG ROAD LENGTH. INSTALL UNITS ALONG ROADWAY WITH 22 UNITS WIDE. RESULTS IN 24,695 CF STORAGE WITHIN THIS TREATMENT AREA.

TREATMENT VOLUME CALCULATIONS

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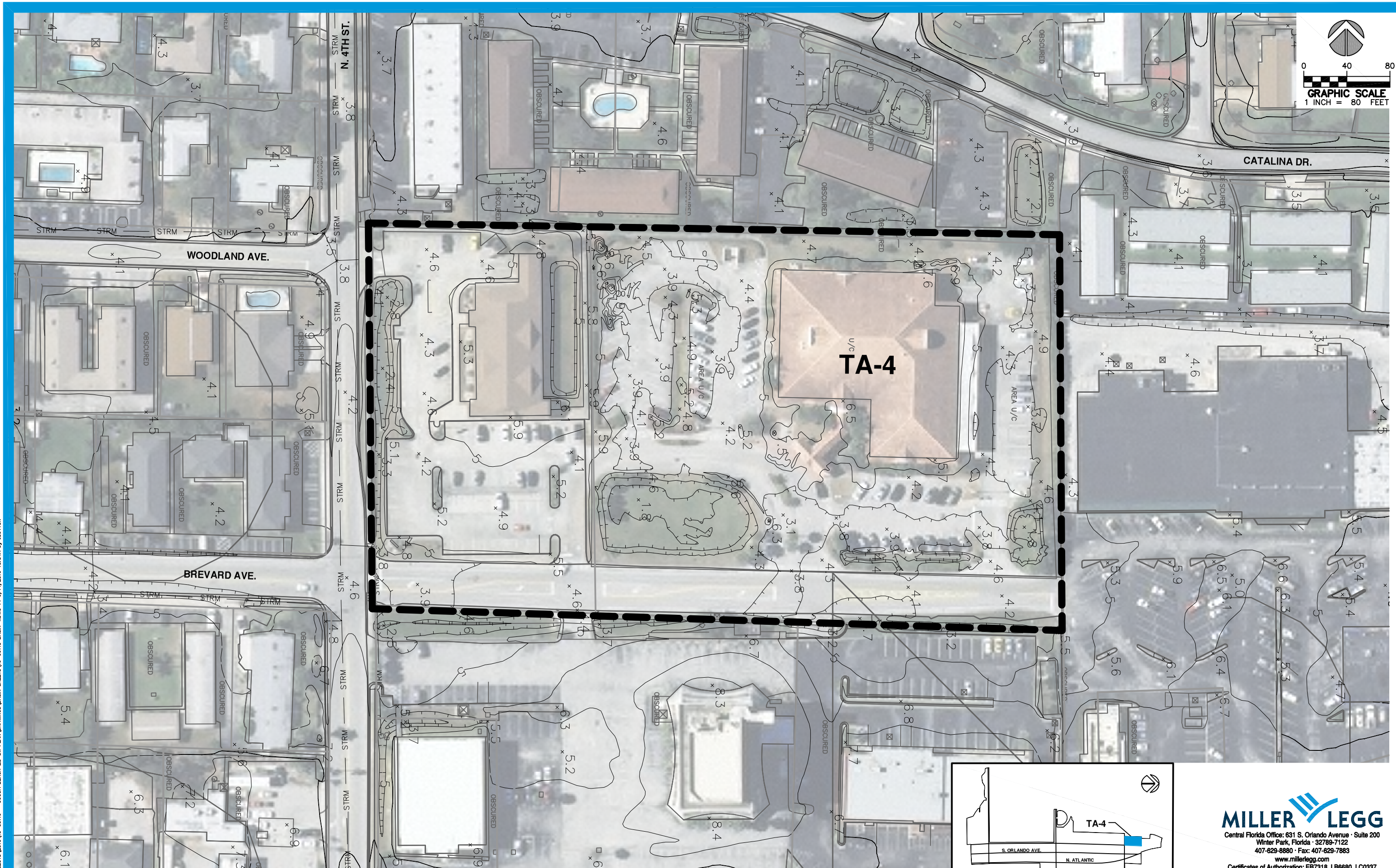
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 4



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NO IMPROVEMENTS PROPOSED

Treatment Area: 4

Area Description: Existing library and post office site developed prior to 2000 which currently provides some level of stormwater treatment facilities. Additional open space areas exists which provide opportunity for dry retention facilities which could be developed as a private-public partnership arrangement.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	A	
CRA Area Acreage	4.51	acres
FDOT Area Acreage	0	acres
Total Area Acreage	4.51	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	76	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.25	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	4.51	acres	x	10.10	lbs/ac	=	**45.55**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**45.55**	**lbs**
TN CRA:	4.51	acres	x	2.036	lbs/ac	=	**9.18**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**9.18**	**lbs**

ALLOWABLE LOADING:

TP CRA:	4.51	acres	x	2.32	lbs/ac	=	**10.46**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**10.46**	**lbs**
TN CRA:	4.51	acres	x	0.344	lbs/ac	=	**1.55**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.55**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**35.09**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**35.09**	**lbs**
TN CRA:	**7.63**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**7.63**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet
Area Treated:	0.00	Acres

TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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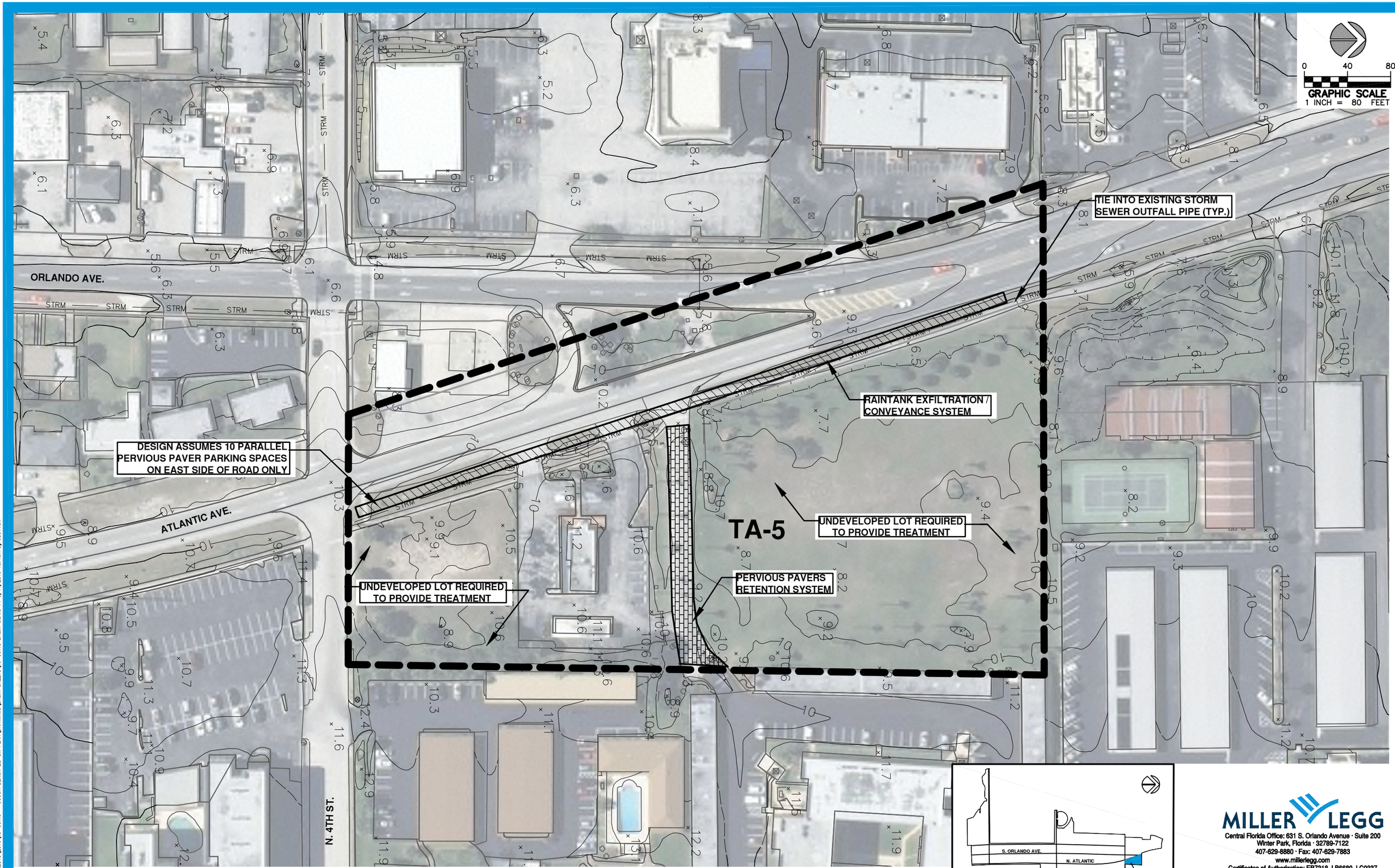
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 5



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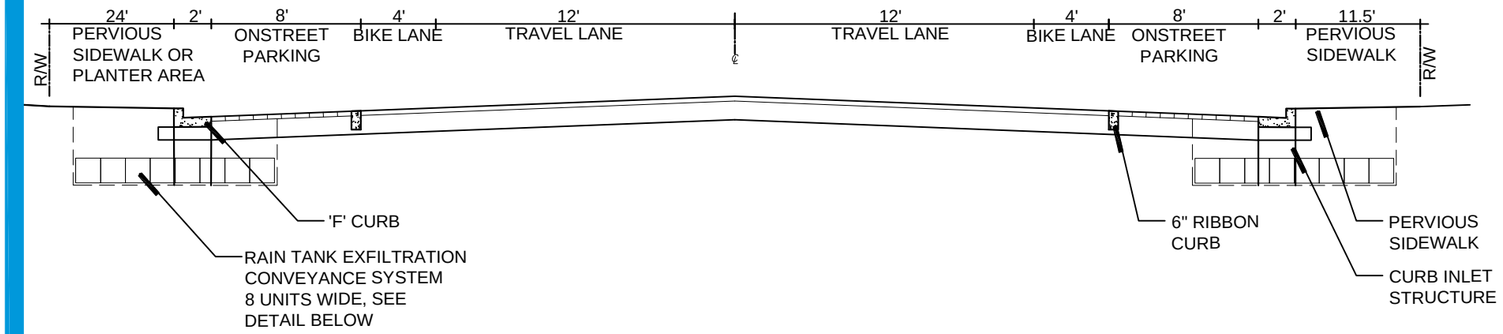
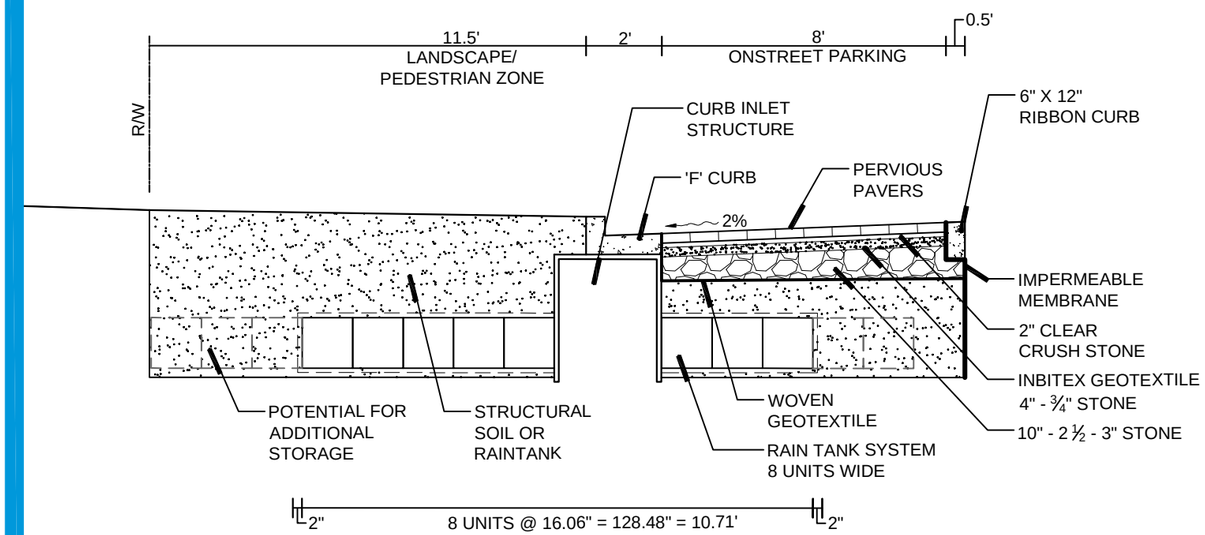


ATLANTIC AVE.SECTION A-A

SCALE: N.T.S.

4TH ST. NORTH TO ~400' SOUTH OF SUNFLOWER STREET (100' R.O.W.)



SCALE: N.T.S.

PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:

1 BLOCKS X 600 LF/BLOCK = 600 LF ROAD
600 LF / 2.25 LF/UNIT = 266 UNITS ALONG ROAD
266 UNITS X 8 WIDE X 1 SIDE = 2,128 UNITS
2,128 UNITS X 4.22 CF/UNIT = 8,980 CF

PERVIOUS PAVERS PARKING:

0.47 CF STORAGE PER SF PERVIOUS PAVERS
= 10 SP X (20' X 7.5')
= 1,500 SF X 0.47 CF/SF
= 705 CF STORAGE

SUNSHINE DRIVE PERVIOUS PAVERS:

= 5,000 SF X 0.47 CF/SF
= 2,350 CF STORAGE

UNDEVELOPED LOTS:

AREA = 20,000 SF + 86,000 SF = 106,000 SF
1.25" TREATMENT VOLUME REQUIRED
106,000 SF X 1.25" X (1FT/12")
= 11,041 CF STORAGE

SUMMARY:

PERVIOUS PAVER PARKING = 705 CF
SUNSHINE DRIVE PERVIOUS PAVERS = 2,350 CF
RAINTANK SYSTEM = 8,980 CF
UNDEVELOPED LOTS = 11,041 CF
TOTAL = 23,076 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: 5

Area Description: Mostly undeveloped site areas. Sunshine Drive provides pervious paver treatment facilities opportunity. Exfiltration and pervious paver treatment systems proposed for A1A right-of-way. Future development of vacant parcels shall be requried to meet up to 100% of the TMDL nutrient reduction requirements.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	A	
CRA Area Acreage	3.435	acres
FDOT Area Acreage	1.449	acres
Total Area Acreage	4.884	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	76	CN
Type of Best Management Practice Proposed:	Exfiltration Trenches	
Required Treatment Volume:	1.25	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.435	acres x	10.10	lbs/ac	=	**34.69**	**lbs**
TP FDOT:	1.449	acres x	9.69	lbs/ac	=	**14.04**	**lbs**
TP Total:					=	**48.73**	**lbs**
TN CRA:	3.435	acres x	2.036	lbs/ac	=	**6.99**	**lbs**
TN FDOT:	1.449	acres x	2.788	lbs/ac	=	**4.04**	**lbs**
TN Total:					=	**11.03**	**lbs**

ALLOWABLE LOADING:

TP CRA:	3.435	acres x	2.32	lbs/ac	=	**7.97**	**lbs**
TP FDOT:	1.449	acres x	2.32	lbs/ac	=	**3.36**	**lbs**
TP Total:					=	**11.33**	**lbs**
TN CRA:	3.435	acres x	0.344	lbs/ac	=	**1.18**	**lbs**
TN FDOT:	1.449	acres x	0.344	lbs/ac	=	**0.50**	**lbs**
TN Total:					=	**1.68**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**26.72**	**lbs**
TP FDOT:	**10.68**	**lbs**
TP Total:	**37.40**	**lbs**
TN CRA:	**5.81**	**lbs**
TN FDOT:	**3.54**	**lbs**
TN Total:	**9.35**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	23076	Cubic-Feet
Area Treated:	5.09	Acres

TP Load Reduction:	**43.16**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**9.73**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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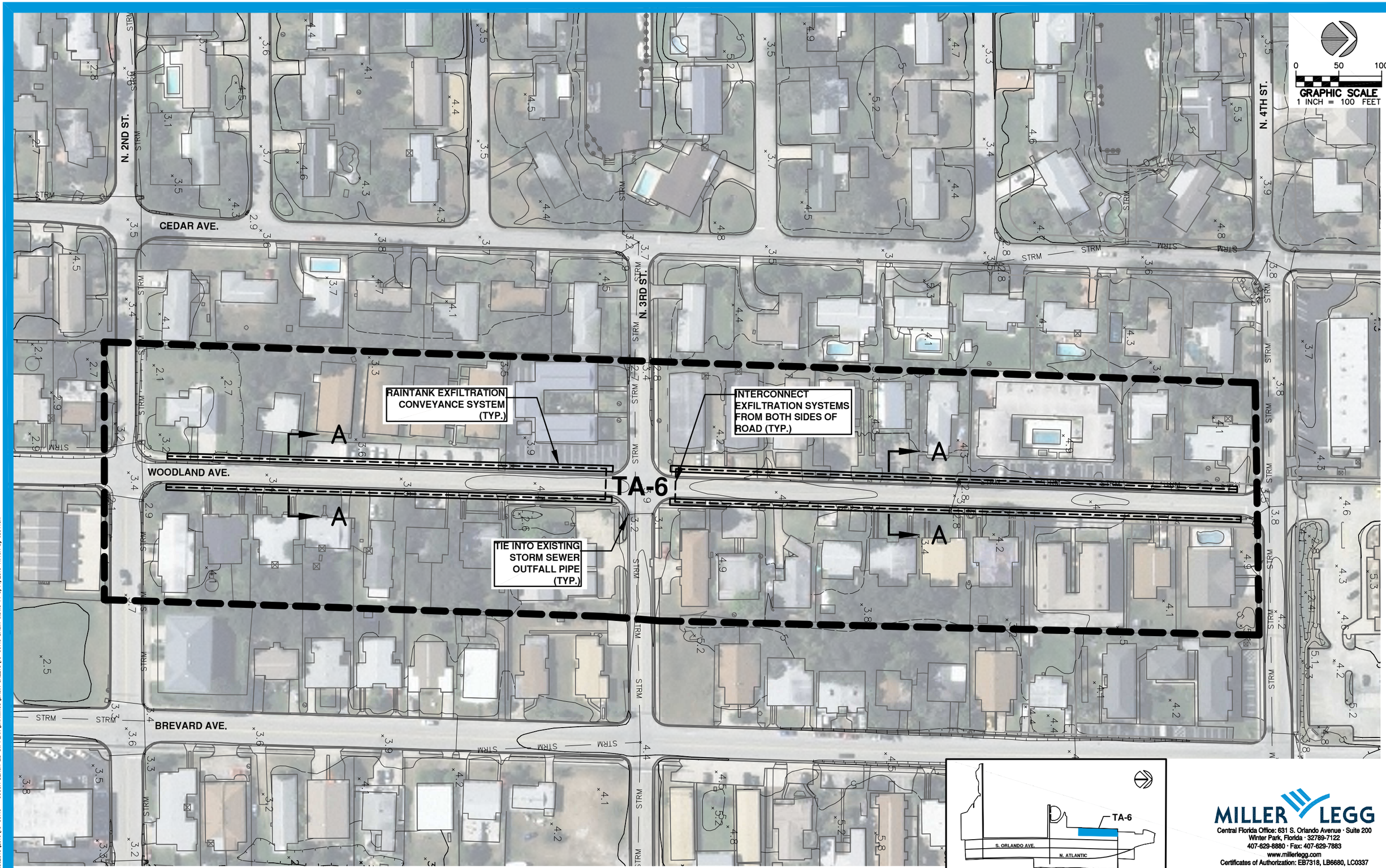
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 6



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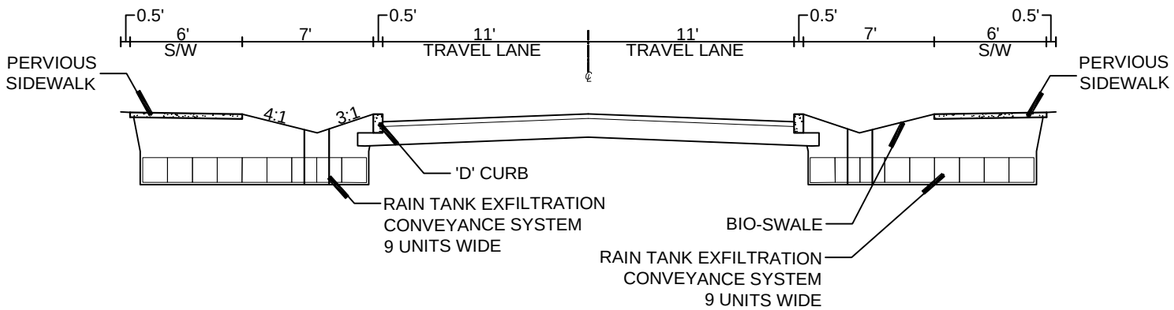
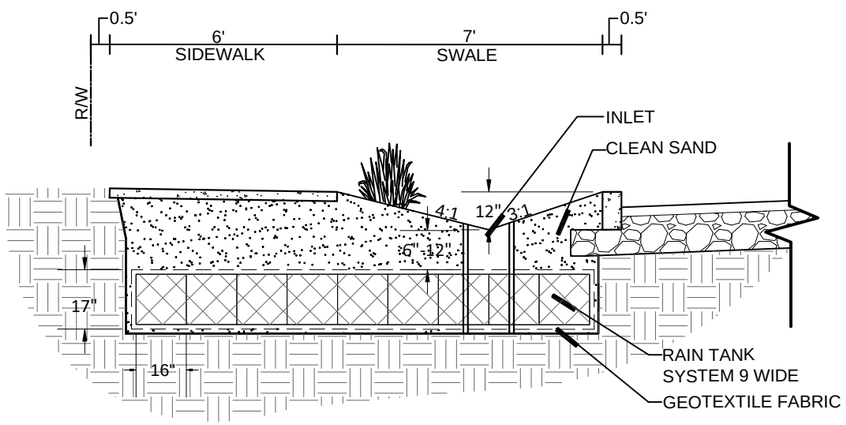


WOODLAND AVENUE TYPICAL SECTION A-A

SCALE: N.T.S.

2ND ST. NORTH TO 4TH ST. NORTH (50' R.O.W.)



SCALE: N.T.S.

TYPICAL BIO-SWALE W/ EXFILTRATION SYSTEM

RAINTANK EXFILTRATION SYSTEM = 2 BLOCKS X 600 LF/BLOCK = 12,000 LF ROAD
1,200 LF ROAD/2.25 LF/UNIT = 533 UNITS ALONG ROAD
533 UNITS X 9 WIDE X 2 SIDES = 9,594 UNITS
9,594 UNITS X 4.22 CF/UNIT = 40,486 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: 6

Area Description: Basin is fully developed with single family residential being the predominant land use. There are no available public or private land areas for treatment facilities with the exception of the existing right-of-way. Underground storage treatment facilities are the recommended treatment option within public right-of-way. Redevelopment would be required to treat up to 100% of the TMDL nutrient reduction requirements.

Proposed Land Use:	Cottage Row Res.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	9.318	acres
FDOT Area Acreage	0	acres
Total Area Acreage	9.318	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	80	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.15	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	9.318	acres	x	10.10	lbs/ac	=	**94.11**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**94.11**	**lbs**
TN CRA:	9.318	acres	x	2.036	lbs/ac	=	**18.97**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**18.97**	**lbs**

ALLOWABLE LOADING:

TP CRA:	9.318	acres	x	2.32	lbs/ac	=	**21.62**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**21.62**	**lbs**
TN CRA:	9.318	acres	x	0.344	lbs/ac	=	**3.21**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.21**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**72.49**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**72.49**	**lbs**
TN CRA:	**15.77**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**15.77**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	40486	Cubic-Feet
Area Treated:	9.70	Acres

TP Load Reduction:	**83.26**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**16.78**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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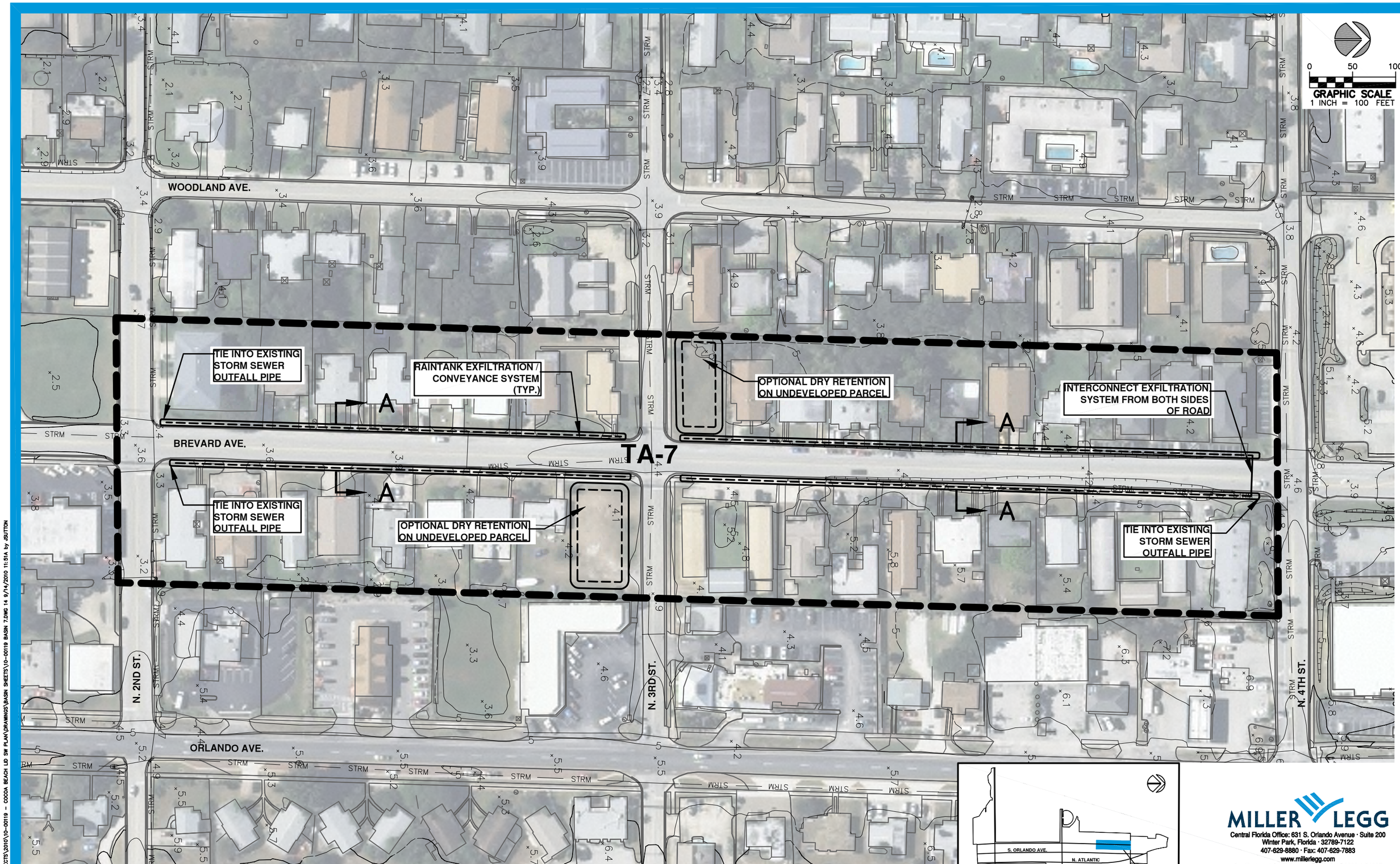
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 7



PLAN VIEW

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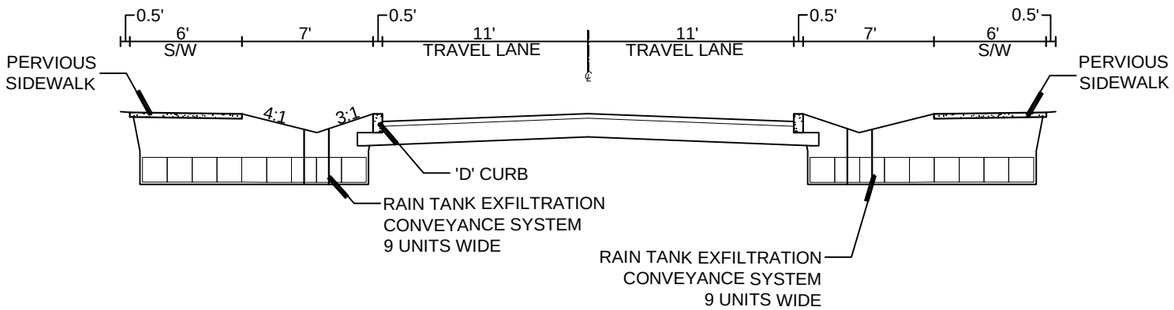
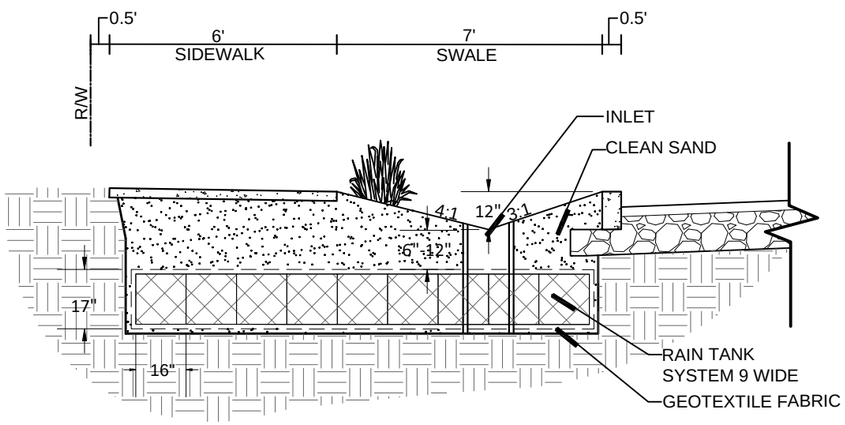


BREVARD AVENUE TYPICAL SECTION A-A

SCALE: N.T.S.

2ND ST. NORTH TO 4TH ST. NORTH (50' R.O.W.)



SCALE: N.T.S.

TYPICAL BIO-SWALE W/ EXFILTRATION SYSTEM

RAINTANK EXFILTRATION SYSTEM = 2 BLOCKS X 600 LF/BLOCK = 12,000 LF ROAD
1,200 LF ROAD/2.25 LF/UNIT = 533 UNITS ALONG ROAD
533 UNITS X 9 WIDE X 2 SIDES = 9,594 UNITS
9,594 UNITS X 4.22 CF/UNIT = 40,486 CF

ALTERNATE TREATMENT OPTION: UNDEVELOPED PARCELS AS DRY RETENTION WILL PROVIDE APPROXIMATELY 10,000 CF STORAGE AT 2' STORAGE DEPTH. IF BOTH LOTS ARE UNDEVELOPED AS DRY RETENTION, THE QUANTITY OF RAINTANK EXFILTRATION UNITS WOULD BE REDUCED BY APPROXIMATELY 4,739 UNITS.

TREATMENT VOLUME CALCULATIONS

Treatment Area: **7**

Area Description: Basin is fully developed with signle family residential and is proposed as Cottage R Residential land use. There are two private undeveloped land parcels available for treatment facilities. Proposed treatment facilites are exfiltration systems within the Brevard Ave. right-of-way with the opti of providing dry retention within the undeveloped lots. Redevelopment would be required to meet 100% of the TMDL nutrient reduction requirements.

Proposed Land Use:	Cottage Row Res.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	9.661	acres
FDOT Area Acreage	0	acres
Total Area Acreage	9.661	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	80	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.15	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	9.661	acres	x	10.10	lbs/ac	=	**97.58**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**97.58**	**lbs**
TN CRA:	9.661	acres	x	2.036	lbs/ac	=	**19.67**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**19.67**	**lbs**

ALLOWABLE LOADING:

TP CRA:	9.661	acres	x	2.32	lbs/ac	=	**22.41**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**22.41**	**lbs**
TN CRA:	9.661	acres	x	0.344	lbs/ac	=	**3.32**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.32**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**75.16**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**75.16**	**lbs**
TN CRA:	**16.35**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**16.35**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	40486	Cubic-Feet
Area Treated:	9.70	Acres

TP Load Reduction:	**83.26**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**16.78**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 7

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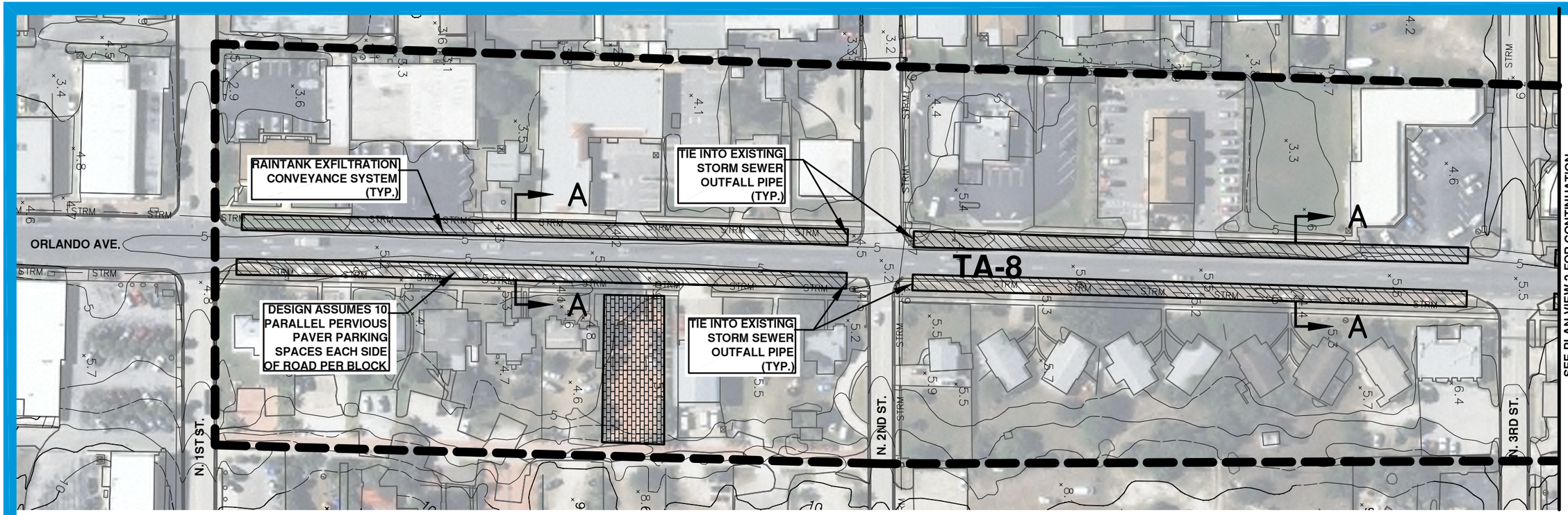
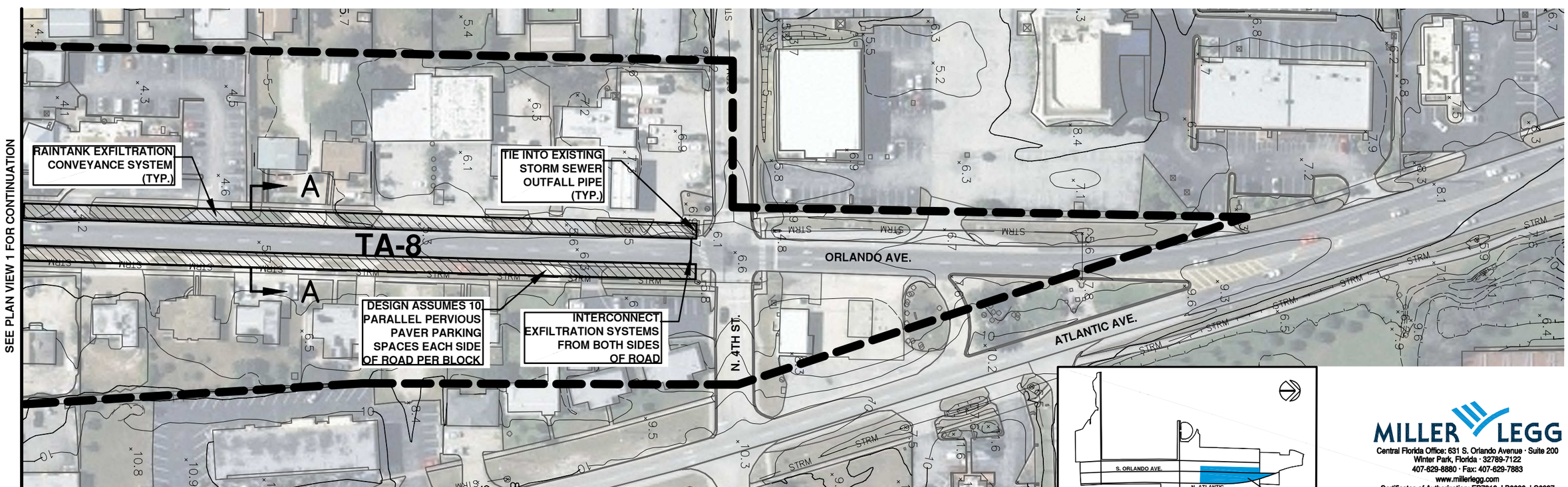
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 8



PLAN VIEW 1



PLAN VIEW 2

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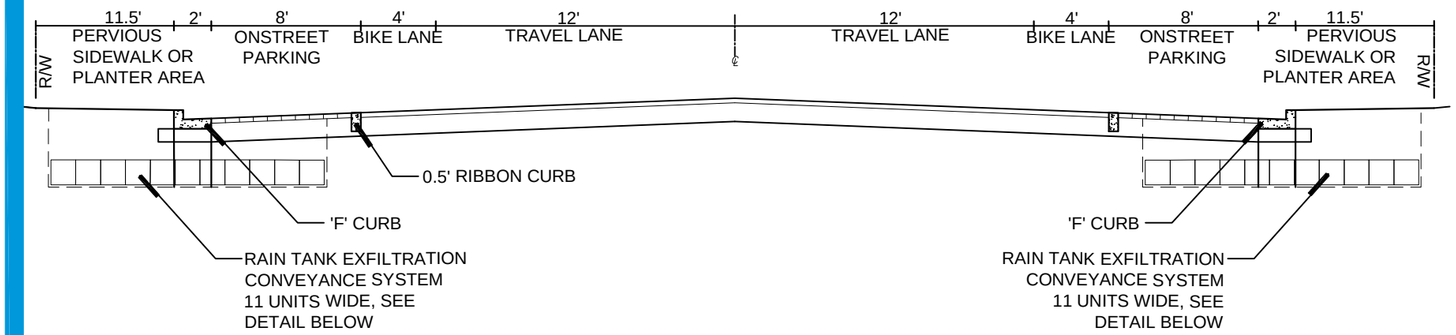
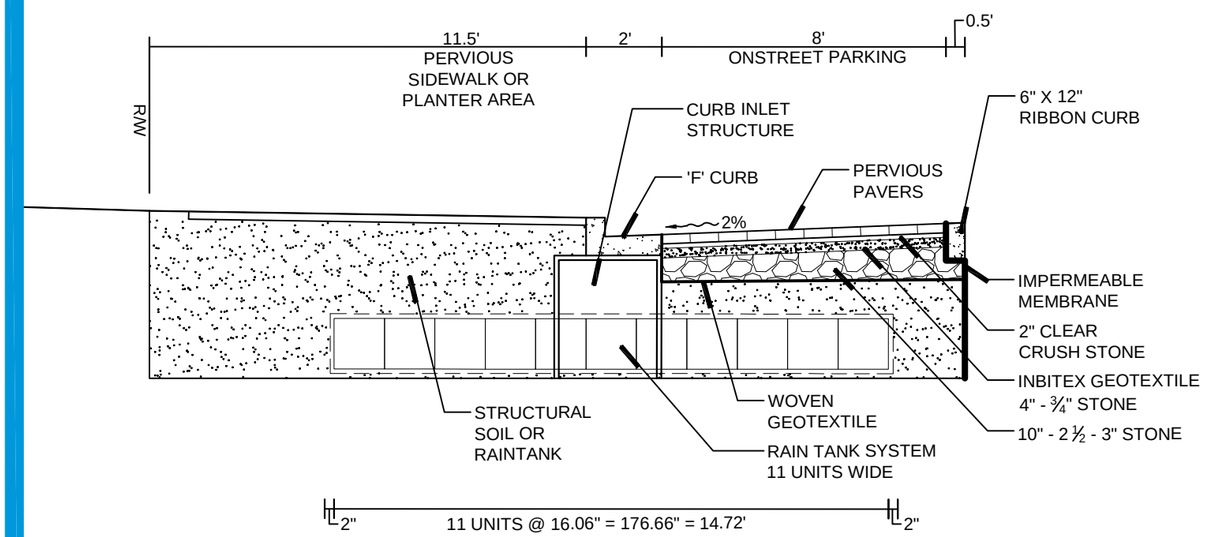


ORLANDO AVE.SECTION A-A

SCALE: N.T.S.

1ST ST. NORTH TO 4TH. NORTH (75' R.O.W.)



SCALE: N.T.S.

PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:

3 BLOCKS X 600 LF/BLOCK = 1,800 LF ROAD
1,800 LF / 2.25 LF/UNIT = 800 UNITS ALONG ROAD
800 UNITS X 11 WIDE X 2 SIDES = 17,600 UNITS
17,600 UNITS X 4.22 CF/UNIT = 74,272 CF

PERVIOUS PAVERS PARKING:

10 PARKING SP. PER BLOCK PER SIDE OF ROAD
0.47 CF STORAGE PER SF PERVIOUS PAVERS
3 BLOCKS
= 3 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')
= 9,000 SF X 0.47 CF/SF
= 4,230 CF STORAGE

COTTAGE ROW PARKING LOT 14:

AREA = 0.33 ACRES
1.26" TREATMENT VOLUME REQUIRED
(0.33 AC X 43,560 SF/AC) X (1.26" X 1FT/12")
= 1,509 CF STORAGE REQUIRED
3,172 CF STORAGE PROVIDED

SUMMARY:

PERVIOUS PAVER PARKING = 4,230 CF
COTTAGE ROW PARKING LOT 14 = 1,509 CF
RAINTANK SYSTEM = 74,272 CF
TOTAL = 80,011 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: 8

Area Description: Basin is fully developed as commercial and is proposed as Cottage Row Commercial land use. Recent development includes the Cottage Row Parking Lot 14 which provides its own treatment facilities. Proposed treatment facilites are exfiltration and pervious paver systems within the Brevard Ave. right-of-way. Redevelopment would be required to meet up to 100% of the TMDL nutrient reduction requirements.

Proposed Land Use:	Cottage Row Com.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	13.134	acres
FDOT Area Acreage	4.213	acres
Total Area Acreage	17.347	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	84	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.26	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	13.134	acres x	10.10	lbs/ac	=	**132.65**	**lbs**
TP FDOT:	4.213	acres x	9.69	lbs/ac	=	**40.82**	**lbs**
TP Total:					=	**173.48**	**lbs**
TN CRA:	13.134	acres x	2.036	lbs/ac	=	**26.74**	**lbs**
TN FDOT:	4.213	acres x	2.788	lbs/ac	=	**11.75**	**lbs**
TN Total:					=	**38.49**	**lbs**

ALLOWABLE LOADING:

TP CRA:	13.134	acres x	2.32	lbs/ac	=	**30.47**	**lbs**
TP FDOT:	4.213	acres x	2.32	lbs/ac	=	**9.77**	**lbs**
TP Total:					=	**40.25**	**lbs**
TN CRA:	13.134	acres x	0.344	lbs/ac	=	**4.52**	**lbs**
TN FDOT:	4.213	acres x	0.344	lbs/ac	=	**1.45**	**lbs**
TN Total:					=	**5.97**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**102.18**	**lbs**
TP FDOT:	**31.05**	**lbs**
TP Total:	**133.23**	**lbs**
TN CRA:	**22.22**	**lbs**
TN FDOT:	**10.30**	**lbs**
TN Total:	**32.52**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	80011	Cubic-Feet	
Area Treated:	17.49	Acres	
TP Load Reduction:	**148.71**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**32.97**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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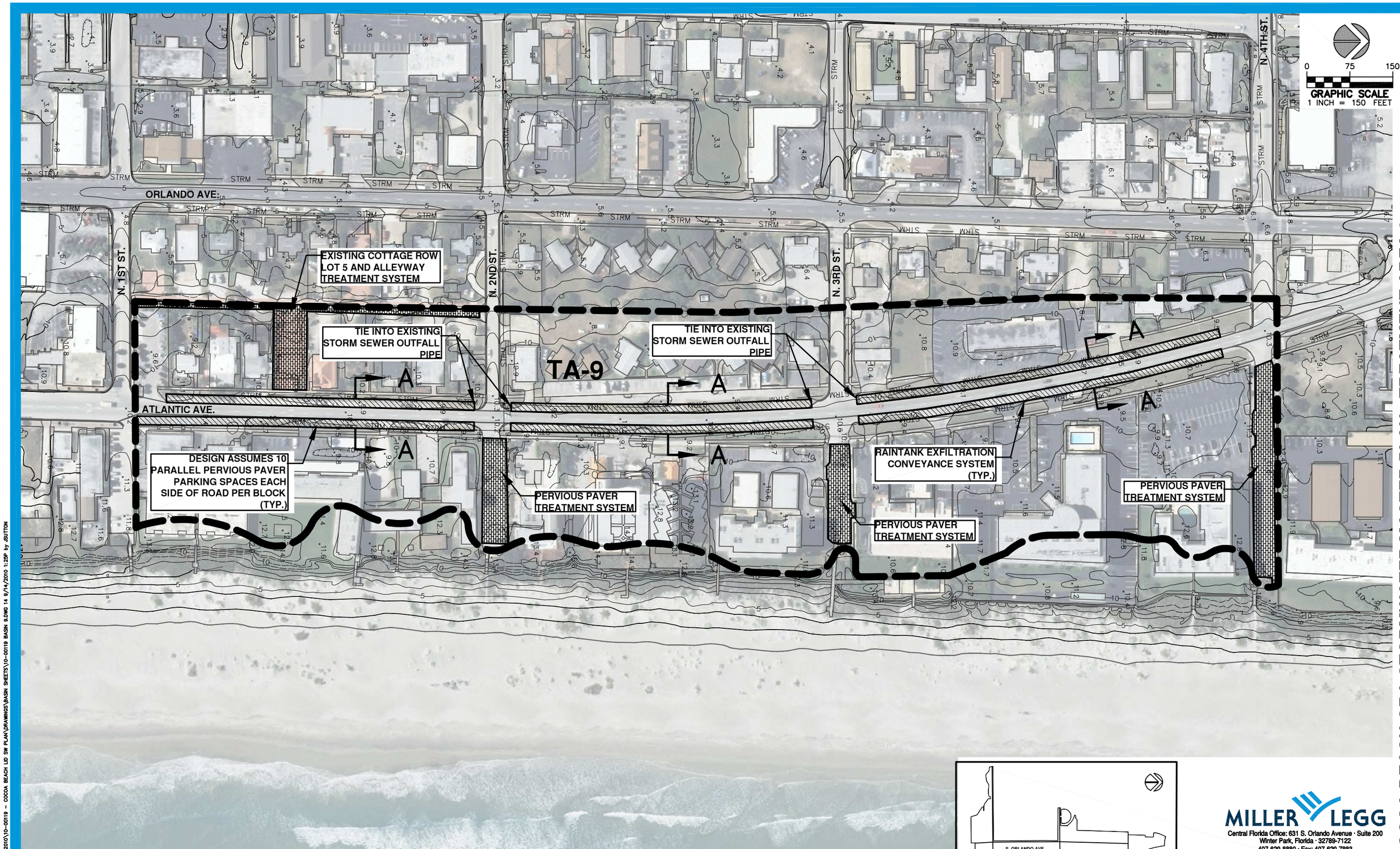
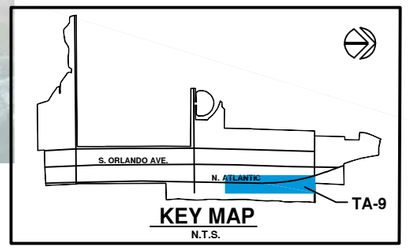
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 9





KEY MAP
N.T.S.

PLAN VIEW

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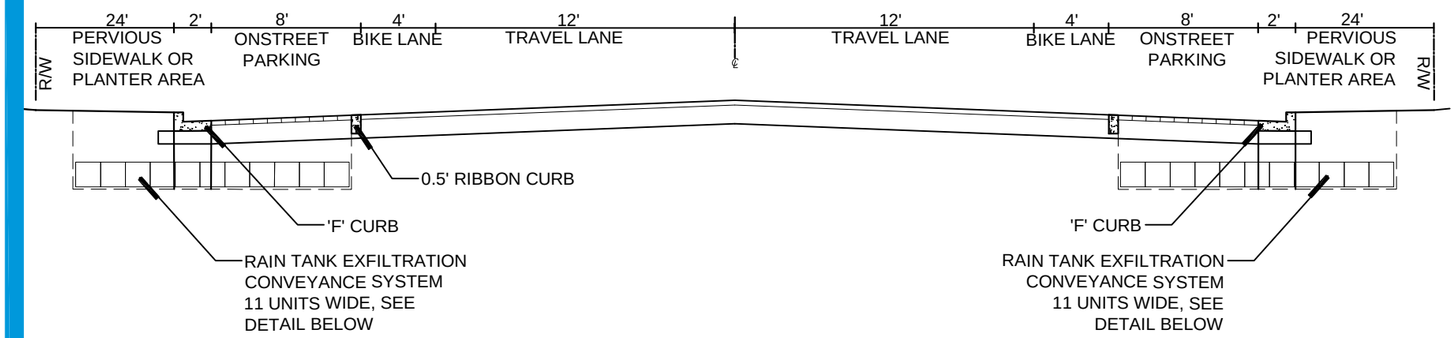
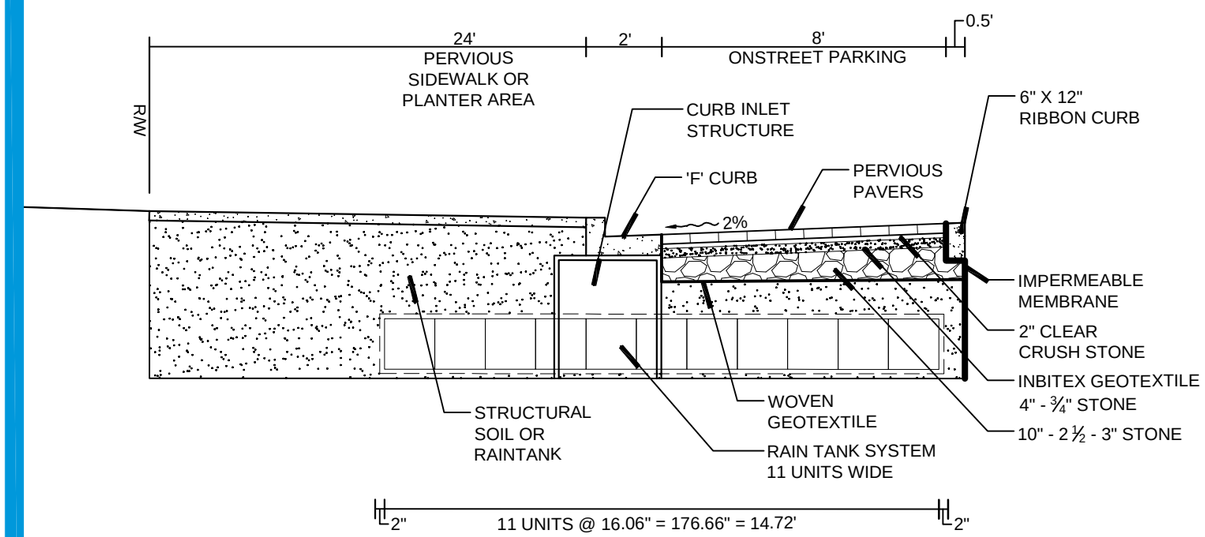


ATLANTIC AVE.SECTION A-A

SCALE: N.T.S.

1ST ST. NORTH TO 4TH. NORTH (100' R.O.W.)



SCALE: N.T.S.

PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:	3 BLOCKS X 600 LF/BLOCK = 1,800 LF ROAD 1,800 LF / 2.25 LF/UNIT = 800 UNITS ALONG ROAD 800 UNITS X 11 WIDE X 2 SIDES = 17,600 UNITS 17,600 UNITS X 4.22 CF/UNIT = 74,272 CF
PERVIOUS PAVERS PARKING:	10 PARKING SP. PER BLOCK PER SIDE OF ROAD 0.47 CF STORAGE PER SF PERVIOUS PAVERS 3 BLOCKS = 3 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5') = 9,000 SF X 0.47 CF/SF = 4,230 CF STORAGE
COTTAGE ROW PARKING LOT 5 + ALLEY:	AREA = 0.55 ACRES 1.32" TREATMENT VOLUME REQUIRED (0.55 AC X 43,560 SF/AC) X (1.32" X 1FT/12") = 2,635 CF STORAGE REQUIRED 7,448 CF STORAGE PROVIDED
BEACH PERVIOUS PAVERS PARKING AREA:	= 7,750 SF (2ND ST N) + 7,000 SF (3RD ST N) + 13,000 SF (4TH ST N) = 27,750 SF = 27,750 X 0.47 CF/SF = 13,042 CF STORAGE
SUMMARY:	PERVIOUS PAVER PARKING = 4,230 CF COTTAGE ROW PARKING LOT 5 + ALLEY = 2,632 CF RAINTANK SYSTEM = 74,272 CF **BEACH PERVIOUS PAVERS PARKING AREA = 13,042 CF** TOTAL = 94,179 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: 9

Area Description: Basin is fully developed as commercial and is proposed as Cottage Row Commercial land use. There are two private undeveloped land parcels available for treatment facilities. Proposed treatment facilites are exfiltration and pervious paver systems within the Brevard Ave. right-of-way with the option of providing dry retention within the undeveloped lots. Redevelopment would be required to meet up to 100% of the TMDL nutrient reduction requirements.

Proposed Land Use:	Oceanside District	
Major Soil Hydrological Group:	C	
CRA Area Acreage	14.18	acres
FDOT Area Acreage	4.648	acres
Total Area Acreage	18.828	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	84	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.32	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	14.18	acres	x	10.10	lbs/ac	=	**143.22**	**lbs**
TP FDOT:	4.648	acres	x	9.69	lbs/ac	=	**45.04**	**lbs**
TP Total:						=	**188.26**	**lbs**
TN CRA:	14.18	acres	x	2.036	lbs/ac	=	**28.87**	**lbs**
TN FDOT:	4.648	acres	x	2.788	lbs/ac	=	**12.96**	**lbs**
TN Total:						=	**41.83**	**lbs**

ALLOWABLE LOADING:

TP CRA:	14.18	acres	x	2.32	lbs/ac	=	**32.90**	**lbs**
TP FDOT:	4.648	acres	x	2.32	lbs/ac	=	**10.78**	**lbs**
TP Total:						=	**43.68**	**lbs**
TN CRA:	14.18	acres	x	0.344	lbs/ac	=	**4.88**	**lbs**
TN FDOT:	4.648	acres	x	0.344	lbs/ac	=	**1.60**	**lbs**
TN Total:						=	**6.48**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**110.32**	**lbs**
TP FDOT:	**34.26**	**lbs**
TP Total:	**144.58**	**lbs**
TN CRA:	**23.99**	**lbs**
TN FDOT:	**11.36**	**lbs**
TN Total:	**35.35**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	94179	Cubic-Feet
Area Treated:	19.66	Acres

TP Load Reduction:	**167.12**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**36.99**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 9

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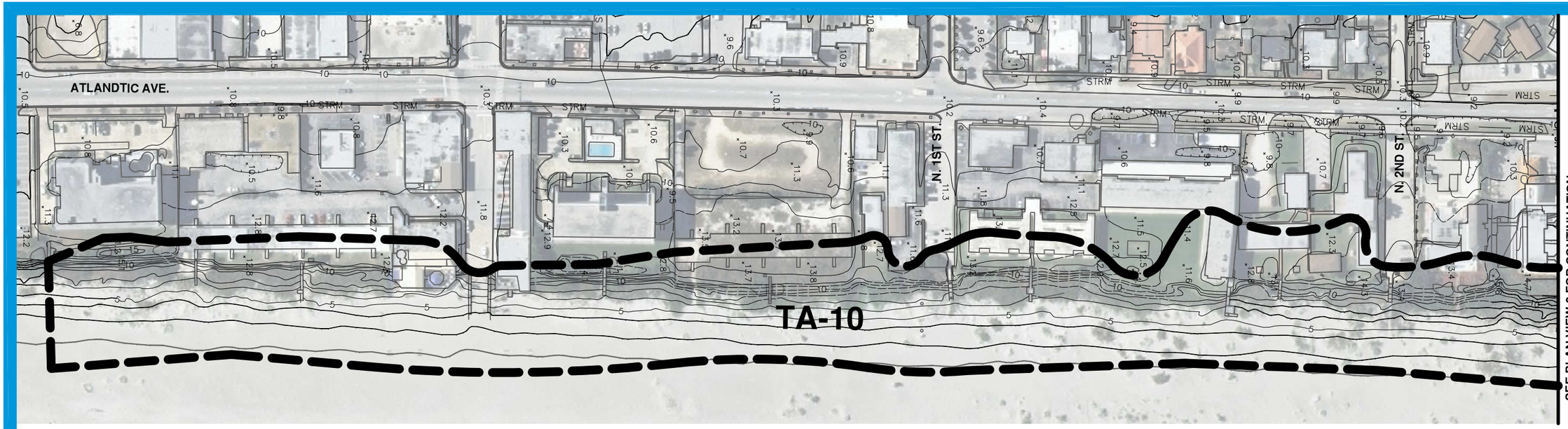
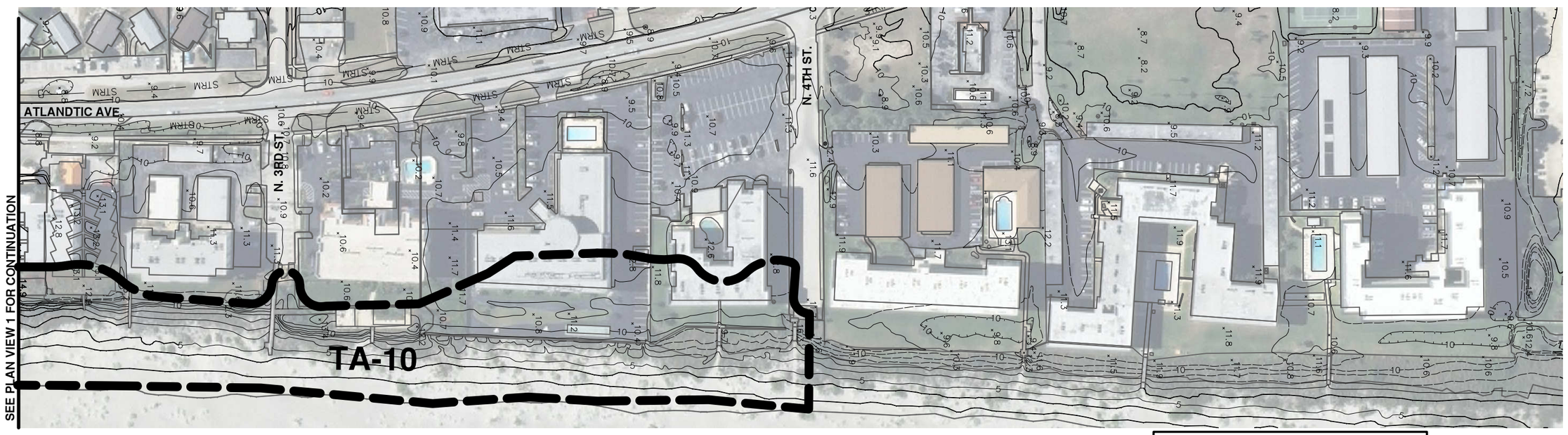
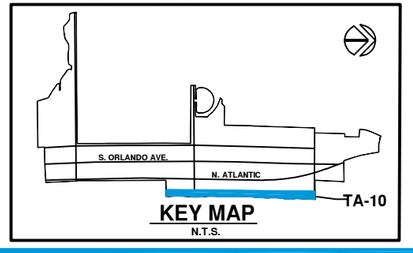


PLAN VIEW 1



PLAN VIEW 2



KEY MAP
N.T.S.

0 75 150
GRAPHIC SCALE
1 INCH = 150 FEET

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 10

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NO IMPROVEMENTS PROPOSED

Treatment Area: 10

Area Description: Area consists of the beach shoreline and a limited amount of developed properties along the shoreline which drain east. No treatment facilities are proposed for this basin.

Proposed Land Use:	Park Lands	
Major Soil Hydrological Group:	A	
CRA Area Acreage	12.621	acres
FDOT Area Acreage	0	acres
Total Area Acreage	12.621	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	41	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	0.25	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	12.621	acres	x	10.10	lbs/ac	=	**127.47**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**127.47**	**lbs**
TN CRA:	12.621	acres	x	2.036	lbs/ac	=	**25.70**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**25.70**	**lbs**

ALLOWABLE LOADING:

TP CRA:	12.621	acres	x	2.32	lbs/ac	=	**29.28**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**29.28**	**lbs**
TN CRA:	12.621	acres	x	0.344	lbs/ac	=	**4.34**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**4.34**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**98.19**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**98.19**	**lbs**
TN CRA:	**21.35**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**21.35**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet
Area Treated:	0.00	Acres

TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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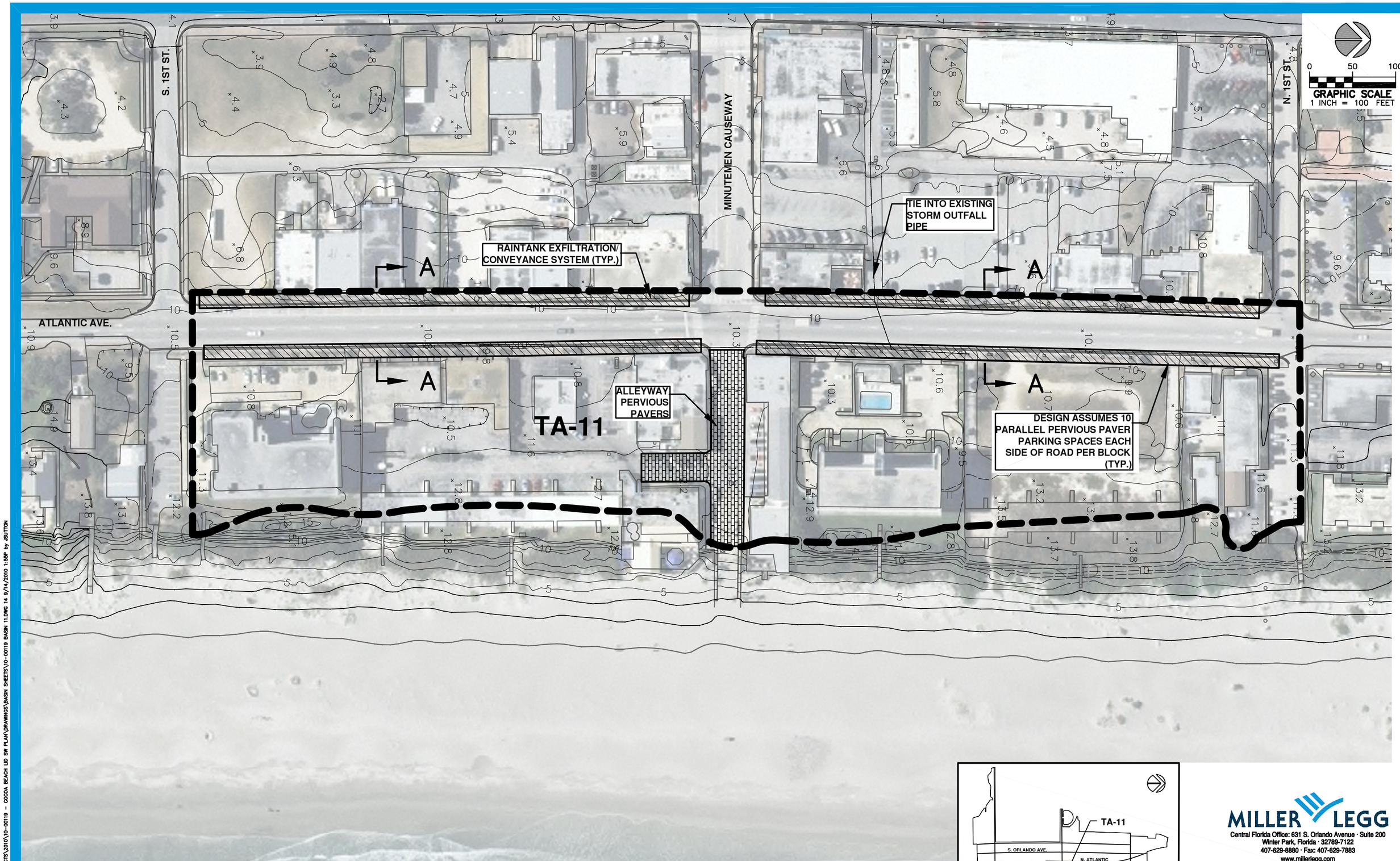

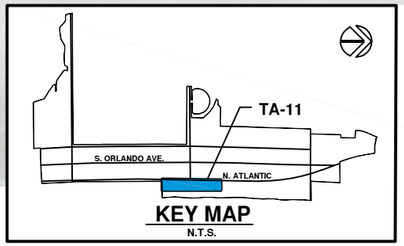

KEY MAP
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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 11

PLAN VIEW

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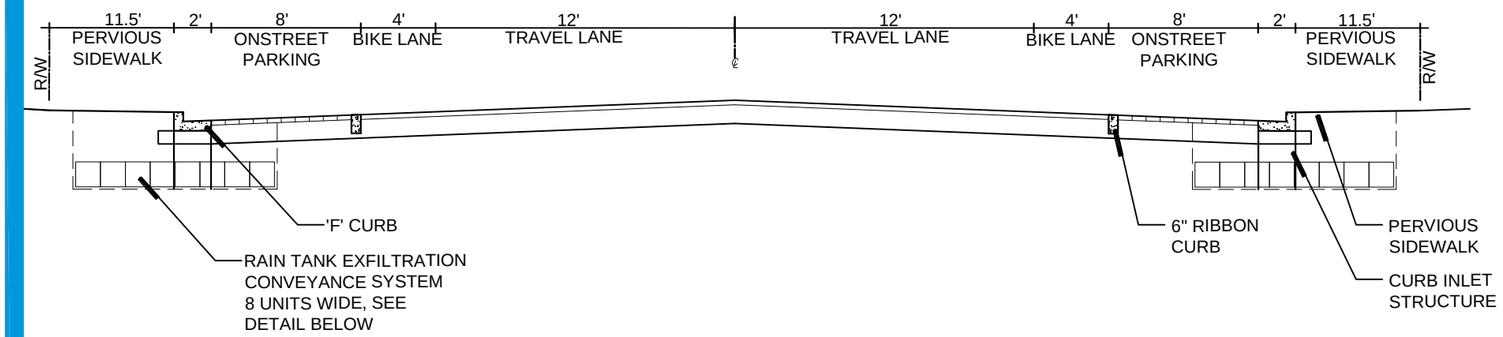
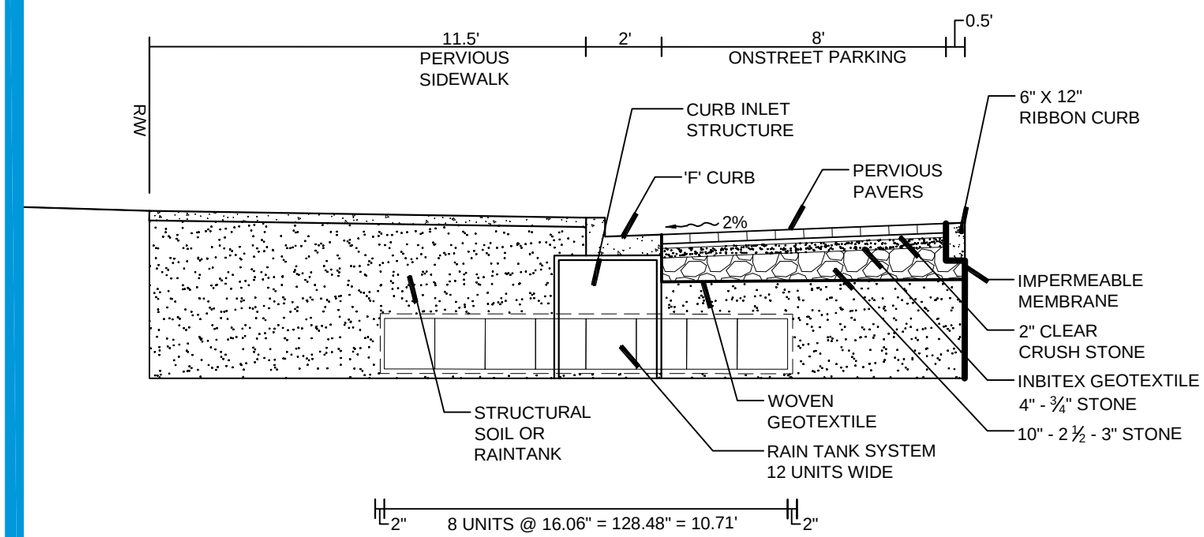


ATLANTIC AVE.SECTION A-A

1ST ST. SOUTH TO 1ST. NORTH (75' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:	**2 BLOCKS X 600 LF/BLOCK = 1,200 LF ROAD** **1,200 LF / 2.25 LF/UNIT = 533 UNITS ALONG ROAD** **533 UNITS X 8 WIDE X 2 SIDES = 8,528 UNITS** **8,528 UNITS X 4.22 CF/UNIT = 35,988 CF**
PERVIOUS PAVERS PARKING:	**10 PARKING SP. PER BLOCK PER SIDE OF ROAD** **0.47 CF STORAGE PER SF PERVIOUS PAVERS** **2 BLOCKS** **= 2 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')** **= 6,000 SF X 0.47 CF/SF** **= 2,820 CF STORAGE**
ALLEYWAY PERVIOUS PAVERS:	**= 12,700 SF X 0.47 CF/SF** **= 5,969 CF STORAGE**
SUMMARY:	**PERVIOUS PAVER PARKING = 2,820 CF** **ALLEYWAY PERVIOUS PAVERS = 5,969 CF** **RAINTANK SYSTEM = 35,988 CF** **TOTAL = 44,777 CF**

TREATMENT VOLUME CALCULATIONS

Treatment Area: 11

Area Description: Area consists of the Downtown Core District between 1st St. South and 1st St. Nort along A1A. Treatment facilities are proposed to occur within the A1A and the Minuteman beach access rights-of-way via pervious pavers and exfiltration systems. Redevelopment would not be expected to meet the TMDL nutrient reduction requirements.

Proposed Land Use:	Downtown Core	
Major Soil Hydrological Group:	A	
CRA Area Acreage	5.293	acres
FDOT Area Acreage	2.627	acres
Total Area Acreage	7.920	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	73	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.43	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	5.293	acres x	10.10	lbs/ac	=	**53.46**	**lbs**
TP FDOT:	2.627	acres x	9.69	lbs/ac	=	**25.46**	**lbs**
TP Total:					=	**78.91**	**lbs**
TN CRA:	5.293	acres x	2.036	lbs/ac	=	**10.78**	**lbs**
TN FDOT:	2.627	acres x	2.788	lbs/ac	=	**7.32**	**lbs**
TN Total:					=	**18.10**	**lbs**

ALLOWABLE LOADING:

TP CRA:	5.293	acres x	2.32	lbs/ac	=	**12.28**	**lbs**
TP FDOT:	2.627	acres x	2.32	lbs/ac	=	**6.09**	**lbs**
TP Total:					=	**18.37**	**lbs**
TN CRA:	5.293	acres x	0.344	lbs/ac	=	**1.82**	**lbs**
TN FDOT:	2.627	acres x	0.344	lbs/ac	=	**0.90**	**lbs**
TN Total:					=	**2.72**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**41.18**	**lbs**
TP FDOT:	**19.36**	**lbs**
TP Total:	**60.54**	**lbs**
TN CRA:	**8.96**	**lbs**
TN FDOT:	**6.42**	**lbs**
TN Total:	**15.38**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	44777	Cubic-Feet	
Area Treated:	8.63	Acres	
TP Load Reduction:	**73.14**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated
TN Load Reduction:	**16.61**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated

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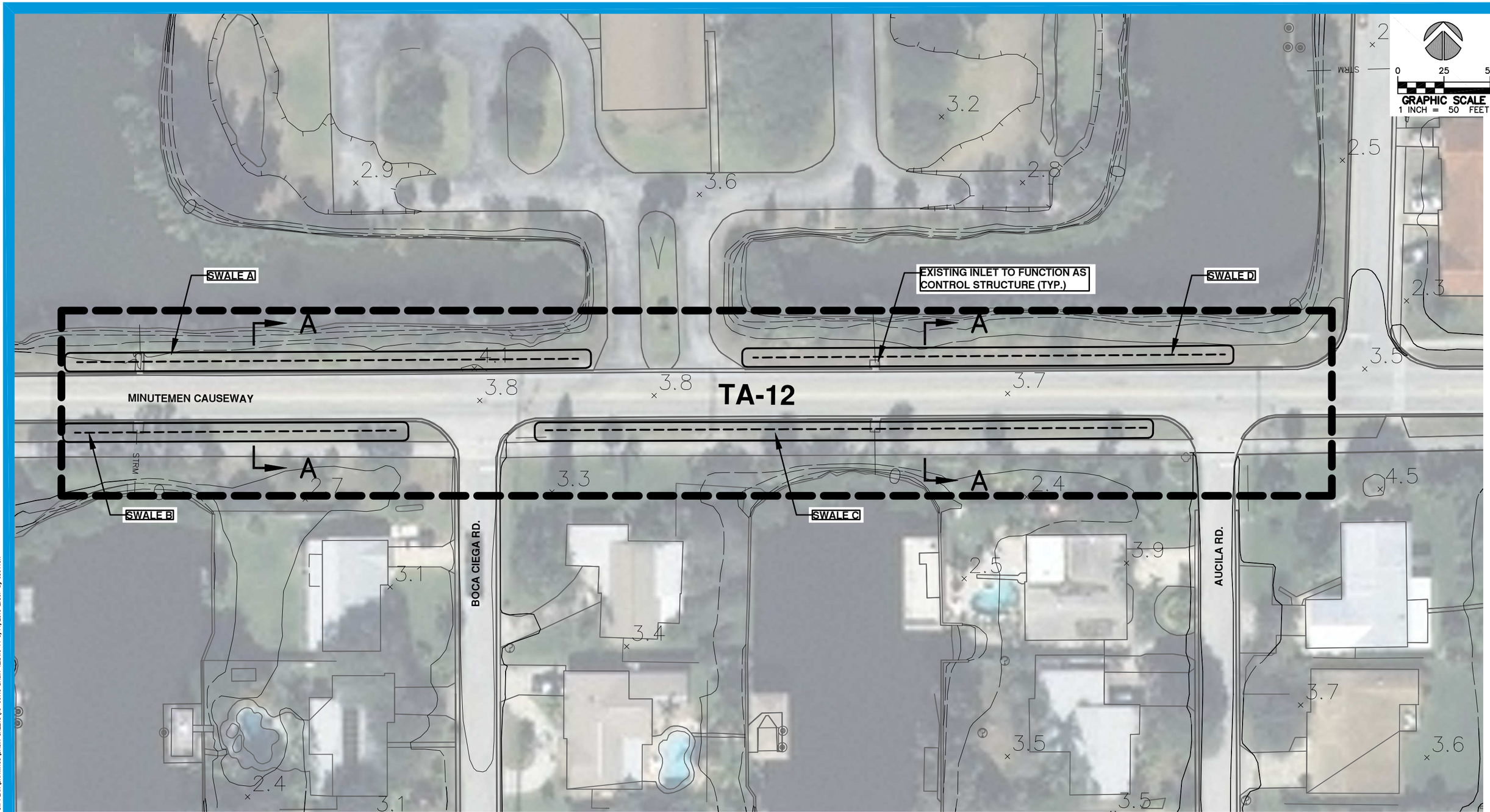
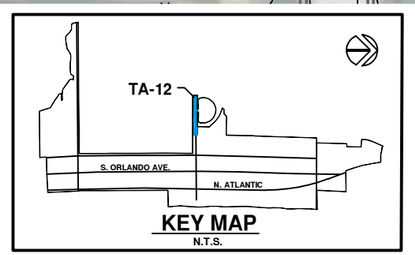


PLAN VIEW



KEY MAP
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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 12

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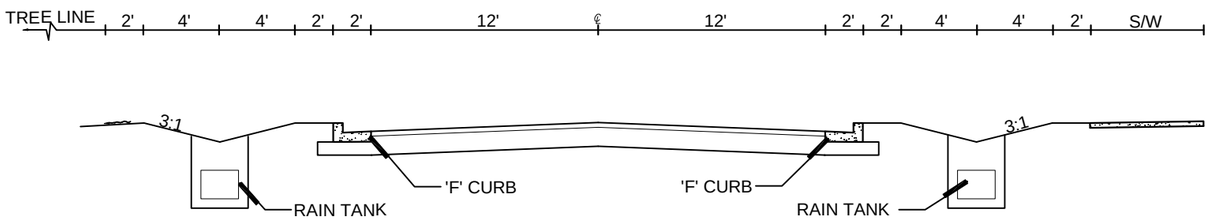
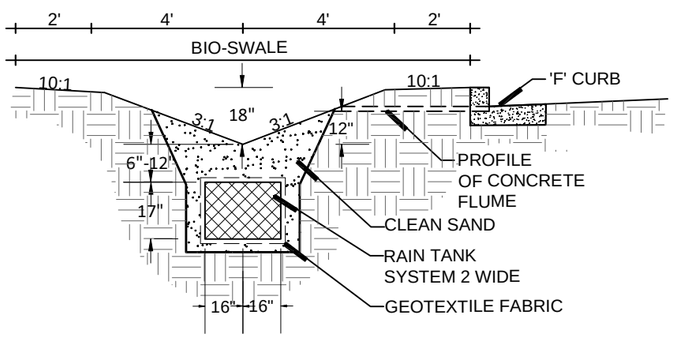


MINUTEMAN CAUSEWAY SECTION A-A



6.75 CF / LF STORAGE = > 3 CF / LF IN SWALE PLUS 3.75 CF / LF IN RAINTANK

TYPICAL BIO-SWALE W/ EXFILTRATION SYSTEM

TREATMENT VOLUME TABLE				
SWALE I.D.	SWALE LENGTH (FT)	SWALE VOL. (CF)	RAW TANK VOL. (CF)	TOTAL VOL. (CF)
A	275	825	1031	1856
B	195	585	731	1316
C	350	1050	1312	2362
D	260	780	975	1755
TOTAL	1080	3240	4049	7289

Treatment Area: 12

Area Description: Area consist of approximately 700 feet of road right-of-way. Road is two lane, 24-fee in width with miami curb and closed drainage system which outfalls to the adjacent canals. Treatment proposed consist of roadside swales with exfiltration system to provide water quality prior to discharge into the adjacent canals via the existing storm sewer system.

Proposed Land Use:	Right-of-Way	
Major Soil Hydrological Group:	C	
CRA Area Acreage	1.298	acres
FDOT Area Acreage	0	acres
Total Area Acreage	1.298	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	90	CN
Type of Best Management Practice Proposed:	Swales w/ Exfiltration System	
Required Treatment Volume:	1.49	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	1.298	acres	x	10.10	lbs/ac	=	**13.11**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**13.11**	**lbs**
TN CRA:	1.298	acres	x	2.036	lbs/ac	=	**2.64**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**2.64**	**lbs**

ALLOWABLE LOADING:

TP CRA:	1.298	acres	x	2.32	lbs/ac	=	**3.01**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**3.01**	**lbs**
TN CRA:	1.298	acres	x	0.344	lbs/ac	=	**0.45**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**0.45**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**10.10**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**10.10**	**lbs**
TN CRA:	**2.20**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**2.20**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	7289	Cubic-Feet
Area Treated:	1.35	Acres

TP Load Reduction:	**11.57**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**2.33**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 12

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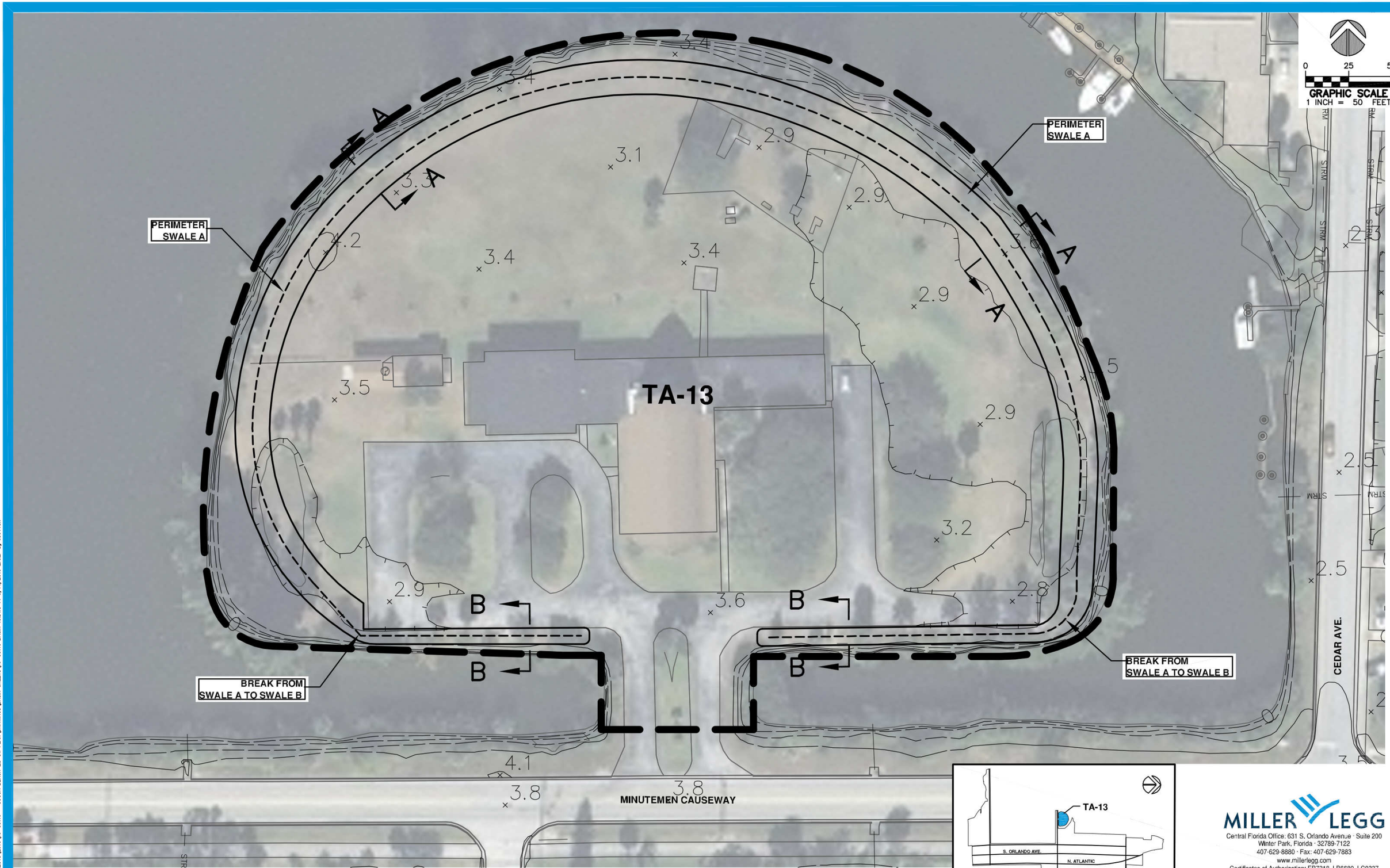
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 13



PLAN VIEW

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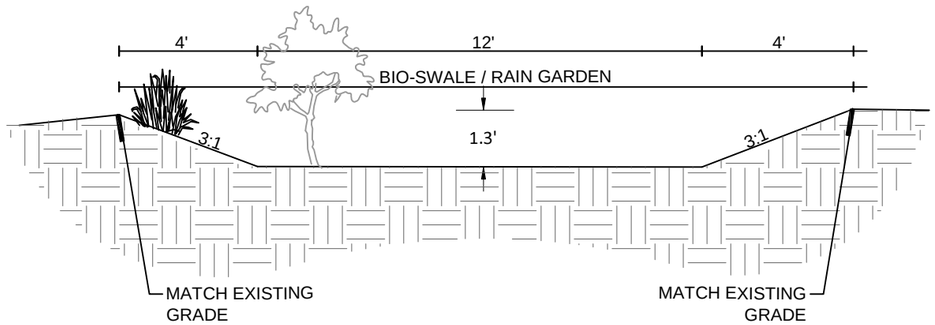
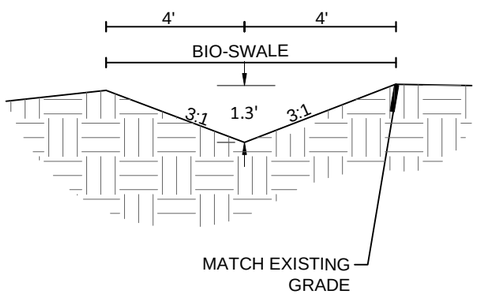


21.2 CF / LF STORAGE

TYPICAL BIO-SWALE SECTION A-A



4.0 CF / LF STORAGE

TYPICAL BIO-SWALE SECTION B-B

TREATMENT VOLUME TABLE		
SWALE I.D.	SWALE LENGTH (FT)	SWALE VOL. (CF)
A	900	19080
B	300	1200
TOTAL	1200	20280

Treatment Area: 13

Area Description: Area is a developed church site on an island parcel. No existing stormwater system is present. Treatment consists of working with the property owner to construct a perimeter swale and/or detention system around the island to treatment runoff prior to overflow into the surround canal.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	C	
CRA Area Acreage	3.8	acres
FDOT Area Acreage	0	acres
Total Area Acreage	3.8	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	89	CN
Type of Best Management Practice Proposed:	Swales	
Required Treatment Volume:	1.48	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.8	acres	x	10.10	lbs/ac	=	**38.38**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**38.38**	**lbs**
TN CRA:	3.8	acres	x	2.036	lbs/ac	=	**7.74**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**7.74**	**lbs**

ALLOWABLE LOADING:

TP CRA:	3.8	acres	x	2.32	lbs/ac	=	**8.82**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**8.82**	**lbs**
TN CRA:	3.8	acres	x	0.344	lbs/ac	=	**1.31**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.31**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**29.56**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**29.56**	**lbs**
TN CRA:	**6.43**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**6.43**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	20280	Cubic-Feet
Area Treated:	3.77	Acres

TP Load Reduction:	**32.41**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**6.53**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 13

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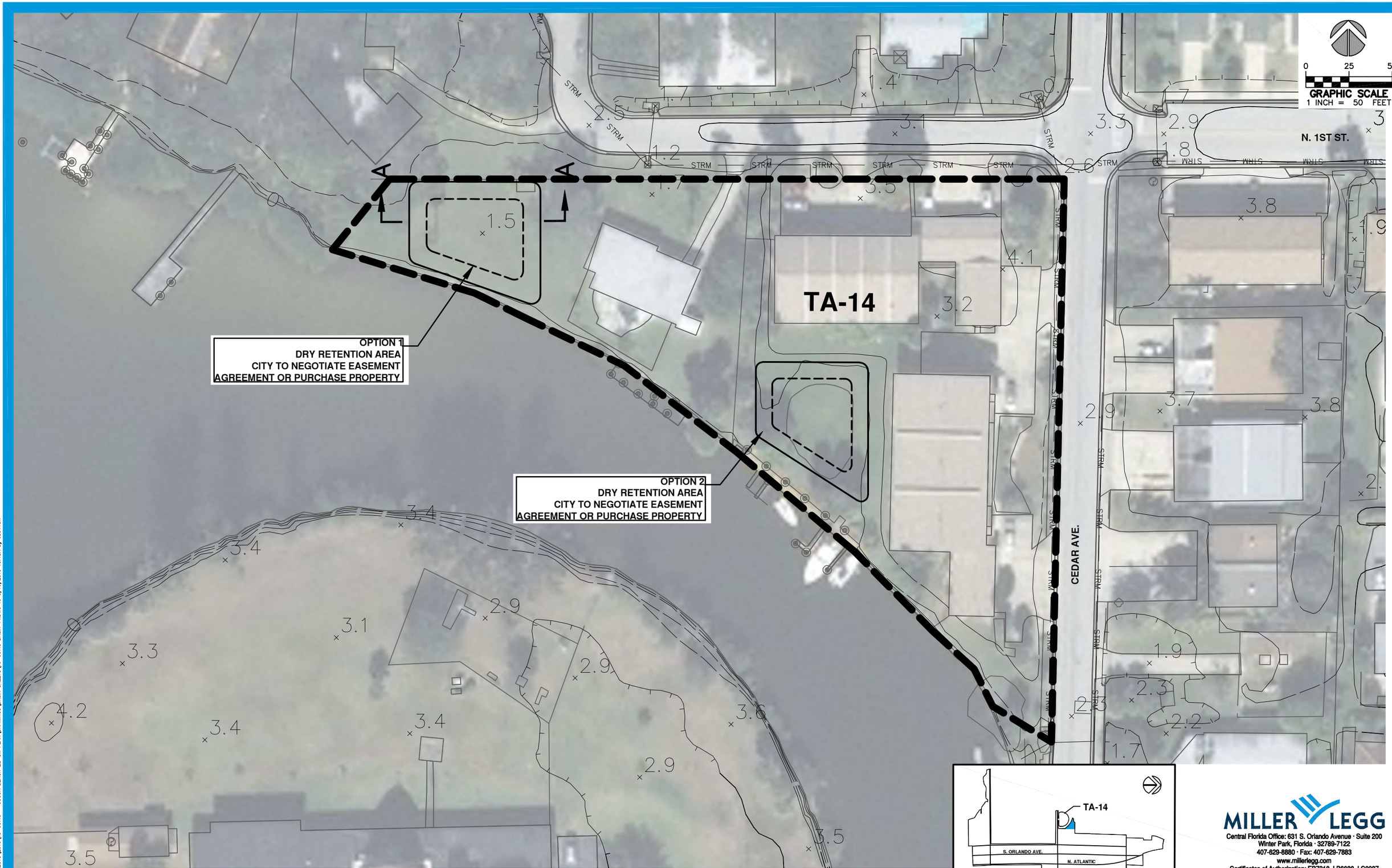
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 14



PLAN VIEW

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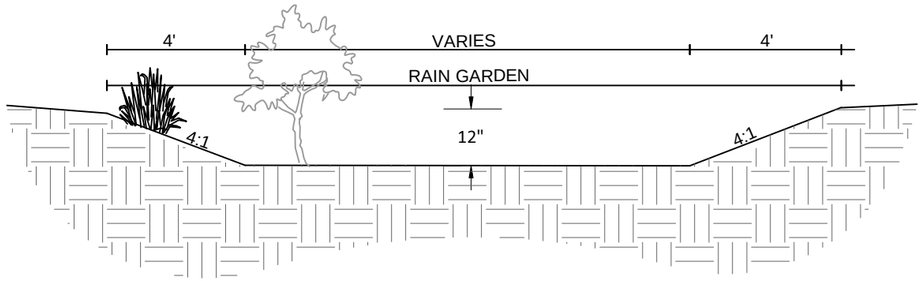

SECTION A-A

TREATMENT VOLUME TABLE		
DRY DETENTION AREA (SF)	DRY DETENTION DEPTH (FT)	DRY DETENTION VOLUME (CF)
3000	1.0	3000

Treatment Area: 14

Area Description: Area consists of 3 private parcels without stormwater systems. Treatment propose to construct a dry detention system within the yard of a private residence. City would need to negotiat easement agreement with property owner and install minimum drainage infrastructure to route runofl into system.

Proposed Land Use:	Cottage Row Res.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	1.263	acres
FDOT Area Acreage	0	acres
Total Area Acreage	1.263	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	80	CN
Type of Best Management Practice Proposed:	Dry Retention Ponds	
Required Treatment Volume:	1.15	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	1.263	acres	x	10.10	lbs/ac	=	**12.76**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**12.76**	**lbs**
TN CRA:	1.263	acres	x	2.036	lbs/ac	=	**2.57**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**2.57**	**lbs**

ALLOWABLE LOADING:

TP CRA:	1.263	acres	x	2.32	lbs/ac	=	**2.93**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**2.93**	**lbs**
TN CRA:	1.263	acres	x	0.344	lbs/ac	=	**0.43**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**0.43**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**9.83**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**9.83**	**lbs**
TN CRA:	**2.14**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**2.14**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	3000	Cubic-Feet
Area Treated:	0.72	Acres

TP Load Reduction:	**6.17**	**lbs**	(Assumes 100% of the FDOT right-of-way is treate
TN Load Reduction:	**1.24**	**lbs**	(Assumes 100% of the FDOT right-of-way is treate

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 14

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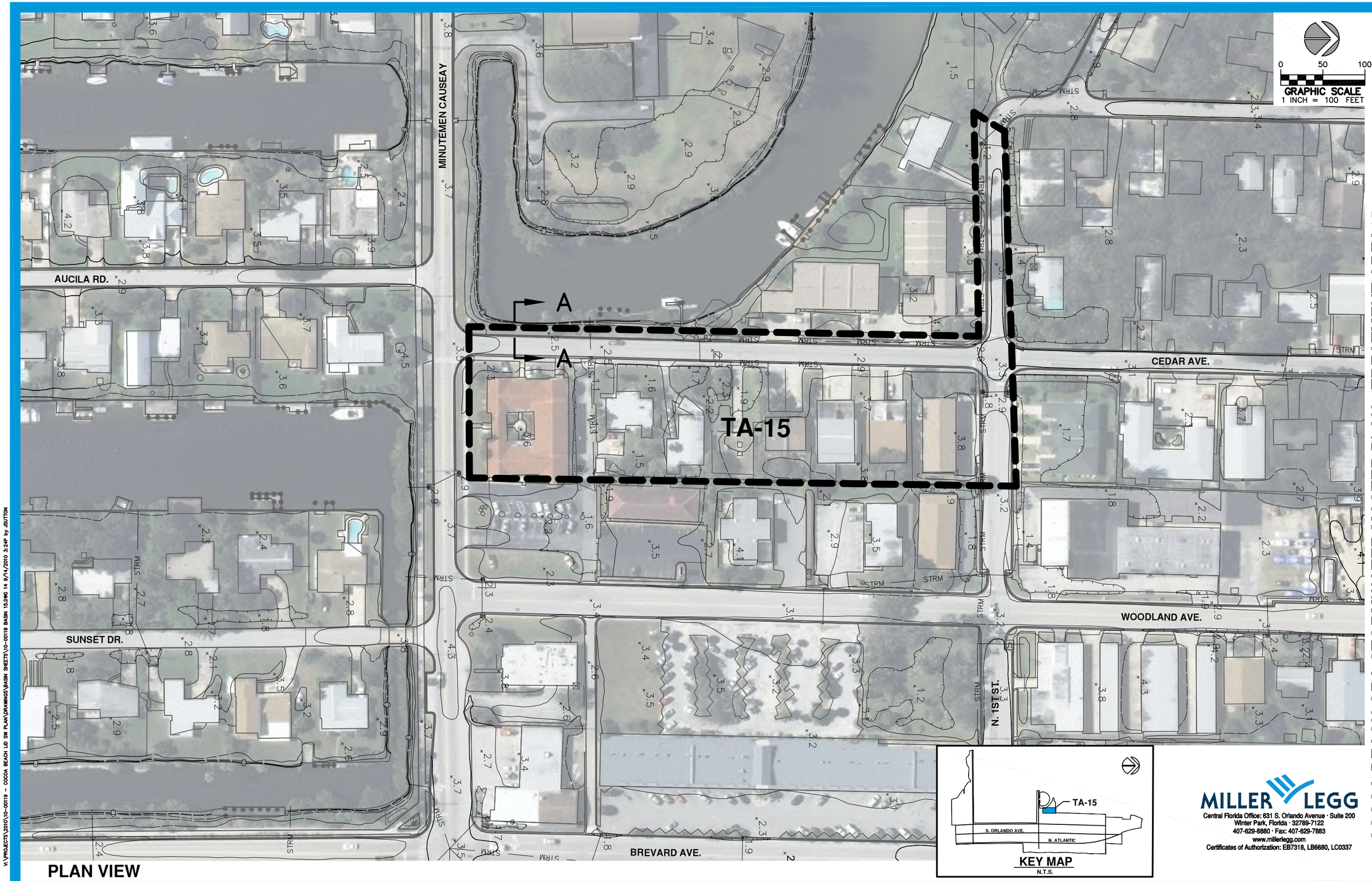
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA15



PLAN VIEW

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NO IMPROVEMENTS PROPOSED

Treatment Area: 15

Area Description: Area consists of a mixture of commercial and single family residential land uses. Area is proposed to contain the Artisan District land use. Due to the limited availabilty of right-of-way and the high groud water table within the area, no treatment facilities are proposed for this area.

Proposed Land Use:	Artisan District	
Major Soil Hydrological Group:	C	
CRA Area Acreage	3.026	acres
FDOT Area Acreage	0	acres
Total Area Acreage	3.026	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	84	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.26	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.026	acres	x	10.10	lbs/ac	=	**30.56**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**30.56**	**lbs**
TN CRA:	3.026	acres	x	2.036	lbs/ac	=	**6.16**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**6.16**	**lbs**

ALLOWABLE LOADING:

TP CRA:	3.026	acres	x	2.32	lbs/ac	=	**7.02**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**7.02**	**lbs**
TN CRA:	3.026	acres	x	0.344	lbs/ac	=	**1.04**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.04**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**23.54**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**23.54**	**lbs**
TN CRA:	**5.12**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**5.12**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet
Area Treated:	0.00	Acres

TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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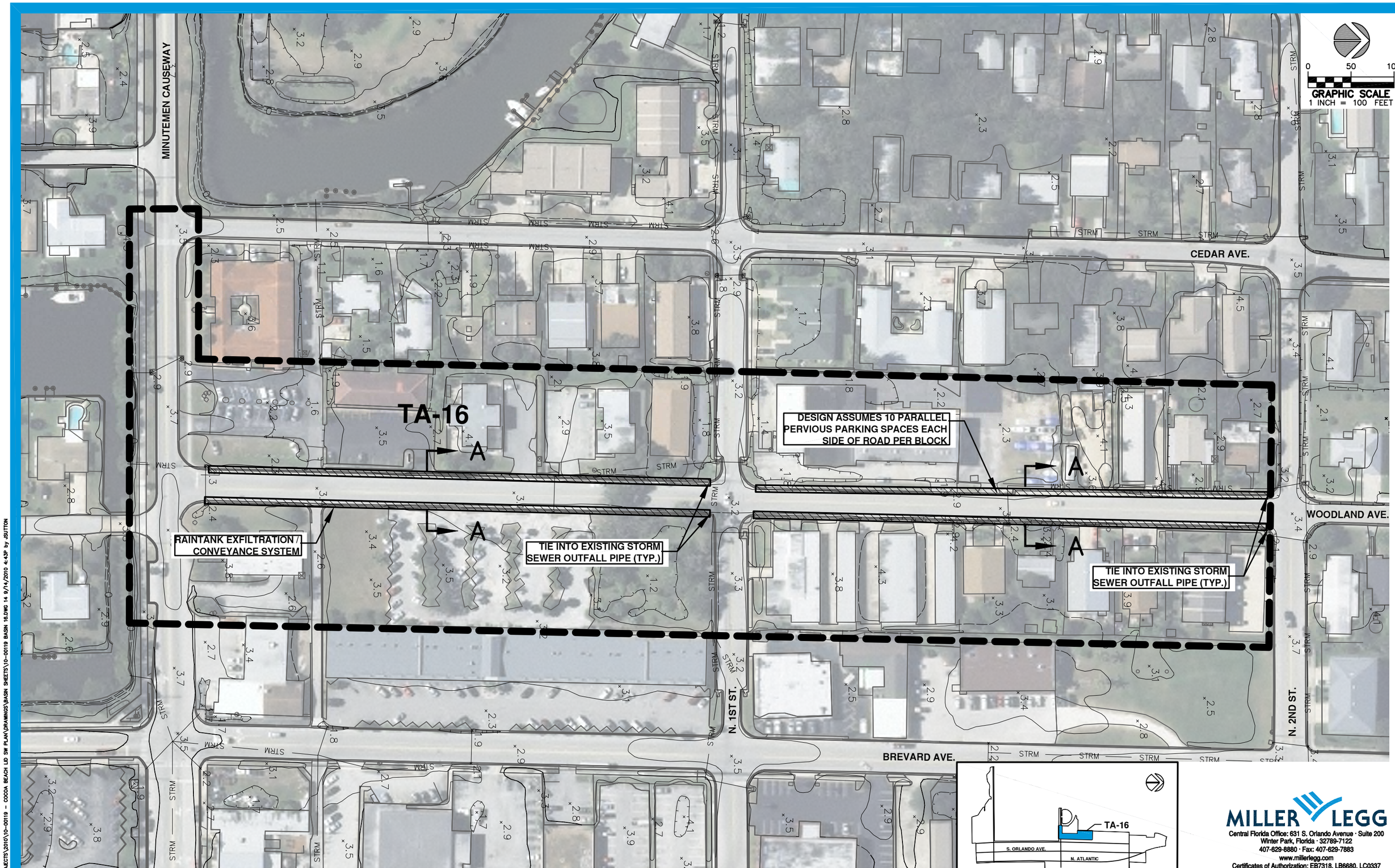
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 16



PLAN VIEW

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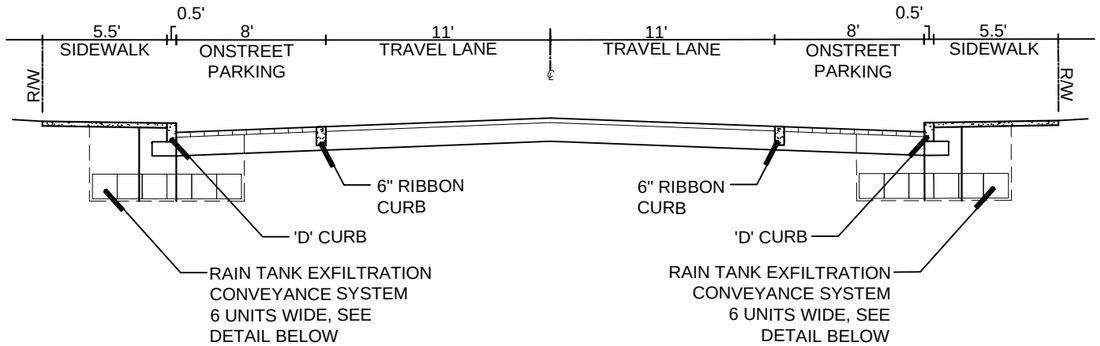
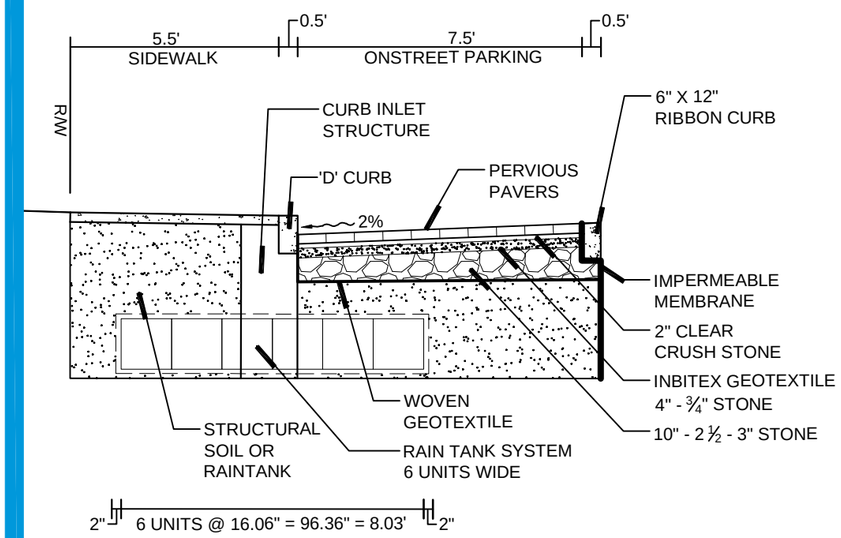


WOODLAND AVENUE SECTION A-A

MINUTEMAN CAUSEWAY TO 2ND ST NORTH (50' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:	**2 BLOCKS X 600 LF/BLOCK = 1,200 LF ROAD** **1,200 LF / 2.25 LF/UNIT = 533 UNITS ALONG ROAD** **533 UNITS X 6 WIDE X 2 SIDES = 6,396 UNITS** **6,396 UNITS X 4.22 CF/UNIT = 26,911 CF**
PERVIOUS PAVERS PARKING:	**10 PARKING SP. PER BLOCK PER SIDE OF ROAD** **0.47 CF STORAGE PER SF PERVIOUS PAVERS** **2 BLOCKS** **= 2 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')** **= 6,000 SF X 0.47 CF/SF** **= 2,820 CF STORAGE**
SUMMARY:	**PERVIOUS PAVER PARKING = 2,820 CF** **RAINTANK SYSTEM = 26,911 CF** **TOTAL = 29,811 CF**

TREATMENT VOLUME CALCULATIONS

Treatment Area: **16**

Area Description: Area is fully developed with a mixture of single family and commercial properties. Area is propsoed to contain the Artisan District land use. Proposed treatment facilities will consist of exfiltration and pervious paver systems located within the Woodland Ave. right-of-way.

Proposed Land Use:	Artisan District	
Major Soil Hydrological Group:	A	
CRA Area Acreage	9.55	acres
FDOT Area Acreage	0	acres
Total Area Acreage	9.55	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	64	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	0.75	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	9.55	acres	x	10.10	lbs/ac	=	**96.46**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**96.46**	**lbs**
TN CRA:	9.55	acres	x	2.036	lbs/ac	=	**19.44**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**19.44**	**lbs**

ALLOWABLE LOADING:

TP CRA:	9.55	acres	x	2.32	lbs/ac	=	**22.16**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**22.16**	**lbs**
TN CRA:	9.55	acres	x	0.344	lbs/ac	=	**3.29**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.29**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**74.30**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**74.30**	**lbs**
TN CRA:	**16.16**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**16.16**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	29811	Cubic-Feet	
Area Treated:	10.95	Acres	
TP Load Reduction:	**94.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**18.95**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 16

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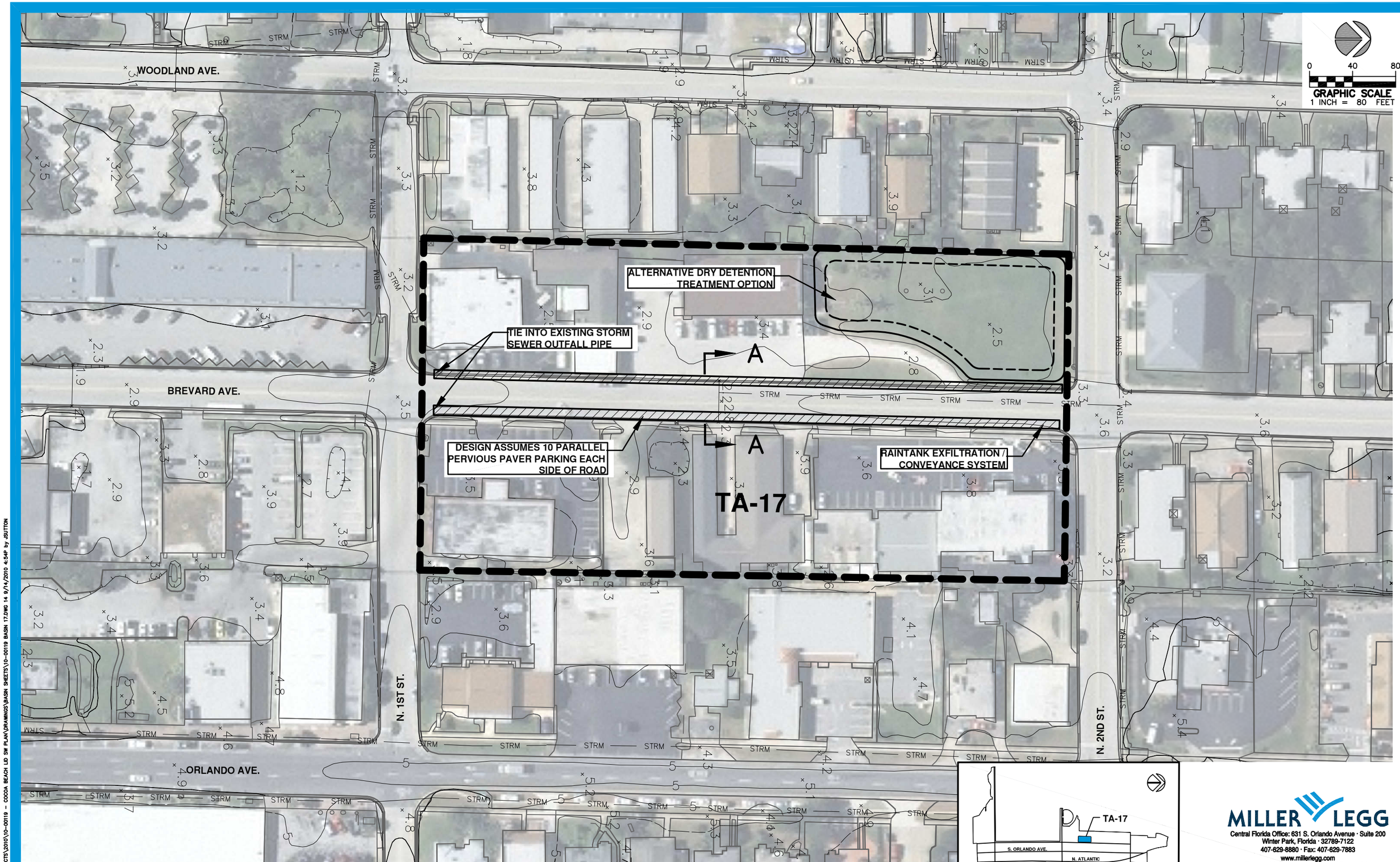
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 17



PLAN VIEW

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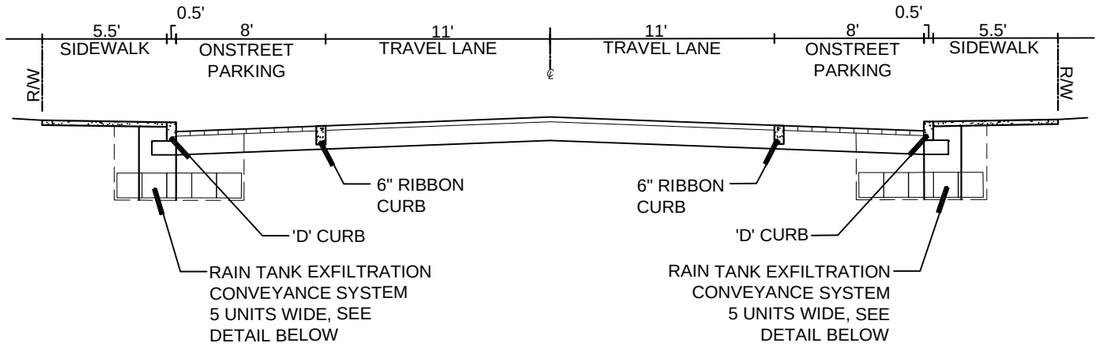
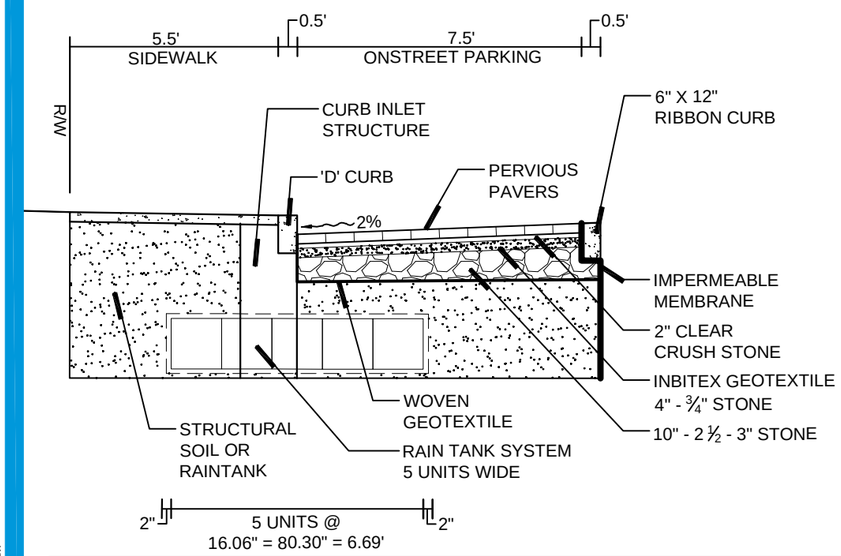


BREVARD AVE.SECTION A-A

1ST ST NORTH TO 2ND ST NORTH (50' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:

1 BLOCK X 600 LF/BLOCK = 600 LF ROAD
600 LF / 2.25 LF/UNIT = 266 UNITS ALONG ROAD
566 UNITS X 5 WIDE X 2 SIDES = 2,660 UNITS
2,660 UNITS X 4.22 CF/UNIT = 11,225 CF

PERVIOUS PAVERS PARKING:

10 PARKING SP. PER BLOCK PER SIDE OF ROAD
0.47 CF STORAGE PER SF PERVIOUS PAVERS
1 BLOCK
= 1 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')
= 3,000 SF X 0.47 CF/SF
= 1,410 CF STORAGE

SUMMARY:

PERVIOUS PAVER PARKING = 1,410 CF
RAINTANK SYSTEM = 11,225 CF
TOTAL = 12,635 CF

ALTERNATE DRY RETENTION ON UNDEVELOPED LOT:

24,000 SF DRY RETENTION AREA AT 1.5 FEET DEEP.
TREATMENT STORAGE PROVIDES 36,000 CF STORAGE.
WOULD ALLOW REDUCTION OF 8,530 EXFILTRATION UNITS.

TREATMENT VOLUME CALCULATIONS

Treatment Area: **17**

Area Description: Area is fully developed with commercial land uses and contains a large vacant parcel. Area is propsoed to contain the Artisan District land use. Proposed treatment facilities will consist of exfiltration and pervious paver systems located within the Brevard Ave. right-of-way. Option exists to utilize undeveloped lands for dry retention facilities.

Proposed Land Use:	Artisan District	
Major Soil Hydrological Group:	A	
CRA Area Acreage	4.231	acres
FDOT Area Acreage	0	acres
Total Area Acreage	4.231	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	64	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	0.75	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	4.231	acres	x	10.10	lbs/ac	=	**42.73**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**42.73**	**lbs**
TN CRA:	4.231	acres	x	2.036	lbs/ac	=	**8.61**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**8.61**	**lbs**

ALLOWABLE LOADING:

TP CRA:	4.231	acres	x	2.32	lbs/ac	=	**9.82**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**9.82**	**lbs**
TN CRA:	4.231	acres	x	0.344	lbs/ac	=	**1.46**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.46**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**32.92**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**32.92**	**lbs**
TN CRA:	**7.16**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**7.16**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	12635	Cubic-Feet
Area Treated:	4.64	Acres

TP Load Reduction:	**39.84**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**8.03**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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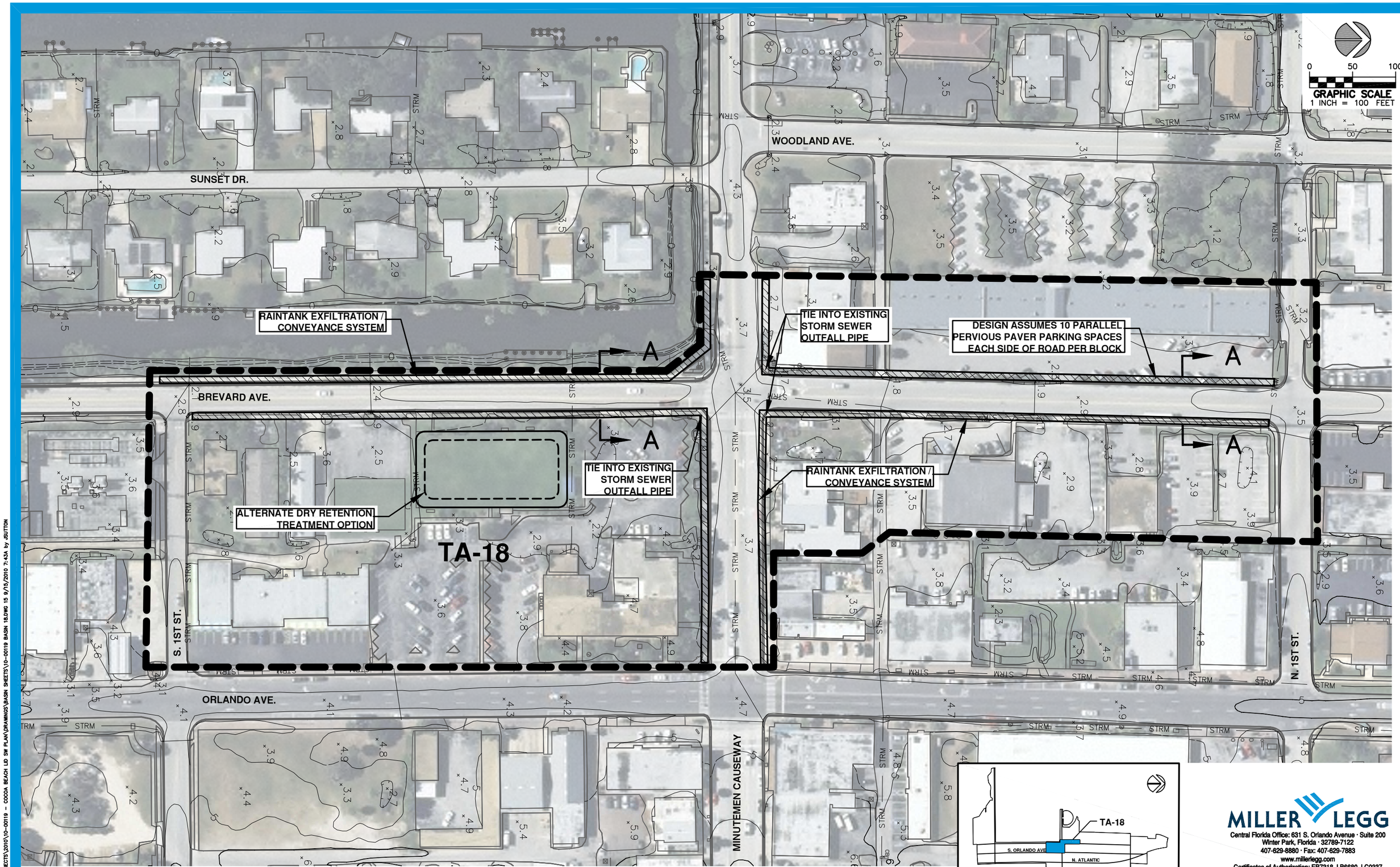
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 18



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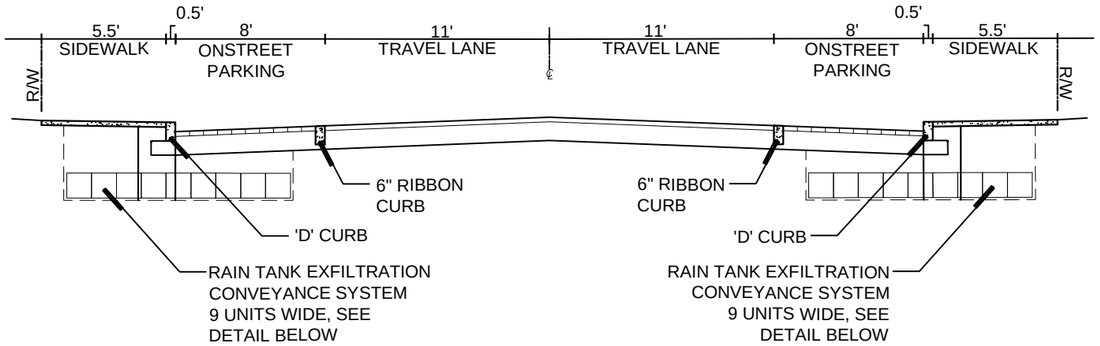
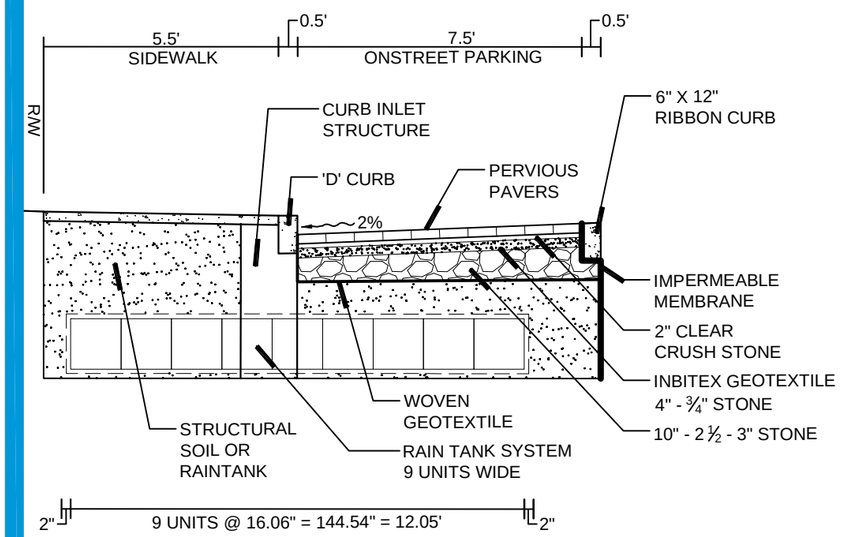


BREVARD AVE.SECTION A-A

1ST ST. SOUTH TO 1ST. NORTH (50' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:

2 BLOCK X 600 LF/BLOCK + 350 LF MINUTEMAN = 1,550 LF ROAD
1,550 LF / 2.25 LF/UNIT = 689 UNITS ALONG ROAD
689 UNITS X 9 WIDE X 2 SIDES = 12,402 UNITS
12,402 UNITS X 4.22 CF/UNIT = 52,336 CF

PERVIOUS PAVERS PARKING:

10 PARKING SP. PER BLOCK PER SIDE OF ROAD
0.47 CF STORAGE PER SF PERVIOUS PAVERS
2 BLOCKS
= 2 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')
= 6,000 SF X 0.47 CF/SF
= 2,820 CF STORAGE

SUMMARY:

PERVIOUS PAVER PARKING = 2,820 CF
RAINTANK SYSTEM = 52,336 CF
TOTAL = 55,156 CF

ALTERNATE DRY RETENTION ON UNDEVELOPED LOT:

17,500 SF DRY RETENTION AREA AT 1.5 FEET DEEP.
TREATMENT STORAGE PROVIDES 26,250 CF STORAGE.
WOULD ALLOW REDUCTION OF 6,220 EXFILTRATION UNITS.

TREATMENT VOLUME CALCULATIONS

Treatment Area: 18

Area Description: Area is fully developed with commercial land uses and contains a large vacant parcel. Area is propsoed to contain the Commercial Core District land use. Proposed treatment facilities will consist of exfiltration and pervious paver systems located within the Brevard Ave. right-of-way. Option exists to utilize undeveloped lands for dry retention facilities.

Proposed Land Use:	Downtown Core	
Major Soil Hydrological Group:	A	
CRA Area Acreage	10.434	acres
FDOT Area Acreage	0	acres
Total Area Acreage	10.434	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	73	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.43	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	10.434	acres	x	10.10	lbs/ac	=	**105.38**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**105.38**	**lbs**
TN CRA:	10.434	acres	x	2.036	lbs/ac	=	**21.24**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**21.24**	**lbs**

ALLOWABLE LOADING:

TP CRA:	10.434	acres	x	2.32	lbs/ac	=	**24.21**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**24.21**	**lbs**
TN CRA:	10.434	acres	x	0.344	lbs/ac	=	**3.59**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.59**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**81.18**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**81.18**	**lbs**
TN CRA:	**17.65**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**17.65**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	55156	Cubic-Feet	
Area Treated:	10.63	Acres	
TP Load Reduction:	**91.22**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**18.39**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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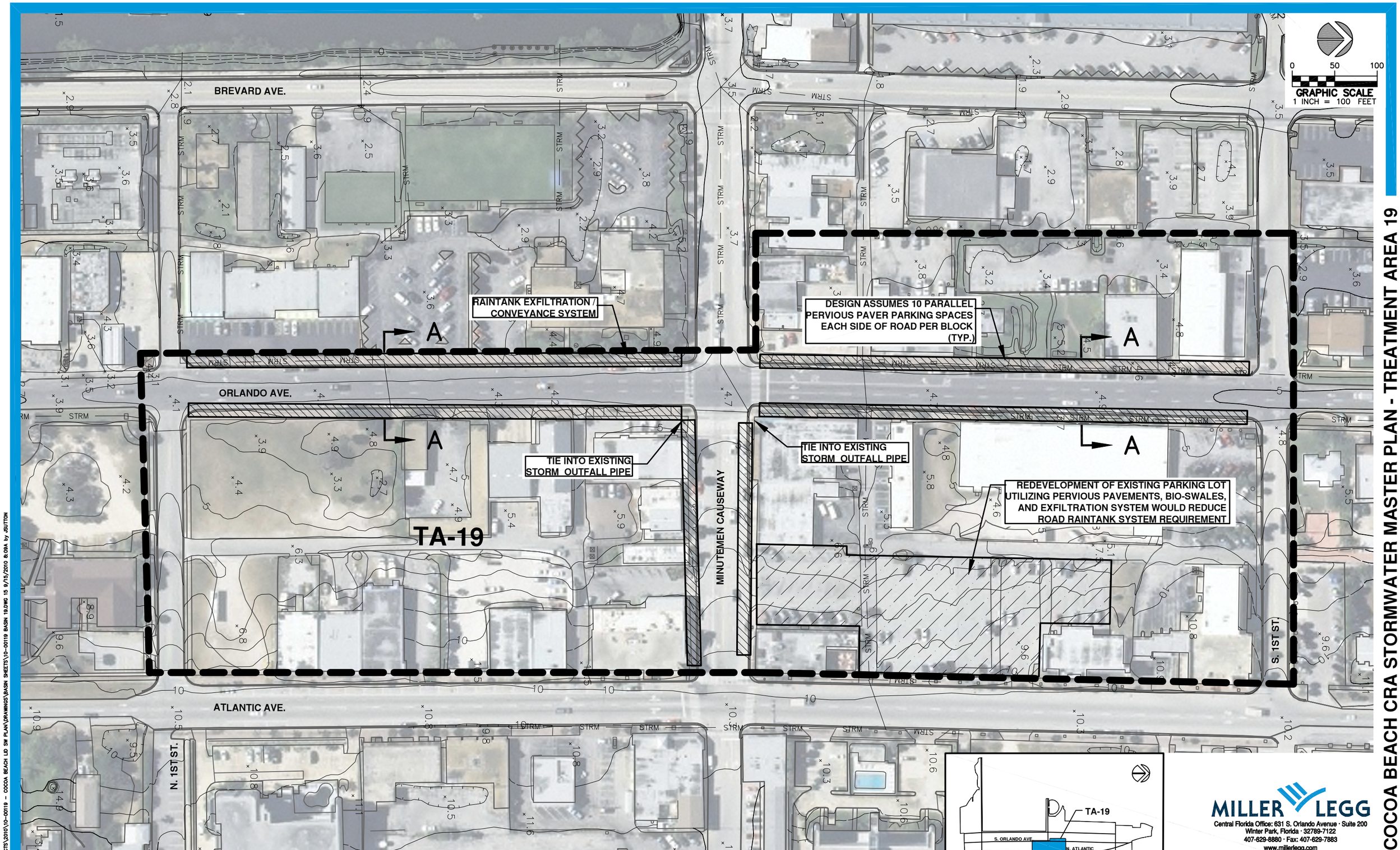

COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 19

PLAN VIEW

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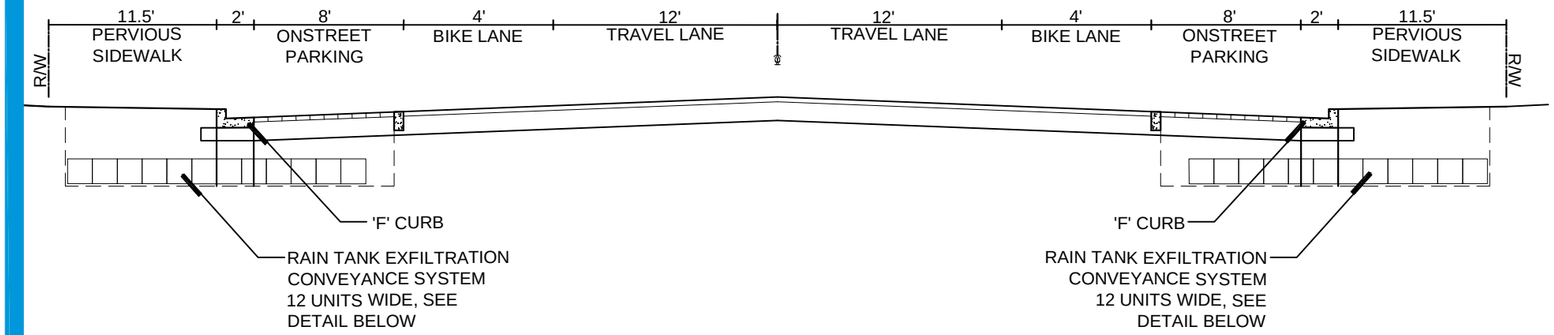
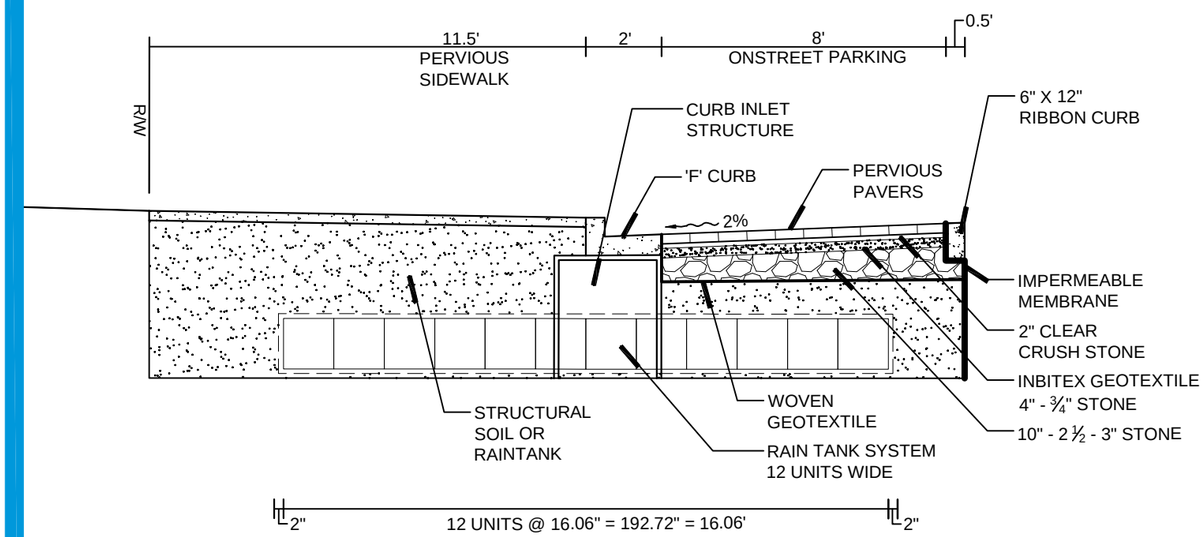


ORLANDO AVE.SECTION A-A

1ST ST. NORTH TO 1ST ST. SOUTH (75' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:

(2 BLOCKS X 600 LF/BLOCK) + 270 LF MINUTEMAN CAUSEWAY = 1,470 LF ROAD
1,470 LF / 2.25 LF/UNIT = 653 UNITS ALONG ROAD
653 UNITS X 12 WIDE X 2 SIDES = 15,672 UNITS
15,672 UNITS X 4.22 CF/UNIT = 66,136 CF

PERVIOUS PAVERS PARKING:

8 PARKING SPACES ON MINUTEMAN CAUSEWAY
10 PARKING SP. PER BLOCK PER SIDE OF ROAD
0.47 CF STORAGE PER SF PERVIOUS PAVERS
2 BLOCKS
= (2 BLOCKS X 10 SP X 2 SIDES + 8 MINUTEMAN SPACES) X (20' X 7.5')
= 7,200 SF X 0.47 CF/SF
= 3,384 CF STORAGE

SUMMARY:

PERVIOUS PAVER PARKING = 3,384 CF
RAINTANK SYSTEM = 66,136 CF
TOTAL = 69,520 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: **19**

Area Description: Area consists of the Downtown Core District between 1st St. South and 1st St. North along Orlando Ave. Treatment is proposed to occur witin the Orlando Ave. and Minuteman rights-of-way via pervious paver and exfiltration systems. Additional treatment opportunities exists associated with the redevelopment of the public parking area between A1A and Orlando Ave. north of Minuteman Causeway.

Proposed Land Use:	Downtown Core	
Major Soil Hydrological Group:	A	
CRA Area Acreage	11.332	acres
FDOT Area Acreage	2.211	acres
Total Area Acreage	13.543	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	73	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.43	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	11.332	acres	x	10.10	lbs/ac	=	**114.45**	**lbs**
TP FDOT:	2.211	acres	x	9.69	lbs/ac	=	**21.42**	**lbs**
TP Total:						=	**135.88**	**lbs**
TN CRA:	11.332	acres	x	2.036	lbs/ac	=	**23.07**	**lbs**
TN FDOT:	2.211	acres	x	2.788	lbs/ac	=	**6.16**	**lbs**
TN Total:						=	**29.24**	**lbs**

ALLOWABLE LOADING:

TP CRA:	11.332	acres	x	2.32	lbs/ac	=	**26.29**	**lbs**
TP FDOT:	2.211	acres	x	2.32	lbs/ac	=	**5.13**	**lbs**
TP Total:						=	**31.42**	**lbs**
TN CRA:	11.332	acres	x	0.344	lbs/ac	=	**3.90**	**lbs**
TN FDOT:	2.211	acres	x	0.344	lbs/ac	=	**0.76**	**lbs**
TN Total:						=	**4.66**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**88.16**	**lbs**
TP FDOT:	**16.30**	**lbs**
TP Total:	**104.46**	**lbs**
TN CRA:	**19.17**	**lbs**
TN FDOT:	**5.40**	**lbs**
TN Total:	**24.58**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	69520	Cubic-Feet
Area Treated:	13.39	Acres

TP Load Reduction:	**114.21**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**24.59**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 19

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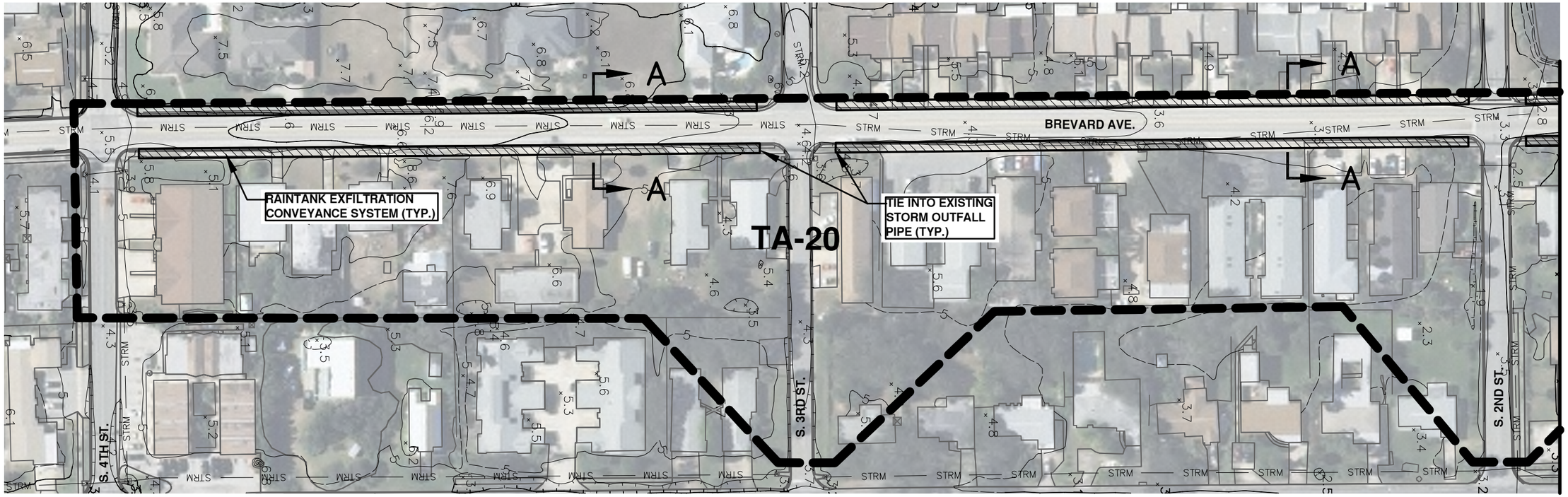
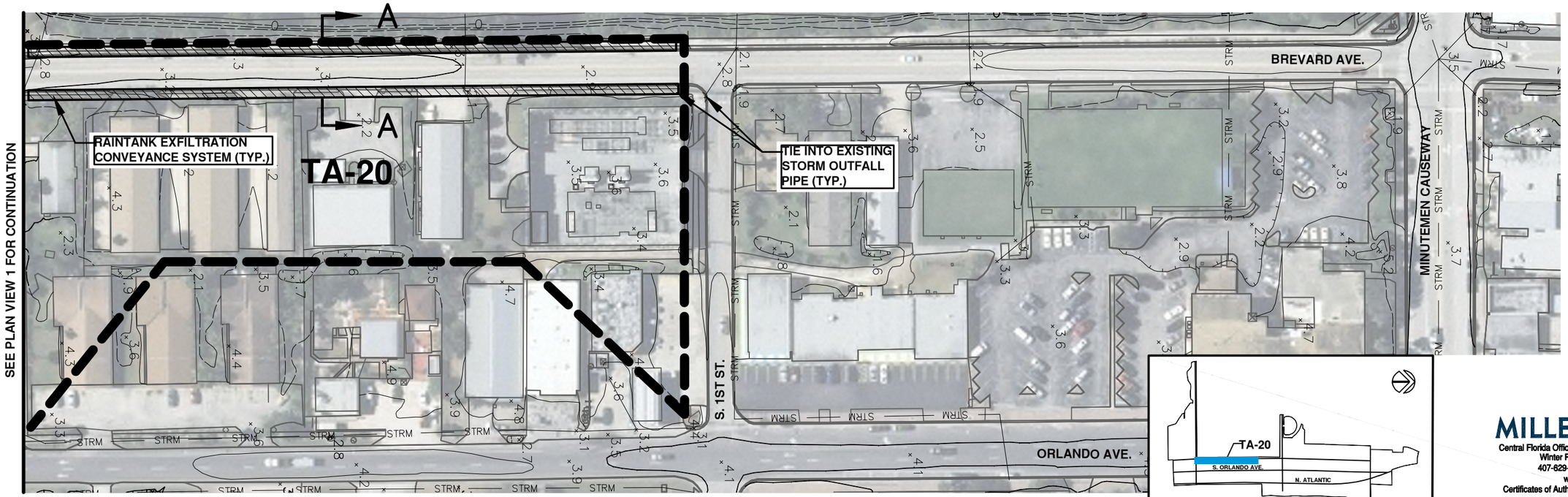


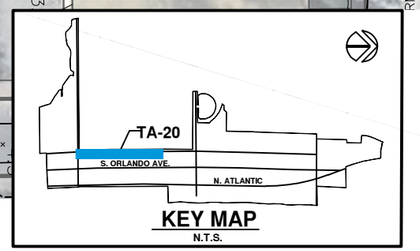
SEE PLAN VIEW 2 FOR CONTINUATION

0 50 100
GRAPHIC SCALE
1 INCH = 100 FEET

PLAN VIEW 1



SEE PLAN VIEW 1 FOR CONTINUATION



KEY MAP
N.T.S.

PLAN VIEW 2

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 20

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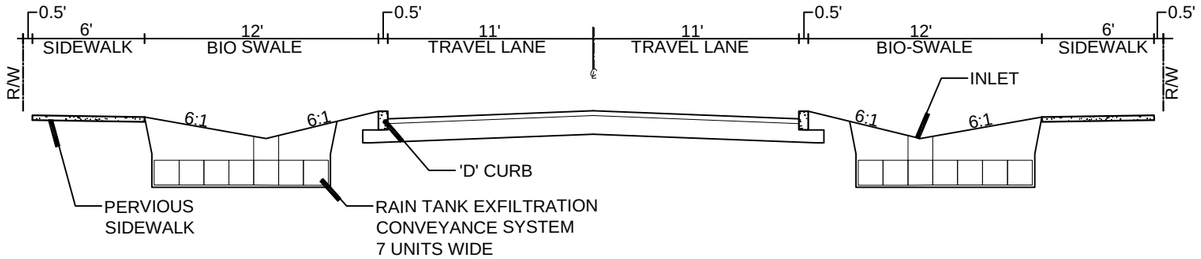
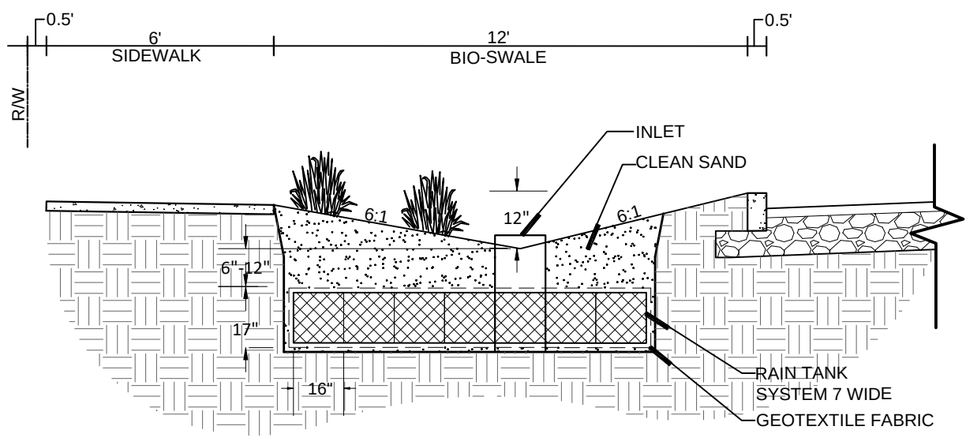


BREVARD TYPICAL SECTION A-A

4TH ST. SOUTH TO 1ST ST. SOUTH (60' R.O.W.)



TYPICAL BIO-SWALE W/ EXFILTRATION SYSTEM

RAINTANK EXFILTRATION SYSTEM = 3 BLOCKS X 600 LF/ BLOCK = 1800 LF ROAD
1800 LF / 2.25 LF / UNIT = 800 UNITS
800 UNITS X 7WIDE X 2 SIDES = 11,200 UNITS
11,200 UNITS X 4.22 CF / UNIT = 47,264 CF

TREATMENT STORAGE CALCULATION

Treatment Area: 20

Area Description: Area consists of the Cottage Row Residential land use east of Brevard between 4th St. South and 1st St. South. Treatment is proposed to be provided via exfiltration systems located within the Brevard Ave. right-of-way.

Proposed Land Use:	Cottage Row Res.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	11.004	acres
FDOT Area Acreage	0	acres
Total Area Acreage	11.004	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	80	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.15	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	11.004	acres	x	10.10	lbs/ac	=	**111.14**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**111.14**	**lbs**
TN CRA:	11.004	acres	x	2.036	lbs/ac	=	**22.40**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**22.40**	**lbs**

ALLOWABLE LOADING:

TP CRA:	11.004	acres	x	2.32	lbs/ac	=	**25.53**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**25.53**	**lbs**
TN CRA:	11.004	acres	x	0.344	lbs/ac	=	**3.79**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.79**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**85.61**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**85.61**	**lbs**
TN CRA:	**18.62**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**18.62**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	47264	Cubic-Feet
Area Treated:	11.32	Acres

TP Load Reduction:	**97.20**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**19.59**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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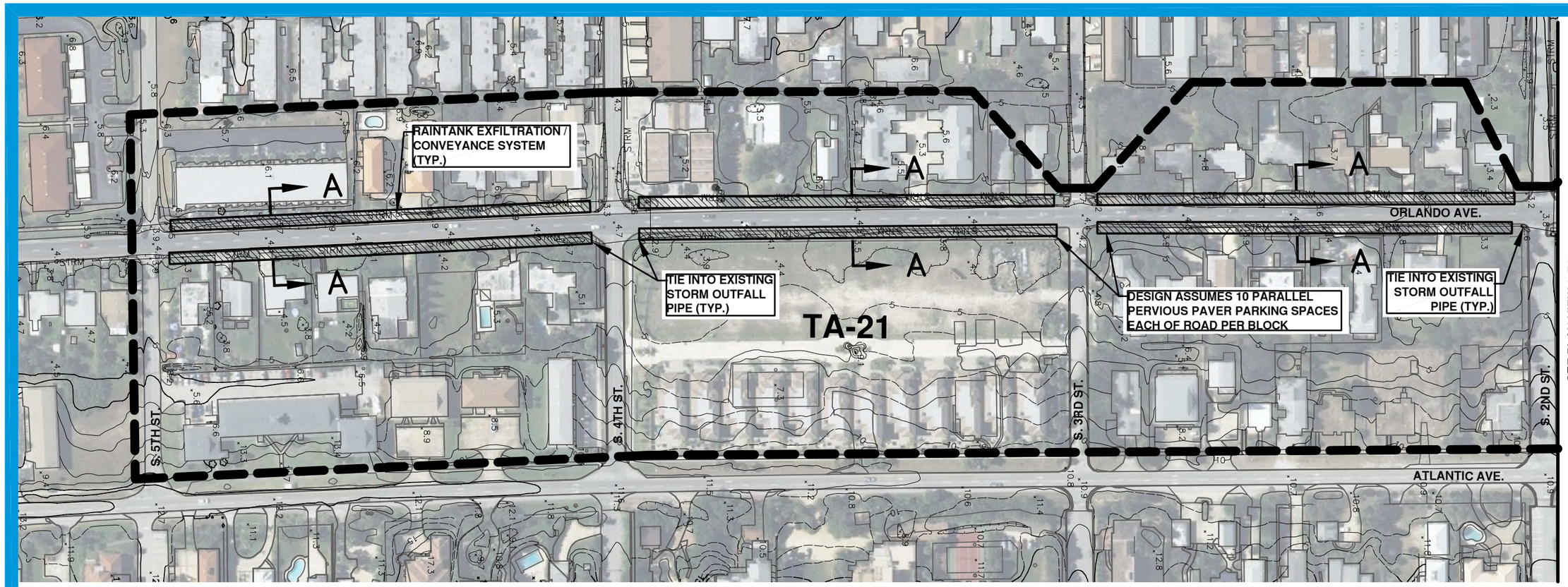
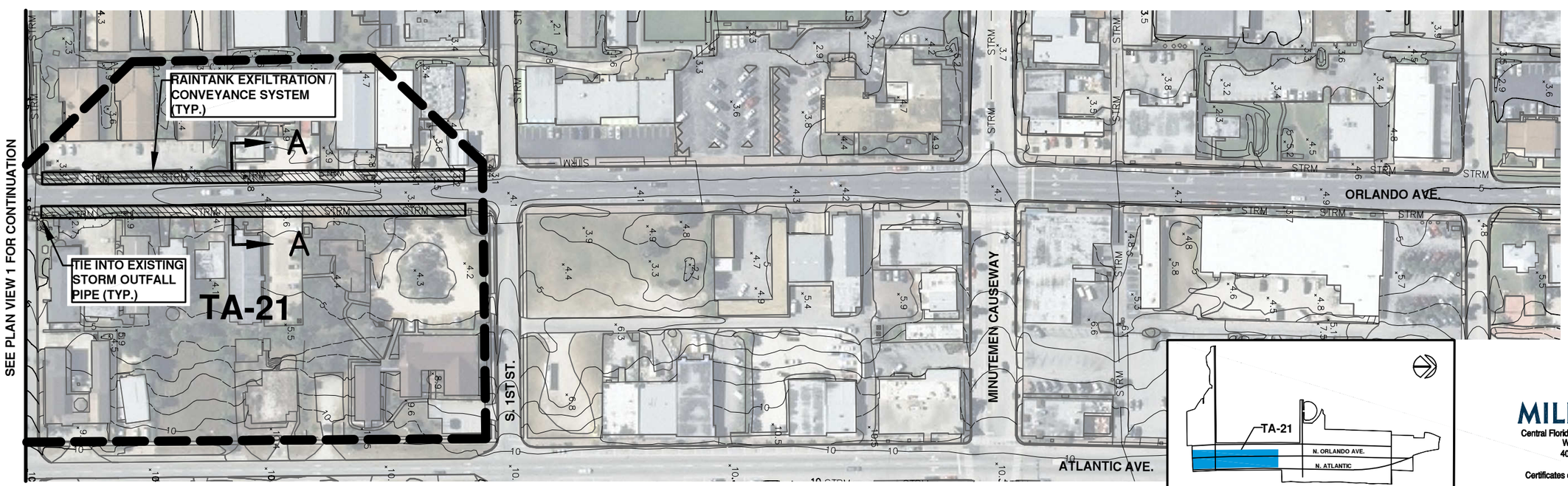
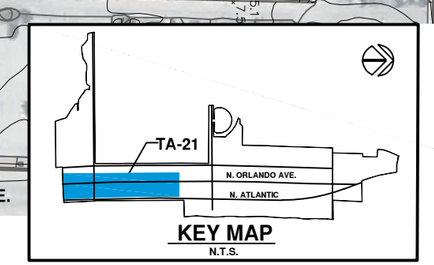


PLAN VIEW 1



PLAN VIEW 2



KEY MAP
N.T.S.

0 75 150
GRAPHIC SCALE
1 INCH = 150 FEET

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 21

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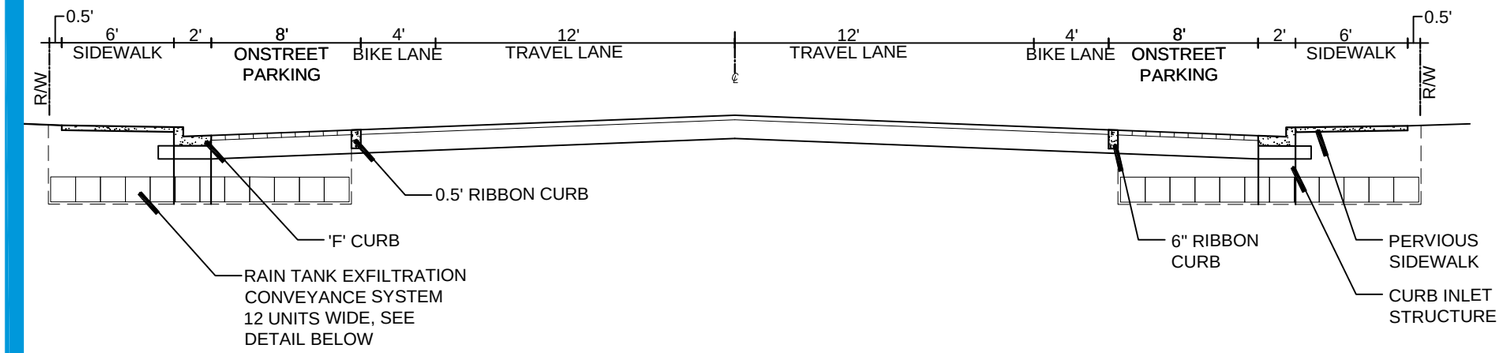
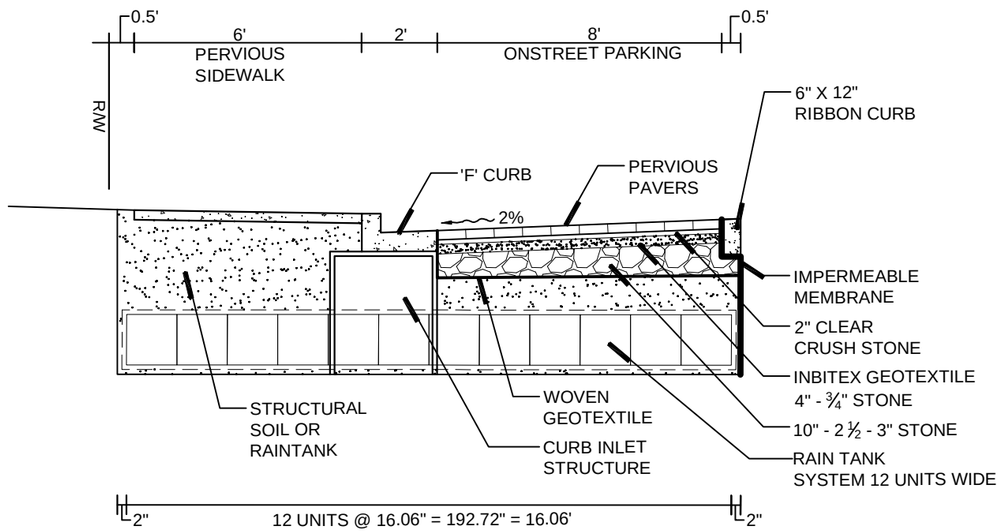


ORLANDO AVE.SECTION A-A

5TH ST. SOUTH TO 1ST. SOUTH (65' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

PERVIOUS PAVERS SYSTEM ASSUMPTIONS:
4 BLOCKS
10 PARKING SPACES PER BLOCK PER SIDE OF ROAD
0.47 CF STORAGE PER SF PERVIOUS PAVERS
= 4 BLOCKS X 10 SPACES X (20' X 7.5') X 2 SIDES
= 12,000 SF X 0.47 CF / SF
= 5,640 CF STORAGE

RAWTANK EXFILTRATION SYSTEM:
4 BLOCKS X 600 LF / BLOCK = LF ROAD
2,400 LF / 2.25 LF / UNIT = 1,067 UNITS
1,067 UNITS X 12 WIDE X 2 SIDES = 25,608 UNITS
25,608 UNITS X 4.22 CF / UNIT = 108,065 CF

THE ENCLAVE DEVELOPMENT:
4.13 ACRES
1.15" TREATMENT VOLUME REQUIRED
= (4.13 AC X 43,560 SF / AC) X (1.15" X 1 FT / 12 IN)
= 17, 240 CF STORAGE REQUIRED
32,754 CF STORAGE PROVIDED

SUMMARY:

PERVIOUS PAVER SYSTEM	= 5,640 CF
RAINTANK SYSTEM	= 108,065 CF
THE ENCLAVE	**= 17,240 CF**
TOTAL STORAGE	= 130,945 CF

TREATMENT VOLUME CALCULATIONS

Treatment Area: 21

Area Description: Area consists of Cottage Row Residential type land use and Orlando Ave. right-of-way. Treatement is proposed within the Orlando Ave ROW through the use of a pervious pavers treatment system in conjunciton with the Raintank Exfiltration System. Additional treatment storage is provided within this basin in the newly developed Enclave Development.

Proposed Land Use:	Cottage Row Res.	
Major Soil Hydrological Group:	C	
CRA Area Acreage	25.501	acres
FDOT Area Acreage	3.762	acres
Total Area Acreage	29.263	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	80	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.15	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	25.501	acres	x	10.10	lbs/ac	=	**257.56**	**lbs**
TP FDOT:	3.762	acres	x	9.69	lbs/ac	=	**36.45**	**lbs**
TP Total:						=	**294.01**	**lbs**
TN CRA:	25.501	acres	x	2.036	lbs/ac	=	**51.92**	**lbs**
TN FDOT:	3.762	acres	x	2.788	lbs/ac	=	**10.49**	**lbs**
TN Total:						=	**62.41**	**lbs**

ALLOWABLE LOADING:

TP CRA:	25.501	acres	x	2.32	lbs/ac	=	**59.16**	**lbs**
TP FDOT:	3.762	acres	x	2.32	lbs/ac	=	**8.73**	**lbs**
TP Total:						=	**67.89**	**lbs**
TN CRA:	25.501	acres	x	0.344	lbs/ac	=	**8.77**	**lbs**
TN FDOT:	3.762	acres	x	0.344	lbs/ac	=	**1.29**	**lbs**
TN Total:						=	**10.07**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**198.40**	**lbs**
TP FDOT:	**27.73**	**lbs**
TP Total:	**226.12**	**lbs**
TN CRA:	**43.15**	**lbs**
TN FDOT:	**9.19**	**lbs**
TN Total:	**52.34**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	130945	Cubic-Feet
Area Treated:	31.37	Acres

TP Load Reduction:	**267.98**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**56.69**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 21

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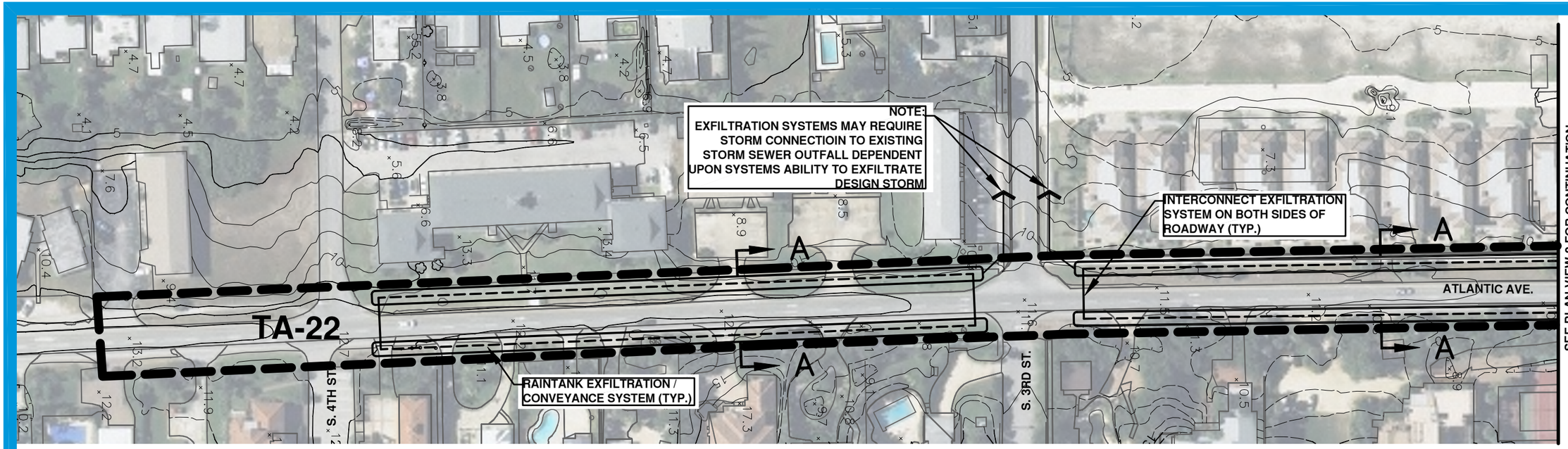
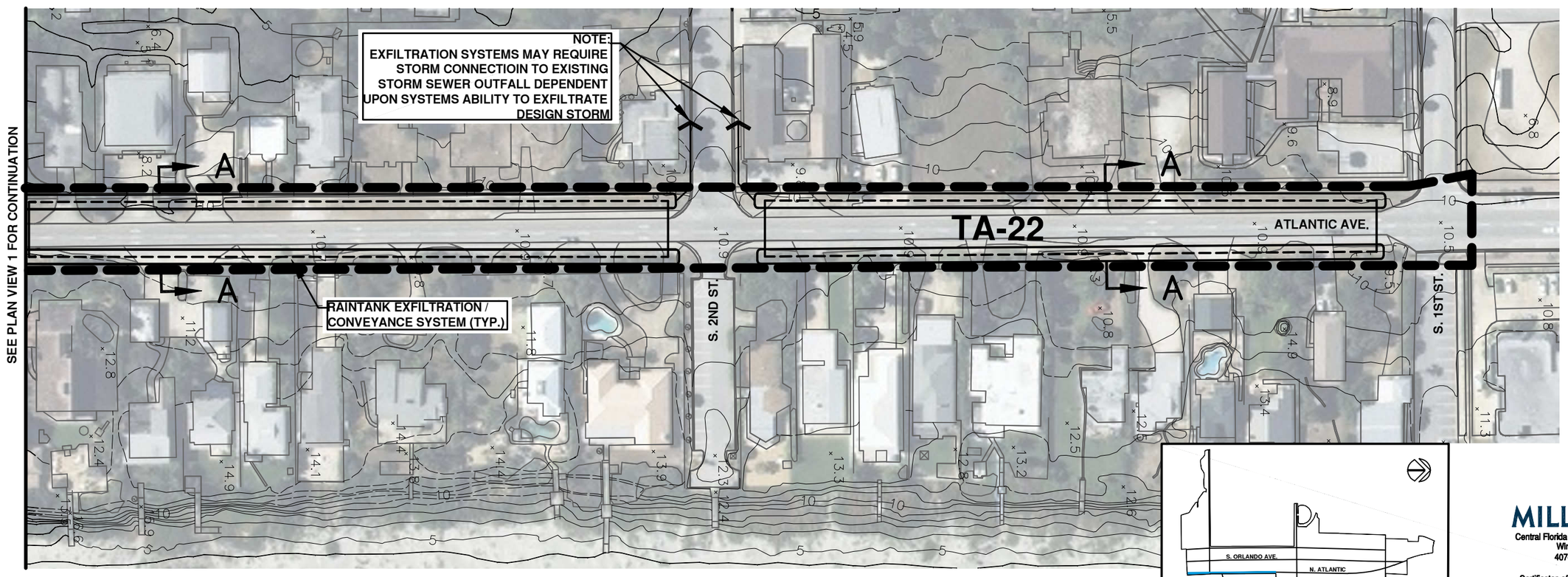


PLAN VIEW 1



PLAN VIEW 2

0 50 100
GRAPHIC SCALE
1 INCH = 100 FEET

COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 22

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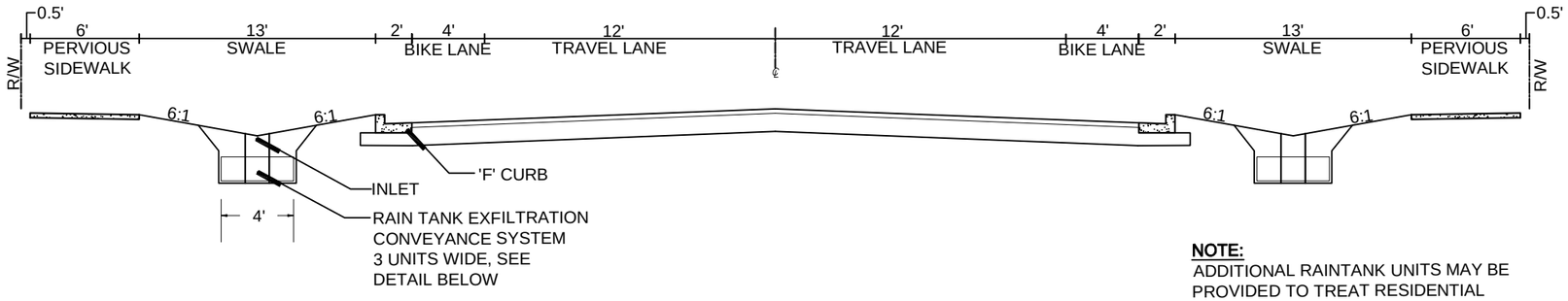
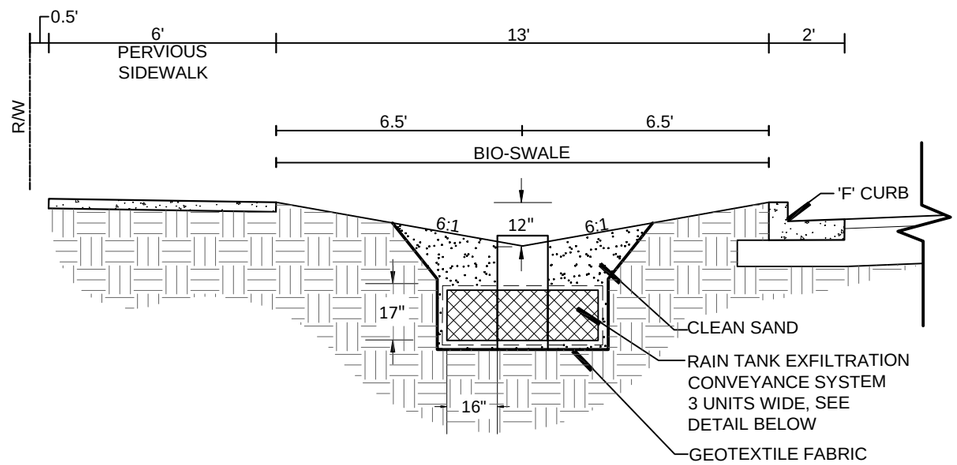


NOTE:
ADDITIONAL RAINTANK UNITS MAY BE PROVIDED TO TREAT RESIDENTIAL AREA ON EAST SIDE OF A1A NORTH.

ATLANTIC AVENUE TYPICAL SECTION A-A

5TH ST. SOUTH TO 1ST ST. SOUTH (75' R.O.W.)



5.6 CF / LF IN RAINTANK SYSTEM PER SIDE

TYPICAL BIO-SWALE W/ EXFILTRATION SYSTEM

TREATMENT VOLUME TABLE		
SWALE I.D.	SWALE LENGTH (FT)	SWALE VOL. (CF)
A	2400	13440
B	2400	13440
TOTAL	4800	26880

Treatment Area: 22

Area Description: Area consists of the A1A right-of-way which when redeveloped will contain 2 - 1: wide travel lanes, 2 - 4' bike lanes, type F curb and gutter, 2 - 6' sidewlaks, and roadside swale system with Infiltration system. Additional storage may be provided within system to treat upstream residen area to the east of A1A.

Proposed Land Use:	Right-of-Way	
Major Soil Hydrological Group:	C	
CRA Area Acreage	0	acres
FDOT Area Acreage	4.322	acres
Total Area Acreage	4.322	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	90	CN
Type of Best Management Practice Proposed:	Swales w/ Exfiltration System	
Required Treatment Volume:	1.49	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	0	acres	x	10.10	lbs/ac	=	**0.00**	**lbs**
TP FDOT:	4.322	acres	x	9.69	lbs/ac	=	**41.88**	**lbs**
TP Total:						=	**41.88**	**lbs**
TN CRA:	0	acres	x	2.036	lbs/ac	=	**0.00**	**lbs**
TN FDOT:	4.322	acres	x	2.788	lbs/ac	=	**12.05**	**lbs**
TN Total:						=	**12.05**	**lbs**

ALLOWABLE LOADING:

TP CRA:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP FDOT:	4.322	acres	x	2.32	lbs/ac	=	**10.03**	**lbs**
TP Total:						=	**10.03**	**lbs**
TN CRA:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN FDOT:	4.322	acres	x	0.344	lbs/ac	=	**1.49**	**lbs**
TN Total:						=	**1.49**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**0.00**	**lbs**
TP FDOT:	**31.85**	**lbs**
TP Total:	**31.85**	**lbs**
TN CRA:	**0.00**	**lbs**
TN FDOT:	**10.56**	**lbs**
TN Total:	**10.56**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	26880	Cubic-Feet
Area Treated:	4.97	Acres

TP Load Reduction:	**41.16**	**lbs**	(Assumes 100% of the FDOT right-of-way is treate
TN Load Reduction:	**11.36**	**lbs**	(Assumes 100% of the FDOT right-of-way is treate

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 22

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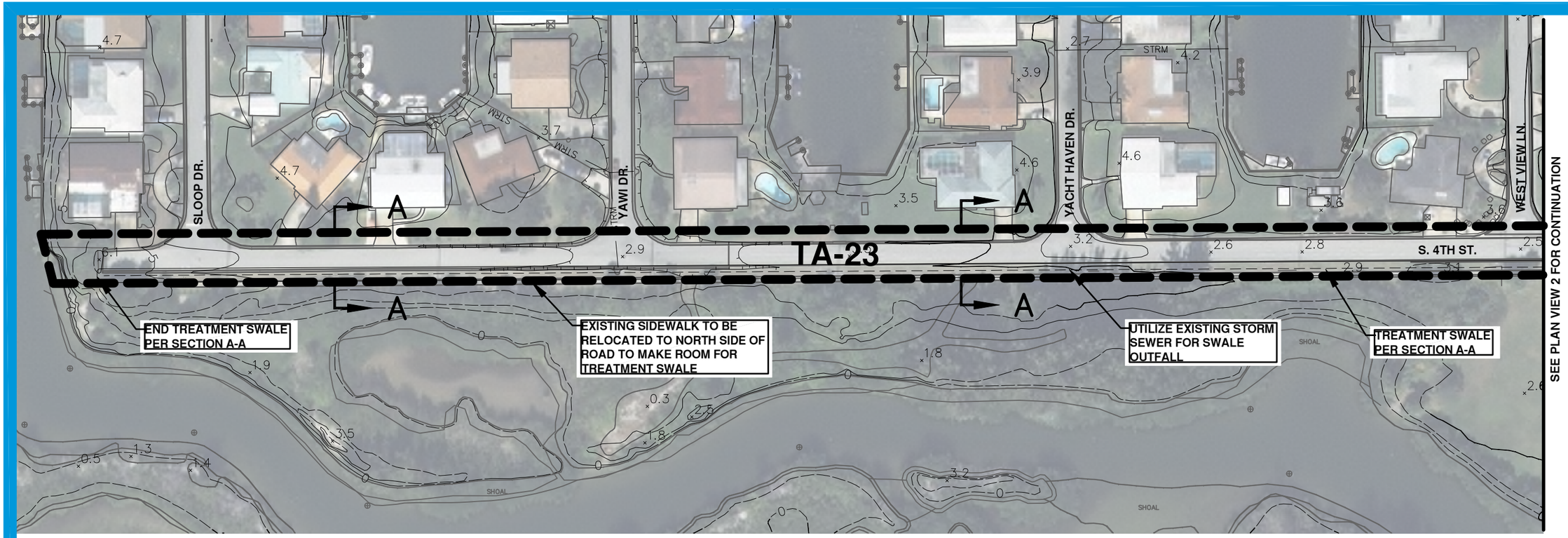
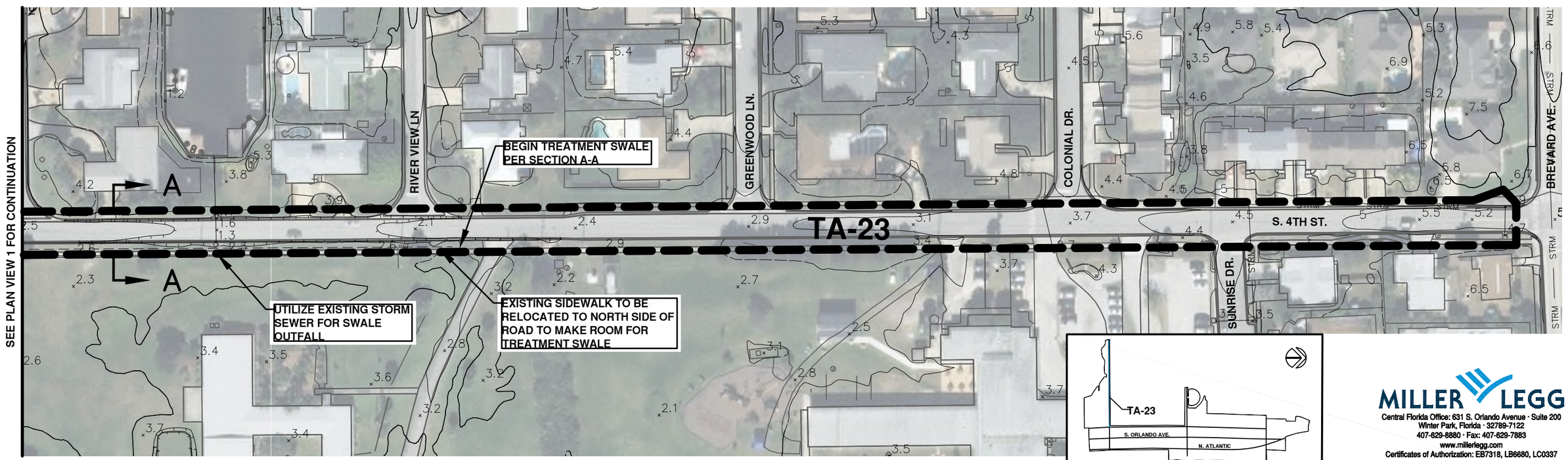
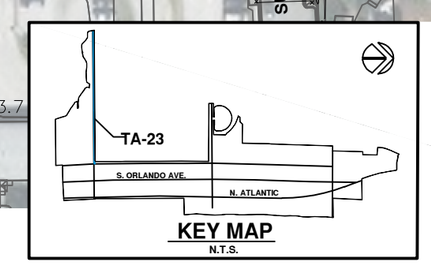
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 23



PLAN VIEW 1



PLAN VIEW 2



KEY MAP
N.T.S.

0 50 100
GRAPHIC SCALE
1 INCH = 100 FEET

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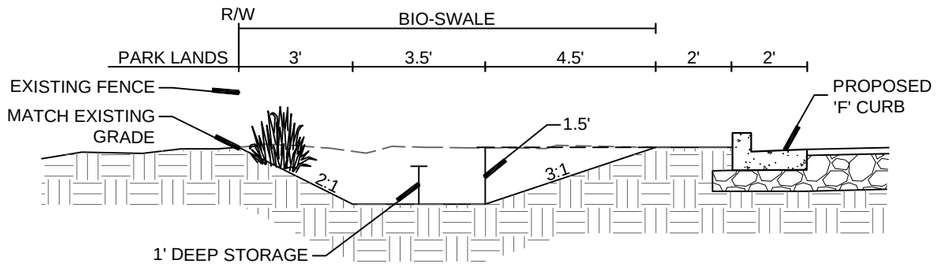

NOTES

1. EXISTING SIDE TO BE RELOCATED TO NORTH SIDE OF 4TH STREET SOUTH.
2. DITCH BLOCKS TO BE PROVIDED AS NEEDED.
3. 7.5 CF/LF STORAGE.

SOUTH 4TH STREET TYPICAL BIO-SWALE SECTION

N.T.S.

TREATMENT VOLUME TABLE		
SWALE I.D.	SWALE LENGTH (FT)	SWALE VOL. (CF)
A	400	3,000
B	1,825	13,688
TOTAL	2,225	16,688

Treatment Area: 23

Area Description: Area consist of approximately 2500 feet of 4th Street South right-of-way which contains a two lane, 24-foot wide roadway with curb and gutter and closed drainage system which outfalls into adjacent canals. Treatment consists of the construction of a swale drainage system along the south side of the roadway which would utilize the existing storm sewer to outfall to existing canals. Existing sidewalk on south side of roadway would require relocation to north side of road where sufficient right-of-way exists.

Proposed Land Use:	Right-of-Way	
Major Soil Hydrological Group:	C	
CRA Area Acreage	3.021	acres
FDOT Area Acreage	0	acres
Total Area Acreage	3.021	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	90	CN
Type of Best Management Practice Proposed:	Swales w/ Check Damns	
Required Treatment Volume:	1.49	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.021	acres x	10.10	lbs/ac	=	**30.51**	**lbs**
TP FDOT:	0	acres x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**30.51**	**lbs**
TN CRA:	3.021	acres x	2.036	lbs/ac	=	**6.15**	**lbs**
TN FDOT:	0	acres x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**6.15**	**lbs**

ALLOWABLE LOADING:

TP CRA:	3.021	acres x	2.32	lbs/ac	=	**7.01**	**lbs**
TP FDOT:	0	acres x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**7.01**	**lbs**
TN CRA:	3.021	acres x	0.344	lbs/ac	=	**1.04**	**lbs**
TN FDOT:	0	acres x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**1.04**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**23.50**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**23.50**	**lbs**
TN CRA:	**5.11**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**5.11**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	16688	Cubic-Feet	
Area Treated:	3.09	Acres	
TP Load Reduction:	**26.49**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**5.34**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 23

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 24

PLAN VIEW

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NO IMPROVEMENTS PROPOSED

Treatment Area: 24

Area Description: Area consists of undisturbed natural lands which would require impact in order to construct treatment facilities. As such, no treatment improvements are recommended for this area.

Proposed Land Use:	Park Lands	
Major Soil Hydrological Group:	C	
CRA Area Acreage	3.241	acres
FDOT Area Acreage	0	acres
Total Area Acreage	3.241	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	75	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.00	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	3.241	acres x	10.10	lbs/ac	=	**32.73**	lbs
TP FDOT:	0	acres x	9.69	lbs/ac	=	**0.00**	lbs
TP Total:					=	**32.73**	lbs
TN CRA:	3.241	acres x	2.036	lbs/ac	=	**6.60**	lbs
TN FDOT:	0	acres x	2.788	lbs/ac	=	**0.00**	lbs
TN Total:					=	**6.60**	lbs

ALLOWABLE LOADING:

TP CRA:	3.241	acres x	2.32	lbs/ac	=	**7.52**	lbs
TP FDOT:	0	acres x	2.32	lbs/ac	=	**0.00**	lbs
TP Total:					=	**7.52**	lbs
TN CRA:	3.241	acres x	0.344	lbs/ac	=	**1.11**	lbs
TN FDOT:	0	acres x	0.344	lbs/ac	=	**0.00**	lbs
TN Total:					=	**1.11**	lbs

REQUIRED LOAD REDUCTION:

TP CRA:	**25.21**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**25.21**	**lbs**
TN CRA:	**5.48**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**5.48**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet
Area Treated:	0.00	Acres

TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 25

PLAN VIEW

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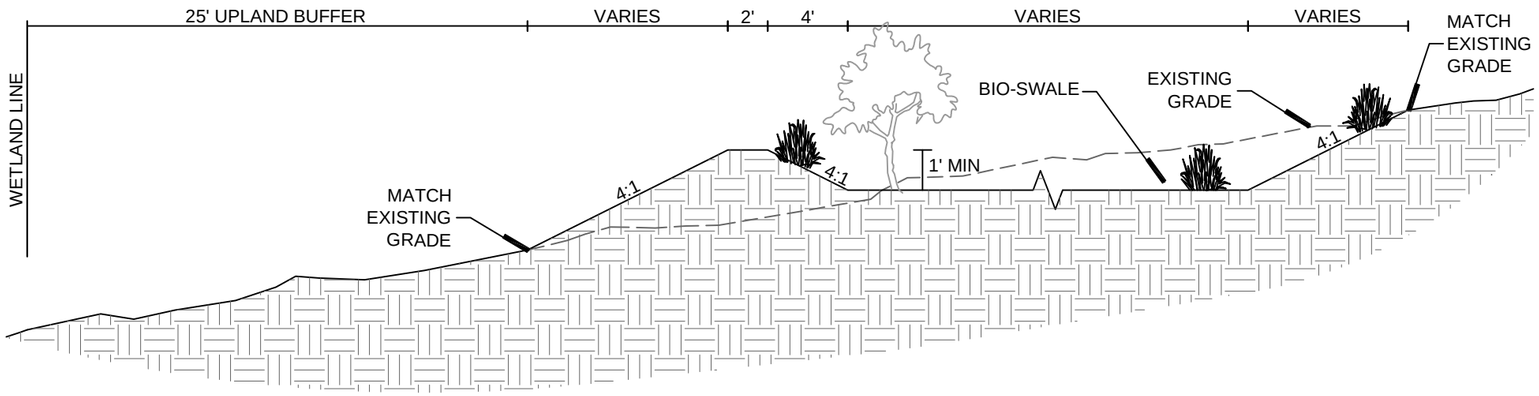

TYPICAL SECTION A-A

N.T.S.

Treatment Area: 25

Area Description: Area is an exisitng church development without stormwater failities. Site has a large amount of open space available for treatment facilities. City and property owner agreement for the construction of facilities may be required. Facilities treat onsite areas only and consist of dry retention areas along the shoreline of the site to capture and treat overland flow prior to discharge.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	C	
CRA Area Acreage	4.232	acres
FDOT Area Acreage	0	acres
Total Area Acreage	4.232	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	89	CN
Type of Best Management Practice Proposed:	Dry Retention Ponds	
Required Treatment Volume:	1.48	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	4.232	acres	x	10.10	lbs/ac	=	**42.74**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**42.74**	**lbs**
TN CRA:	4.232	acres	x	2.036	lbs/ac	=	**8.62**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**8.62**	**lbs**

ALLOWABLE LOADING:

TP CRA:	4.232	acres	x	2.32	lbs/ac	=	**9.82**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**9.82**	**lbs**
TN CRA:	4.232	acres	x	0.344	lbs/ac	=	**1.46**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**1.46**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**32.92**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**32.92**	**lbs**
TN CRA:	**7.16**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**7.16**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	22250	Cubic-Feet	
Area Treated:	4.14	Acres	
TP Load Reduction:	**35.56**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**7.17**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 25

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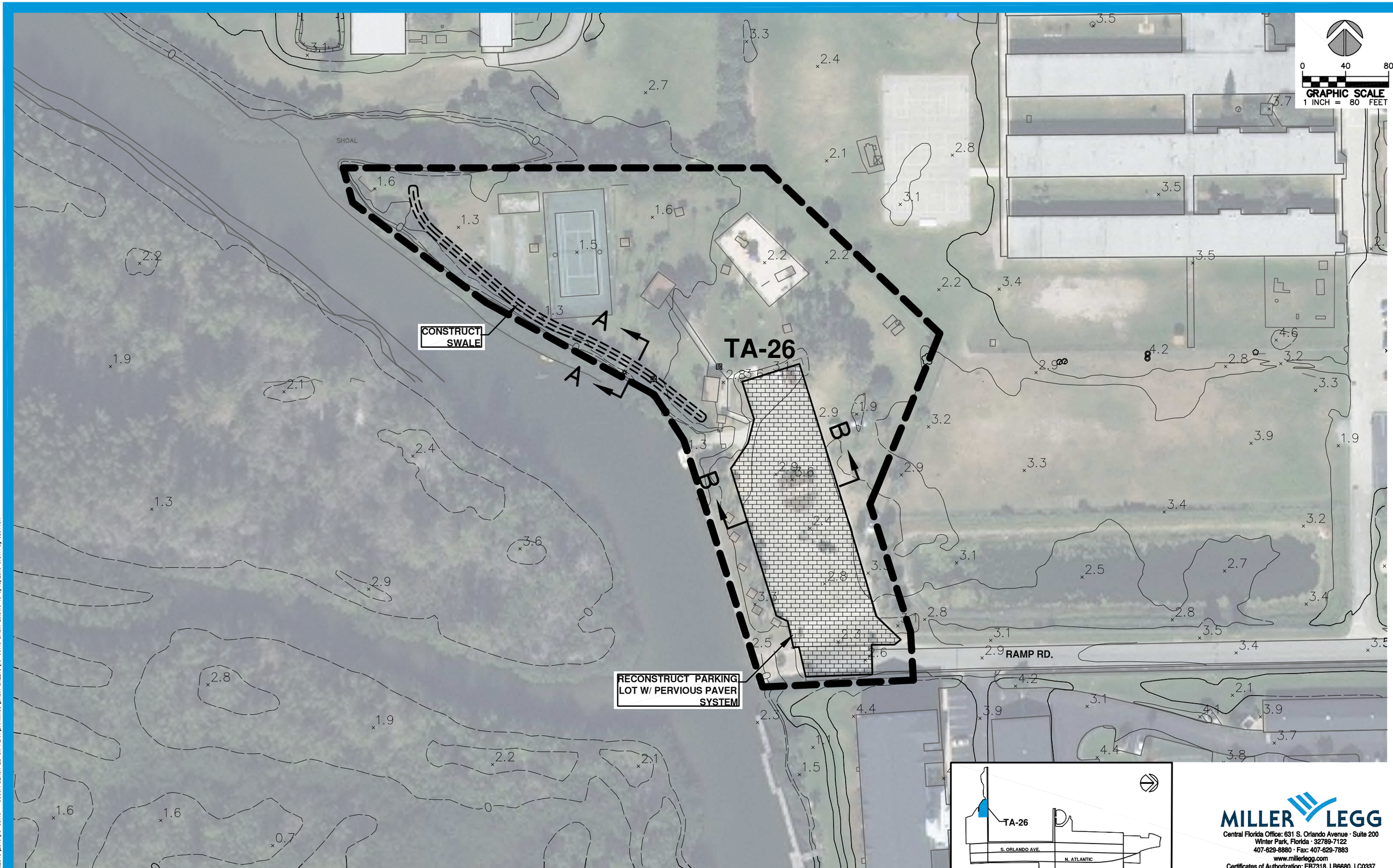

PLAN VIEW

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 26

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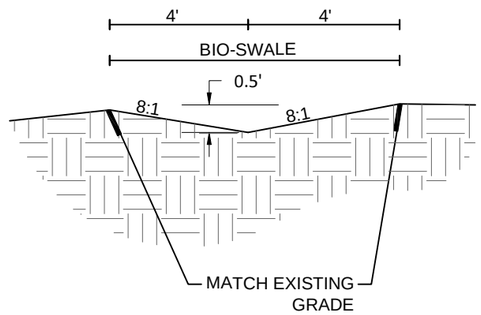
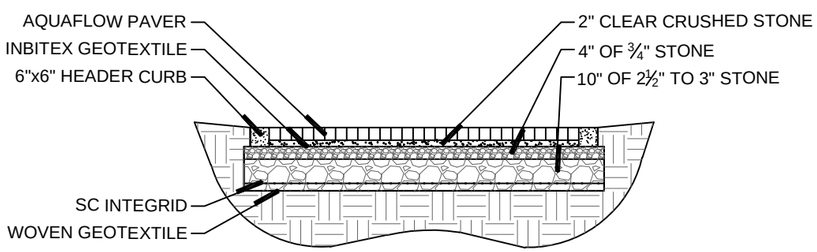


STORAGE = 350 LF @ 2.0 CF/LF = 175 CF

TYPICAL BIO-SWALE SECTION A-A

N.T.S.



TYPICAL SECTION B-B

N.T.S.

Treatment Area: 26

Area Description: Area is an existing park facility with parking and boat ramp. Parking and boat ramp pavement surfaces are in poor condition. Treatment facilities proposed include pervious paver parking and drive aisles with reinforcement to accommodate anticipated loading. An environmental swale is proposed along the remainder of the shoreline to provide treatment of overland flow.

Proposed Land Use:	Park Lands	
Major Soil Hydrological Group:	C	
CRA Area Acreage	2.862	acres
FDOT Area Acreage	0	acres
Total Area Acreage	2.862	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	75	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.00	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	2.862	acres x	10.10	lbs/ac	=	**28.91**	**lbs**
TP FDOT:	0	acres x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**28.91**	**lbs**
TN CRA:	2.862	acres x	2.036	lbs/ac	=	**5.83**	**lbs**
TN FDOT:	0	acres x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**5.83**	**lbs**

ALLOWABLE LOADING:

TP CRA:	2.862	acres x	2.32	lbs/ac	=	**6.64**	**lbs**
TP FDOT:	0	acres x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:					=	**6.64**	**lbs**
TN CRA:	2.862	acres x	0.344	lbs/ac	=	**0.98**	**lbs**
TN FDOT:	0	acres x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:					=	**0.98**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**22.27**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**22.27**	**lbs**
TN CRA:	**4.84**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**4.84**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	12375	Cubic-Feet
Area Treated:	3.41	Acres

TP Load Reduction:	**29.27**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**5.90**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 26

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 27

PLAN VIEW

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Treatment Area: 27

Area Description: Area consists of the existing Freedom Elementary School which currently provides wet deterntion stormwater treatment facilities. As such, no additional treatment facilities are proposed for this site. Recommend coordination with Brevard County Schools. Update Interlocal Agreement to include some level or enhanced treatment of school sites.

Proposed Land Use:	Civic/Semi-Public	
Major Soil Hydrological Group:	C	
CRA Area Acreage	10.411	acres
FDOT Area Acreage	0	acres
Total Area Acreage	10.411	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	89	CN
Type of Best Management Practice Proposed:	None	
Required Treatment Volume:	1.48	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	10.411	acres	x	10.10	lbs/ac	=	**105.15**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**105.15**	**lbs**
TN CRA:	10.411	acres	x	2.036	lbs/ac	=	**21.20**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**21.20**	**lbs**

ALLOWABLE LOADING:

TP CRA:	10.411	acres	x	2.32	lbs/ac	=	**24.15**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**24.15**	**lbs**
TN CRA:	10.411	acres	x	0.344	lbs/ac	=	**3.58**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.58**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**81.00**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**81.00**	**lbs**
TN CRA:	**17.62**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**17.62**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	0	Cubic-Feet	
Area Treated:	0.00	Acres	
TP Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**0.00**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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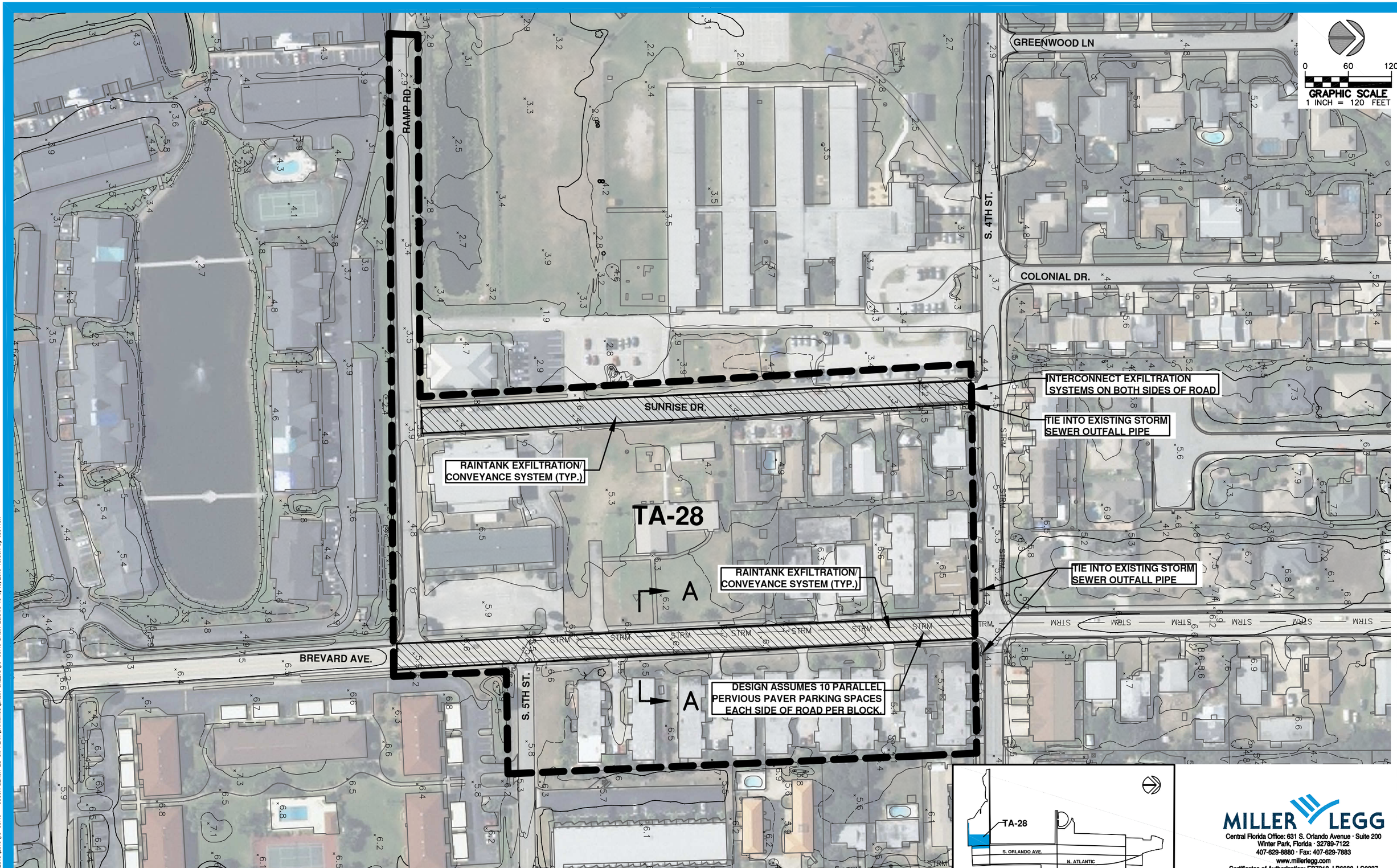
COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 28



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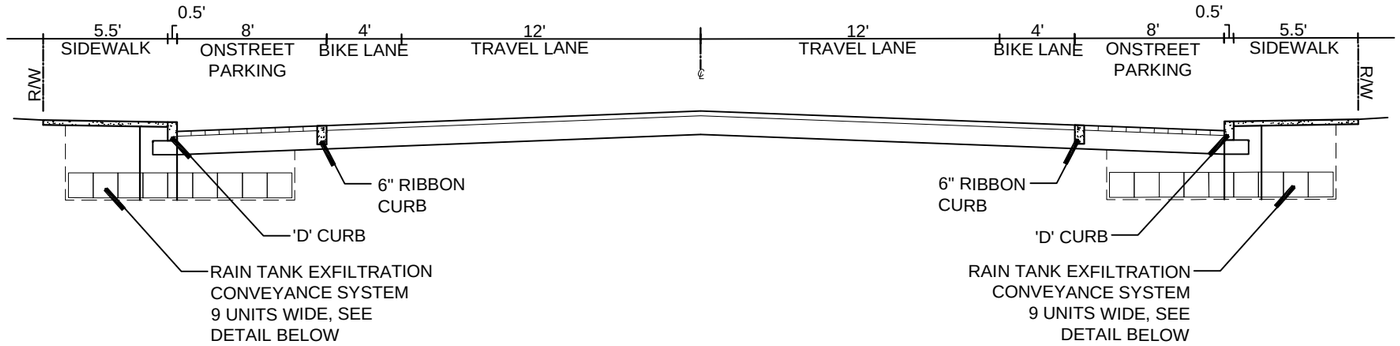
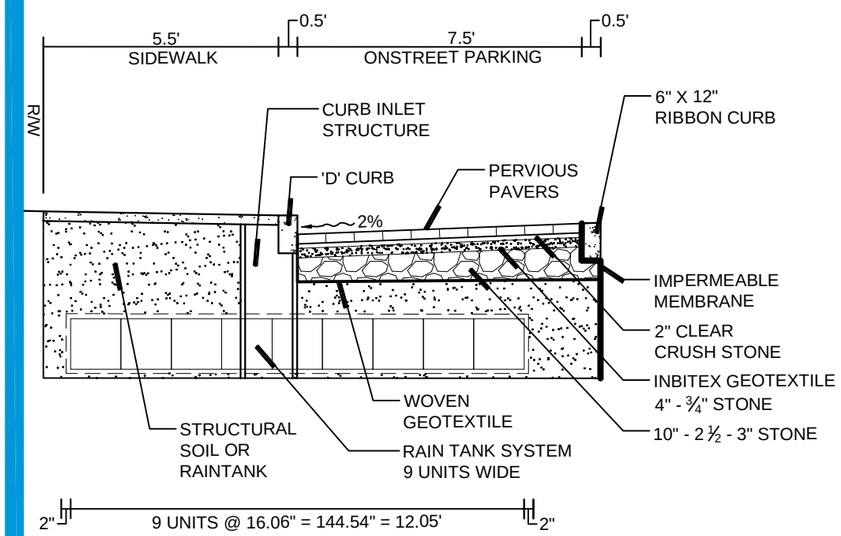


BREVARD AVE.SECTION A-A

RAMP ROAD TO 4TH STREET SOUTH (60' R.O.W.)



PERVIOUS PAVER / RAINTANK EXFILTRATION / CONVEYANCE SYSTEM

RAIN TANK:	**2 BLOCKS X 600 LF/BLOCK = 1,200 LF ROAD** **1,200 LF / 2.25 LF/UNIT = 533 UNITS ALONG ROAD** **533 UNITS X 9 WIDE X 2 SIDES = 9,594 UNITS** **9,594 UNITS X 4.22 CF/UNIT = 40,487 CF**
PERVIOUS PAVERS PARKING:	**10 PARKING SP. PER BLOCK PER SIDE OF ROAD** **0.47 CF STORAGE PER SF PERVIOUS PAVERS** **2 BLOCKS** **= 2 BLOCKS X 10 SP X 2 SIDES X (20' X 7.5')** **= 6,000 SF X 0.47 CF/SF** **= 2,820 CF STORAGE**
SUMMARY:	**PERVIOUS PAVER PARKING = 2,820 CF** **RAINTANK SYSTEM = 40,487 CF** **TOTAL = 43,307 CF**

TREATMENT VOLUME CALCULATIONS

Treatment Area: **28**

Area Description: Area consists of a mixture of residential and commercial land uses. Area is proposed to contain the Artisan District land use. Treatment facilities proposed shall consist of exfiltration and pervious paver systems located within the Brevard Ave. and Sunrise Drive rights-of-way.

Proposed Land Use:	Artisan District	
Major Soil Hydrological Group:	C	
CRA Area Acreage	9.485	acres
FDOT Area Acreage	0	acres
Total Area Acreage	9.485	acres
DCIA:	0.5525	Percent
Non-DCIA Curve Number:	84	CN
Type of Best Management Practice Proposed:	Underground Exfiltration	
Required Treatment Volume:	1.26	Inches

EXISTING LOADING CALCULATIONS:

TP CRA:	9.485	acres	x	10.10	lbs/ac	=	**95.80**	**lbs**
TP FDOT:	0	acres	x	9.69	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**95.80**	**lbs**
TN CRA:	9.485	acres	x	2.036	lbs/ac	=	**19.31**	**lbs**
TN FDOT:	0	acres	x	2.788	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**19.31**	**lbs**

ALLOWABLE LOADING:

TP CRA:	9.485	acres	x	2.32	lbs/ac	=	**22.01**	**lbs**
TP FDOT:	0	acres	x	2.32	lbs/ac	=	**0.00**	**lbs**
TP Total:						=	**22.01**	**lbs**
TN CRA:	9.485	acres	x	0.344	lbs/ac	=	**3.26**	**lbs**
TN FDOT:	0	acres	x	0.344	lbs/ac	=	**0.00**	**lbs**
TN Total:						=	**3.26**	**lbs**

REQUIRED LOAD REDUCTION:

TP CRA:	**73.79**	**lbs**
TP FDOT:	**0.00**	**lbs**
TP Total:	**73.79**	**lbs**
TN CRA:	**16.05**	**lbs**
TN FDOT:	**0.00**	**lbs**
TN Total:	**16.05**	**lbs**

LOADING REDUCTION PROVIDED:

Storage Provided:	43307	Cubic-Feet	
Area Treated:	9.47	Acres	
TP Load Reduction:	**81.29**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)
TN Load Reduction:	**16.39**	**lbs**	(Assumes 100% of the FDOT right-of-way is treated)

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COCOA BEACH CRA STORMWATER MASTER PLAN - TREATMENT AREA 28

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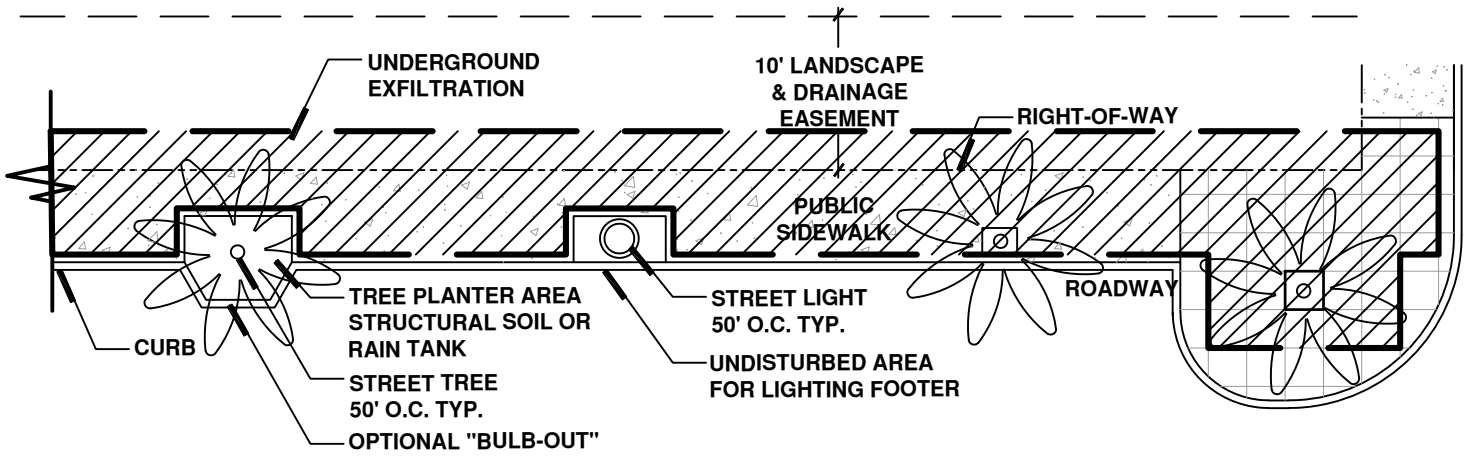
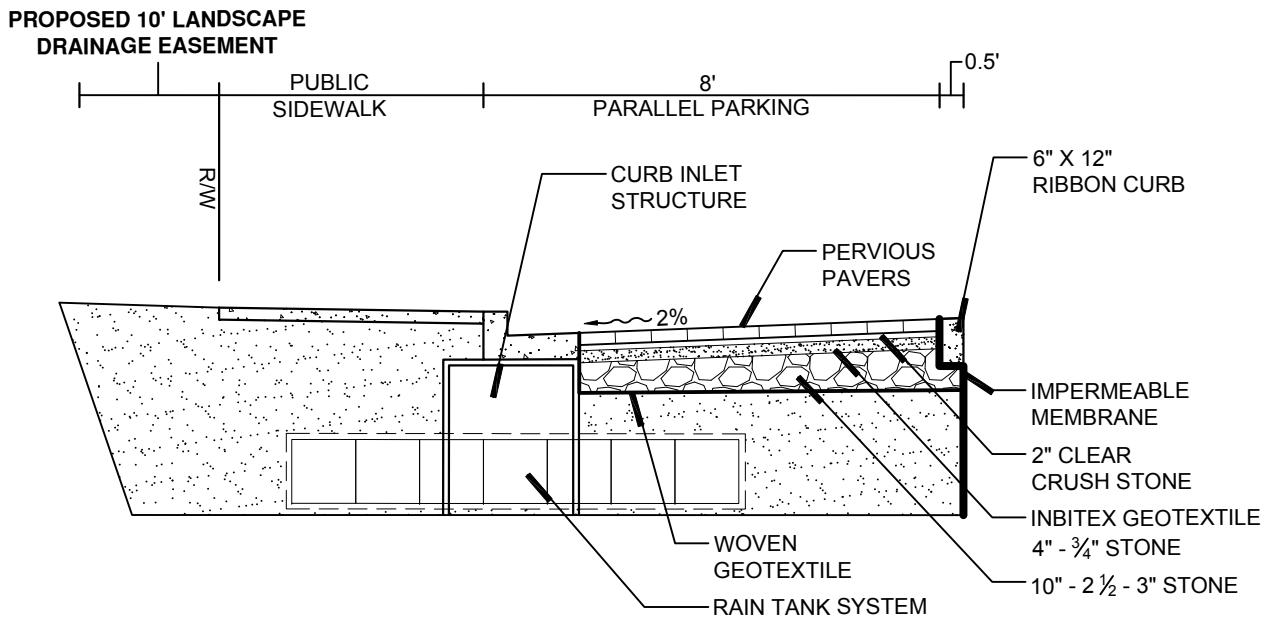
COCOA BEACH CRA STORMWATER MASTER PLAN
SYSTEMS UTILIZING TECHNIQUES



RAIN TANK EXFILTRATION - TYPICAL PLAN VIEW

SCALE: N.T.S.

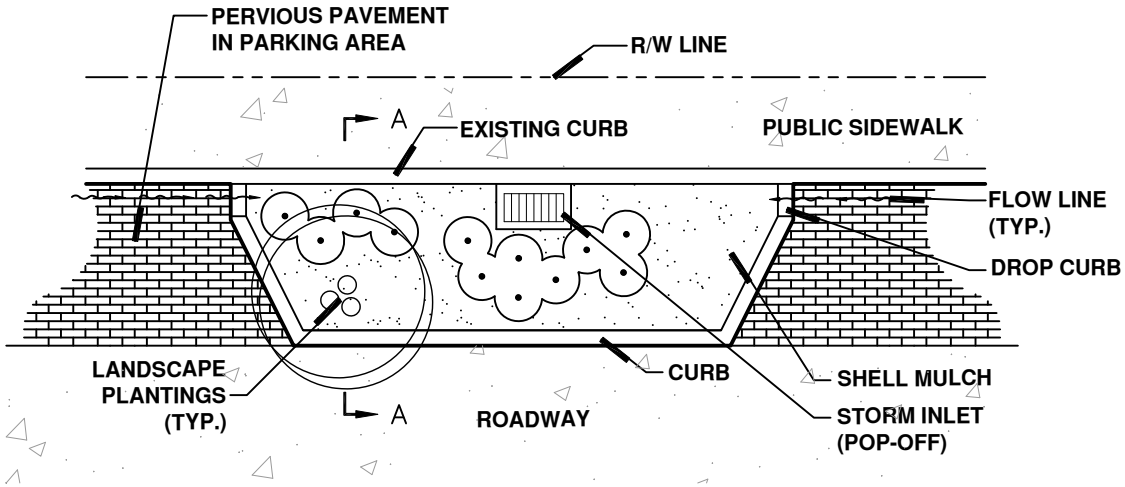
COCOA BEACH CRA STORMWATER MASTER PLAN
SYSTEMS UTILIZING TECHNIQUES



RAIN TANK EXFILTRATION - TYPICAL SECTION

SCALE: N.T.S.

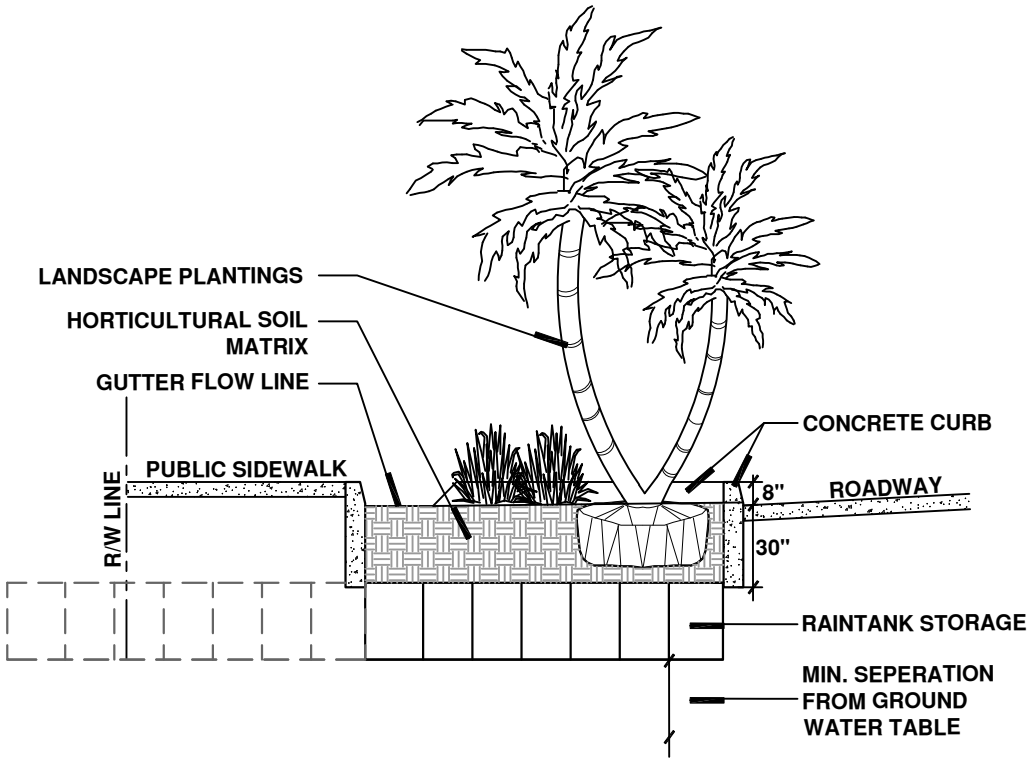
COCOA BEACH CRA STORMWATER MASTER PLAN
SYSTEMS UTILIZING TECHNIQUES



LANDSCAPE INFILTRATION ISLAND - TYPICAL PLAN VIEW

SCALE: N.T.S.

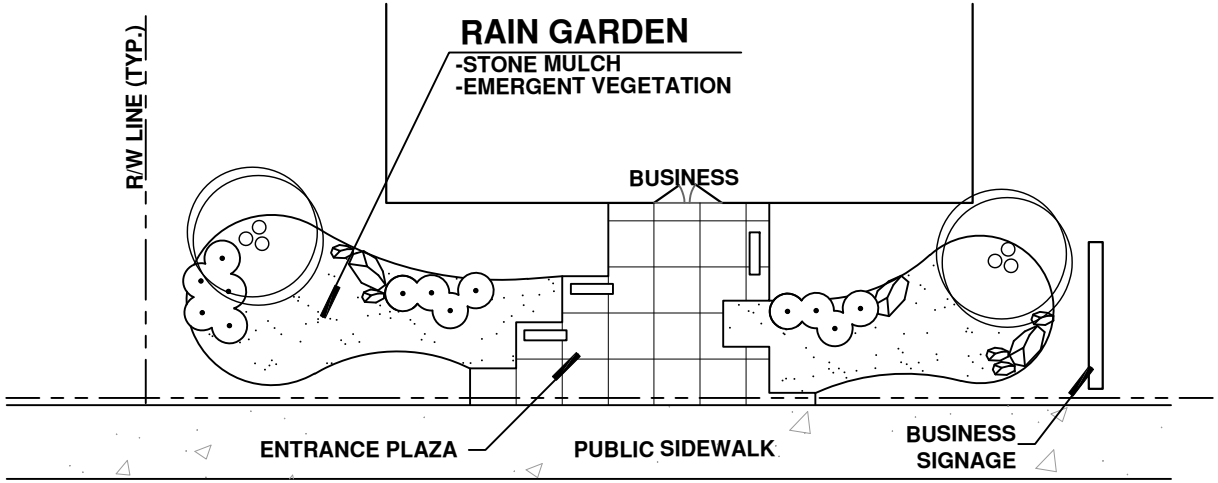
COCOA BEACH CRA STORMWATER MASTER PLAN
SYSTEMS UTILIZING TECHNIQUES



LANDSCAPE INFILTRATION ISLAND - TYPICAL SECTION

SCALE: N.T.S.

COCOA BEACH CRA STORMWATER MASTER PLAN
SYSTEMS UTILIZING TECHNIQUES



BIO-RETENTION AREA/ RAIN GARDEN ON PRIVATE PROPERTY

SCALE: N.T.S.