SOP Technologies
Environmental Solutions
soptechint.com

CITY OF AVENTURA

STORMWATER FILTERS ANALYSIS REPORT

2019-2020

Updated: June 30, 2020

EXECUTIVE SUMMARY

The City of Aventura first implemented SOP Technologies' patented stormwater curb inlet filters in Oct 2017, and city-wide in all city inlets in the summer of 2019.

Debris and litter in front of the filters were collected and analyzed In order to provide more data about the impacts of the stormwater filters as a Best Management Practice (BMP).

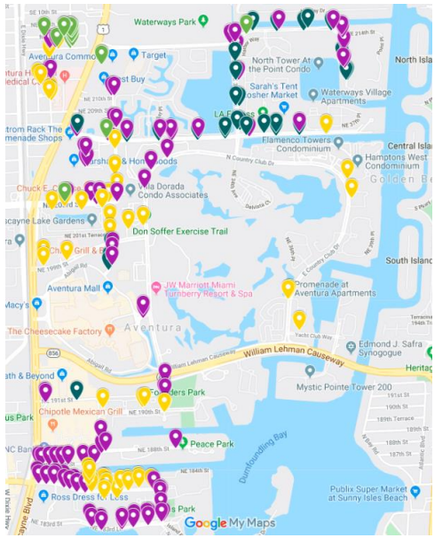
Summary of findings:

- Annual Pollution Prevention with Stormwater Filters
  - 38,528 lbs. of leaves, street litter and debris prevented from entering the stormwater system, local groundwater, and the Biscayne Bay.
  - Nutrient load reductions
    - 14.56 lbs. of Total Phosphorus (TP)
    - 30.25 lbs. of Total Nitrogen (TN)
  - Thousands of cigarette butts, plastic and paper objects, and other street litter are kept out of local waterways.

- Cost Savings
  - $43,000 - $97,000 net cost savings within 10 years
  - $188 - $420 saved within 10 years per curb inlet that has a stormwater filter

- Flood Prevention and Resilience Benefits
  - The city is keeping thousands of pounds of leaves and litter out of stormwater catch basins and pipes, thereby preventing street flooding.

Link to view map of stormwater filters



ABOUT SOP TECHNOLOGIES STORMWATER FILTERS

SOP Technologies' patented upward flow stormwater drainage filters are used to prevent leaves, trash and debris from entering stormwater drainage systems. This stormwater Best Management Practice (BMP) has been proven effective in the field since 2011 in Florida, and Australia since 2018.

Curb inlet filters keep debris at the street to facilitate debris removal and prevent debris and litter from entering stormwater drainage systems.

The three main benefits of the stormwater filters are:

1. **Pollution Prevention**: With less debris entering stormwater systems, less nutrients and pollutants are discharged to waterways or introduced into groundwater.
2. **Cost Savings:** Debris is swept from the street (low cost) instead of using vacuum trucks (high cost) to remove debris from catch basins and pipes.
3. **Flood Prevention**: With less debris in catch basins and pipes, cleaner and greater volumes of water flow freely; thereby reducing flood risks and duration of floods.

INDUSTRY RECOGNITION

In 2019, the City of Aventura received the Branch Stormwater Project of the Year from the South Florida branch of the American Public Works Association (APWA).

The award was in recognition of implementing innovating and cost-effective best practices for stormwater management, due to the city's use of SOP Technologies' stormwater filters.

POLLUTION PREVENTION ANALYSIS

Based on the recommendation from the Florida Department of Environmental Protection (FDEP), debris/litter was collected as follows:

Two tiers/types of areas were selected:

- Residential areas (10 inlets)
- Commercial areas (10 inlets)

The map on the right highlights the locations of the inlets.

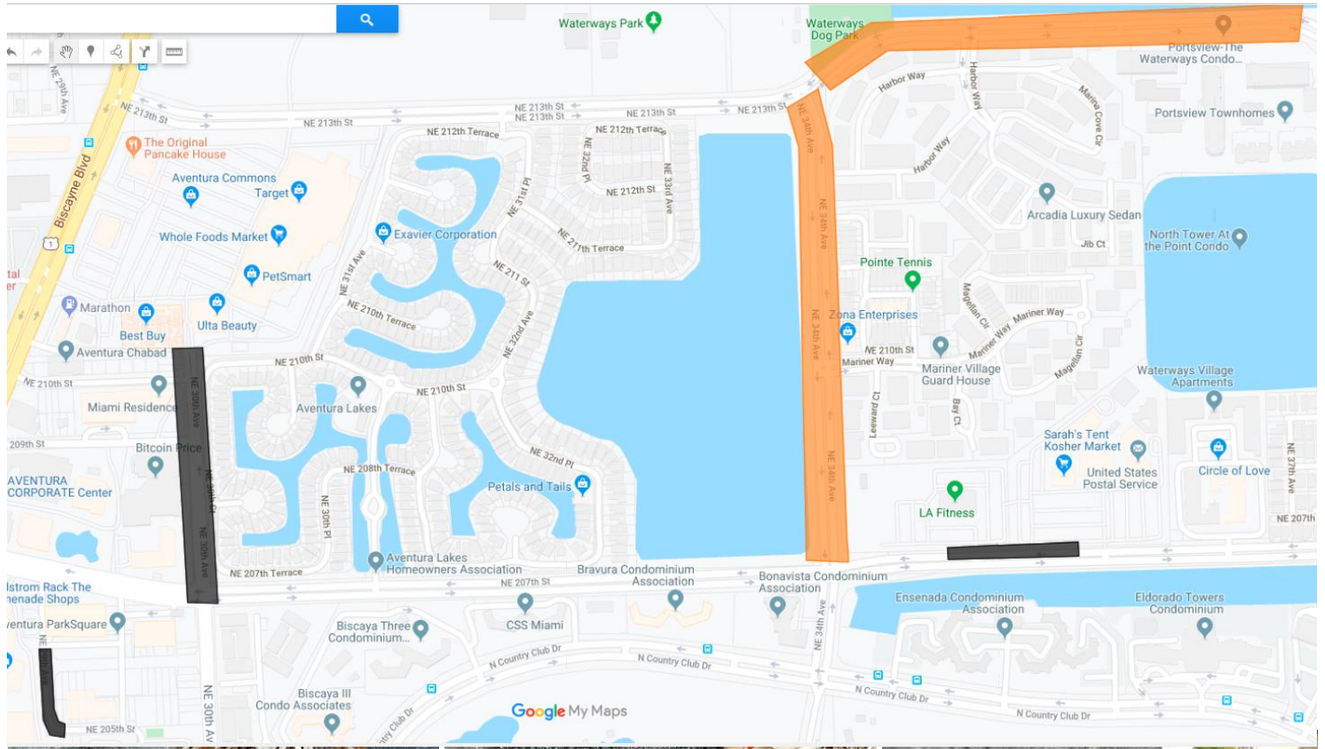
The inlets were all cleaned one week prior to collecting the data, so the debris collected accounts for debris/litter accumulation in front of the stormwater filters between 9/12/2019 and 9/19/2019.

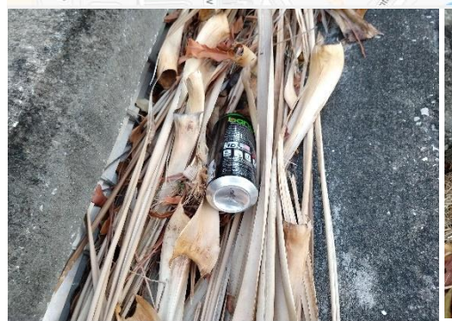
Debris collected in the Residential areas was kept separate from the Commercial area debris. This way, we were able to compare the difference in debris accumulation for each tier.

Click here to view the map of the areas.

Areas highlighted in **ORANGE** are primarily residential.

Areas highlighted in **GREY** are primarily commercial.





POLLUTION PREVENTION ANALYSIS RESULTS

Debris collected from Residential areas and Commercial areas were grouped in separate bags and weighed using a luggage scale.

The total weight of the debris collected in front of the 20 inlet filters was 110.76 lbs. The commercial areas had more man-made litter, such as plastics and cans.

Residential Areas

- Weight of debris in front of 10 inlet filters: 42.72 lbs.
- Average debris weight per filter: 4.272 lbs.
- Estimated weight for 1 year of debris, per filter: 222.14 lbs.

Commercial Areas

- Weight of debris in front of 10 inlet filters: 68.04 lbs.
- Average debris weight per filter: 6.804 lbs.
- Estimated weight for 1 year of debris, per filter: 353.81 lbs.

POLLUTION PREVENTION ANALYSIS RESULTS (CONTINUED)

In order to more accurately represent the amount of debris/litter removed by use of the SOP Technologies curb inlet filters, several adjustments were made based on the average inlet sizes throughout the city and the proportion of Residential versus Commercial zones.

Residential versus Commercial areas review, used for adjustments
According to the current version of the City of Aventura Comprehensive Plan, in 2005, there were:

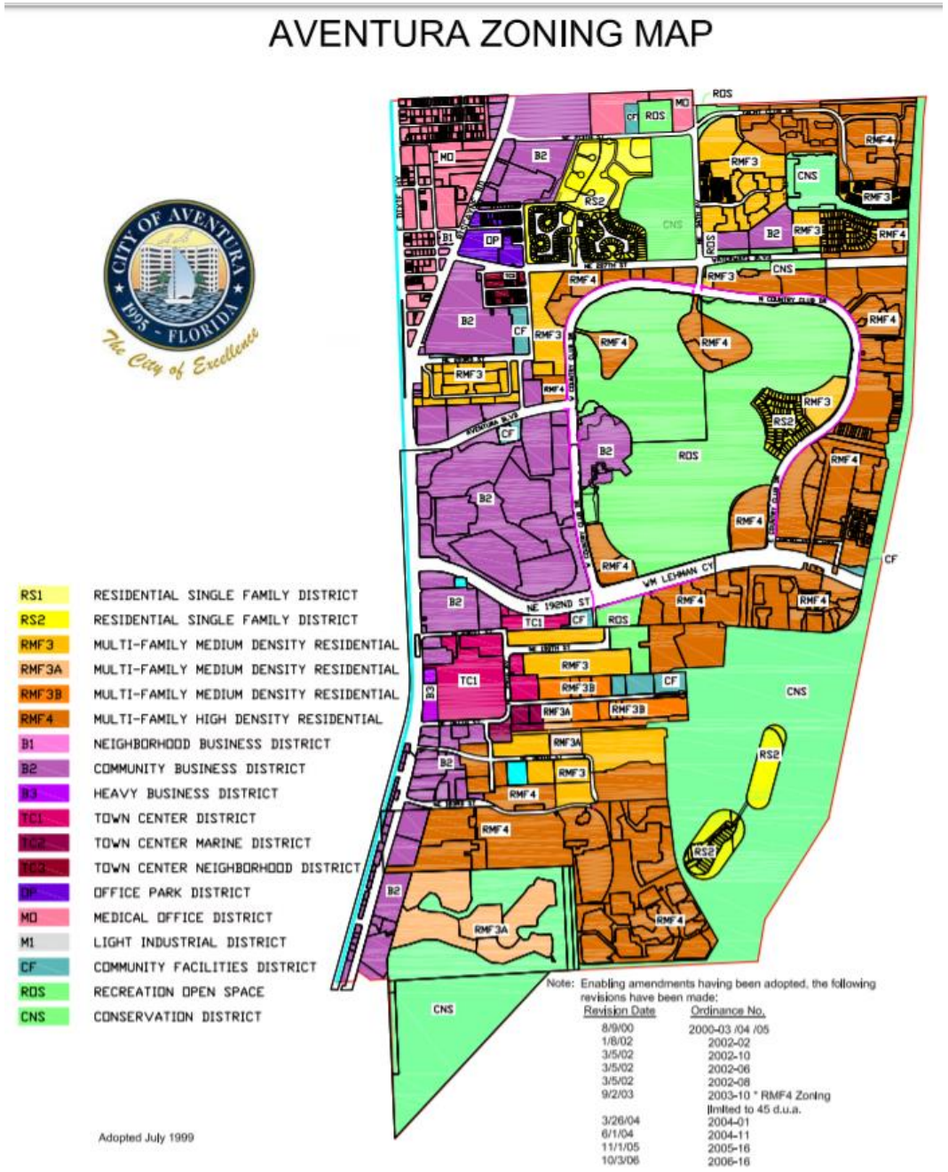
- 523.89 acres of residential uses, and
- 319.97 acres of commercial uses

Adjusting for inlet sizes
The City of Aventura is using 232 SOP Technologies stormwater inlet filters throughout the city.

Adjusting for the average size of the stormwater inlet filters in Aventura, when compared to the inlets used for the debris analysis, the following figures are a more accurate representation of pounds of debris prevented from entering stormwater systems by the filters:

- Residential Areas: 135.59 lbs. per year, per inlet
- Commercial Areas: 215.95 lbs. per year, per inlet

Total lbs. of debris blocked by the filters, factoring proportion of Residential and Commercial zones in the city: 38,528.74 lbs. per year.



Aventura Planning and Zoning Documents: https://www.cityofaventura.com/207/Planning-Zoning

POLLUTION PREVENTION ANALYSIS RESULTS (CONTINUED)

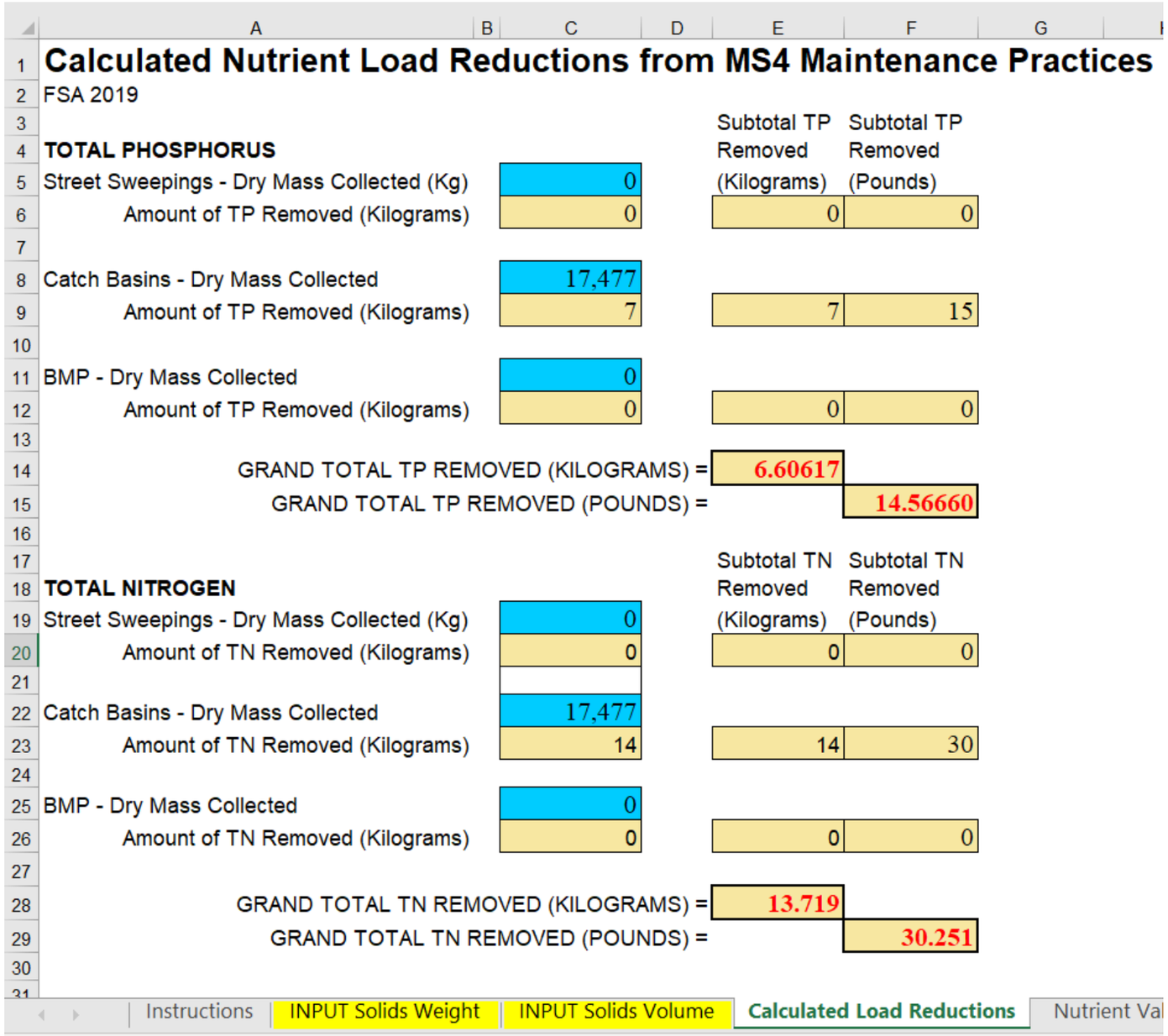
Total Nitrogen (TN) and Total Phosphorus (TP) captured by the stormwater filters in the City of Aventura were quantified using the FSA MS4 Load Reduction Assessment Tool available on the FDEP website.[1]

Total annual lbs. of debris blocked by the SOP Technologies filters, factoring the proportion of Residential and Commercial zones in the city is: 38,528.74 lbs. per year.

The total pounds calculation of 38,528.74 was entered into the Load Reduction Assessment Tool to derive the Total Nitrogen (TN) and Total Phosphorus (TP) prevented from entering the stormwater systems.

Annual removal with SOP Technologies stormwater inlet filters / screens:

- **TP** 14.566 lbs.
- **TN** 30.251 lbs.



Calculated Nutrient Load Reductions from MS4 Maintenance Practices

FSA 2019

			Subtotal TP Removed (Kilograms)	Subtotal TP Removed (Pounds)
TOTAL PHOSPHORUS				
Street Sweepings - Dry Mass Collected (Kg)	0			
Amount of TP Removed (Kilograms)	0		0	0
Catch Basins - Dry Mass Collected	17,477			
Amount of TP Removed (Kilograms)	7		7	15
BMP - Dry Mass Collected	0			
Amount of TP Removed (Kilograms)	0		0	0
GRAND TOTAL TP REMOVED (KILOGRAMS) =		6.60617		
GRAND TOTAL TP REMOVED (POUNDS) =				14.56660

			Subtotal TN Removed (Kilograms)	Subtotal TN Removed (Pounds)
TOTAL NITROGEN				
Street Sweepings - Dry Mass Collected (Kg)	0			
Amount of TN Removed (Kilograms)	0		0	0
Catch Basins - Dry Mass Collected	17,477			
Amount of TN Removed (Kilograms)	14		14	30
BMP - Dry Mass Collected	0			
Amount of TN Removed (Kilograms)	0		0	0
GRAND TOTAL TN REMOVED (KILOGRAMS) =		13.719		
GRAND TOTAL TN REMOVED (POUNDS) =				30.251

Instructions | INPUT Solids Weight | INPUT Solids Volume | Calculated Load Reductions | Nutrient Val

1. FSA-MS4 Loan Reduction Assessment Tool updated 2019. Accessed 5/5/2020
https://floridadep.gov/water/stormwater/documents/fsa-ms4-load-reduction-tool-updated-2019

POLLUTION PREVENTION ANALYSIS RESULTS (CONTINUED)

Most of the debris in front of the stormwater filters was composed of leaves and organic matter, but there was also lots of street litter.

As shown on the table on the right, street litter was more prevalent in the Commercial areas when compared to Residential areas.

Item type	Quantity collected in front of the 10 Commercial Area filters	Quantity collected in front of the 10 Residential Area filters
Cigarette Butts	39	7
Plastic bottles, lids and other larger plastics	8	2
Plastic bottle caps, wrappers and smaller plastics	35	4
Glass bottles	1	0
Paper wrappers, napkins and paper products	39	9
Metal cans and metal objects	8	0
Styrofoam pieces and other materials	16	2

Litter in front of the 10 inlets in Commercial Areas

Litter in front of the 10 inlets in Residential Areas

COST SAVINGS ANALYSIS

The City of Aventura protected 232 curb inlets using SOP Technologies' stormwater filters, and the average curb inlet opening area (Height x Length) is 523 square inches. The inlet open area determines the filter size, which determines pricing, amount of debris and litter blocked at the inlet, etc. Therefore, this cost analysis can be used to determine cost savings for inlets of other sizes.

Based on the FDEP Load Reduction Tool results, costs of street sweeping and catch basin cleaning were compared using the University of Florida study to FDEP, *"Municipal Separate Storm Sewer System (MS4) Practices Assessment Phase III – Reclaimed Water Areas"* (2019) by Sansalone, et al, University of Florida. The study includes cost comparisons of using street sweeping versus catch basin cleaning (figures shown below for TP and TN).

Collecting leaves, debris and street litter costs much less using street sweepers when compared to using vacuum trucks.

Implementing stormwater inlet filters allowed the City of Aventura to collect significantly more debris with street sweepers, thereby saving money.

Street Sweeping
$257 / lb. of TP
$165 / lb. of TN

Catch Basin Cleaning
$1,656 / lb. of TP
$1,016 / lb. of TN

Using data from the debris collected in front of the City of Aventura inlets, and the cost of TN and TP removal, we plotted the cost of implementing the filters and using street sweeping, versus not having filters and using catch basin cleanings. Quantities of Total Nitrogen (TN) and Total Phosphorus (TP) collected by the filters were calculated using the FDEP Load Reduction Tool and data gathered at the City of Aventura for the pounds of debris SOP Technologies filters prevented from entering stormwater catch basins.

The data show that it costs less to use SOP Technologies inlet filters and street sweeping to remove debris, when compared to not using filters and using catch basin cleaning. **Within 10 years, the net cost savings per inlet in Aventura that uses a stormwater filter is from $188 (for TP removal) and $420 (for TN removal).** The cost savings factor the upfront costs to purchase the stormwater filters, filter installations, and street sweeping throughout the 10 years.

https://floridadep.gov/water/stormwater/documents/fsa-ms4-load-reduction-tool-updated-2019
Municipal Separate Storm Sewer System (MS4) Practices Assessment Phase III – Reclaimed Water Areas Final Report To Florida Department of Environmental Protection (FDEP). University of Florida (UF) College of Engineering, Engineering School of Sustainable Infrastructure and Environment (ESSIE), Environmental Engineering Sciences (EES) Department. Gainesville, Florida 32611 USA. January 2019. https://www.florida-stormwater.org/assets/FSAEF/Research/MS4/UF%20FDEP%20MS4%20Maintenance%20Final%20Report_edited.pdf

COST SAVINGS ANALYSIS (CONTINUED)

The net cost savings per inlet with a curb inlet filter is $188 - $420 within 10 years. This includes the cost of the filter, filter installation, and ongoing debris removal using street sweeping after filter implementation.

The estimated lifespan of SOP Technologies stormwater drainage filters is over 10 years; therefore, 10 years was used to conservatively estimate the Return on Investment (ROI) and cost savings (from maintenance operations) of implementing the stormwater filters.

The total cost, including installations, to implement stormwater curb drainage filters throughout the City of Aventura was $159,972.

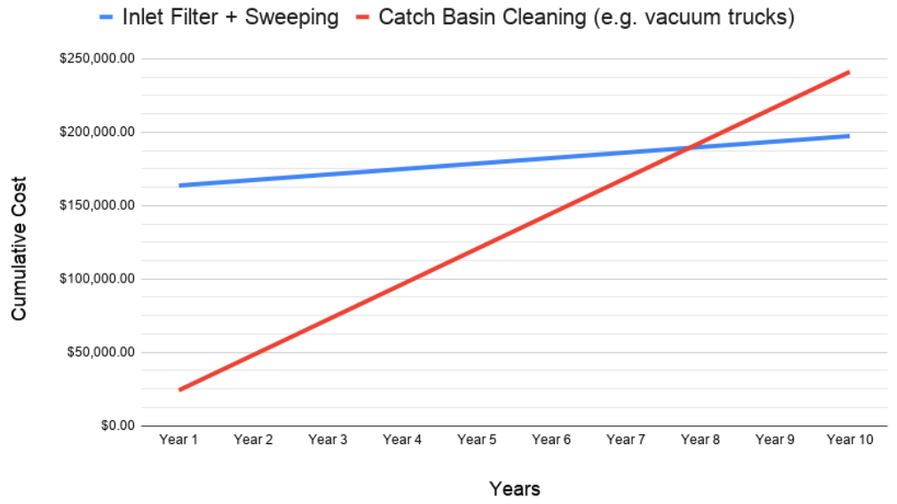
The financial "break-even point" of implementing the stormwater filters is from 6-8 years. Within 10 years, the city is estimated to save $43,000 - $97,000 on stormwater maintenance efforts because of the stormwater filters implementations.

Costs of street sweeping and catch basins cleanings are based on the cost per pound of Total Nitrogen (TN) and Total Phosphorus (TP) removal, using data from the FDEP Load Reduction Assessment Tool and the University of Florida MS4 study.

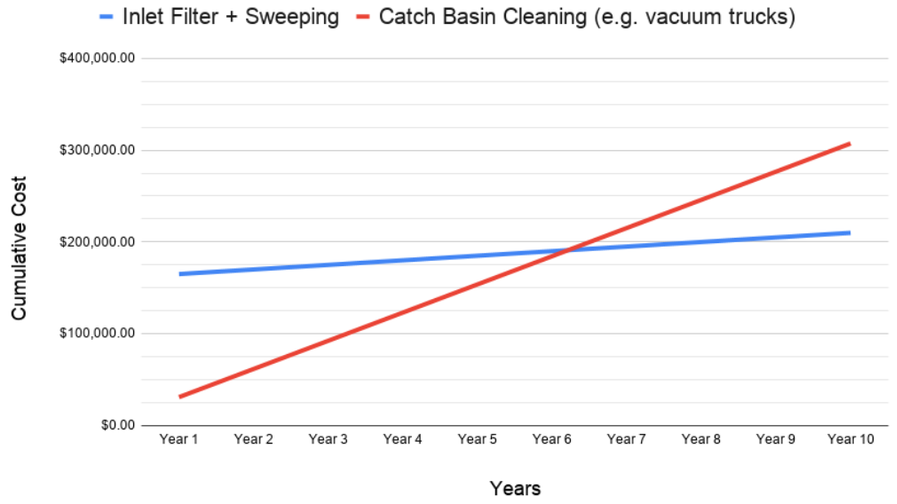
Maintenance Frequency

Before implementing stormwater curb inlet filters, the City of Aventura had a monthly (city-wide) street sweeping schedule. After implementing the filters, the city increased street sweeping to take place once every two weeks. The street sweeping is enough to keep the stormwater filters clean.

TP Removal 10 Year Cost Comparison (city-wide): Inlet Filters + Sweeping vs Catch Basin Cleanings



TN Removal 10 Year Cost Comparison (city-wide): Inlet Filters + Sweeping vs Catch Basin Cleanings



FLOOD PREVENTION ANALYSIS

Around the world, leaves, trash and debris on roadways clog stormwater drainage systems and cause floods. Although we have not quantified the specific flood prevention benefits of implementing our stormwater filters, it is known that having cleaner water flowing through drainage pipes is a way to effectively convey water, as opposed to having leaves and other items inhibiting water flow. In the City of Aventura, there haven't been floods caused by clogged storm drains or clogged stormwater filters.
Cleaner stormwater systems are more resilient to severe storm events. Here are some news headlines that tie leaves, trash and debris to flooding:

Tampa, FL *Heavy Rains Test Tampa Stormwater Drainage Improvements* *link*
""We've actually had dive teams go out and do major cleaning of barnacles and trash in some of our big pipes that outfall into the bay that have completely been blocked," said Jean Duncan, director of the city's stormwater services."

Wellington, FL *What caused Wellington roads to flood? Rapid rainfall plus clogged drains* *link*
"Not only did the sluggish storm system dump 4.25 inches of rain on Wellington in less than an hour and a half, it also came with wild winds that knocked loose branches, leaves and pine needles and clogged drains, Assistant Village Manager Jim Barnes said."

San Diego, CA *Rain floods buildings on the campus of UC San Diego* *link*
"Campus police told 10News that clogged drains may have been the cause for most of the flooding."

Denver, CO *Denver clearing debris-clogged storm drains to avert flooding* *link*
"The wrath of Mother Nature is not the only culprit behind the flooding. Trash tossed in the streets is as much to blame, said Public Works spokeswoman Emily Williams. "A lot of times, it's trash, yard debris and pet waste that is being removed from the drains," she said."

Sacramento, CA *With More Rain On The Way, County Officials Say Months Of Planning Goes Into Preventing Flooding* *link*
"The county said it's also reminding people to simply pick up any trash or leaves in their neighborhood to prevent possible drain clogging."

New York, NY *Storm Drains Fail Again in Brooklyn* *link*
"The flooding occurred because to the catch basins, which collect rain water, were full of garbage, said a city Department of Environmental Protection spokeswoman. "

Malaysia *Maintain drainage system to avoid floods - Malacca exco* *link*
""We hope all parties would adhere to the standards and regulations (on drainage system maintenance) according to schedule as we know floods occur when drains and rivers are not properly maintained. "The rain may be heavy but with the drainage system clogged with grass and mud, the situation is worsened and as such all parties should not take lightly frequent cleaning up of drains," he told *Bernama*."

West Palm Beach, FL

West Palm Beach utility crews work to clear drains to prevent flooding during, after storms *link*
"WPTV found drains clogged with vegetation, beer cans, plastics and anything else you might imagine following the flood."

SOP Technologies
Environmental Solutions
soptechint.com

For questions about this report,
please contact:

Emilio Lopez, CEO
305-792-8778
emilio@soptechint.com

Learn more about SOP Technologies stormwater filters at

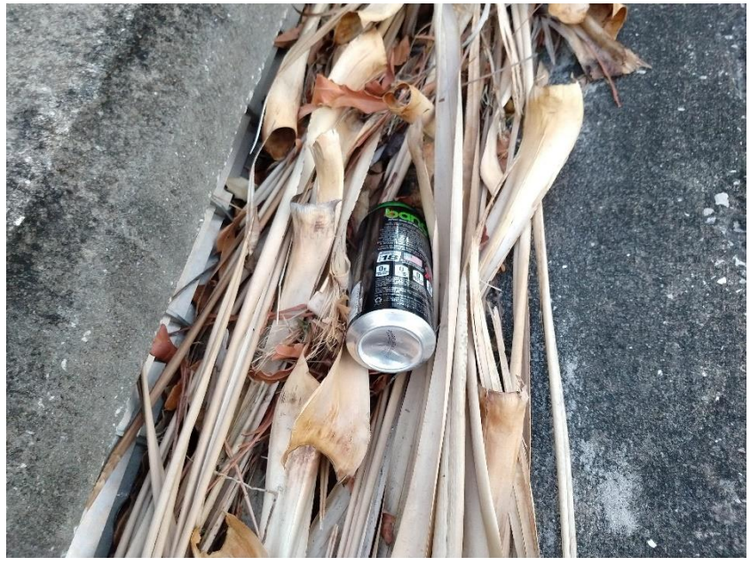
www.soptechint.com

APPENDIX

Photos of debris in front of inlet filters

APPENDIX

Photos of debris in front of inlet filters



APPENDIX

Photos of debris in front of inlet filters

APPENDIX

Photos of debris in front of inlet filters

APPENDIX

Photos of debris in front of inlet filters

APPENDIX

Photos of debris in front of inlet filters

APPENDIX

Photos of debris in front of inlet filters and weighing debris