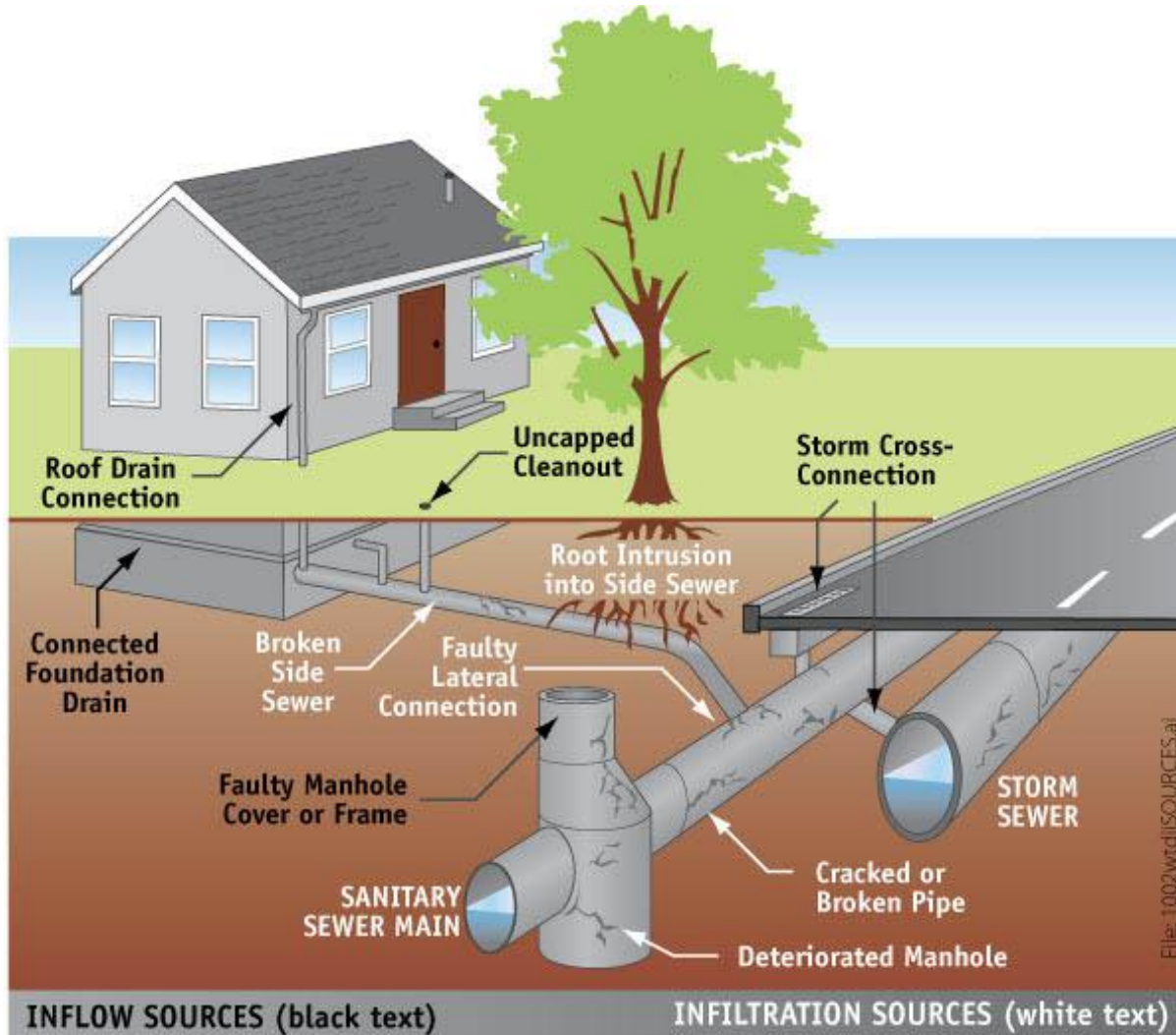


# **Town of Palm Beach Sanitary Sewer System Inflow and Infiltration**

# What is I&I?

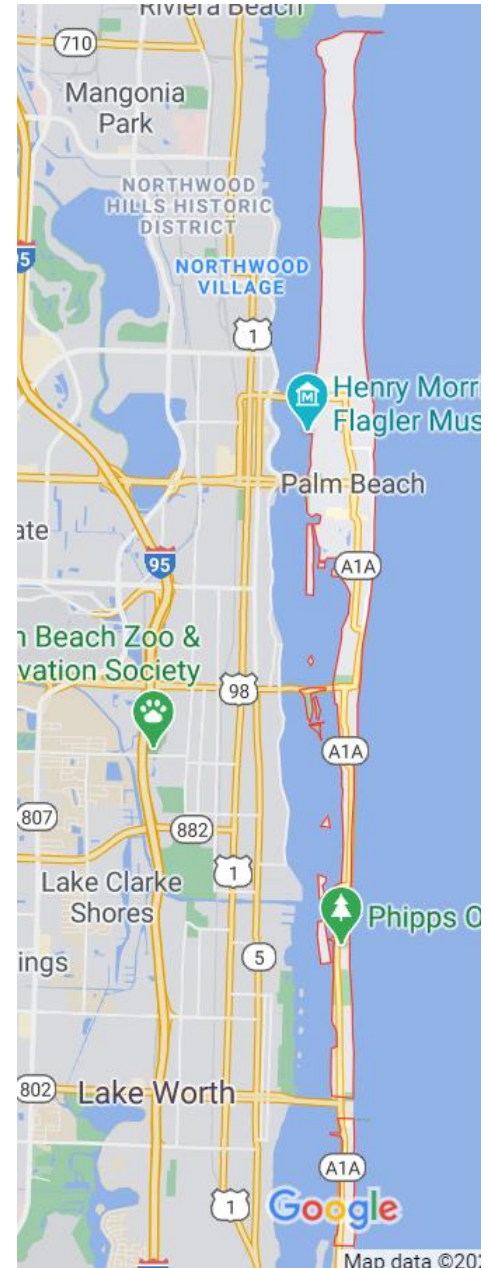


# Definitions

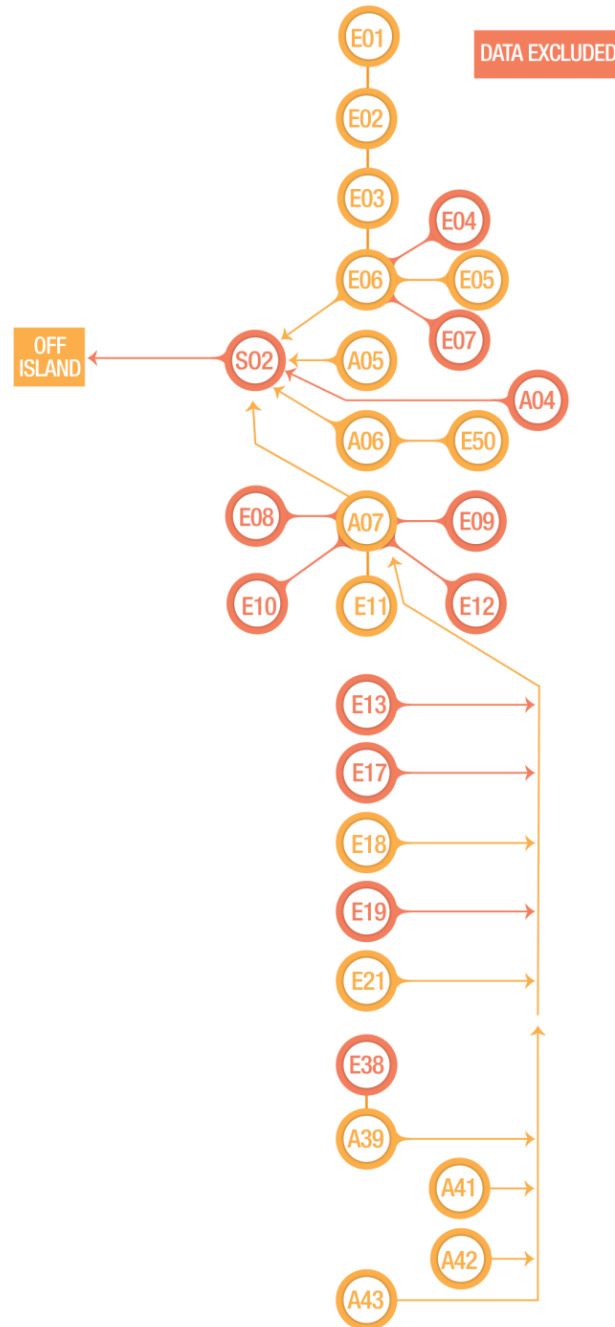
- **Infiltration** – entry of stormwater and groundwater into a sewer system from saturated soil or high-water table causing leakage underground through cracked pipes and laterals, pipe joints, or manhole chimneys
- **Inflow** – the direct entry of stormwater and groundwater into a sewer system through means such as broken manhole lids, stormwater cross-connections, open clean outs, etc.
- **Baseline Infiltration** – The groundwater infiltration that is present during dry-weather flow
- **RDII** – Rainfall Derived Inflow and Infiltration; defined as the difference between dry-weather flow and wet-weather flow
- **Slow Response** – the effect on flow in a sewer system resulting from infiltration
- **Medium Response** – the effect on flow in a sewer system caused by a combination of the continuation of inflow and the beginnings of effects from infiltration
- **Fast Response** – the immediate effect on flow in a sewer system caused by inflow

# Town of Palm Beach

- 40 miles of gravity sewer main
- 1,000 manholes
- 56 Pump/Lift Stations
- 27 miles of sewer force main
- 10,000 year-round and 25,000 seasonal residents
- Wastewater is treated at the East Central Regional Water Reclamation Facility (ECRWRF).



# Schematic Diagram of The Town of Palm Beach Sanitary Sewer System



# Sanitary Sewer Flows

Pump 1	Time Step (HH:MM:SS)	Run Time (MM:SS)	Run Time Per Hour (Min)	Hour of the Day
ON	0:13:01	03:18	3.30	0 AM - 1 AM
OFF	0:16:19			
ON	0:57:05	03:45	3.75	1 AM - 2 AM
OFF	1:00:50			
ON	2:00:46	03:02	3.03	2 AM - 3 AM
OFF	2:03:48			
ON	2:59:24	03:38	6.63	3 AM - 4 AM
OFF	3:03:02			
ON	3:56:57			
OFF	3:59:57			



Pump 2	Time Step (HH:MM:SS)	Run Time (MM:SS)	Run Time Per Hour (Min)	Hour of the Day
ON	0:41:58	02:26	2.43	0 AM - 1 AM
OFF	0:44:24			
ON	1:24:46	02:28	2.47	1 AM - 2 AM
OFF	1:27:14			
ON	2:34:28	02:24	2.40	2 AM - 3 AM
OFF	2:36:52			
ON	3:17:16	02:35	2.58	3 AM - 4 AM
OFF	3:19:51			

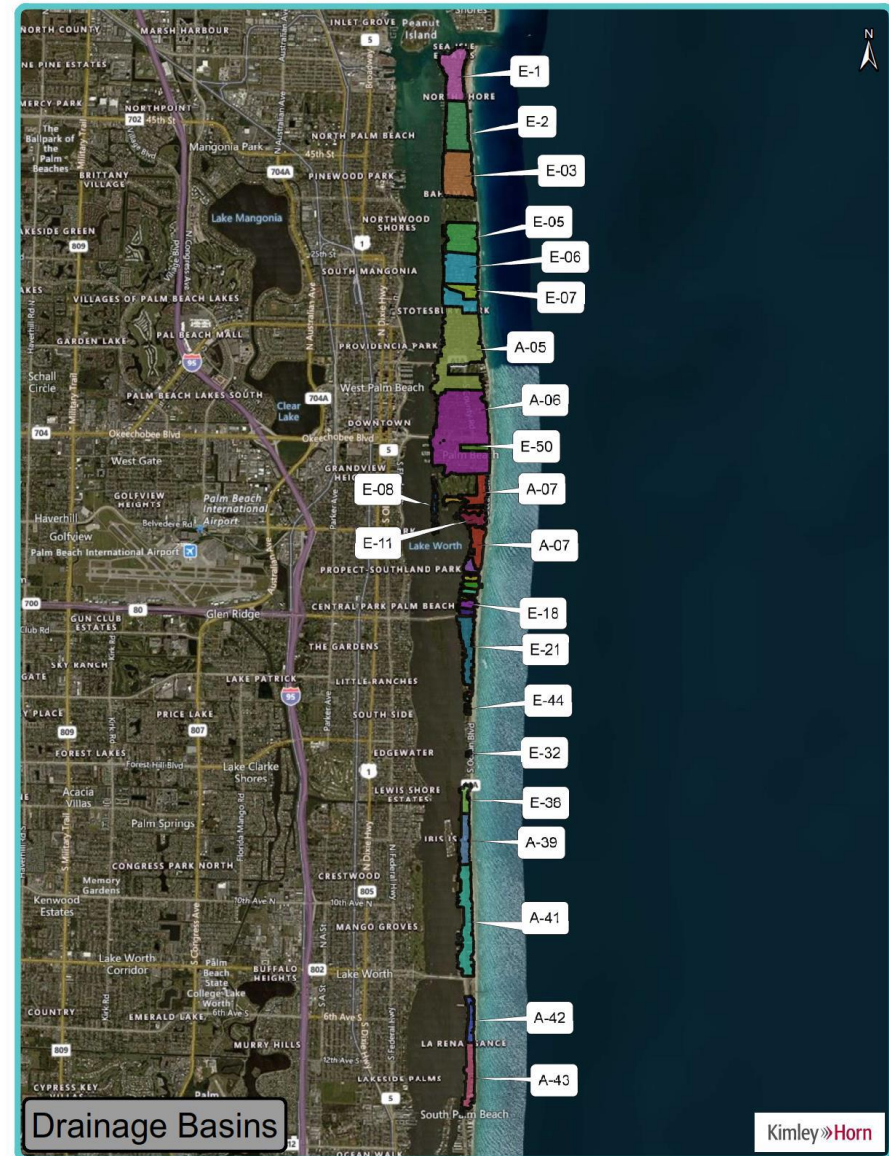


Hour of the Day	Combined Pump Run Time (Min)	Average Pump Rate (GPM)	Flow Rate (GPH)	Flow Rate (GPM)
0 AM - 1 AM	5.73	207.8	1190.69	19.84
1 AM - 2 AM	6.22		1292.52	21.54
2 AM - 3 AM	5.43		1128.35	18.81
3 AM - 4 AM	9.21		1913.84	31.90



# Sewer Basins

- Topographically delineated basins using LiDAR data
- 60 inches of average annual rainfall
- Data from the rain gauge at the Palm Beach International Airport was downloaded from NOAA NECI GIS portal to identify rain events over the prior year in Palm Beach County



Overall Sewer Basins for The Town of Palm Beach

# Sewer Basins





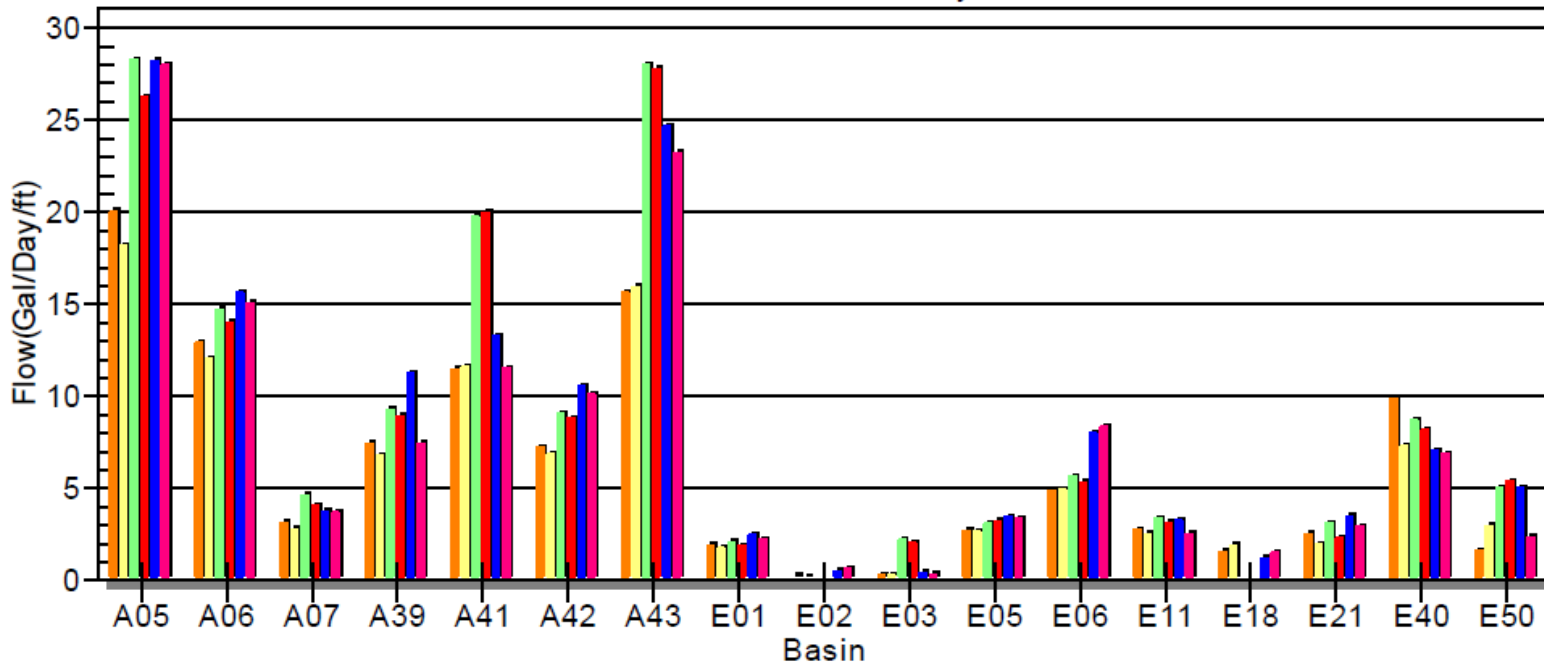
# Analysis

- ADS Environmental Slicer program
- Three yearly population seasons:
  - Winter - January to early May
  - Summer - May to early September
  - Fall – Remainder of the year
- Data analyzed between weekdays and weekends

# Determination of Dry-Weather Flows

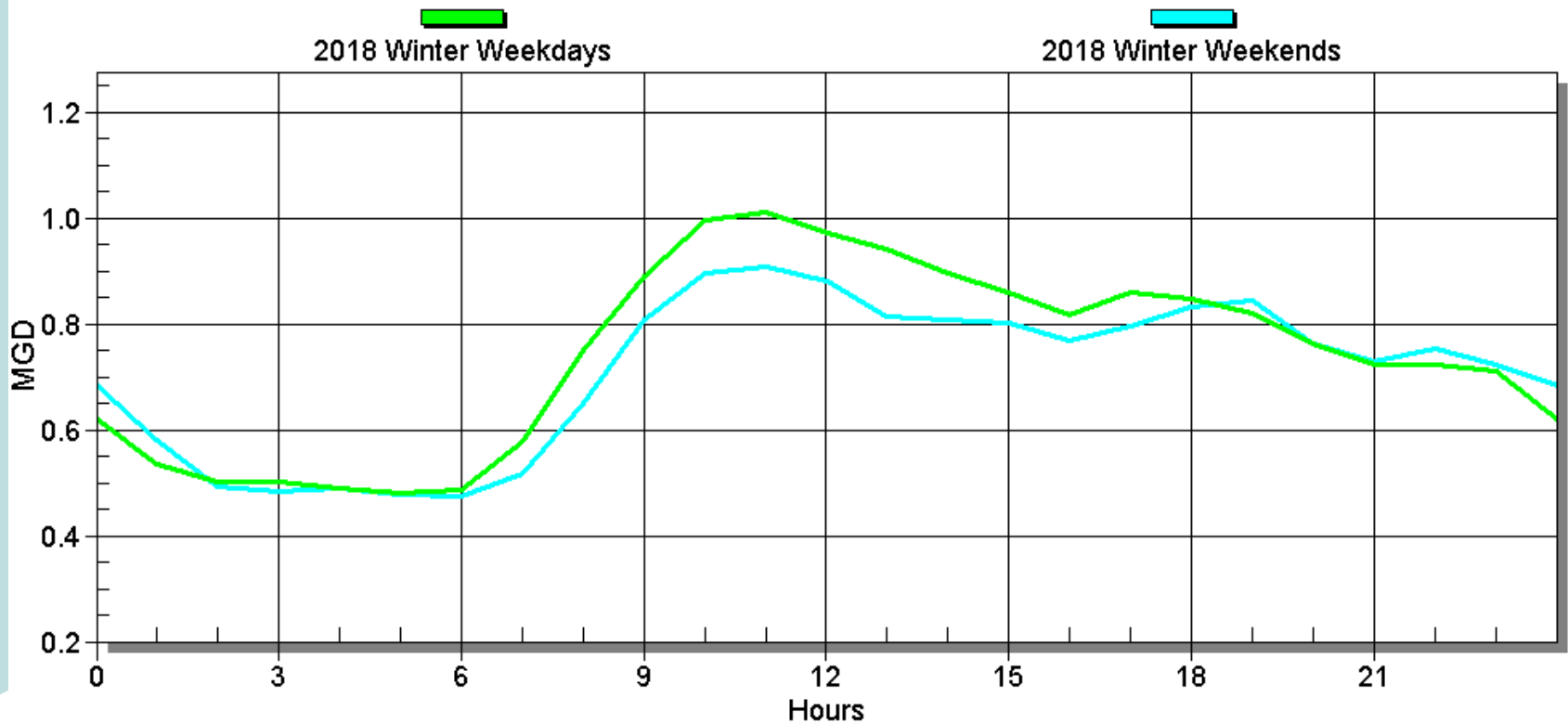
## Dry Day Flow Parameters

NetDiurnalAverage for Various Day Groups



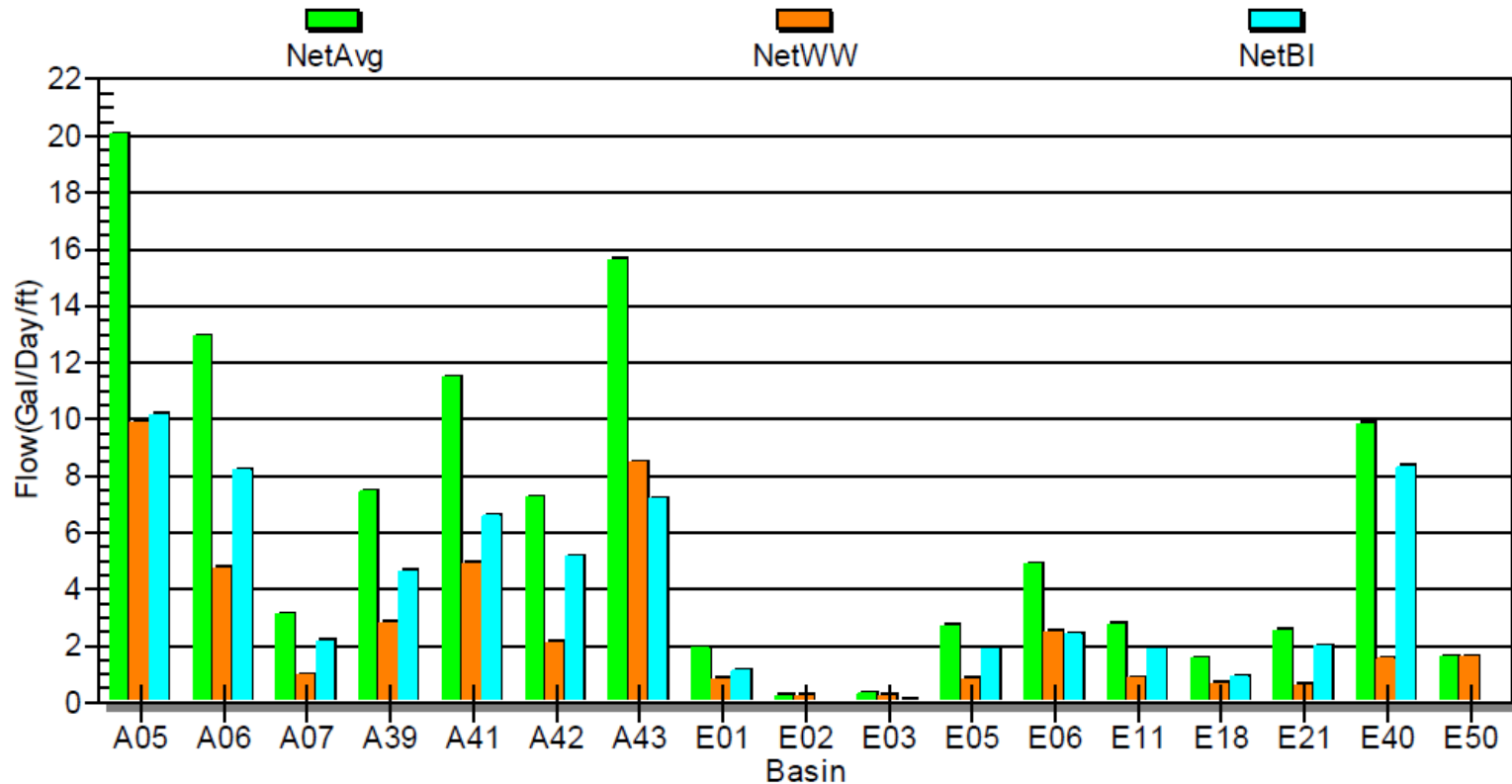
# Typical Diurnal Pattern

Dry Weather Flow  
A06



# Baseline Infiltration

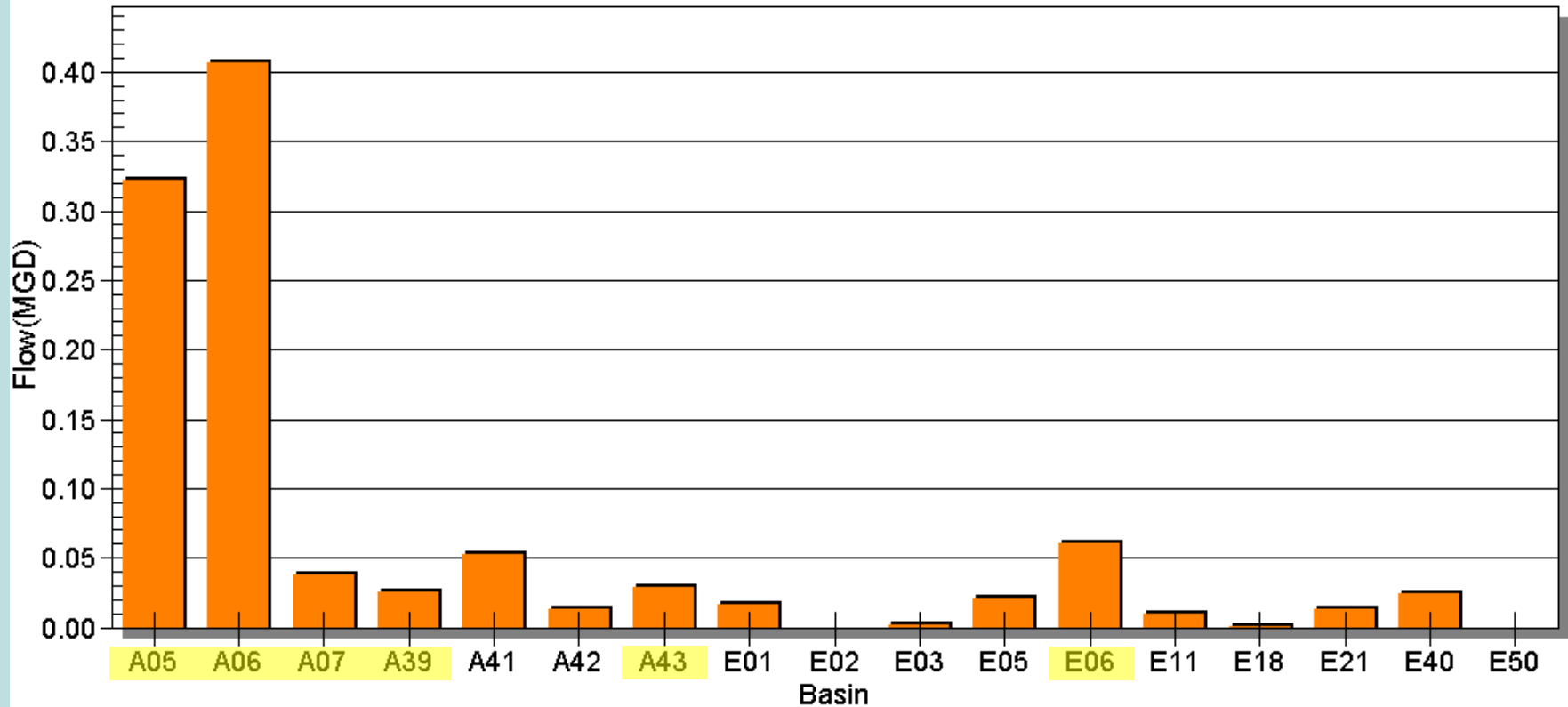
Dry Day Flow Parameters  
for 2018-Summer-Weekdays



\*Baseline Infiltration is calculated using the Stevens/Schutzbach method within the Slicer program

# Summary

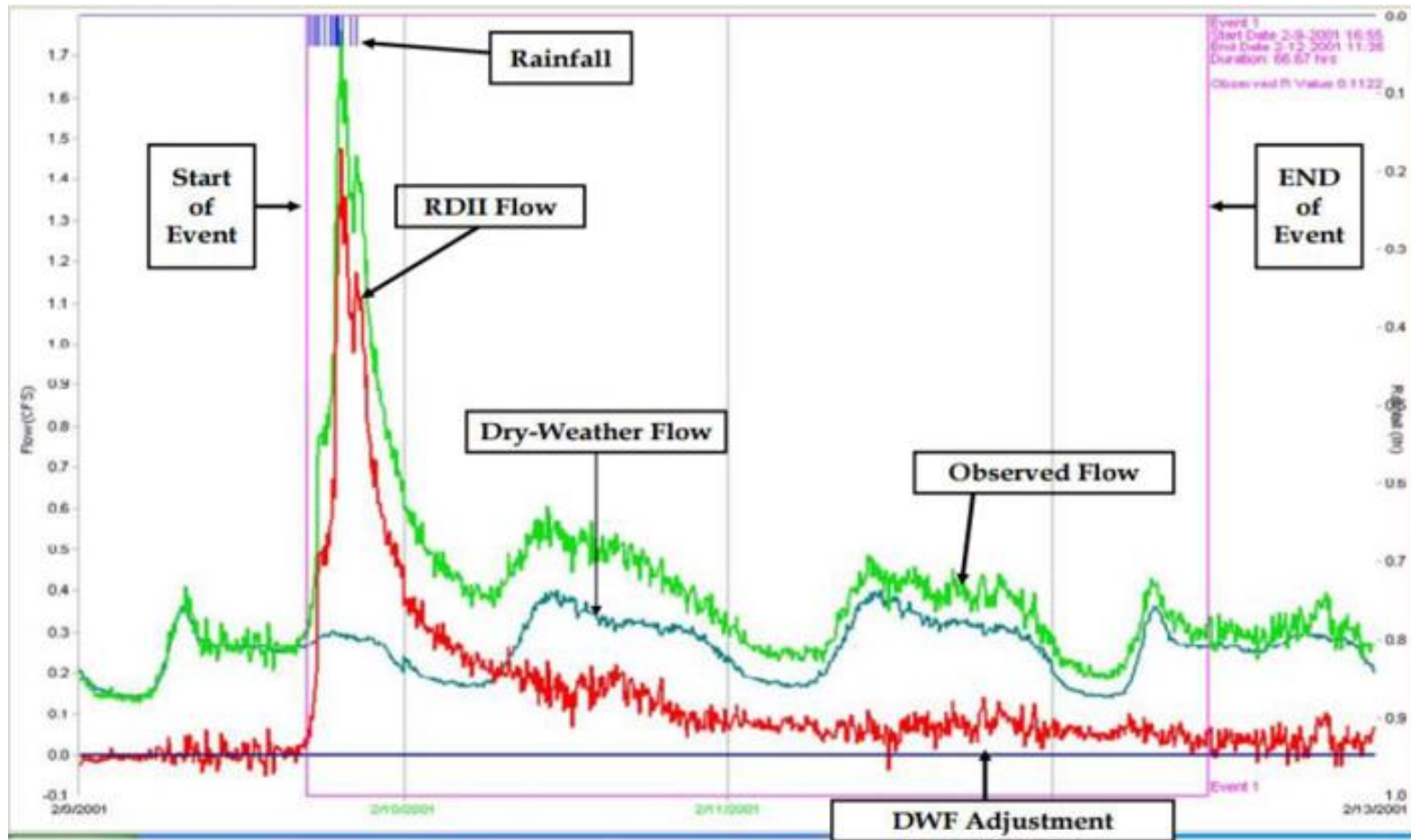
Dry Day Flow Parameters  
NetBaseInfil for Summer-2018-Weekdays



Base Infiltration Bar Graph



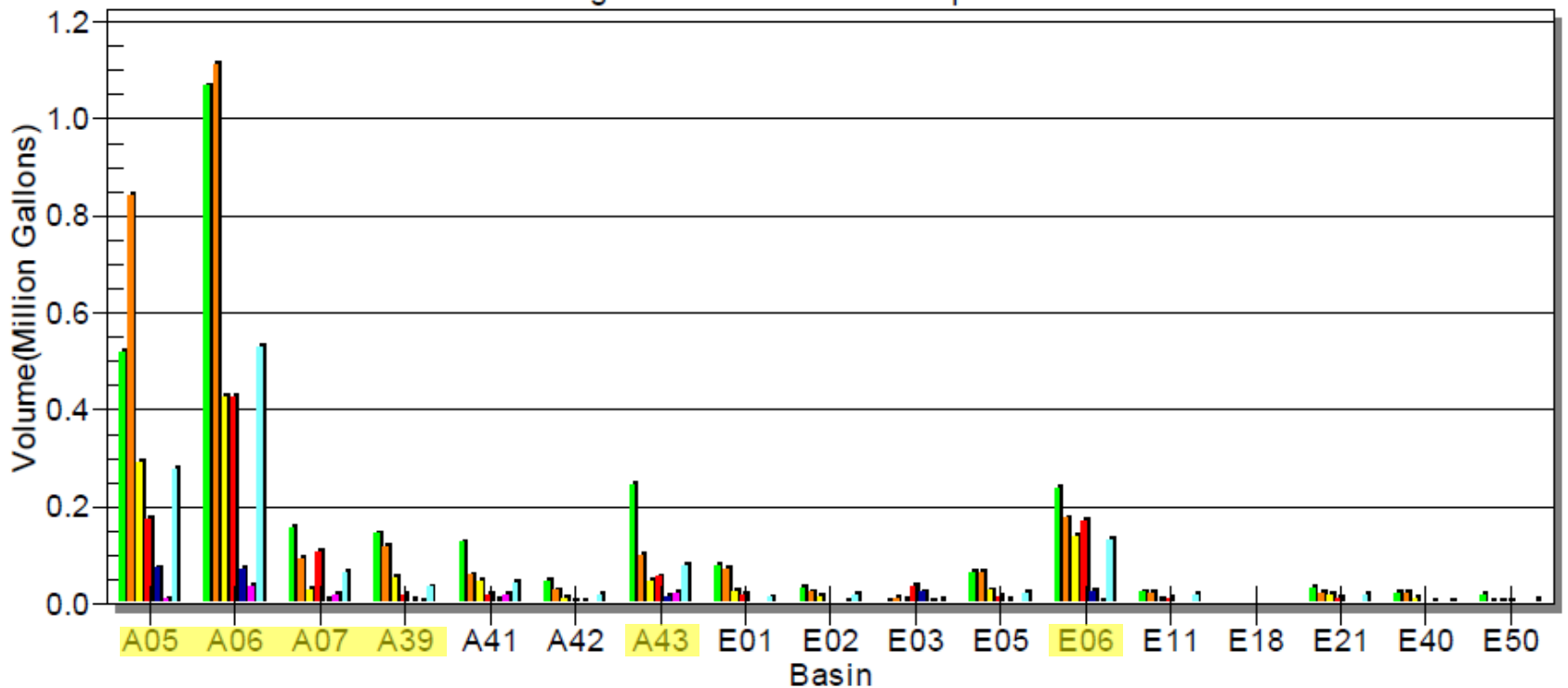
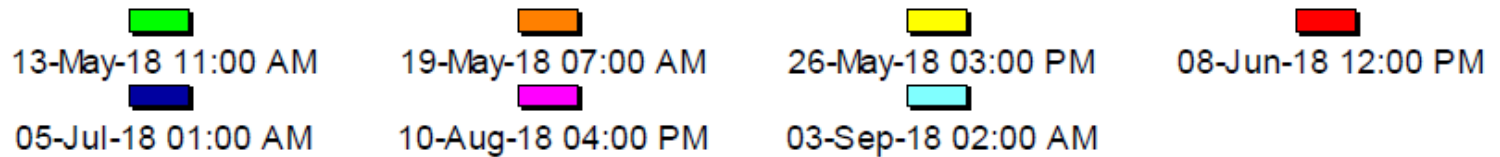
# Determination of Wet-Weather Flows



# Summary

## Rainfall Dependent Inflow/Infiltration

NetIIVolumeEvent for Various Storms



RDII Bar Graph

# Results

- Six basins account for at least 80% of the total Base Infiltration over the year and 80% of the total RDII by volume for seven storm events

Basin	Linear Feet of Sewer Pipe	Avg. Net RDII Volume (MG)	Avg. RDII Severity (Gal/LF/In.)	Avg. Base Infiltration (Gal/Day/ft.)
A06	49,800	0.524	5.603	10.156
A05	31,700	0.311	5.340	8.174
E06	25,500	0.127	2.685	2.154
A43	3,950	0.081	10.298	5.126
A07	22,600	0.078	2.286	6.574
A39	5,500	0.053	4.910	7.162

# Results

## Town of Palm Beach System Flow and Savings

<b>Base Infiltration (MGD)*</b>	<b>1.80</b>
<b>Base Infiltration (MGD) from Six Priority Basins</b>	<b>1.56</b>
<b>Est. % Infiltration Reduction</b>	<b>66%</b>
<b>Est. Infiltration Reduction (MGD)</b>	<b>1.03</b>
<b>Cost Saving per 1,000/gallons</b>	<b>\$1.85</b>
<b>Est. Cost Savings Per Year</b>	<b>\$696,000</b>

\*Base Infiltration Analyzed from 17 Sewer Basins within the Town

# Recommendations

- Flow Monitoring Meters
  - Within critical sewer basins
- Rain Gauges
  - Two gauges
  - Lift station A-39 and S-02
- Groundwater Level Sensors
  - Five Piezometers to be placed throughout the Town
  - Establish Groundwater Levels for limits of I&I Repairs
- Rehabilitation/Replacement Recommendations Pending



# Acknowledgements

- Town of Palm Beach
- ASCE Palm Beach Branch
- Tom Jensen, P.E. (Kimley-Horn)
- Jordan Walker, P.E. (Kimley-Horn)
- ADS Environmental

# Questions

