The Metropolitan

Water Reclamation District

of Greater Chicago

# WELCOME
# TO THE JANUARY EDITION
# OF THE 2017
# M&R SEMINAR SERIES

# BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2017 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

# KULDIP KUMAR, *Ph.D.*

***Current:*** Senior Environmental Soil Scientist, Biosolids Utilization and Soil Science Section, M&R, MWRDGC

***Experience:*** Associate Environmental Soil Scientist, Biosolids Utilization and Soil Science Section, M&R, MWRDGC
- GI studies: CDOT streetscape & permeable pavement
- Phosphorus source identification and tracking
- MWRD research study on using algae for nutrient removal and recovery

***Education:*** Ph.D. (Soil Science), Lincoln University, Canterbury, New Zealand
M.Sc. (Soil Sci.-Soil Physics), Punjab Agricultural University, Ludhiana, India
Bachelor of Agricultural Science (Hons. in Soil Sci.), Punjab Agricultural University, Ludhiana, India

***Professional:*** Incoming Chair of *Soil and Environmental Quality Division* of American Society of Agronomy
Associate Editor – Journal of Environmental Quality (2007 – 2013)
Senior Associate Editor – Agronomy Journal (2008 – Present)
Published over 90 papers

***Award:*** "*Fund for Excellence Award*" by Lincoln University
"*Best Quality Research Award*" by Lincoln University

# Jim Duncker

- Mr. Duncker is currently a hydrologist in the USGS Illinois District Office in Urbana.
- Mr.  Duncker has been with the USGS since 1983. starting his USGS career as a student field assistant in the USGS DeKalb Field Office collecting streamflow and groundwater data throughout northern Illinois. In 1988, he transferred to the USGS Illinois District Office in Urbana as a hydrologist working on a wide range of urban hydrology studies.
- Projects include the Lake Michigan Diversion Accounting (LMDA) program, monitoring the diversion of Lake Michigan water to the Illinois River Basin, and working jointly with UIUC and MWRD on urban hydraulics and hydrology throughout the Chicago area.  He gained solid experience in hydroacoustic flow measurements using acoustic Doppler current profilers (ADCP's), and contributed to the application of hydroacoustic flow measurement technologies within the USGS. He has also involved in studies to evaluate the effectiveness of urban stormwater best management practices utilizing his USGS experience.
- Married with wife, Carrie, and two sons, Ben and Patrick.  Enjoy a wide range of outdoor activities, watching college wrestling and listening music.

# Monitoring the Effectiveness of Urban Stormwater Best Management Practices in the Cermak-Blue Island Streetscapes Corridor in Chicago, Illinois

**Kuldip Kumar**
Metropolitan Water Reclamation District of Greater Chicago

**James Duncker**
United States Geological Survey

January 27, 2017

# Presentation Outline

- Project Background
- Need for Stormwater Management in Urban Areas
- What is Green Infrastructure (GI) Best Management Practices (BMPs)
- Streetscape Project Sustainability Goals
- Pre- and Post-Construction Conditions
- Description of BMPs
- Monitoring Plan & Results: Sewer Levels & Flow, Catch Basins, and Groundwater
- Condition and Performance of BMPs: Infiltration Characteristics, Plant Performance, & Water Quality
- Conclusions

# Background

CDOT Project – Janet Attarian & David Leopold
Monitoring Responsibility: MWRD & USGS

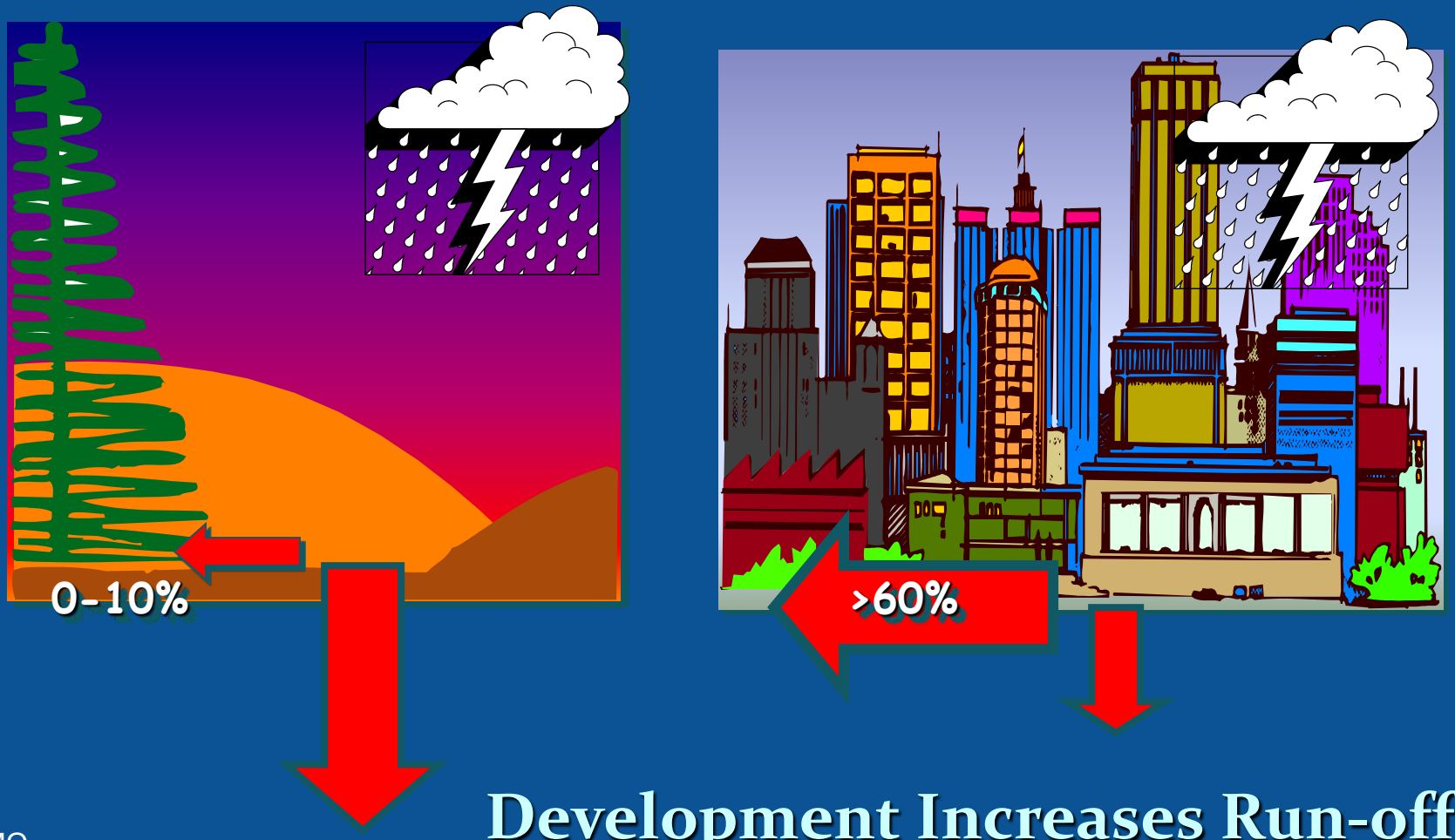
Monitoring Funding: MWRD & USGS
MWRD Funding – Stormwater Group in Engineering
(John Murray & Joe Kratzer)
M&R – Joe Kozak & Kuldip Kumar

USGS: Jim Duncker, Bill Morrow

Morton Arboretum and Chicago Botanical Garden


> 75% Impervious Surfaces
Center for Watershed Protection

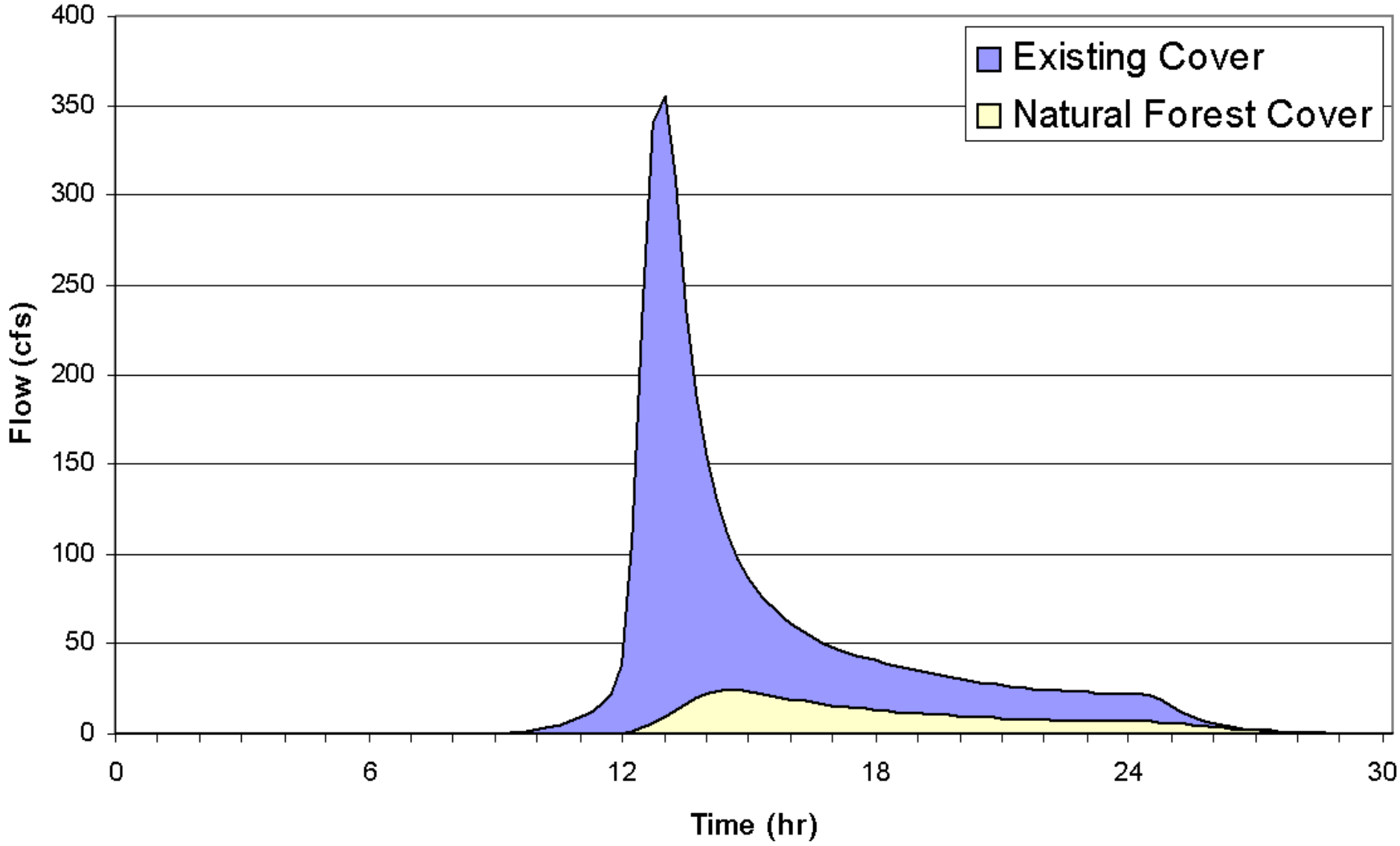
# Why Do We Need Stormwater Green Infrastructure Features?




Development Increases Run-off

NEMO

# Meeting of the Waters: 2-yr Runoff Hydrographs



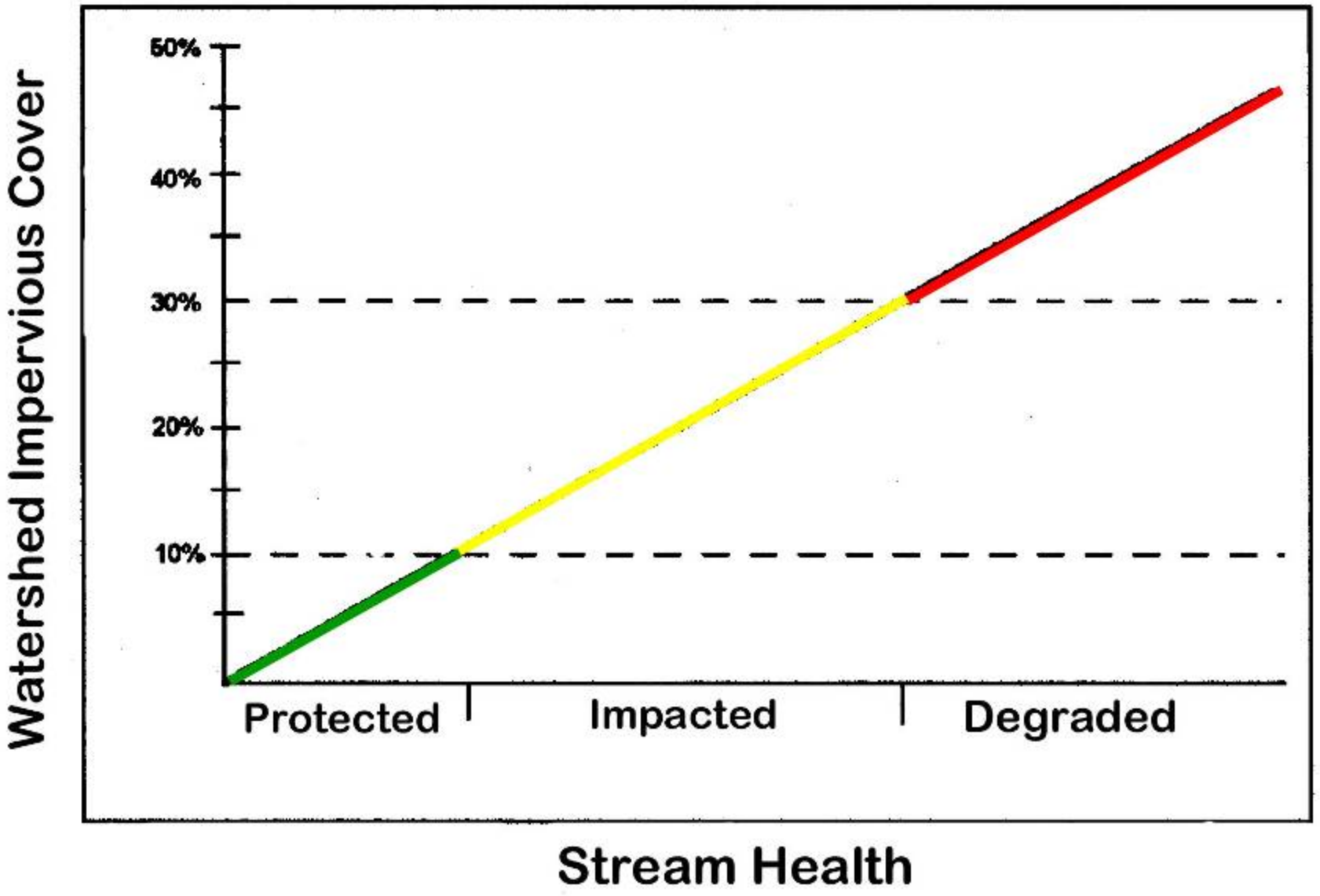
# Pollutants in Stormwater Discharges

Nutrients
Pathogens
Sediment
Toxic Contaminants
Oil and Grease
Thermal Stress

**Increased quantity**

**Decreased quality**

# Relationship of Impervious Cover to Stream Health




Center for Watershed Protection

# What is Green Infrastructure?

Utilizing soil and vegetation to manage rainwater where it falls

- Infiltration
- Vegetative uptake
- Storage
- Reuse

# Sustainable ROI

- ***Environmental:*** can both manage stormwater volume and treat runoff for a variety of pollutants
- ***Social :*** aesthetically pleasing and community building
- ***Economic:*** Can reduce the capital costs and O & M costs of gray technology; short term quicker impact

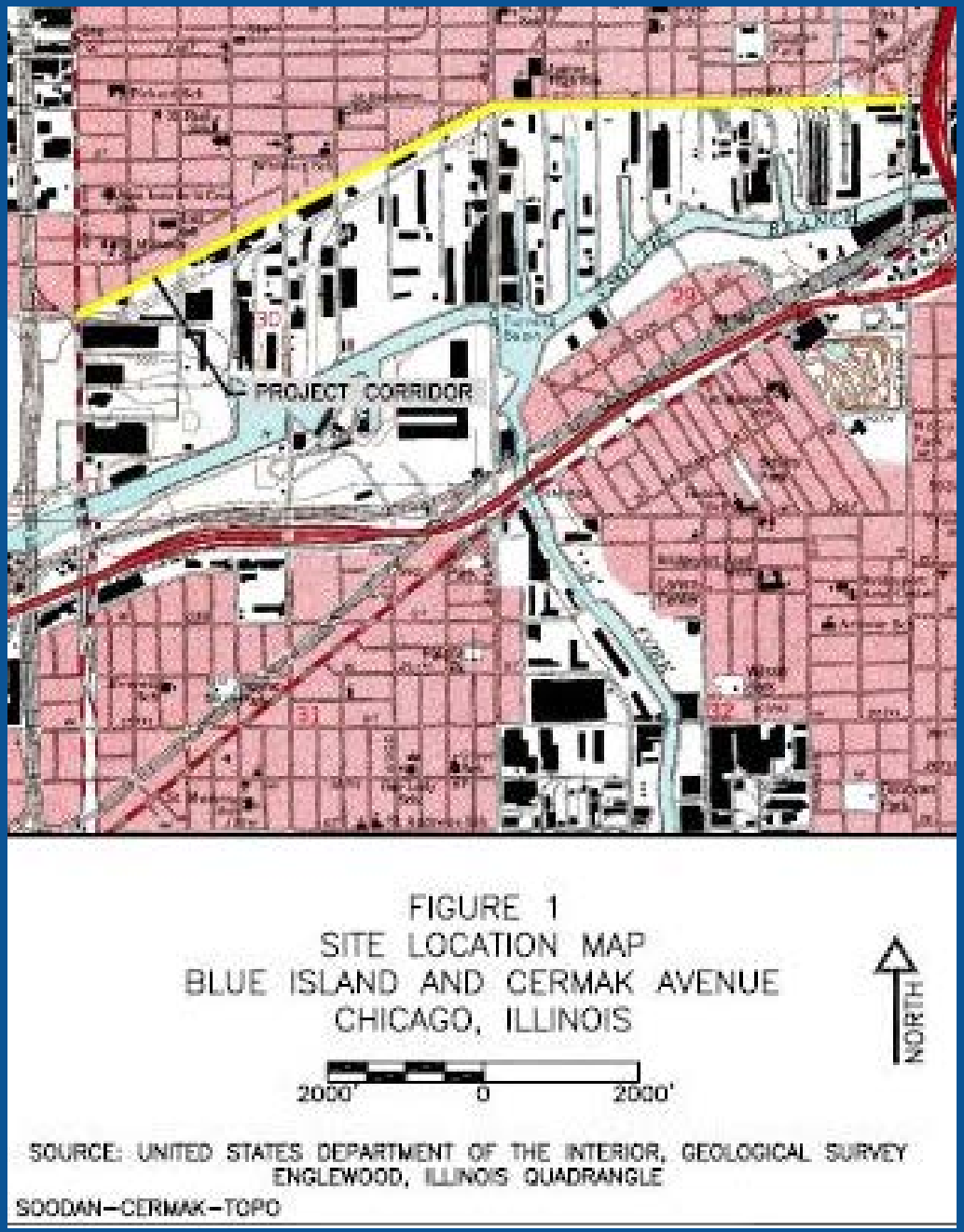
# Green Infrastructure Improves:

- Water quality
- Air quality
- Neighborhood aesthetics
- Habitat and biodiversity
- Recreational and transportation opportunities
- Property values
- Community health and vitality

# Project Sustainable Goals

| | |
|---|---|
| ***Stormwater Management*** | Divert 80% of the typical average annual rainfall and at least 2/3 of rainwater falling within catchment area into stormwater best management practices. |
| ***Water Efficiency*** | Eliminate use of potable water for irrigation, specify native or climate adapted, drought tolerant plants for all landscape material. |
| ***Transportation*** | Improve bus stops with signage, shelters and lighting where possible, promote cycling with new bike lanes, improve pedestrian mobility with accessible sidewalks. |
| ***Energy Efficiency*** | Reduce energy use by min. 40% below a typical streetscape baseline, use reflective surfaces on roads/sidewalks, use dark sky-friendly fixtures. Min. 40% of total materials will be extracted, harvested, recovered, and/or manufactured within 500 miles of the project site. |
| ***Recycling*** | Recycle at least 90% of construction waste based on LEED NC criteria, Post/Pre-Consumer recycled content must be min. 10% of total materials value. |
| ***Urban Heat Island, Air Quality*** | Reduce ambient summer temperatures on streets and sidewalks through use of high albedo pavements, roadway coatings, landscaping, and permeable pavements. Require ultra low sulfur diesel and anti-idling. |
| ***Education, Beauty & Community*** | Provide public outreach materials/self-guided tour brochure to highlight innovative, sustainable design features of streetscape. Create places that celebrate community, provide gathering space, allow for interaction and observation of people and the natural world. |
| ***Commissioning*** | Model Stormwater BMP's in Infoworks to analyze and refine design. Monitor stormwater BMP's to ensure predicted performance and determine maintenance practices. |

# Cermak-Blue Island Sustainable Streetscapes Corridor




**Pilsen neighborhood**

# Streetscape Corridor, Phase - I

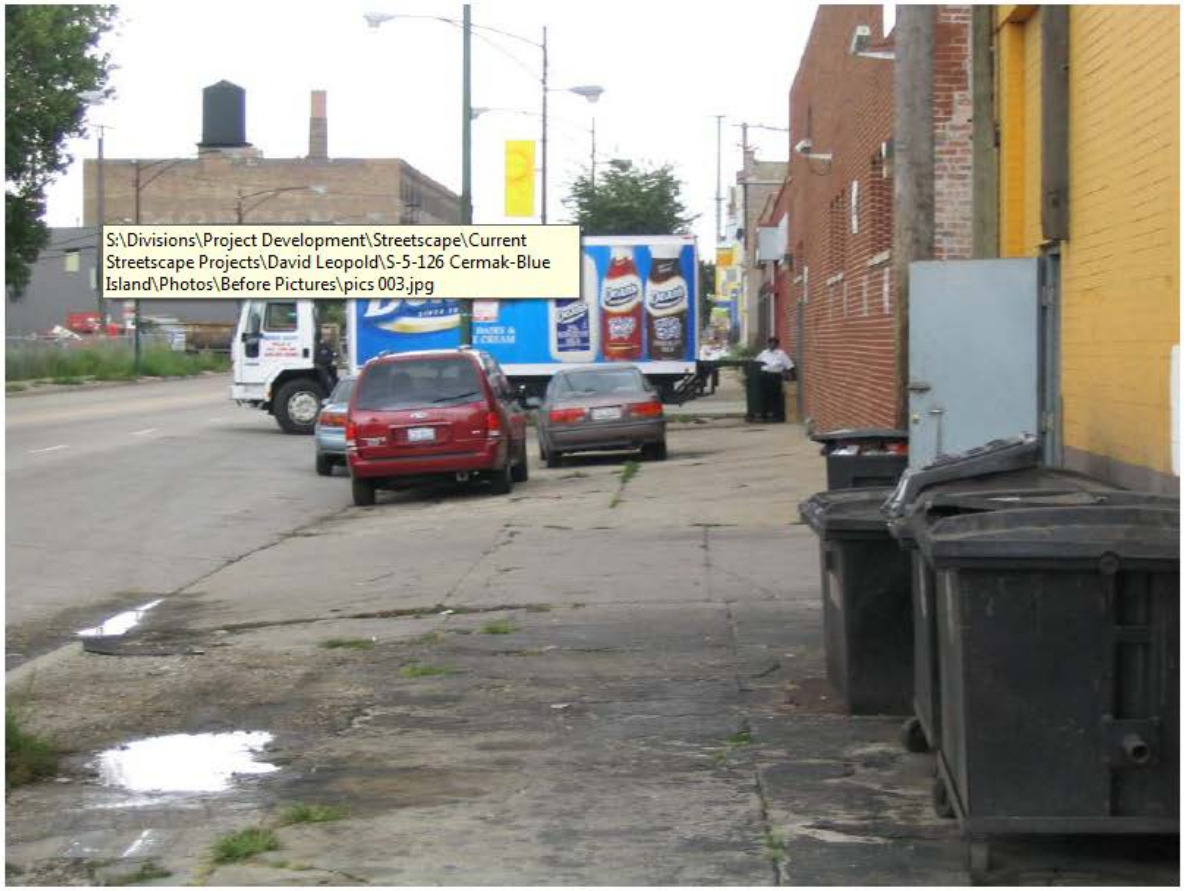
# Pre-construction conditions

Blue Island Avenue


Cermak Road

CDOT
CHICAGO DEPARTMENT
OF TRANSPORTATION

# Pre-construction conditions




CDOT
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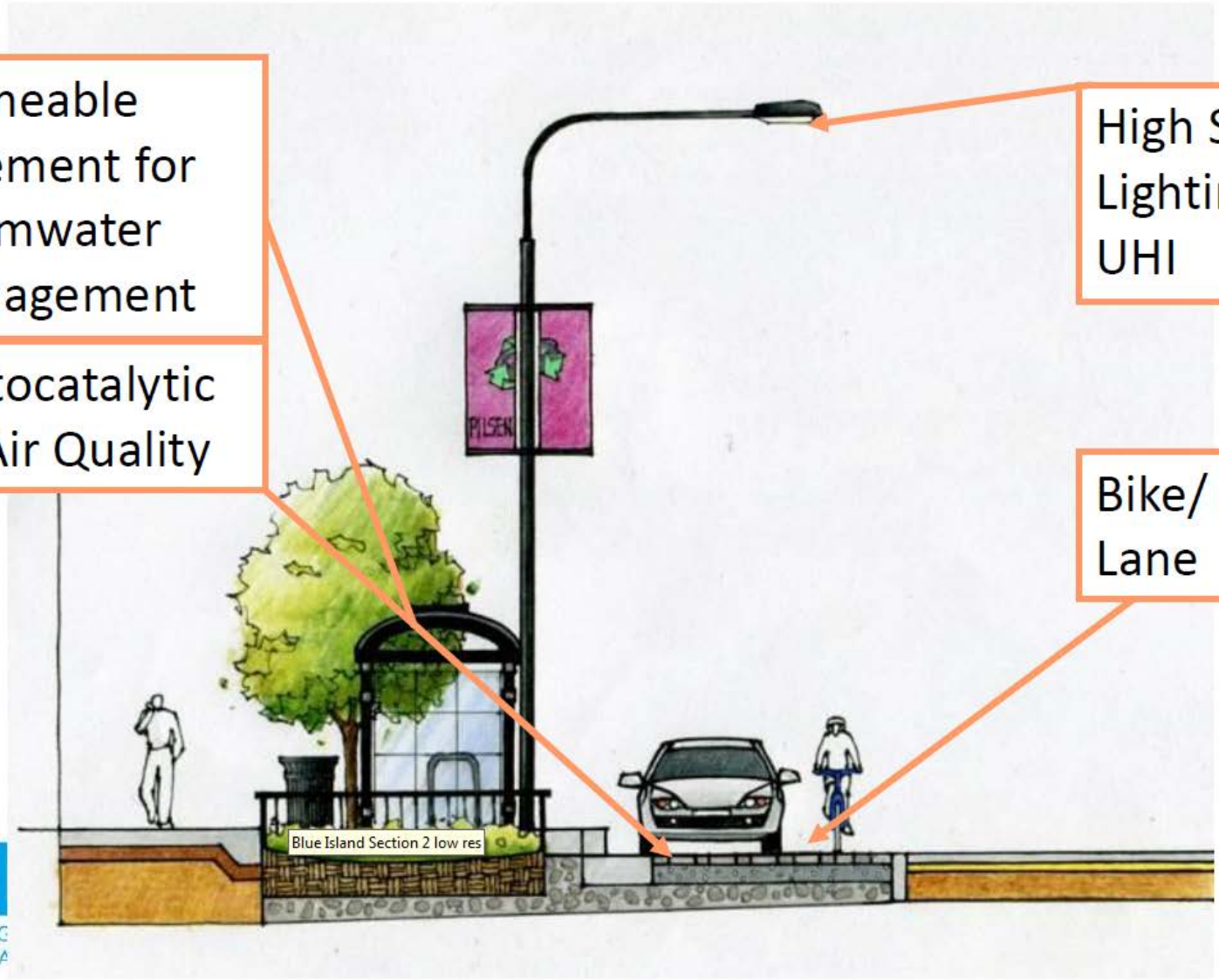
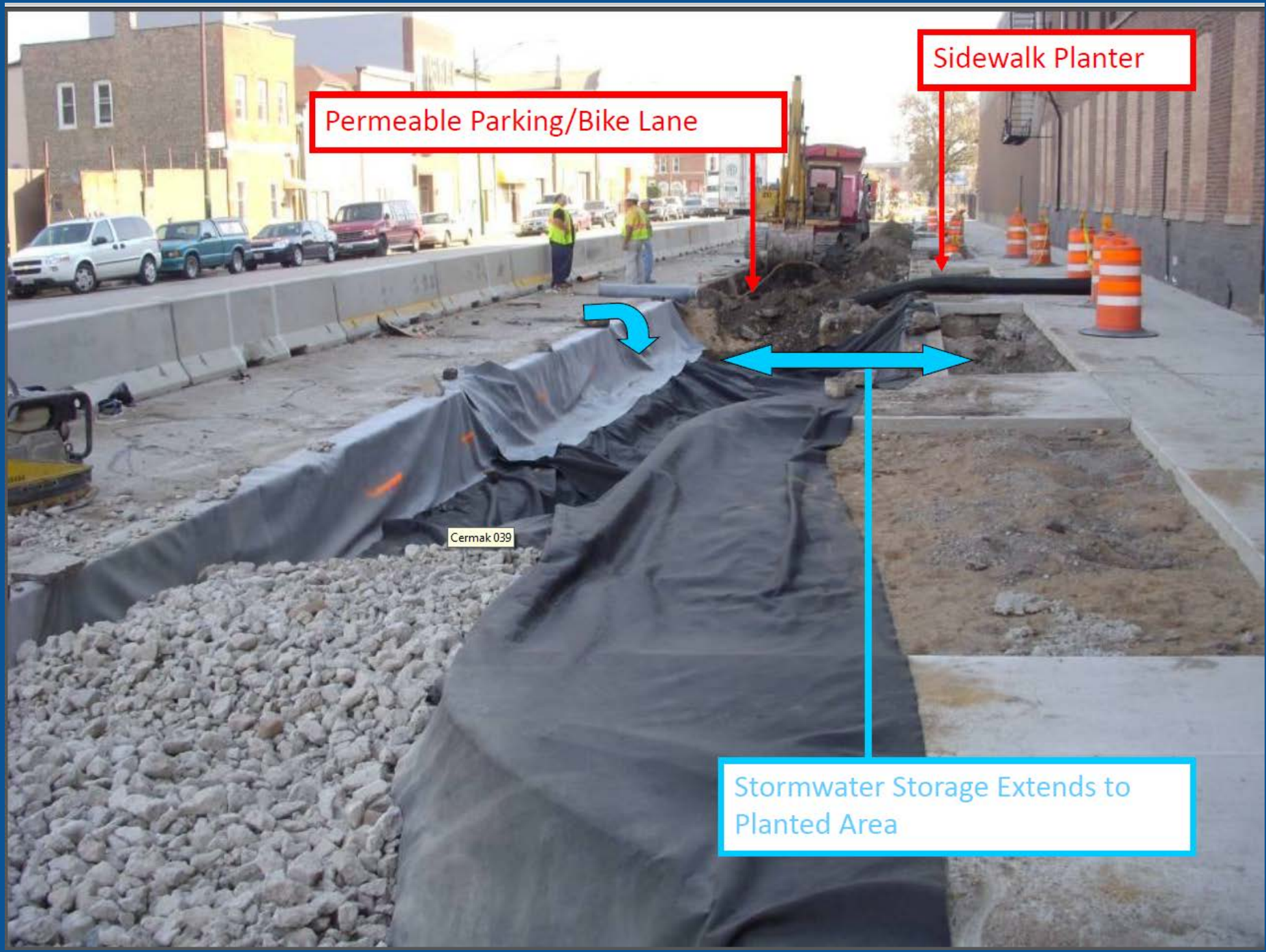
# Integrated Design: Blue Island Cross Section




Sidewalk Planter
Permeable Parking/Bike Lane
Cermak 039
Stormwater Storage Extends to Planted Area

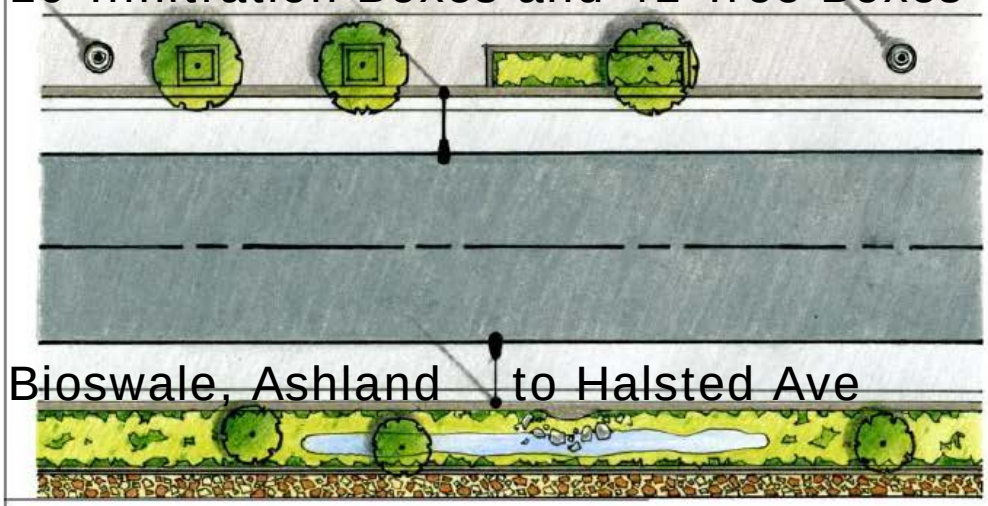

RIGHT
LANE
ONLY
2012.10.04

# Before & Present

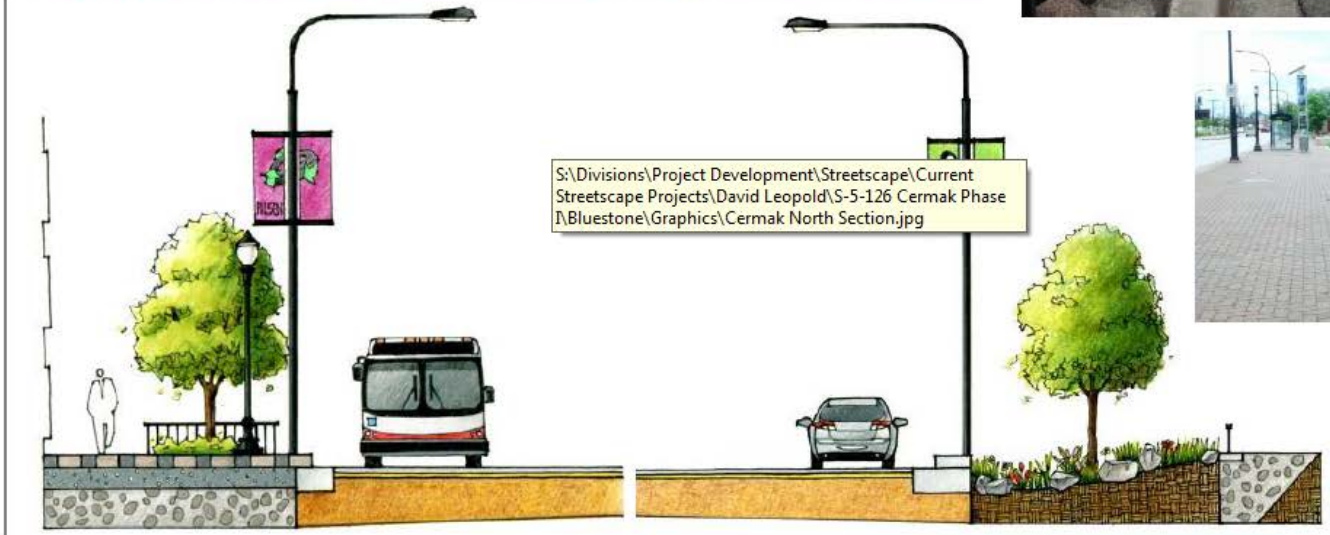
43 Infiltration Boxes -Blue Island Rd

# Cermak Road

19 Infiltration Boxes and 41 Tree Boxes



Bioswale, Ashland to Halsted Ave

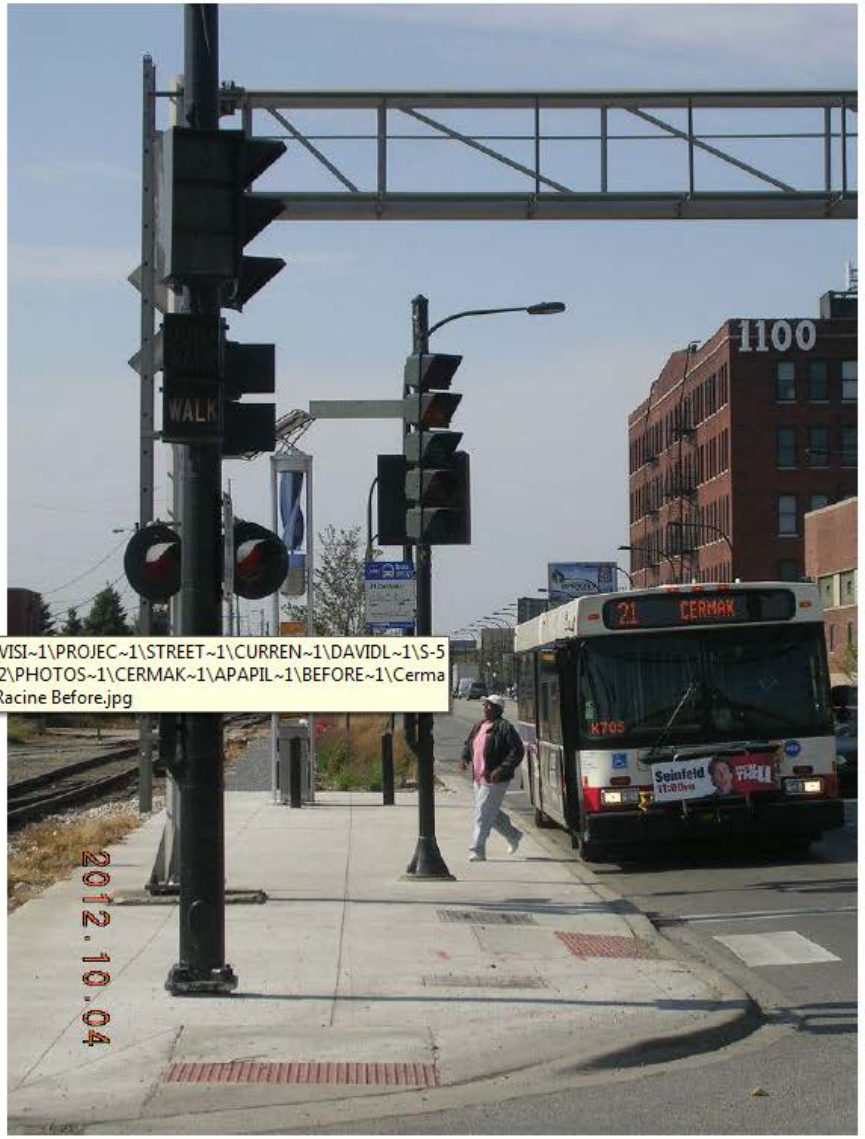



Bioswale - School

# Before/After Cermak Rd.


S:\DIVISI~1\PROJEC~1\STREET~1\CURREN~1\DAVIDL~1\S-5-12~2\PHOTOS~1\CERMAK~1\APAPIL~1\BEFORE~1\Cermak at Peoria Before_v2.jpg

# Before/After Cermak Rd.




S:\DIVISI~1\PROJEC~1\STREET~1\CURREN~1\DAVIDL~1\S-5-12~2\PHOTOS~1\CERMAK~1\APAPIL~1\BEFORE~1\Cermak at Racine Before.jpg

# Juarez Water Feature


CDOT
CHICAGO DEPARTMENT OF TRANSPORTATION

S:\Divisions\Project Development\Streetscape\Current Streetscape Projects\David Leopold\S-5-126 Cermak Phase I\Bluestone\Graphics\Juarez Plan.jpeg

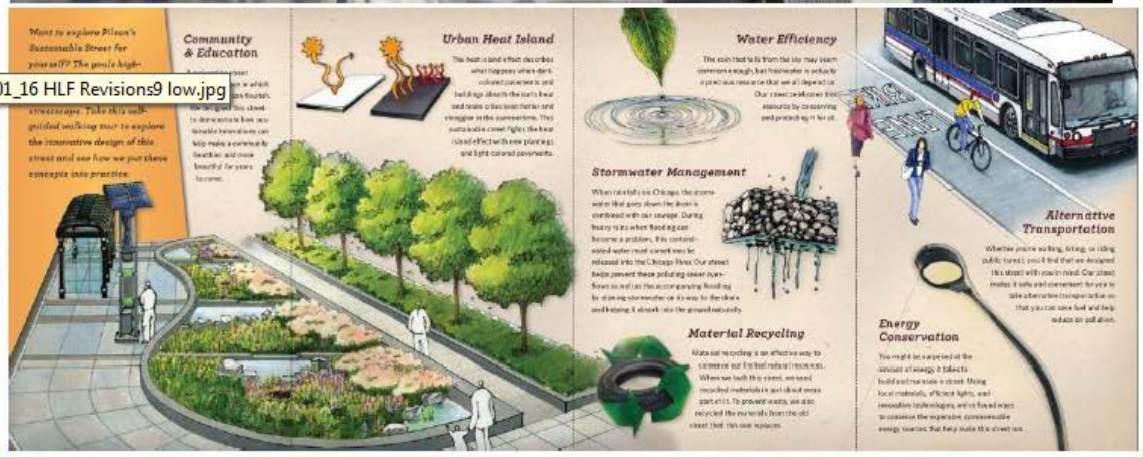
# Juarez Water Feature

S:\Divisions\Project Development\Streetscape\Current Streetscape Projects\David Leopold\S-5-126 Cermak Phase I\Bluestone\Graphics\12.29.11 NEW JUAREZ PICS DSCN3868.jpg

# Education: Informational Kiosks with Interpretive Graphics, Lightpole Identifiers, and Walking Tour



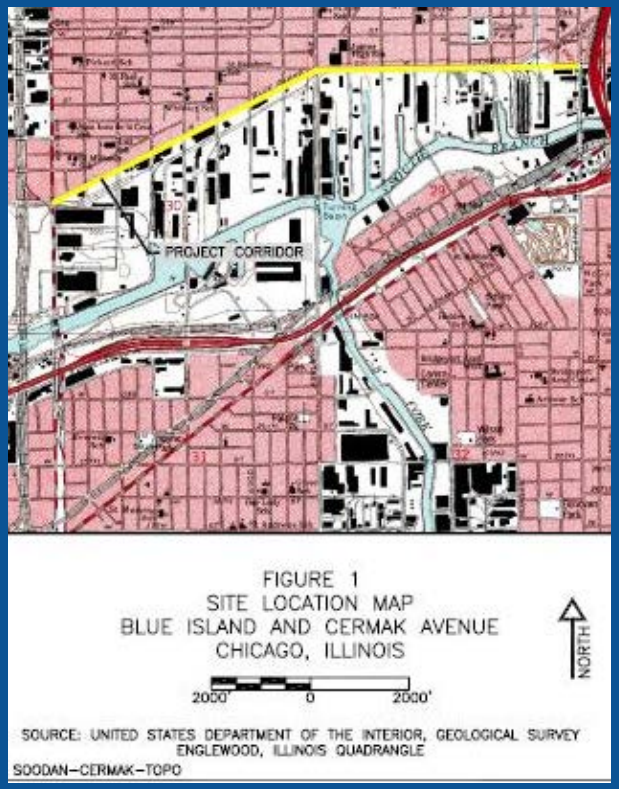

2011_01_16 HLF Revisions9 low.jpg

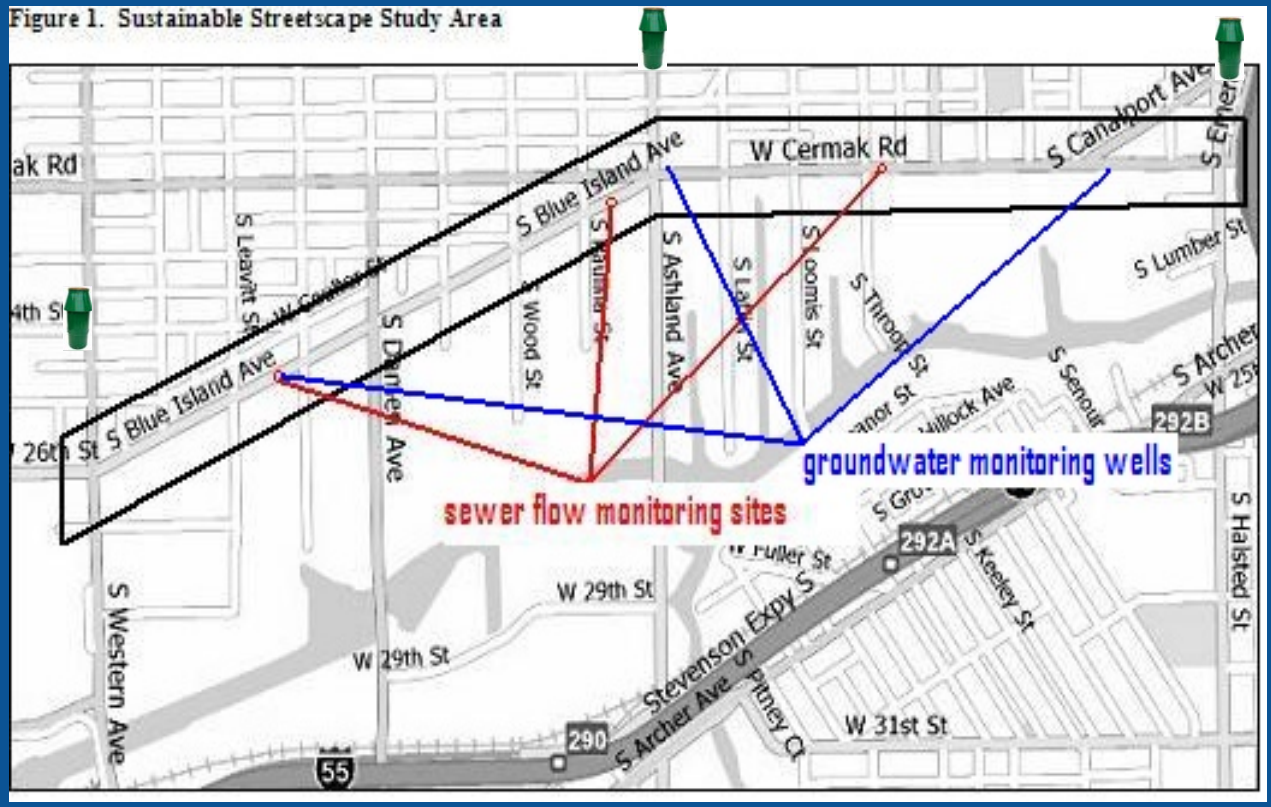


# Stormwater Volume Reduction

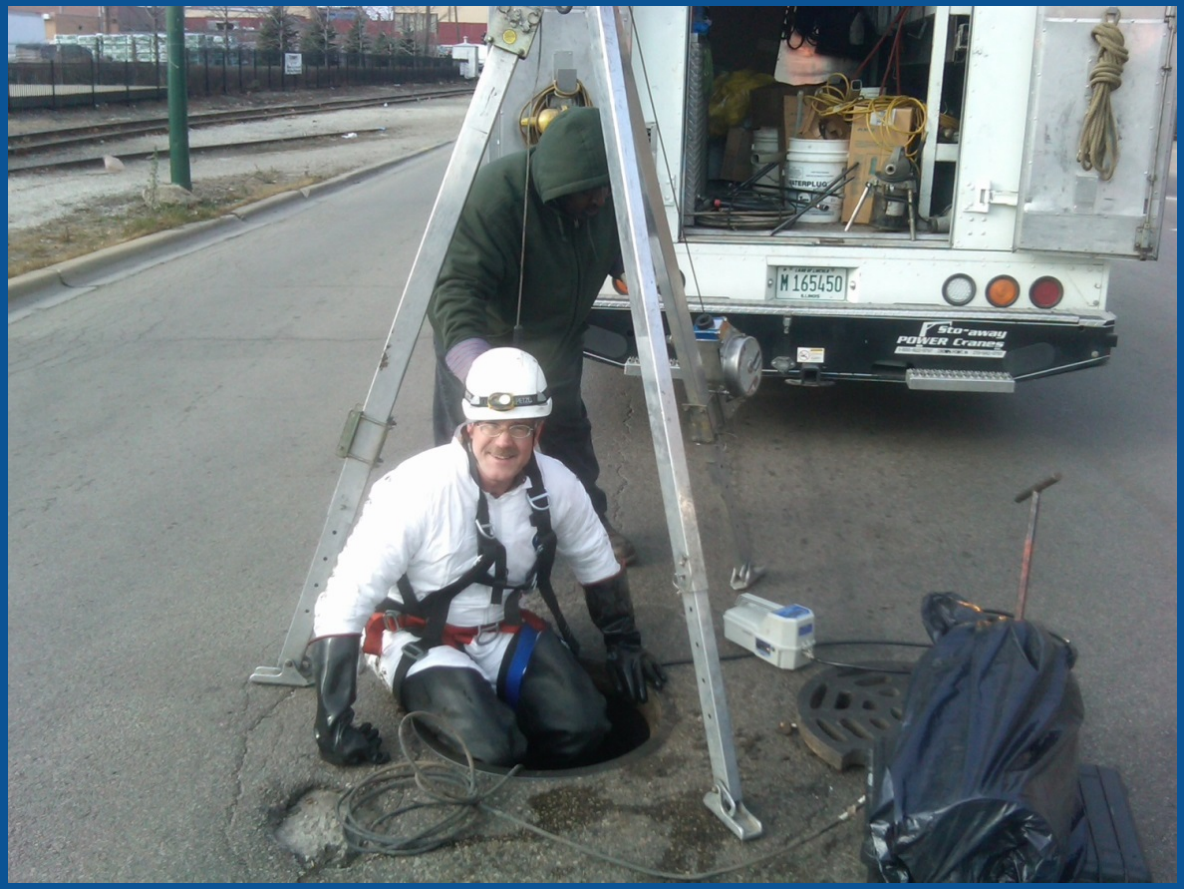
# Sewer geyser - MWRD interceptor near Cermak and Ashland

# Streetscapes Project Monitoring Area: Blue Island Ave-Cermak Rd Corridor

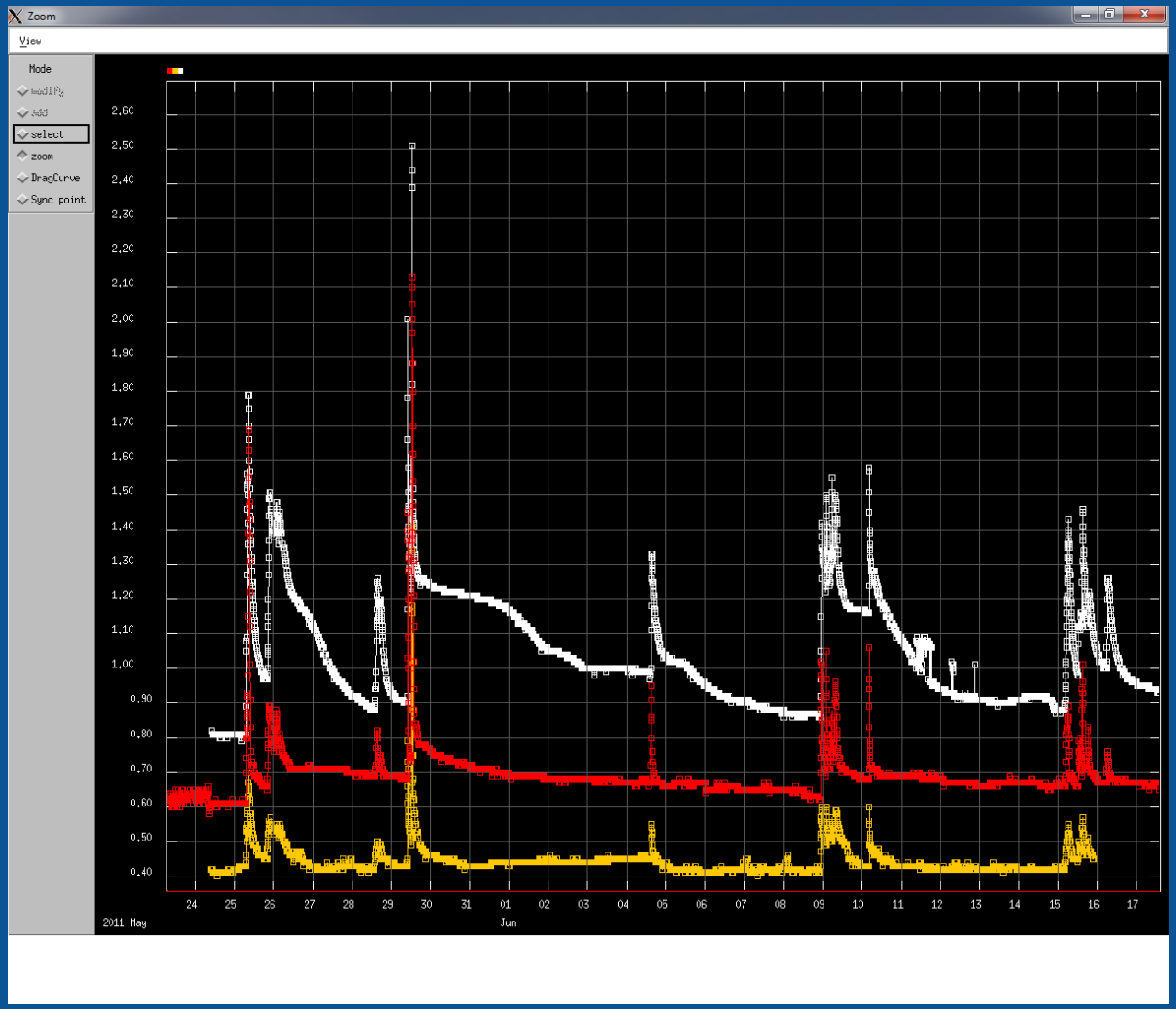


# Sewer flow monitoring




Analysis of sewerflow data pre- and post-construction of BMP's to evaluate effectiveness at reducing stormwater loads to local sewers.




# Pre-construction Sewer flow data

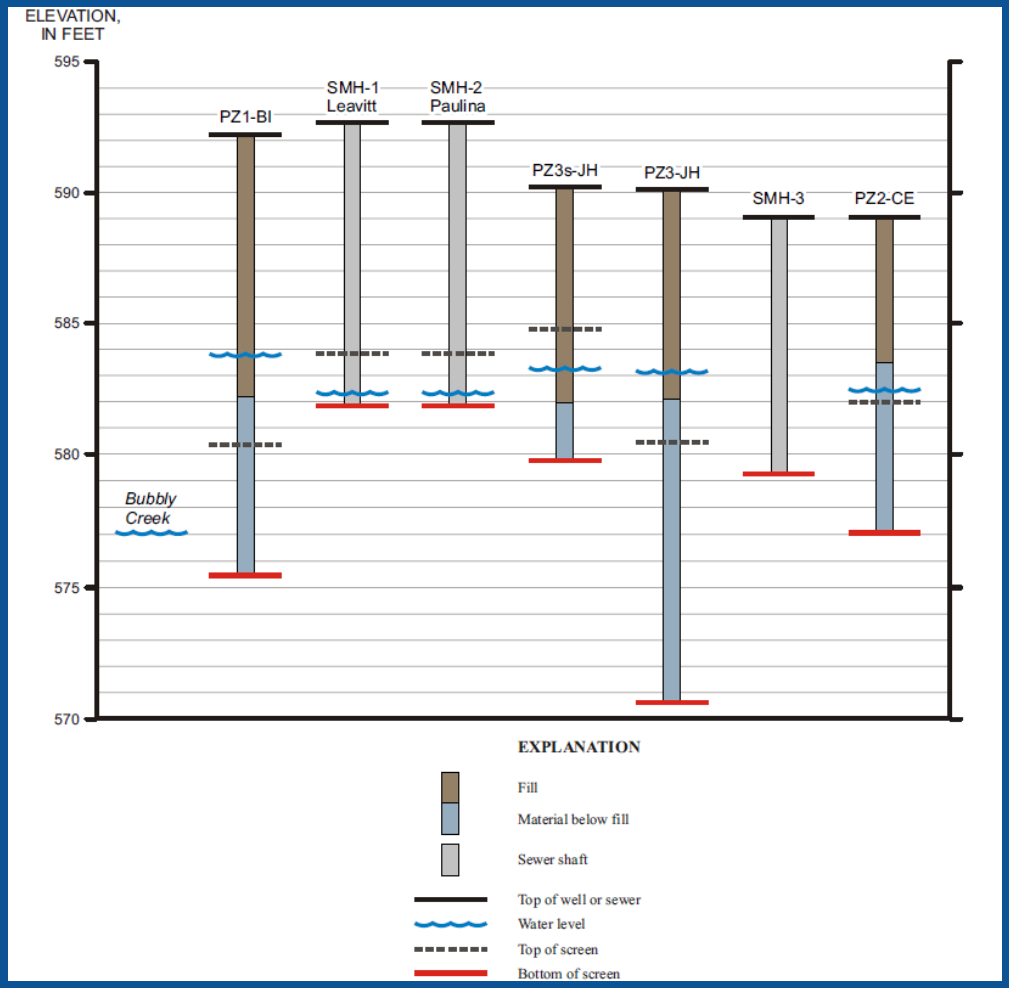
white- Throop
red- Leavitt
yellow- Paulina

(Separate sewer lines)

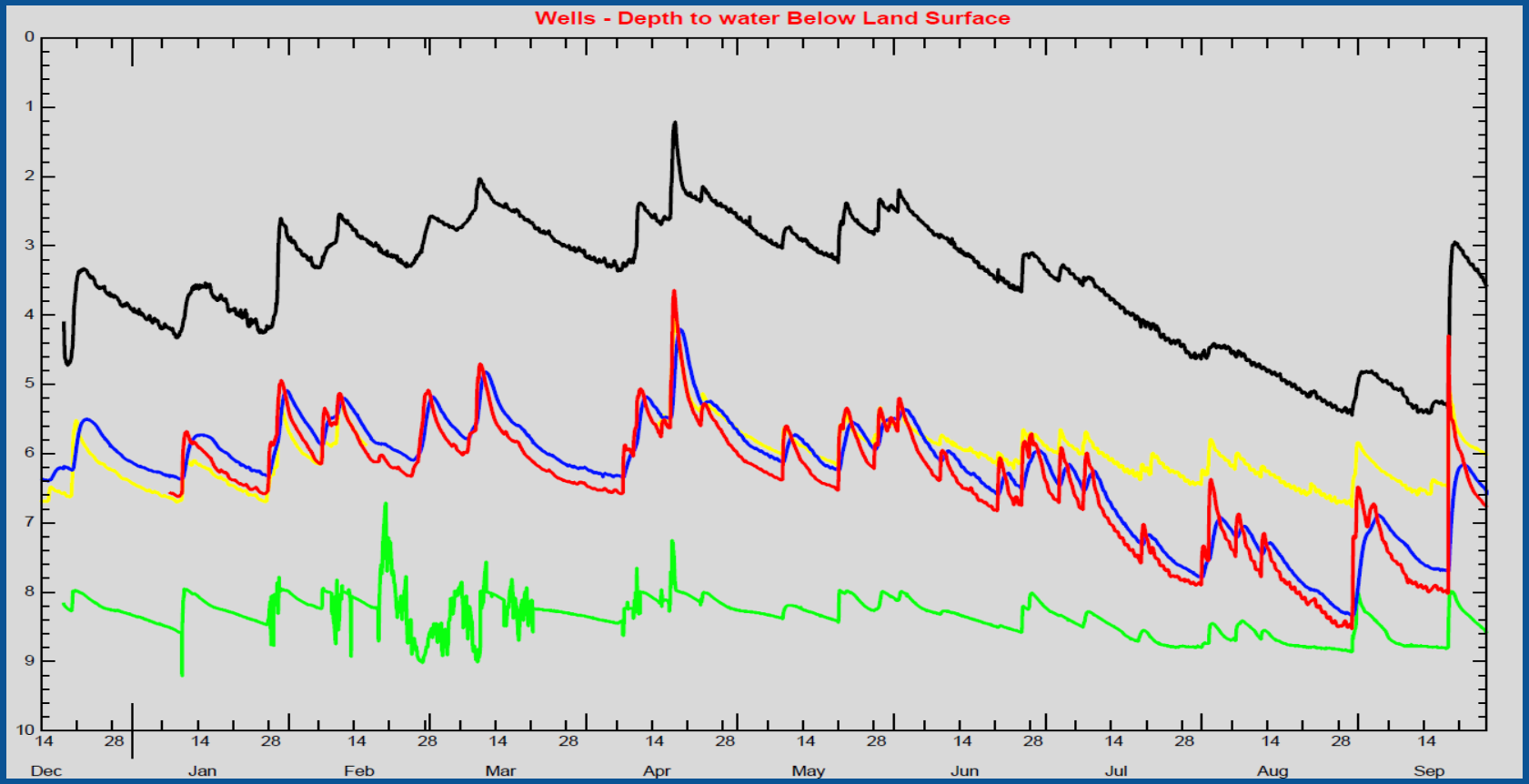
# Groundwater Monitoring

- Four monitoring locations (5 monitoring wells)
  - Leavitt
  - Juarez High school (2)
  - Canalport
  - Bioswale
- Groundwater level relative to sewers and BMP's
- What are characteristics of groundwater infiltration after storm event. Drainage rates??

# Groundwater-relative water elevations



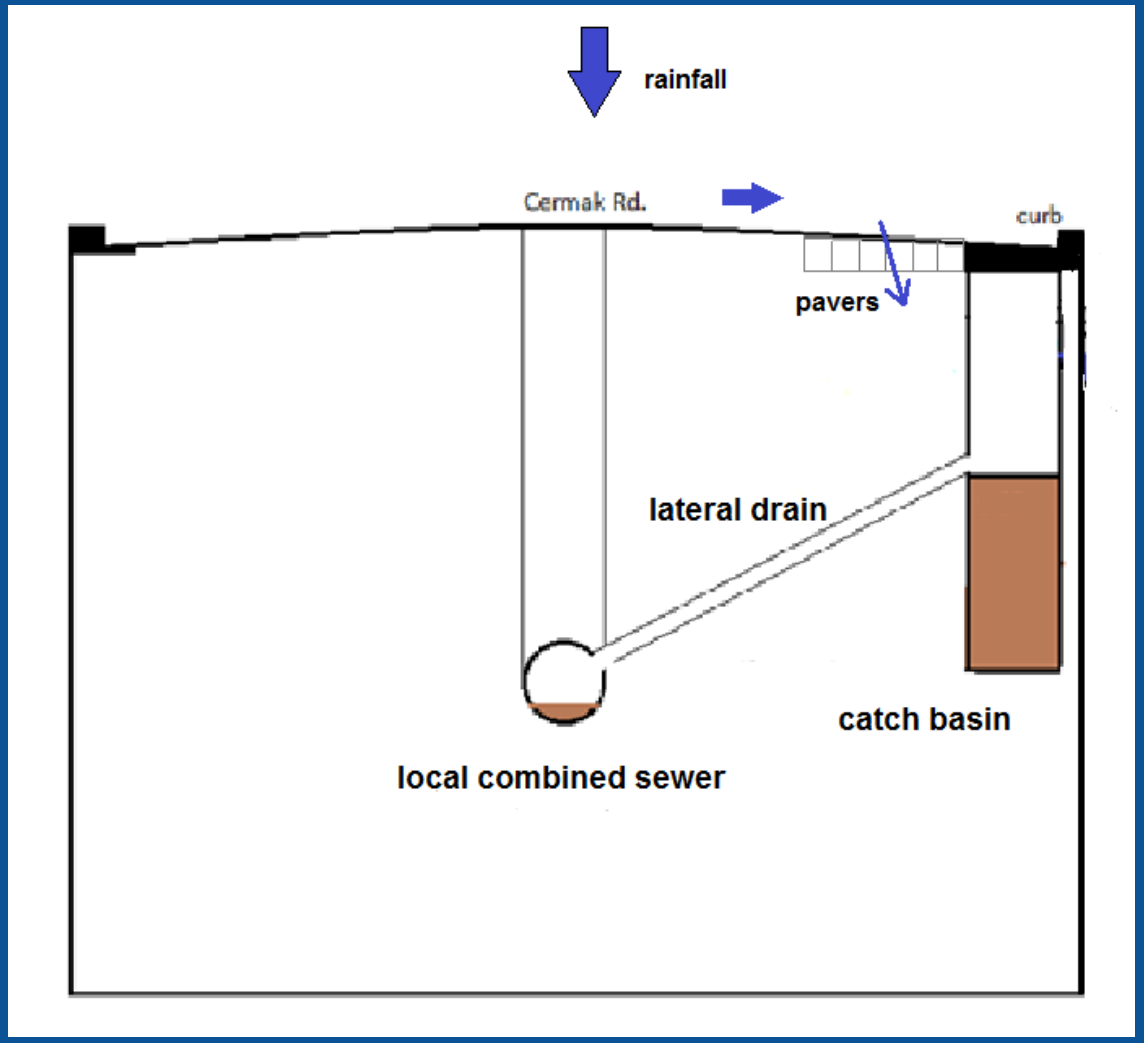

- Groundwater levels are higher than sewer elevations, however no evidence in sewer monitoring for inflow.
- Fill material has the greatest hydraulic conductivity .

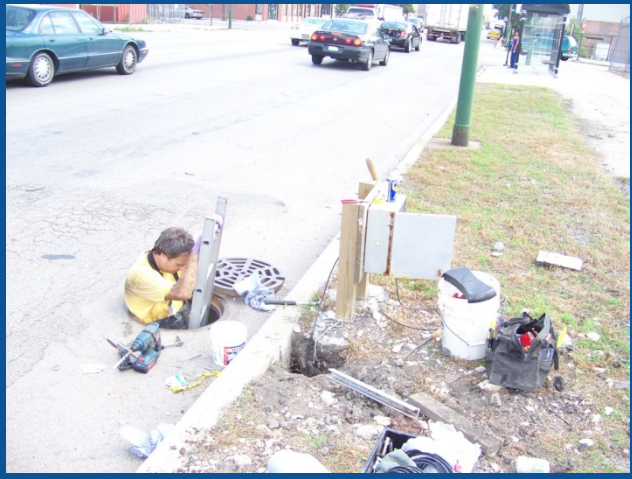



Offset reflects the depth to the water table (GW) and the water moving through the unsaturated zone at the bioswale

Black - Bioswale,
Red - Juarez HS (shallow)
Blue – Juarez HS (deep)
Yellow – Canalport (east)
Green-Leavitt (west)

# Permeable Pavers and Catch Basins



Rain falling onto the crowned road surface flows over permeable pavers and infiltrates before reaching the curb.

# Catch basin data

**65% of Chicago's yearly precip comes on days with less than 1.00 inches of rain.**


Red-Leavitt
Green-Paulina

- Leavitt catch basin is in a reach at the western end of the study area with no stormwater BMP's.
- Paulina is in the center of the study area and has stormwater BMP's in place.
- Permeable pavers are capturing first flush.

# Permeable pavers-estimated capture of annual stormwater runoff volume

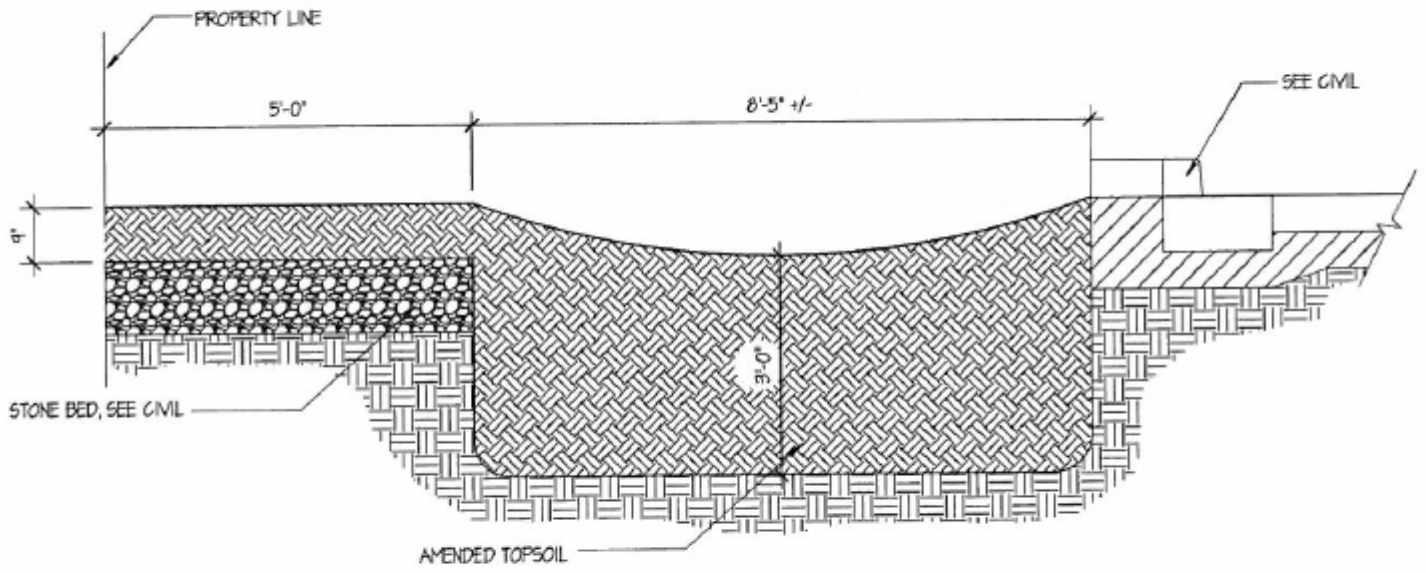
| Water Year | Total annual rainfall gage no. 9 (in.) | Total annual rainfall gage no. 10 (in.) | Average annual rainfall (in.) | Estimated Stormwater Runoff volume (gallons) |
|---|---|---|---|---|
| 2012 | 32.36 | 33.96 | 33.16 | 154,847 |
| 2013 | 35.01 | 38.32 | 36.66 | 171,117 |
| 2014 | 46.62 | 42.41 | 44.52 | 208,146 |
| 2015 | 38.42 | 35.76 | 37.09 | 173,361 |

Paulina Catch basin catchment area= 250 ft x 30 ft = 7500 square ft.

Annual rainfall converted to depth (in ft) and total volume converted from cubic ft to gallons.

# Bioswale

Cermak Road Bioswale

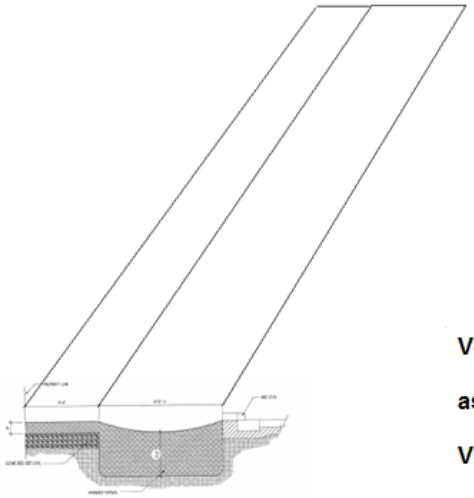



6
L14.0

# BIOSWALE WITH ROCK CATCHMENT

SCALE: 1/2"=1'-0"

# Bioswale



**Bioswale Volume**

**Volume A = (2400 ft) (8.4 ft) (3.0 ft) = 60,480 cubic ft**

**assuming 20 % porosity ~ 12,096 cubic ft**

**Volume B = (2400 ft) (5.0 ft) (1.6 ft) = 19,200 cubic ft**

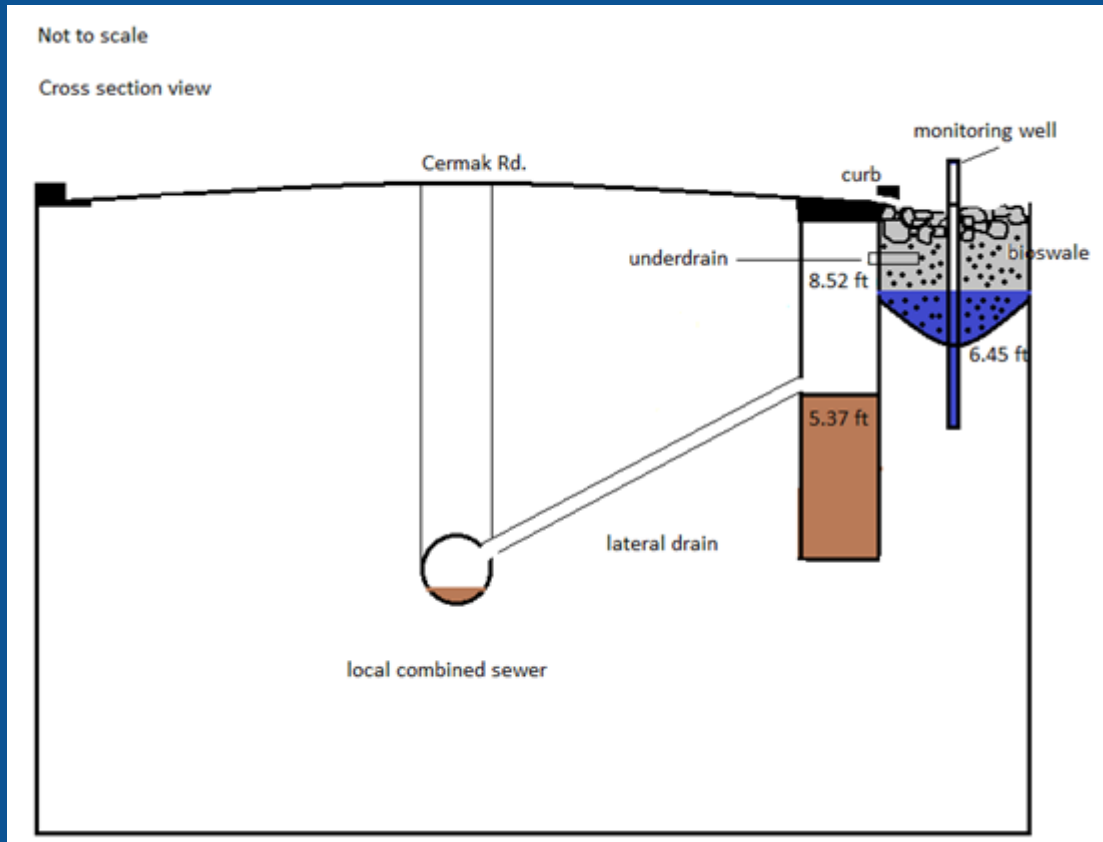
**assuming 30% porosity ~ 5,760 cubic ft**

**Total bioswale volume = 17,856 cubic ft = 133,572 gallons**

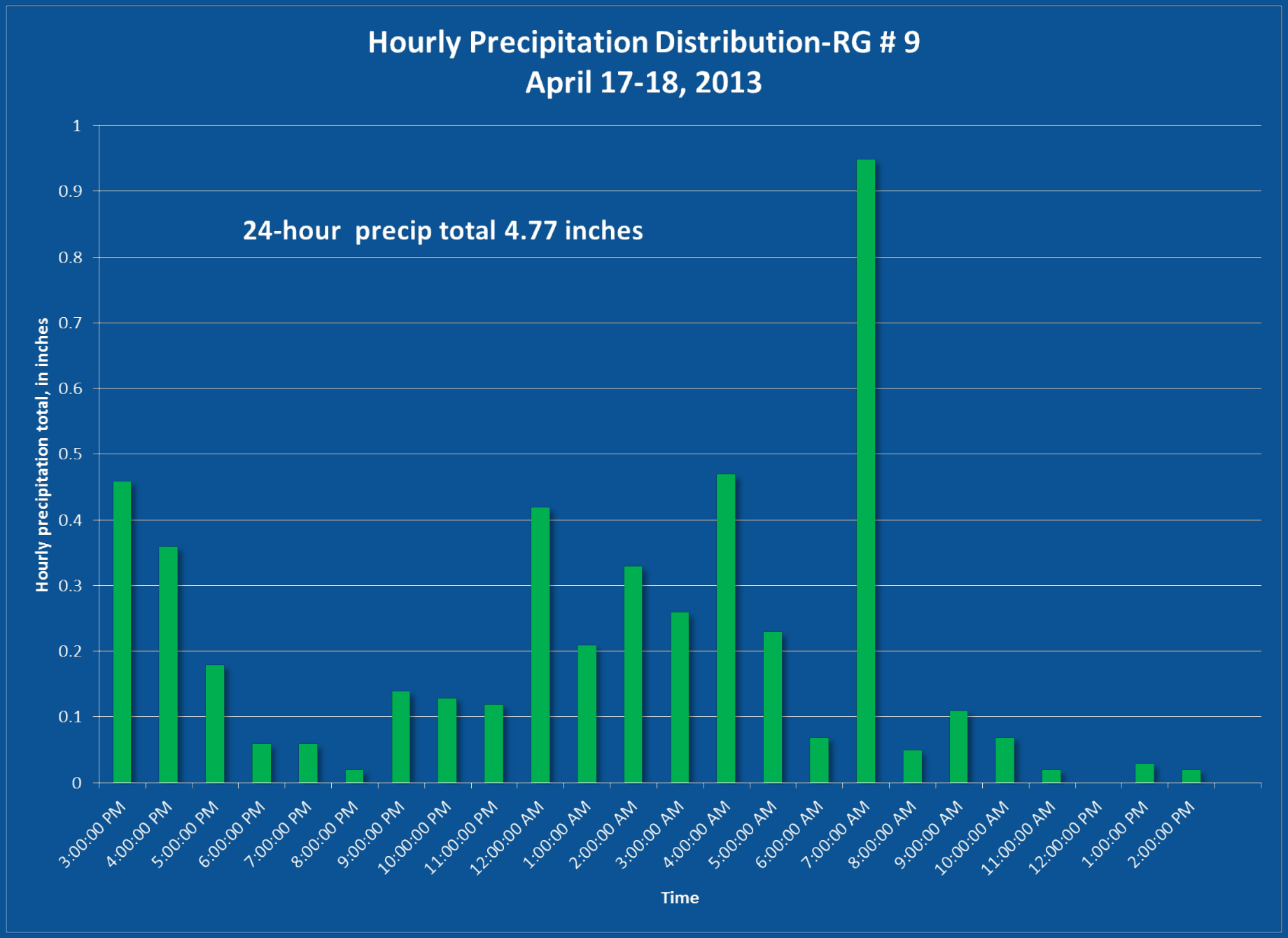
# Bioswale

- Leavitt-installed 08-04 2012
- Paulina-installed 08-08-2012

In 3 years of monitoring, the bioswale never returned water to the catch basin through the underdrain.



# Bioswale monitoring well


Hourly Precipitation Distribution-RG # 9
April 17-18, 2013
24-hour precip total 4.77 inches
Hourly precipitation total, in inches
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3:00:00 PM
4:00:00 PM
5:00:00 PM
6:00:00 PM
7:00:00 PM
8:00:00 PM
9:00:00 PM
10:00:00 PM
11:00:00 PM
12:00:00 AM
1:00:00 AM
2:00:00 AM
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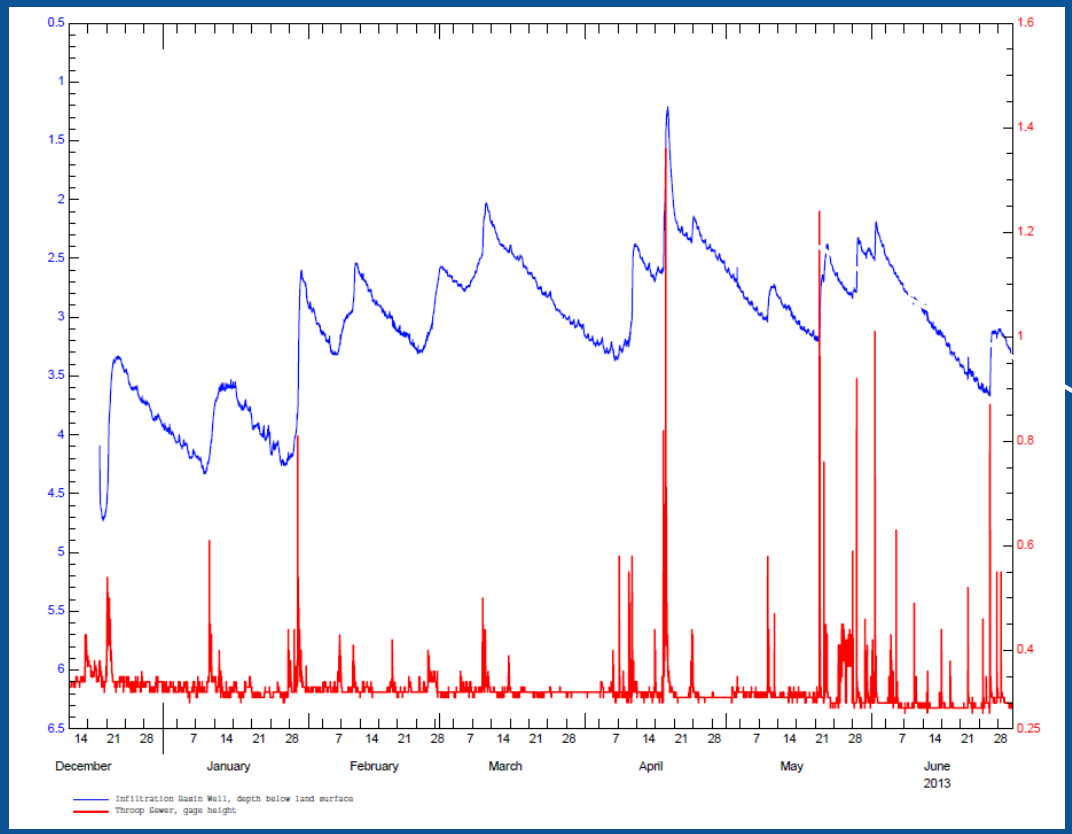
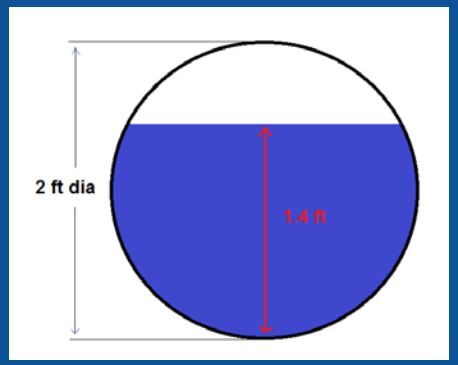
2:00:00 PM
Time

# Bioswale performance




- April 17-18,2013
- 4.7 inches of rain in 24 hrs
- >10-yr recurrence interval
- did not surcharge sewer line.



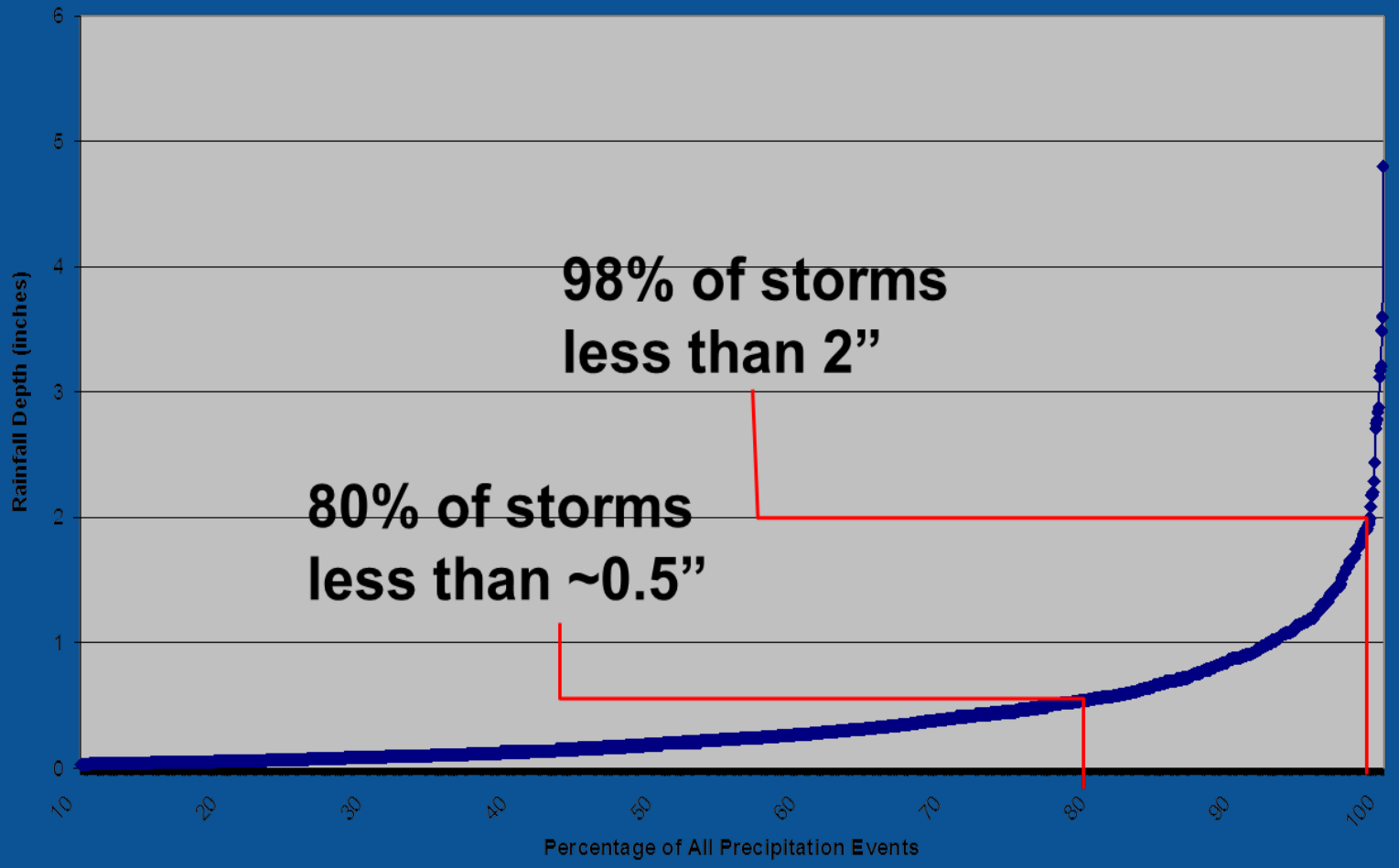

- Chicago sewers designed for 5-yr event.

Blue - Bioswale, depth below land surface, in feet
Red –Throop Sewer flow meter, water level, in feet

# Estimations of Total Runoff Generated in the Catchment Area and Percent Rainfall Infiltrated in BMPs

| Year | Average Annual Rainfall (In.) | Blue Island Ave. Permeable Pavers/Planter Boxes | | Cermak Road Bioswale | |
|---|---|---|---|---|---|
| | | Estimated Stormwater Runoff Volume (Gallons) | % Infiltrated | Estimated Stormwater Runoff Volume (Gallons) | % Infiltrated |
| 2012 | 33.16 | - | - | 1,655,753 | > 99 |
| 2013 | 36.66 | 171,117 | 99.4 | 1,830,528 | > 99 |
| 2014 | 44.52 | 208,146 | 99.3 | 2,222,993 | > 99 |
| 2015 | 37.09 | 173,361 | 98.9 | 1,851,496 | > 99 |

# Rainfall Frequency Spectrum of Chicago Area



# Performance of BMPs Overtime

- Permeable Pavers
- Bioswale
- Planter Boxes
- Plant Performance
- Soil & Water Quality

# Measuring Percolation Rate

# Average Percolation Rate of Pavers (inches/hr)

| Date | Juarez Academy | Blue Island - North | Blue Island - South |
|---|---|---|---|
| October, 2012 | 9 ± 1 | 18 ± 3 | 20 ± 2 |
| June, 2013 | 4 ± 1 | 4 ± 2 | 8 ± 2 |
| Pavers Cleaned | No | Yes; July, 2013 | Yes; July, 2013 |
| August, 2013 | 3 ± 1 | 45 ± 7 | 170 ± 22 |
| May, 2014 | 2 ± 1 | 21 ± 6 | 63 ± 14 |
| Pavers Cleaned | No | Yes; July, 2014 | Yes; July, 2014 |
| August, 2014 | 2 ± 1 | 43 ± 11 | 140 ± 22 |
| May, 2015 | 2 ± 1 | 2 ± 1 | 3 ± 1 |
| Pavers Cleaned | No | Yes; May, 2015 | Yes; May, 2015 |
| June, 2015 | 1.6 ± 0.5 | 21 ± 12 | 7 ± 4 |





# Average Soil Percolation Rate (inches/hr)

## Bioswale

| Date | Near Curb-cut | Center |
|---|---|---|
| Oct, 2012 | 11 ± 4 | 61 ± 18 |
| June, 2013 | 9 ± 3 | 55 ± 15 |
| Aug, 2013 | 8 ± 4 | 50 ± 12 |
| May, 2014 | 6 ± 2 | 21 ± 7 |
| Aug, 2014 | 5 ± 2 | 18 ± 7 |
| May, 2015 | 3 ± 1 | 11 ± 6 |
| June, 2015 | 3 ± 2 | 9 ± 5 |

## Planter Boxes

| Date | Without Curb-cut | With Curb-cut |
|---|---|---|
| Oct, 2012 | 66 ± 15 | 61 ± 15 |
| June, 2013 | 63 ± 14 | 46 ± 11 |
| Aug, 2013 | 56 ± 12 | 43 ± 9 |
| May, 2014 | 52 ± 11 | 36 ± 10 |
| Aug, 2014 | 49 ± 9 | 31 ± 9 |
| May, 2015 | 40 ± 9 | 21 ± 7 |
| June, 2015 | 36 ± 7 | 19 ± 7 |

# Cermak Rd – Bioswale

# Bioswale Characteristics With Time

| Properties | Near Curb Cut | Center |
|---|---|---|
| Sediments | ↑ | ↑ |
| Soil EC (0 - 2 inches) | ↑ | ↑ |
| (0 - 6 inches | ↑ | ↑ |
| Heavy Metals (0 - 2 inches) | ↑ | ↑ |
| (0 - 6 inches) | No Change | No Change |
| Soil pH | ↑ | ↑ |
| Infiltration Rate | ↓ | ↓ |
| Lysimeter Pollutants (between 12 – 15 inch layer) | ↑ | ↑ |

# Estimations of Few Heavy Metals Retention in BMPs (2013 – 2015 Average)

| BMP | Cu | Mn | Ni | Pb | Zn |
|---|---|---|---|---|---|
| Blue Island Ave. (Catchment area – 7500 Sq. ft.) | | | | | |
| Pavers/Planter Boxes (lbs/yr) | 2.0 | 2.3 | 1.7 | 1.8 | 4.3 |
| Cermak Rd. (Catchment area – 80,100 Sq. ft.) | | | | | |
| Bioswale (lbs/yr) | 6.0 | 8.5 | 2.2 | 3.9 | 32.2 |
| | | | | | |
| Stickney WRP Influent **(lbs/day)** | 1212 | 1527 | 180 | 374 | 3018 |
| | | | | | |

# Plant Performance in BMPs – Third Year

## Heavy Metals Uptake

| Species | Tissue sampled | Picture |
|---|---|---|
| Rugosa Rose | New growth |  |
| Day Lili | Two inside leaves |  |
| Prairie dropseed | Aboveground biomass |  |
| Joe Pye Weed | Aboveground biomass |  |
| Western sunflower | Top 5 leaves |  |
| Pennsylvania sedge | Above ground biomass |  |

## Results

- In general, very low heavy metals accumulation in all species tested, much lower than typical uptake by agricultural crops
- No particular trend in heavy metals accumulation depending on sampling location in bioswale
- Prairie dropseed grown in roadside bioswale showed higher accumulation of Zinc & Manganese than grown in school bioswale


© 2013 Google
Image Date: June 2

WHAT MATTERS TODAY

NEWS & NOTES

# Honey Bee Die-Off Caused By Multiple Factors Including Pesticides

May 2, 2013
by Theresa Riley



A federal study released today attributes the massive die-off in American honey bee colonies to a combination of factors, including pesticides, poor diet, parasites and a lack of genetic diversity. Nearly a third of honey bee colonies in the United States have been wiped out since 2006. The estimated value of crops lost if bees were no longer able to pollinate fruits and vegetables is around $15 billion.

CBS THIS MORNING

Politics & Power | HealthWatch | Note to Self | The Green Room | CTM Reads | Saturday | More | The RUNDOWN

April 3, 2013 11:06 AM

PRINT TEXT

# Deepening honey bee crisis creates worry over food supply

Popular Headlin

House approves back pay for furlou workers

Report: Chicken nuggets aren't mad "meat"

# Commissioning- Construction Goals

| Category | Overall Project Goal | Percent of Materials Installed as of Jun 2012 |
|---|---|---|
| Regional Materials | 40% | 76% |
| Recycled Content | 10% | 23% |
| Construction Waste | 90% | 60% |

## Innovations

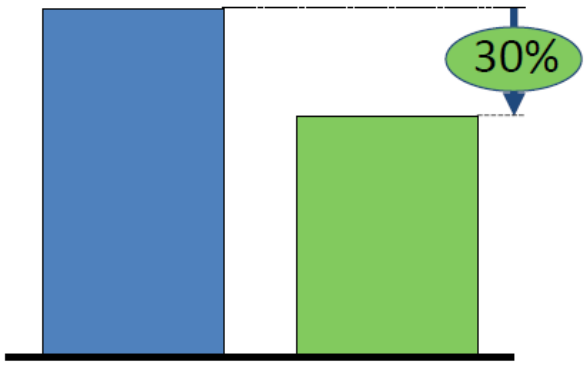
- Photocatalytic, permeable, high albedo Pavers
- New recycled Aggregates
- 30% recycled content concrete – slag, aggregates, wash water
- 40% to 50% recycled content warm mix asphalt -slag, FRAP, RAS, GTR,
- Micro-thin Concrete overlay

CDOT
CHICAGO DEPARTMENT OF TRANSPORTATION

# Cost Benefits

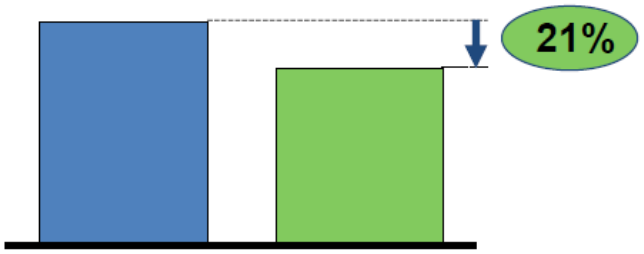
**Cost is 30% less than projected…**

Cermak total project cost ($)

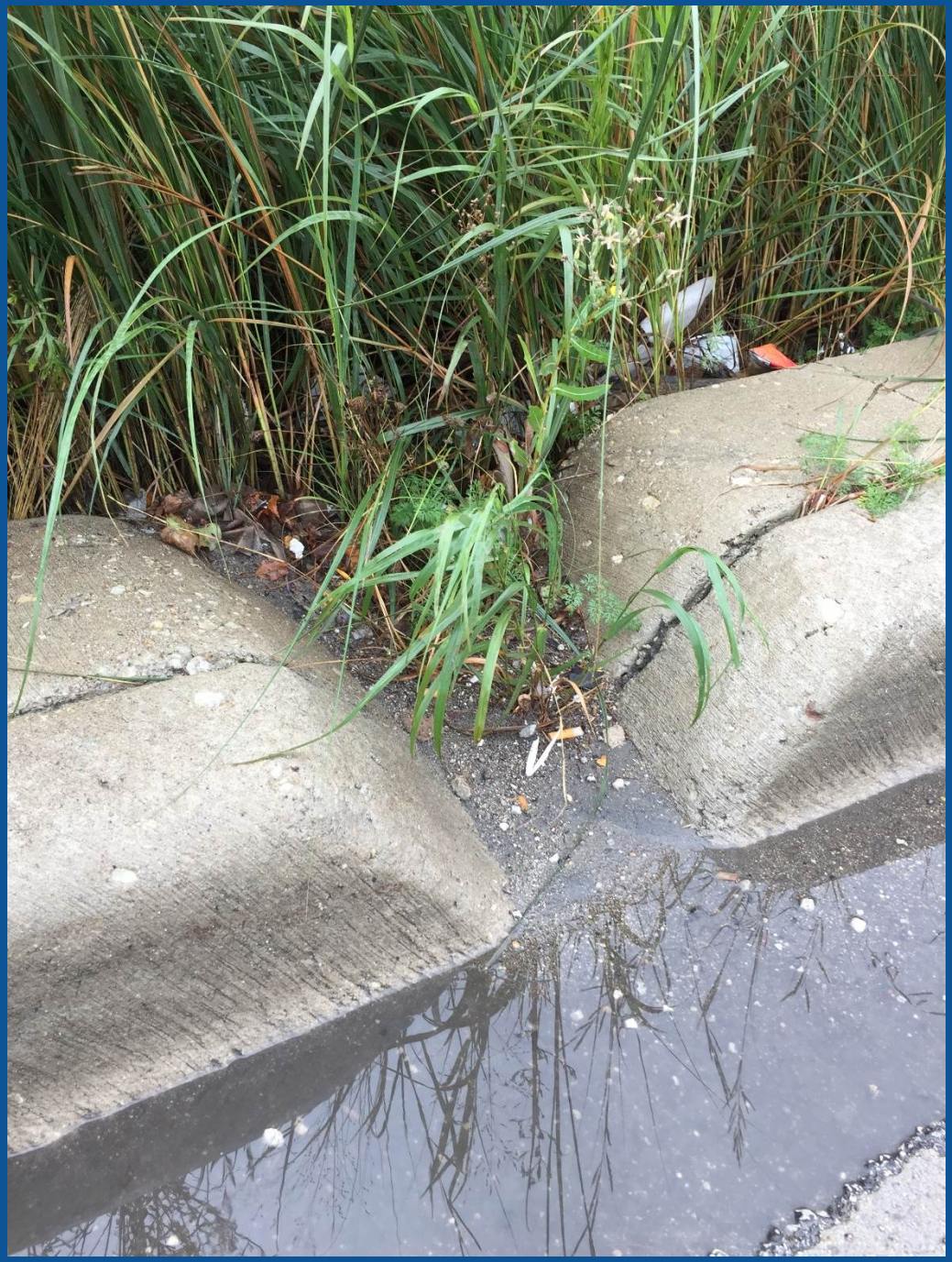



**… And is 20% less expensive than the average block in 2010**

Average per block cost ($)



# BMP maintenance

# Conclusions

- Benefits go beyond storm water management
  - Improved aesthetics and habitat so multi-agency support needed
- Storm water benefits of volume reduction, reducing peak flows, and pollutant retention were clearly observed
- Land use impacts on BMPs performance are important
- Management of BMPs is important
  - Periodic cleaning of permeable pavements
  - Periodic sediment removal from bioswales
- COMMUNITY
  - Education
  - Cleaning of BMPs – Trash – Projects Lacks Recycling/Trash Bins
  - Adopt a bioswale, planter box etc.

# Take Home Message

**Layering** of Stormwater GI-BMPs with traditional sewer systems can greatly increase the capacity of the existing system while providing a wide range of synergistic benefits at a reasonable cost

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