



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 been 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

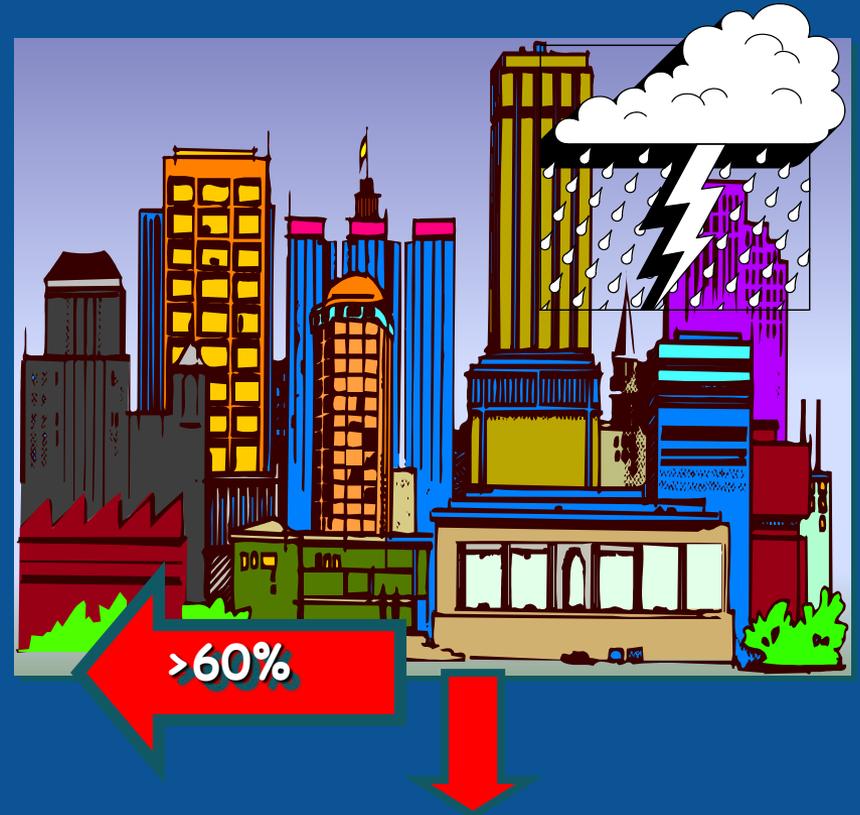
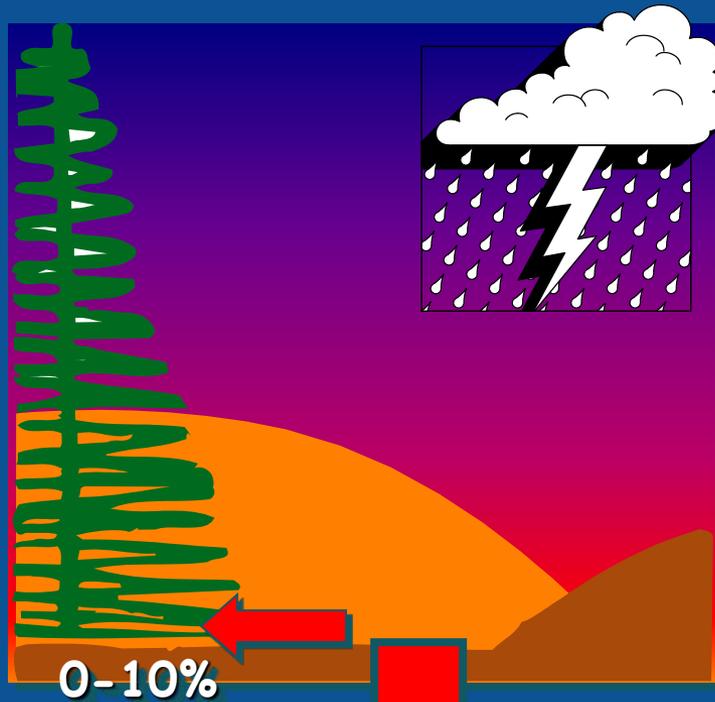
USGS: Jim Duncker, Bill Morrow

Morton Arboretum and Chicago Botanical Garden

An aerial photograph of a city grid, showing a dense network of streets and buildings. A thick black outline highlights a specific area in the center of the image. The text is overlaid on this highlighted area.

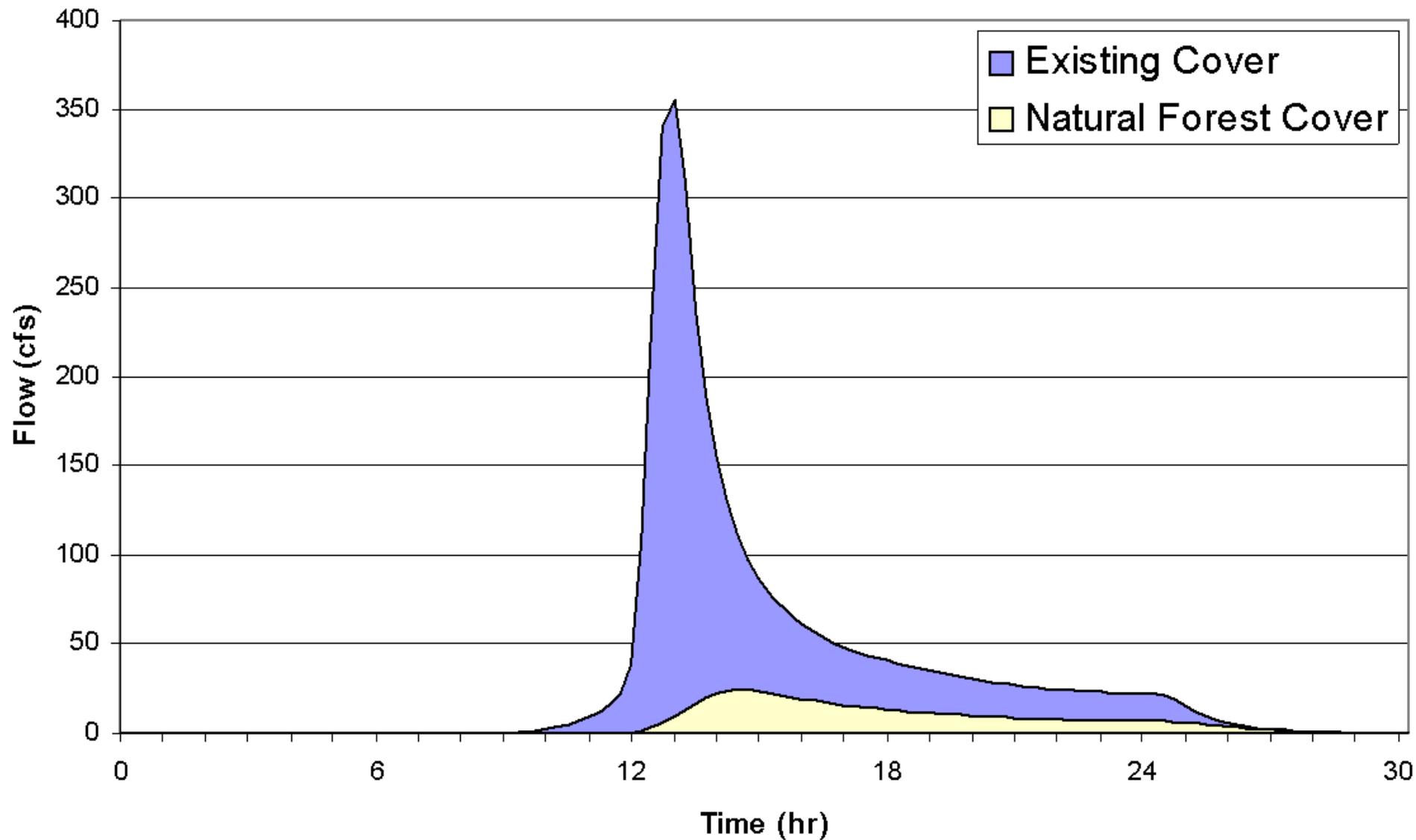
**> 75% Impervious Surfaces**

# Why Do We Need Stormwater Green Infrastructure Features?



Development Increases Run-off

## Meeting of the Waters: 2-yr Runoff Hydrographs





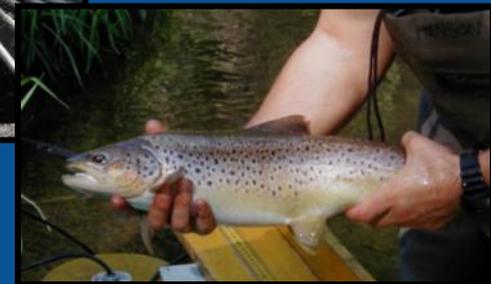
# Pollutants in Stormwater Discharges



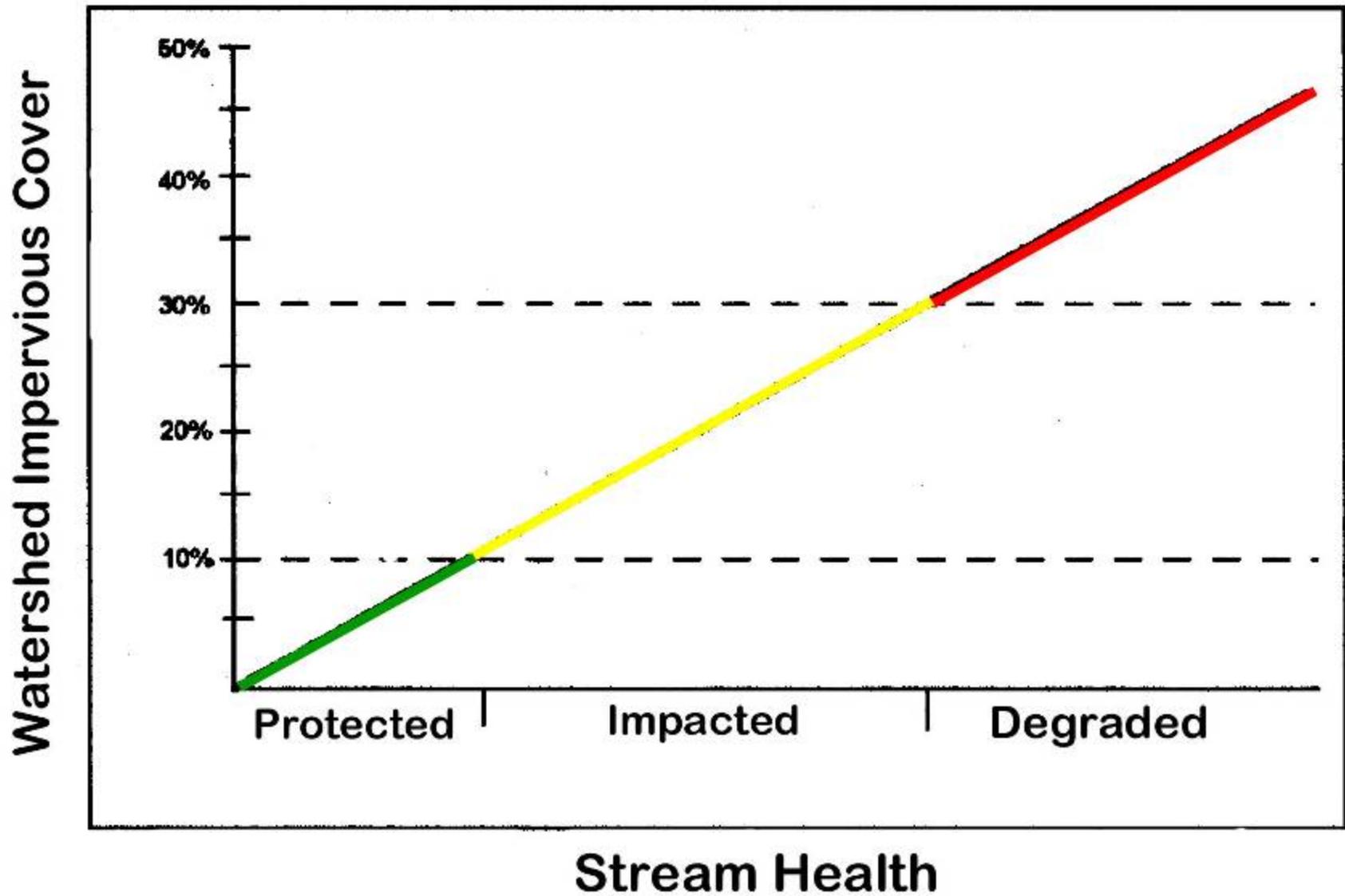
Nutrients  
Pathogens  
Sediment  
Toxic Contaminants  
Oil and Grease  
Thermal Stress



**Increased quantity**  
**Decreased quality**



# Relationship of Impervious Cover to Stream Health



# 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*

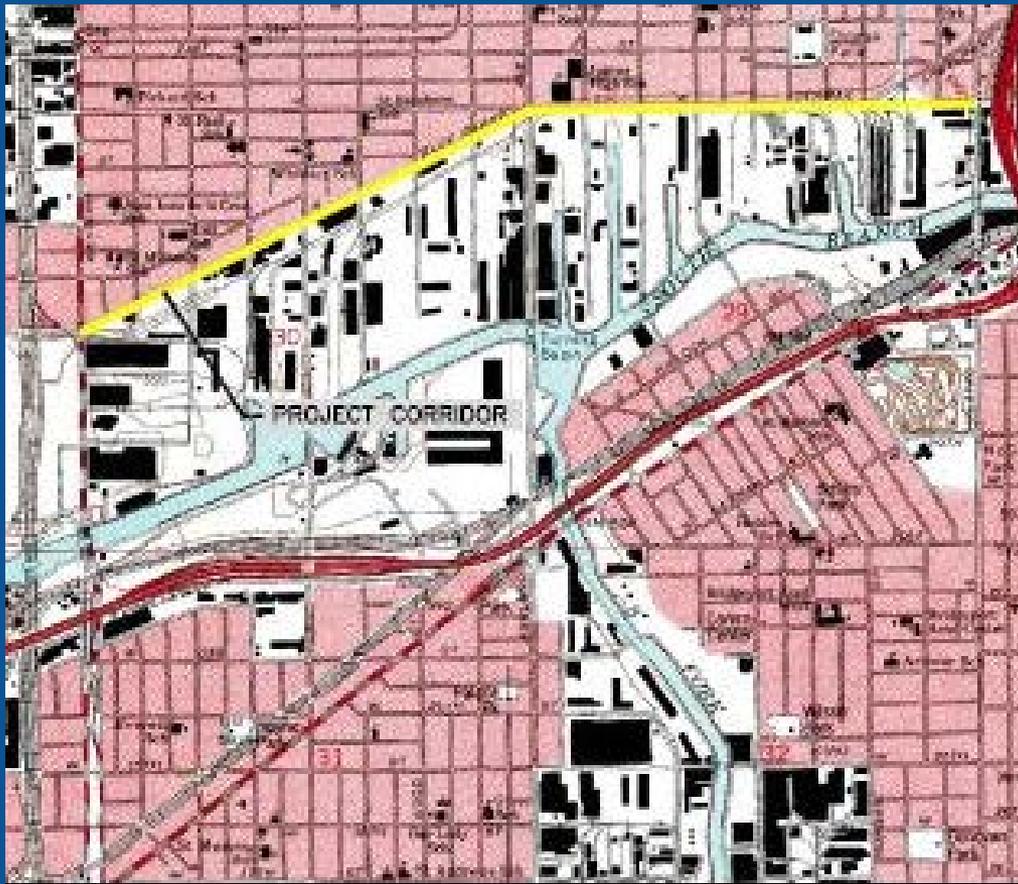
Reduce ambient summer temperatures on streets and sidewalks through use of high albedo pavements, roadway coatings, landscaping, and permeable pavements. Require ultra low sulfur diesel and anti-idling.

### *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*

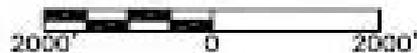
Model Stormwater BMP's in Infoworks to analyze and refine design. Monitor stormwater BMP's to ensure predicted performance and determine maintenance practices.



# Cermak-Blue Island Sustainable Streetscapes Corridor

Pilsen neighborhood

FIGURE 1  
SITE LOCATION MAP  
BLUE ISLAND AND CERMAK AVENUE  
CHICAGO, ILLINOIS



SOURCE: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY  
ENGLEWOOD, ILLINOIS QUADRANGLE

S00DAN-CERMAK-TGPO

# Streetscape Corridor, Phase - I

## Legend



# Pre-construction conditions

Blue Island Avenue



Cermak Road



# Pre-construction conditions



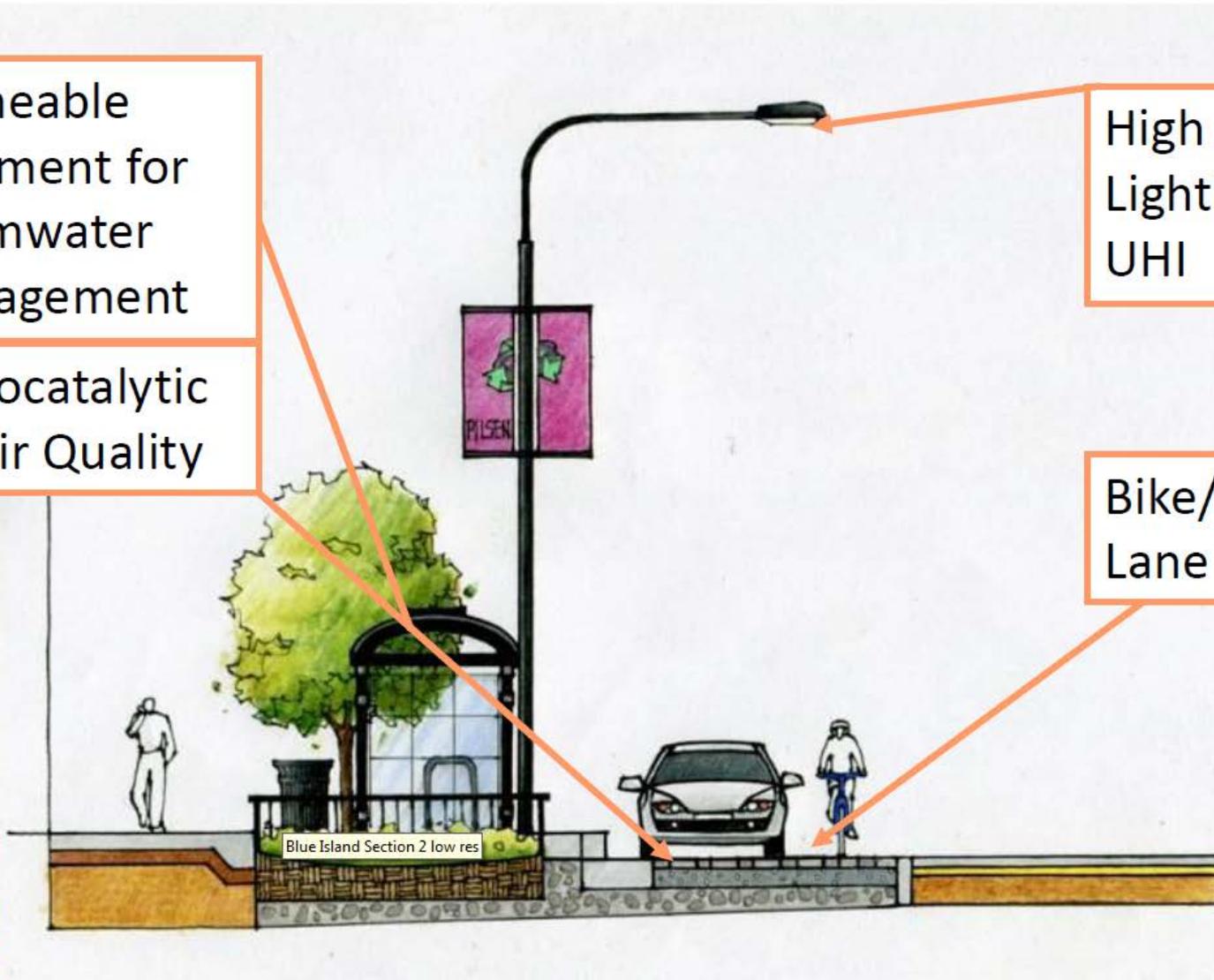
# Integrated Design: Blue Island Cross Section

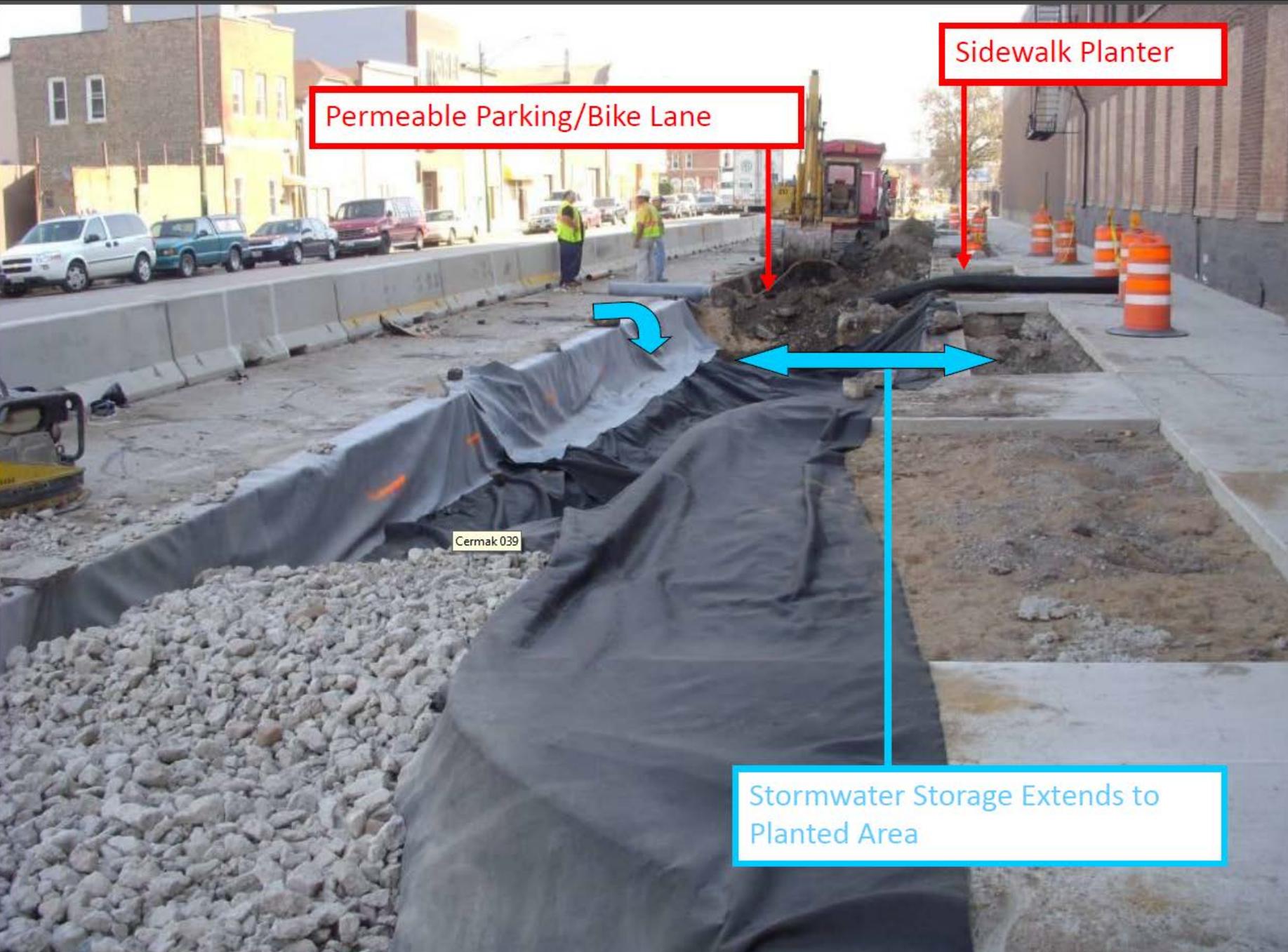
Permeable  
Pavement for  
Stormwater  
Management

Photocatalytic  
for Air Quality

High SRI for  
Lighting and  
UHI

Bike/ Parking  
Lane





Permeable Parking/Bike Lane

Sidewalk Planter

Stormwater Storage Extends to Planted Area

Cermak 039



RIGHT  
LANE  
ONLY



2012.10.04

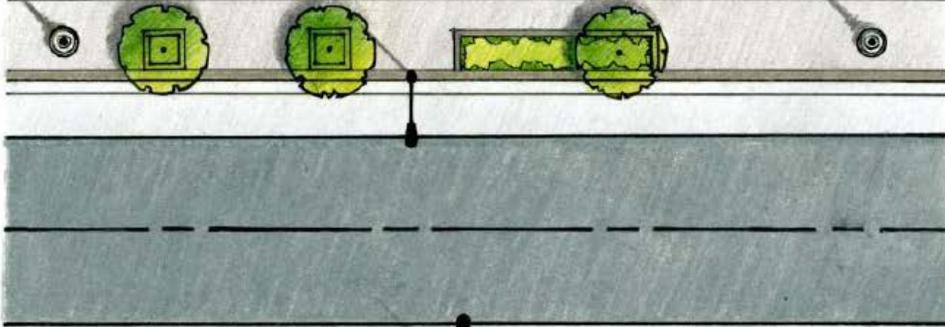
# Before & Present

43 Infiltration Boxes -Blue Island Rd

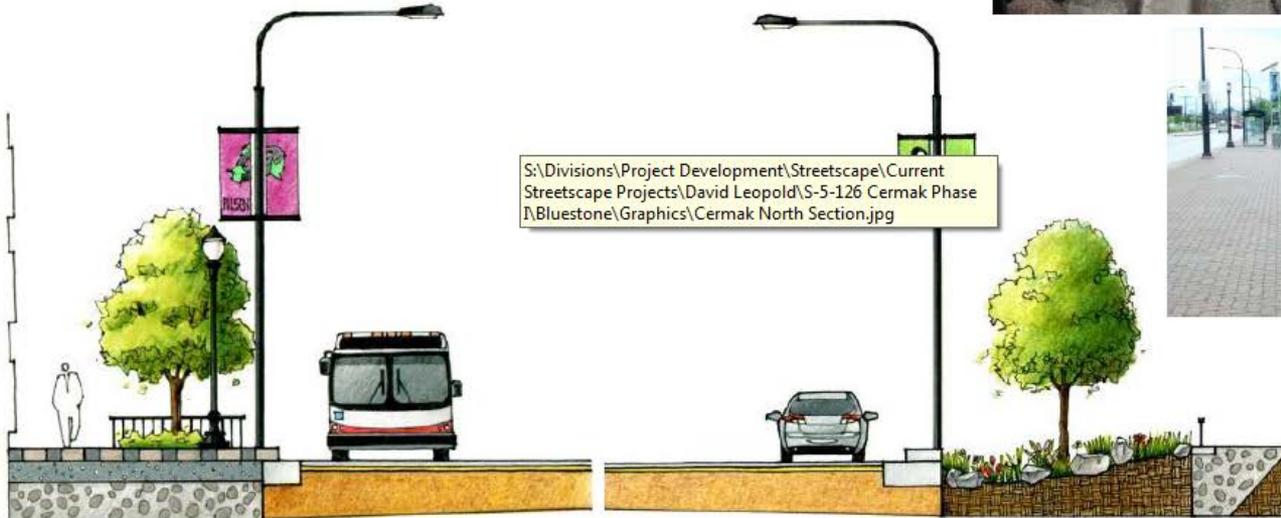


# Cermak Road

19 Infiltration Boxes and 41 Tree Boxes

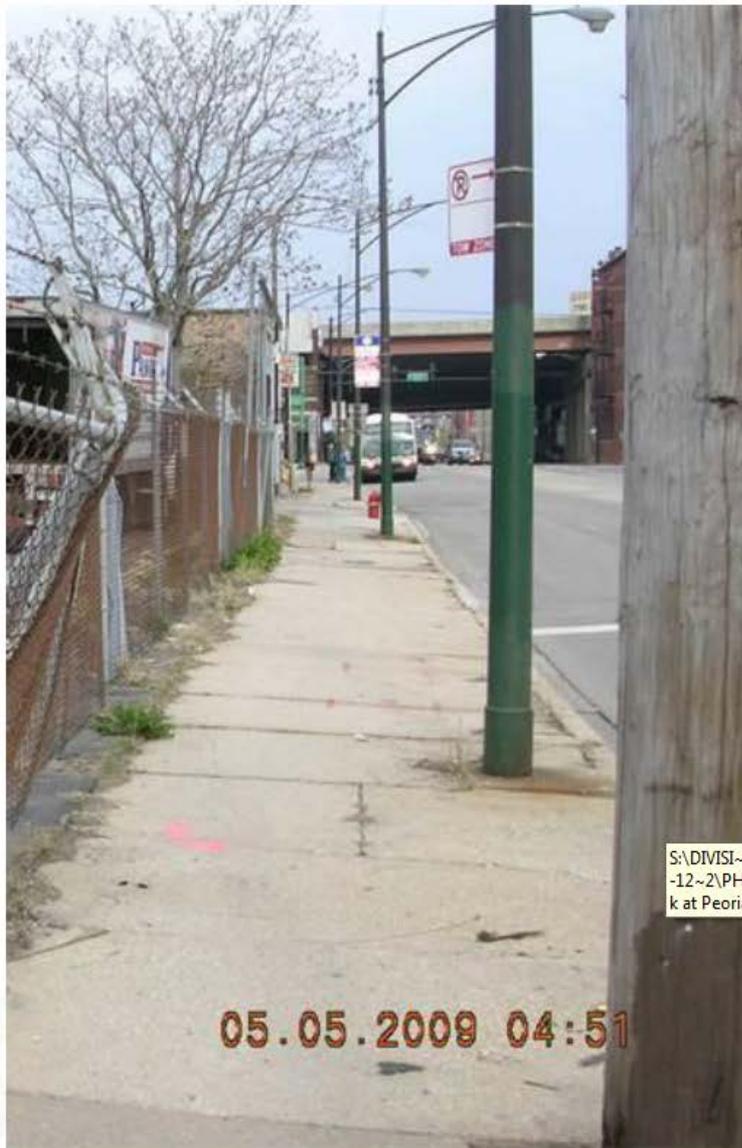


Bioswale, Ashland to Halsted Ave



Bioswale - School

# Before/After Cermak Rd.



05.05.2009 04:51



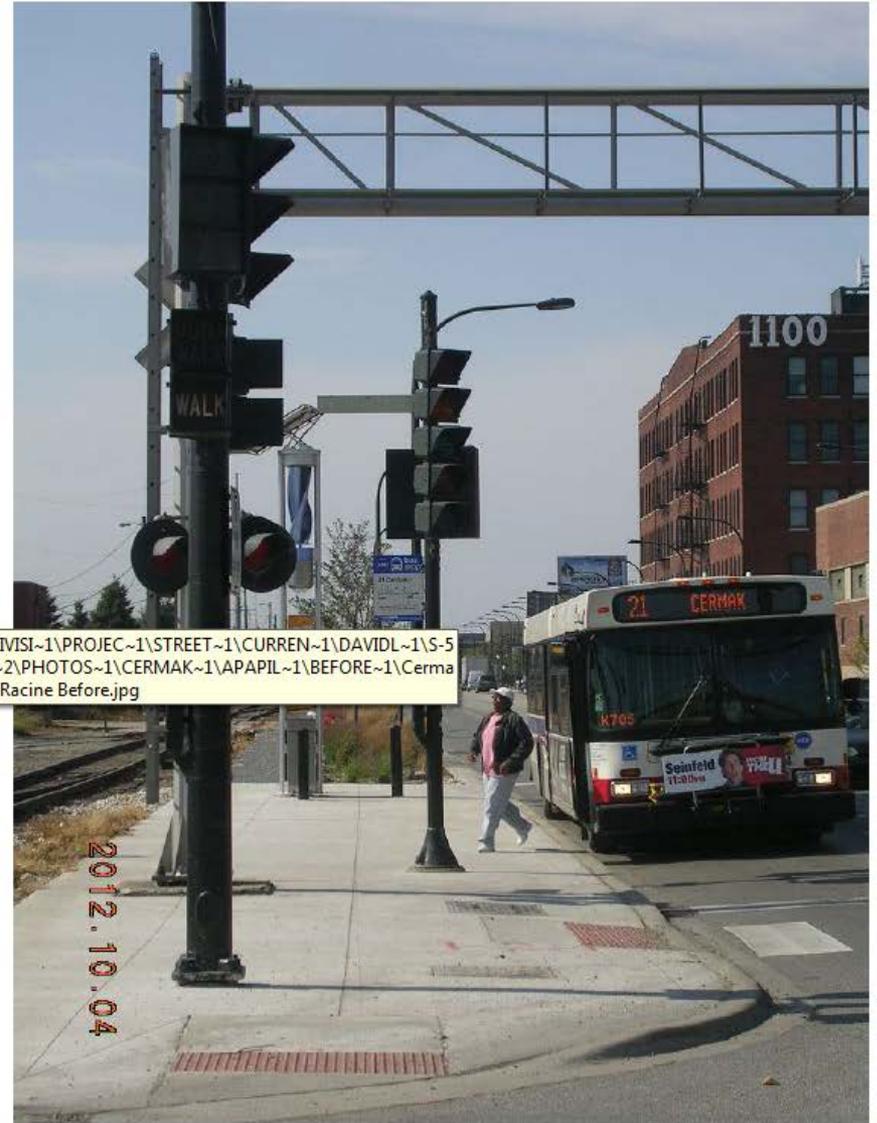
2.10.04

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



# Juarez Water Feature



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

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



**WELCOME TO PILSEN'S SUSTAINABLE STREET!** Here you can explore sustainability in action. We've installed interactive technologies on this street that can improve the quality of your life and create a healthier environment for the future. Take a look at the 7 categories below to see the ways we've changed this street for the better. To find out more, check out other signs like this one all along the street.

**ALTERNATIVE TRANSPORTATION**  
Pick a mode that's right for you. More options, more freedom, and less traffic. This street is designed for all modes, from a car to a bicycle, wheelchair, stroller, and stroller.

**STORMWATER MANAGEMENT**  
Did you ever wonder where all the water goes when it rains, or why we experience flooding in our urban environments? We've designed our streets to allow water to soak into the earth naturally and help reduce flooding.

**WATER EFFICIENCY**  
Have you ever thought about how important fresh water is to your life? On this street, we reduce water and show how it can be conserved as a natural resource to be protected and enhanced.

**HEAT ISLAND REDUCTION**  
Materials on the ground like asphalt and concrete absorb heat and make the street surface even hotter. Light-colored concrete overlays help reduce heat and make the street surface cooler.

**ENERGY CONSERVATION**  
Did you know that energy is an important resource? Our street projects a wide range of energy-saving technologies, while reducing energy use and saving money.

**COMMUNITY & EDUCATION**  
Want to get to know your neighborhood better? Find out more about the history of Pilsen with a walk tour that includes information on the area and its residents.

**MATERIAL RECYCLING**  
Did you ever wonder if there's more to a used material than just a piece of trash? We've recycled all kinds of materials to make the safe, long-lasting materials you see on this street.




**MICRO-THIN CONCRETE OVERLAY**

**WHAT IS IT?**  
If you look over at Oakwood Road from where you stand, you'll see that part of the street looks light grey instead of dark grey. That's because these layers are topped with a thin layer of light-colored concrete called a micro-thin concrete overlay.

**HOW DOES IT HELP?**  
**Heat Island Reduction**  
Ever wonder about that shimmer that you see whenever a road is hot in summer? Dark surfaces absorb heat, just like they can give off heat like a burner on a stove. This makes the air around them hotter, and you know how hot that is. The light-colored overlay on this street reflects heat instead of absorbing it. With the overlay, the temperature stays lower, the temperature and light this surface heat island effect.

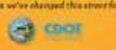
**Energy Conservation**  
With a more comfortable temperature outside, there's a reduced heat island effect, you won't have to use air conditioning as much. This saves you money and conserves the limited supply of fuel that.



**2011\_01\_16 HLF Revisions9 low.jpg**



**PILSEN SUSTAINABLE STREET**




**Want to explore Pilsen's Sustainable Street for your own? The guide is here!**

**Community & Education**  
This is a guide to help you explore the innovative design of this street and see how we put these concepts into practice.

**Urban Heat Island**  
The heat island effect occurs when surfaces that absorb and hold heat, such as asphalt, concrete, and dark-colored roofs, absorb and store heat. This makes the air around them hotter, and you know how hot that is. The light-colored overlay on this street reflects heat instead of absorbing it. With the overlay, the temperature stays lower, the temperature and light this surface heat island effect.

**Water Efficiency**  
The heat island effect occurs when surfaces that absorb and hold heat, such as asphalt, concrete, and dark-colored roofs, absorb and store heat. This makes the air around them hotter, and you know how hot that is. The light-colored overlay on this street reflects heat instead of absorbing it. With the overlay, the temperature stays lower, the temperature and light this surface heat island effect.

**Stormwater Management**  
When it rains on Chicago, the storm water that goes down the drain is combined with car sewage. During heavy rains, this combined water can become a problem. Our street's permeable concrete overlay helps reduce the amount of water that goes down the drain. This combined water can be released into the Chicago River. Our street helps prevent this pollution from happening as well as the storm water flooding by allowing the water to soak into the ground and sink into the ground naturally.

**Material Recycling**  
When you recycle, you're helping to conserve our natural resources. When we build this street, we used recycled materials to make the materials that we used. We've recycled all kinds of materials to make the safe, long-lasting materials you see on this street.

**Alternative Transportation**  
Whether you're walking, biking, or riding a public transit, you'll find that we designed this street with you in mind. Our street makes it easy and convenient for you to explore the neighborhood better. That's why you can see a bus and a bicycle on this street.

**Energy Conservation**  
You'll be surprised at the amount of energy it takes to build and maintain a street. Using local materials, efficient lights, and renewable technologies are to find ways to conserve the precious, non-renewable energy resources that help make life on earth.



# Stormwater Volume Reduction

# Sewer geyser - MWRD interceptor near Cermak and Ashland



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

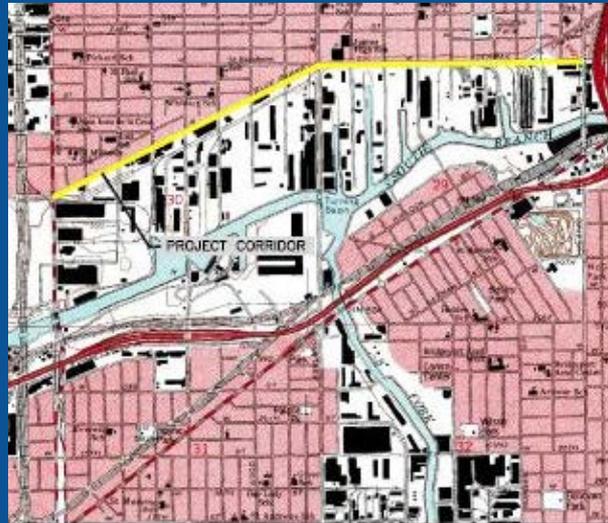


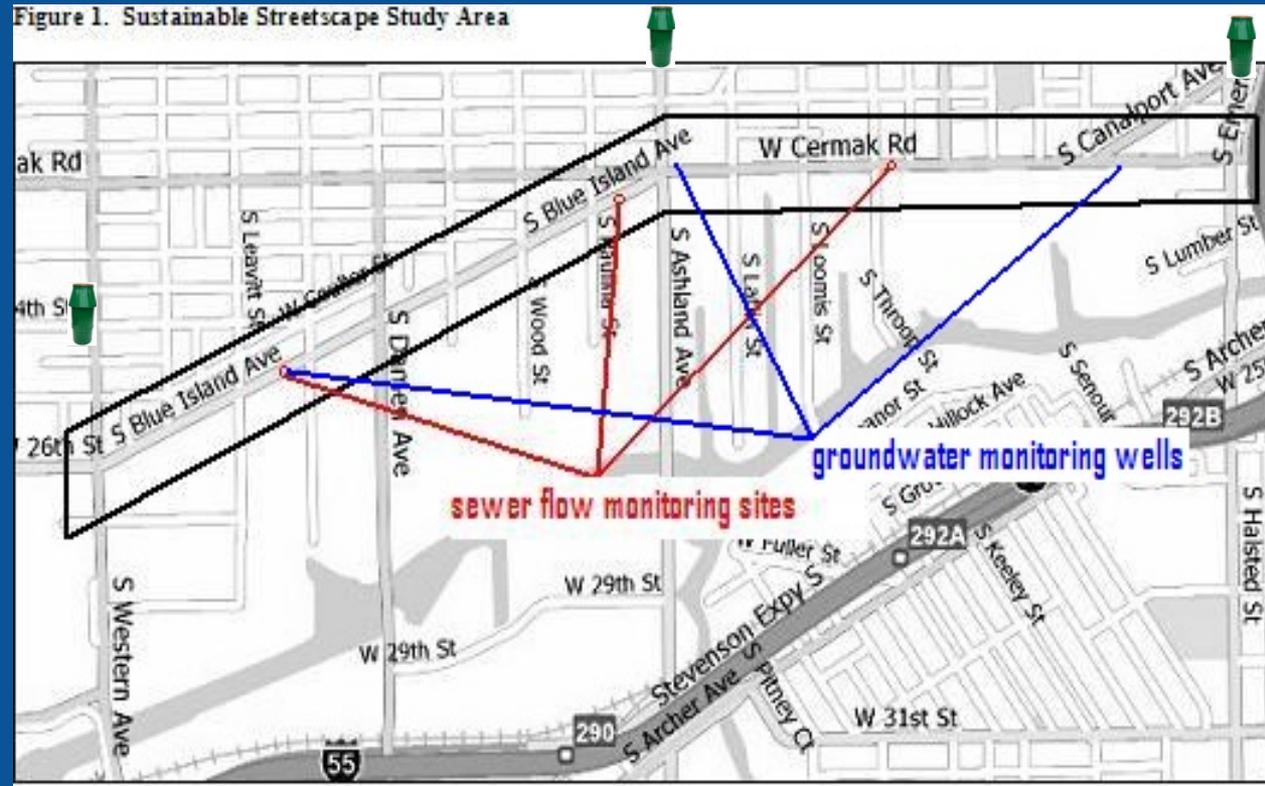
FIGURE 1  
SITE LOCATION MAP  
BLUE ISLAND AND CERMAK AVENUE  
CHICAGO, ILLINOIS

2000' 0 2000'

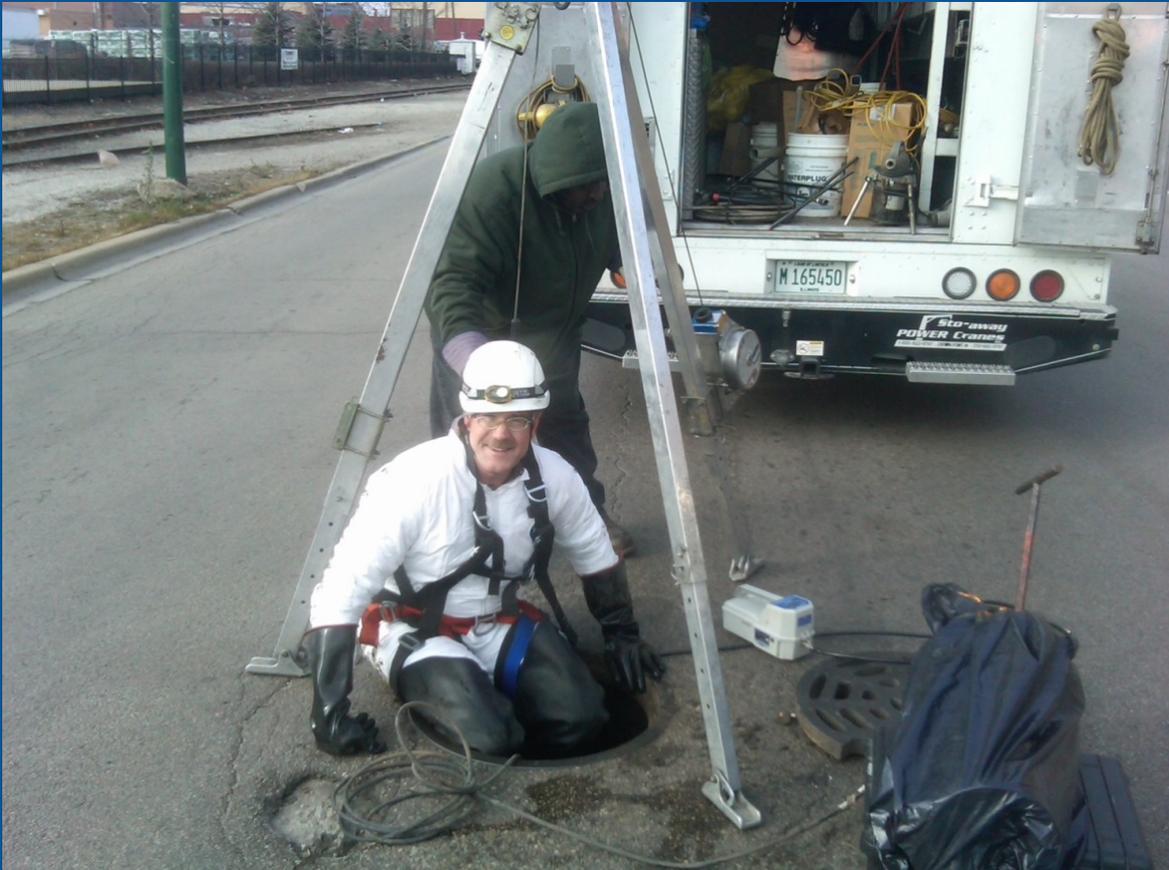


SOURCE: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY  
ENGLEWOOD, ILLINOIS QUADRANGLE  
SODDAN-CERMAK-TOPO

Figure 1. Sustainable Streetscape Study Area

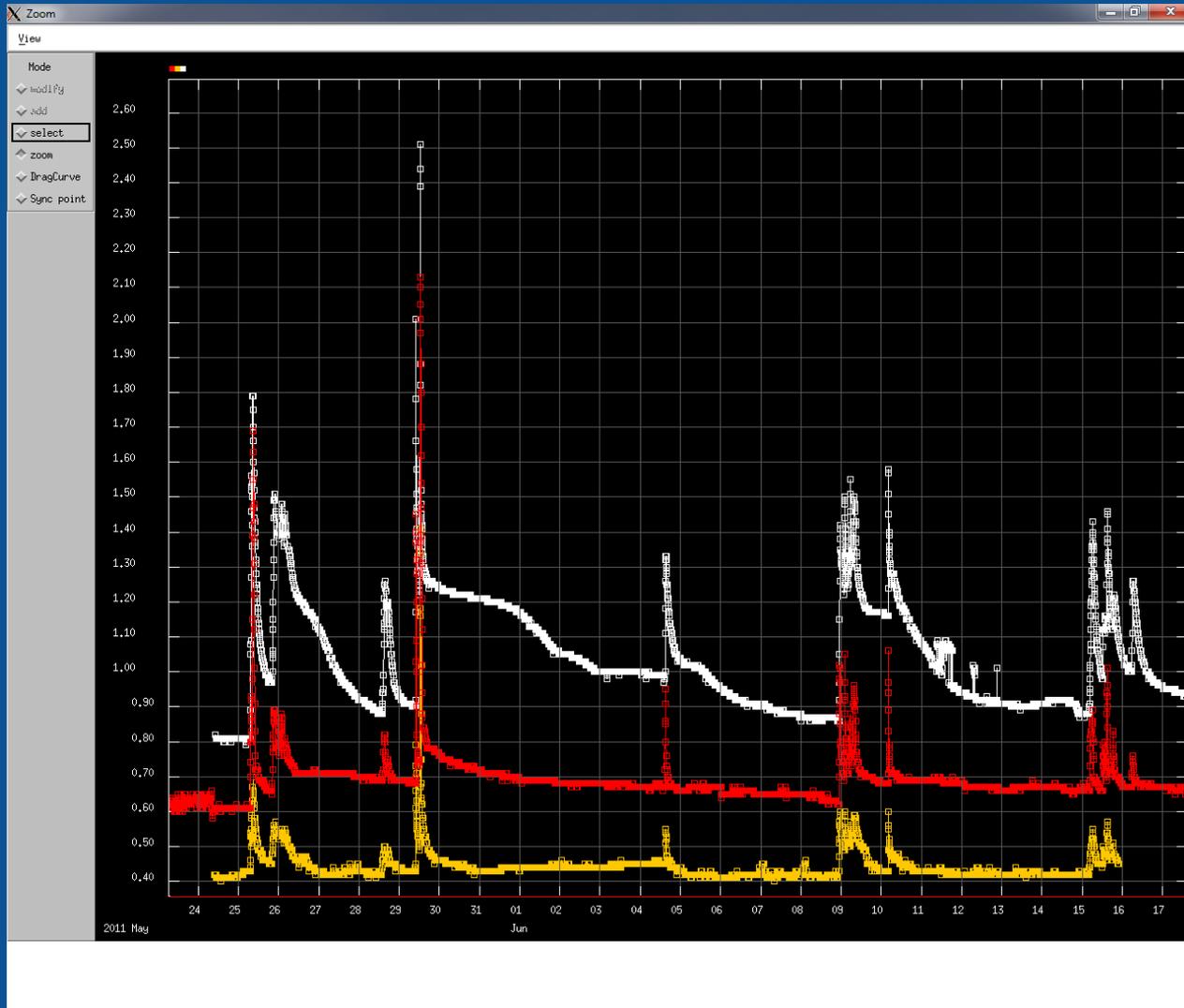


# Sewer flow monitoring



**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

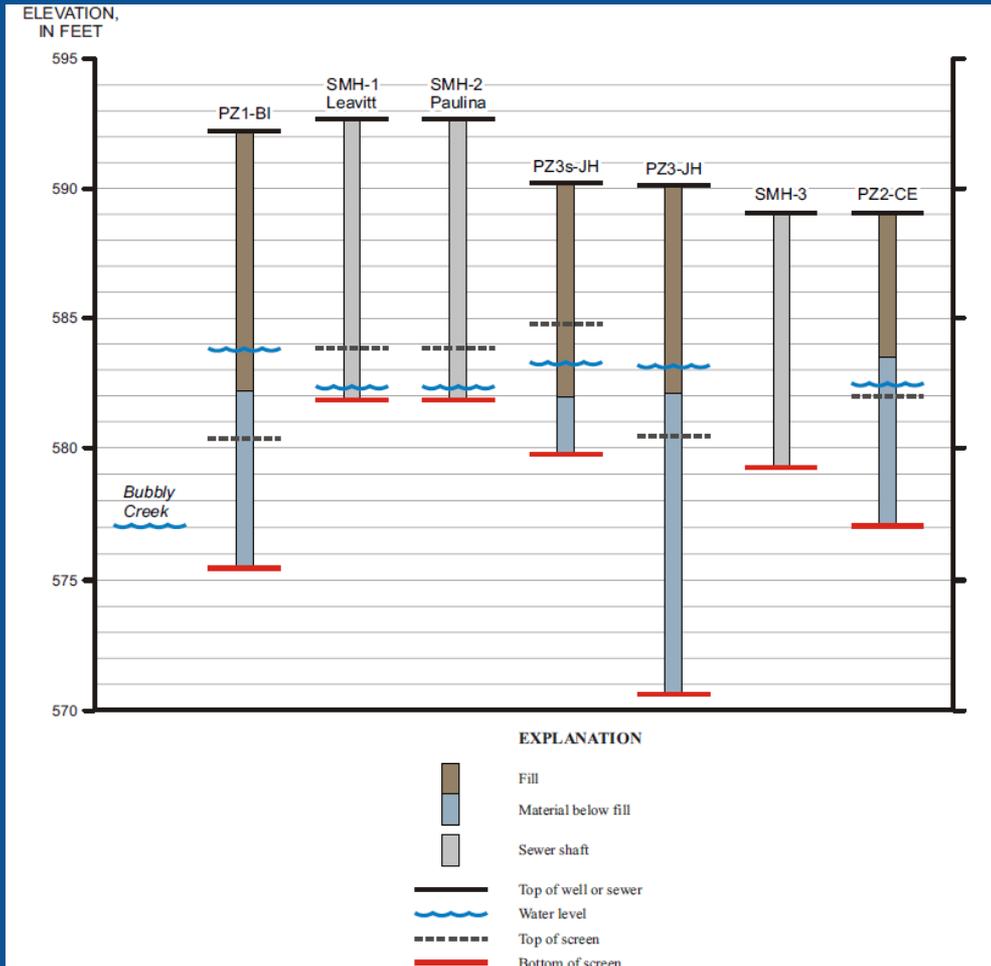
(Separate sewer  
lines)

# Groundwater Monitoring

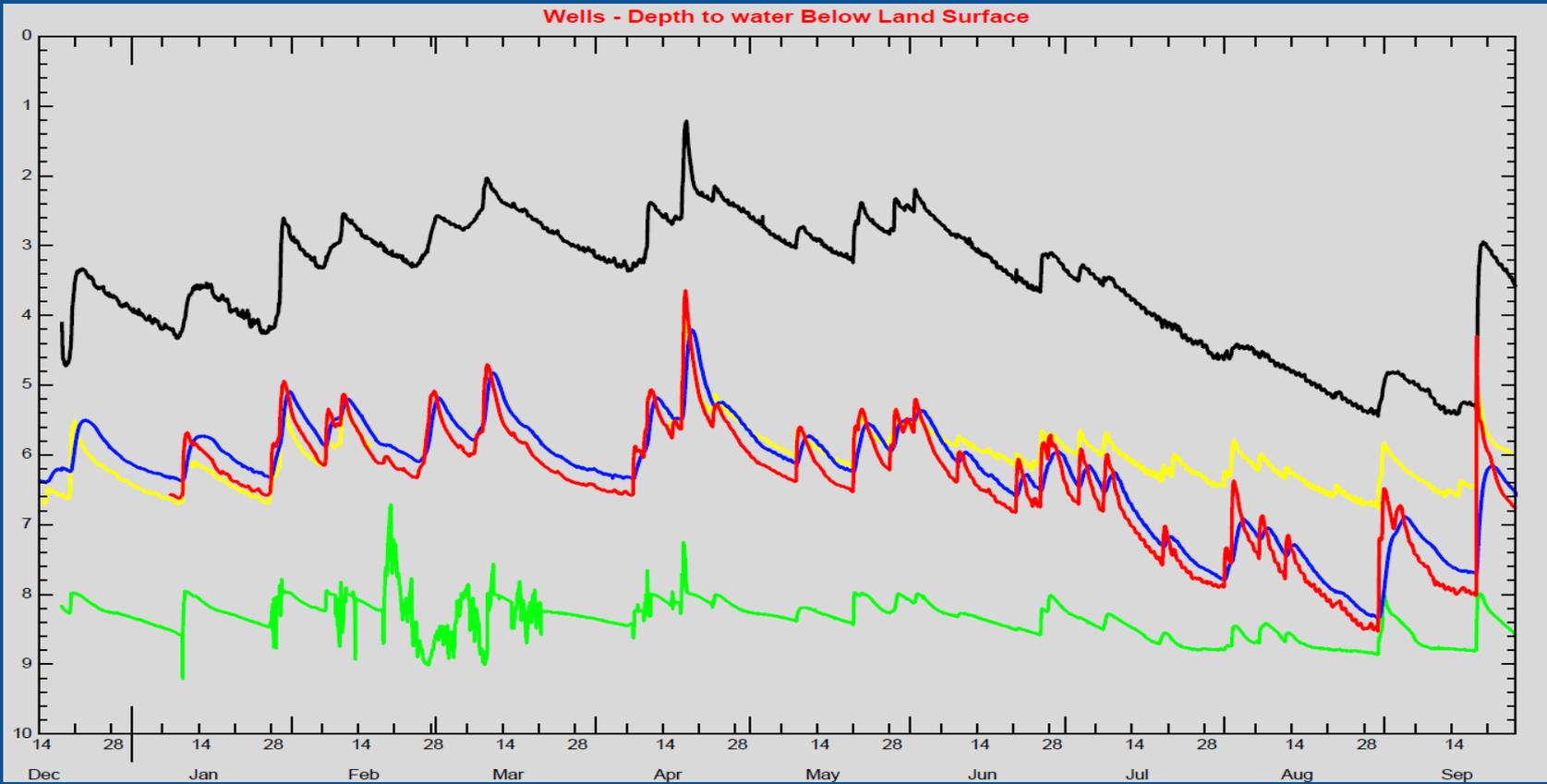
- ❖ Four monitoring locations (5 monitoring wells)
  - ❖ Leavitt
  - ❖ Juarez High school (2)
  - ❖ Canalport
  - ❖ Bioswale
- ❖ Groundwater level relative to sewers and BMP's
- ❖ What are characteristics of groundwater infiltration after storm event. Drainage rates??



# Groundwater-relative water elevations



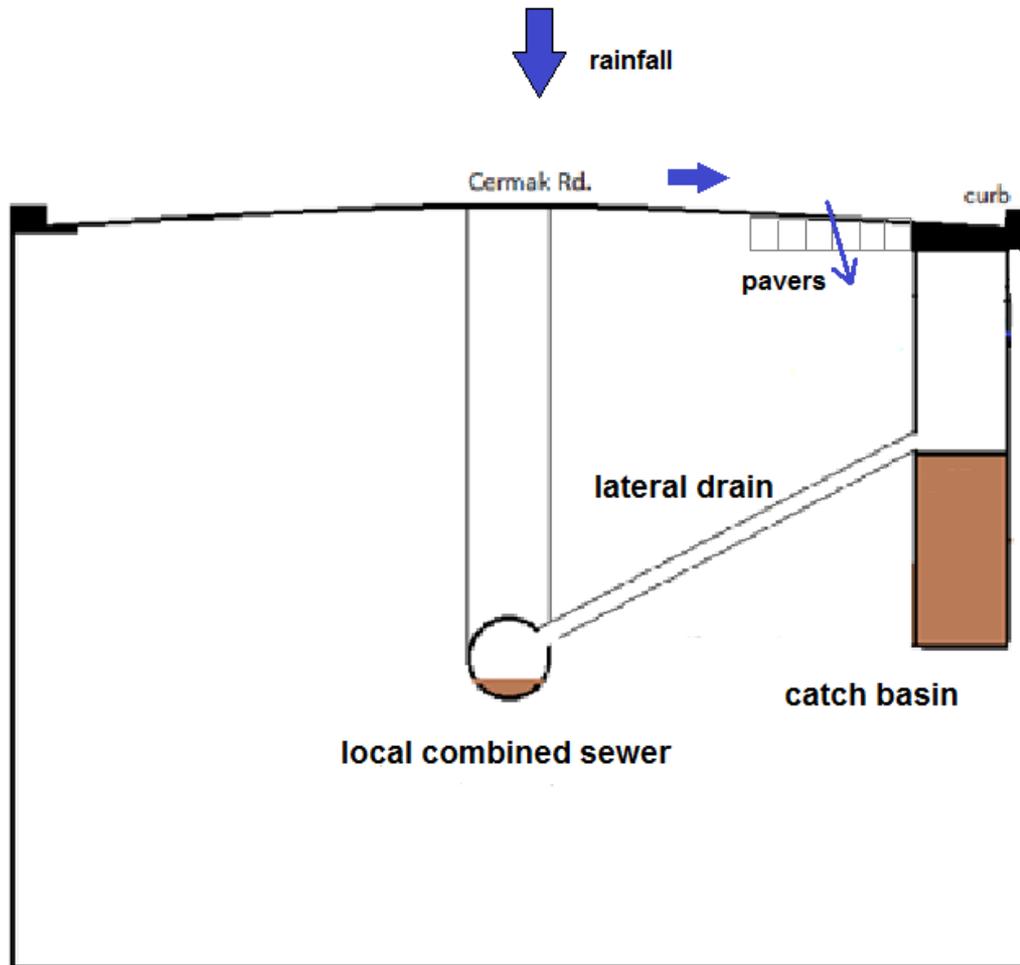
- ❖ Groundwater levels are higher than sewer elevations, however no evidence in sewer monitoring for inflow.
- ❖ Fill material has the greatest hydraulic conductivity .



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

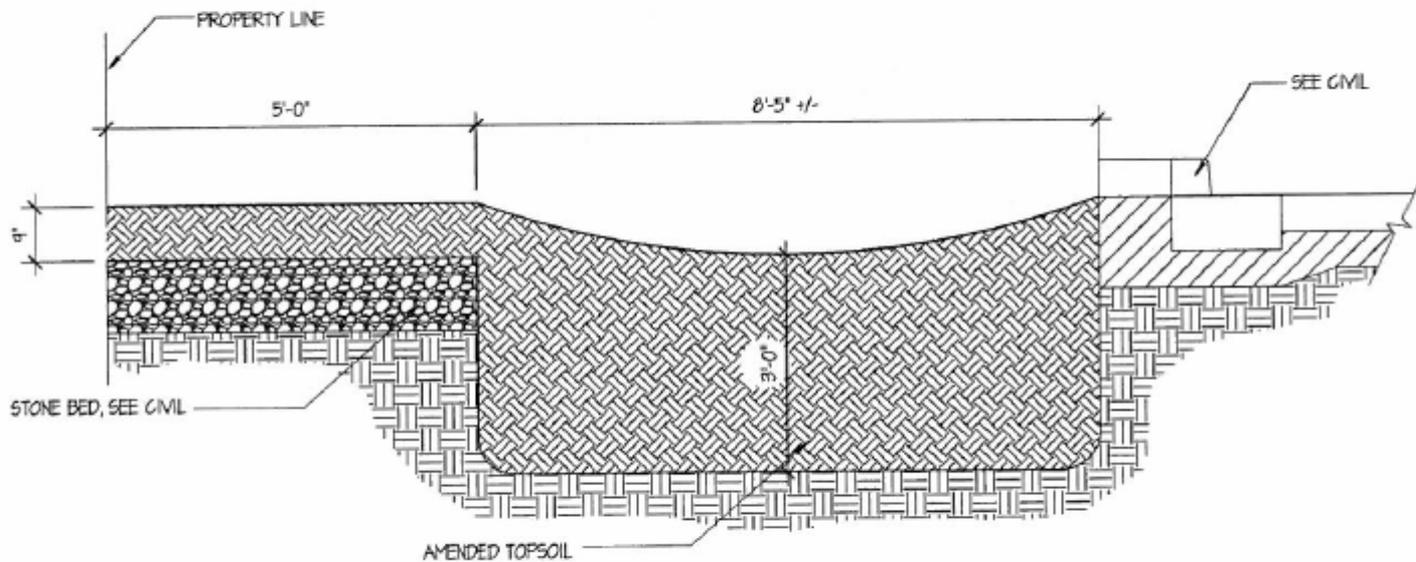
Paulina Catch basin catchment area=  $250 \text{ ft} \times 30 \text{ ft} = 7500$  square ft.

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

# Bioswale

Cermak Road Bioswale



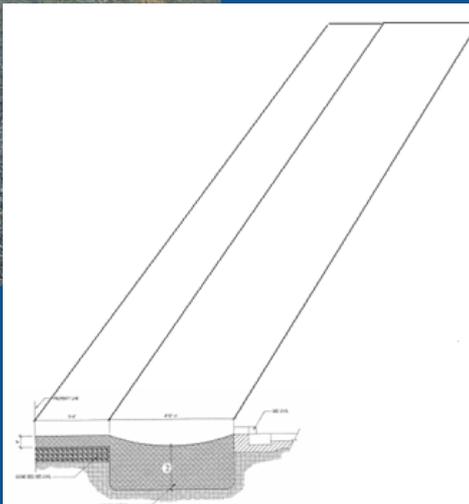


6  
L14.0

## 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

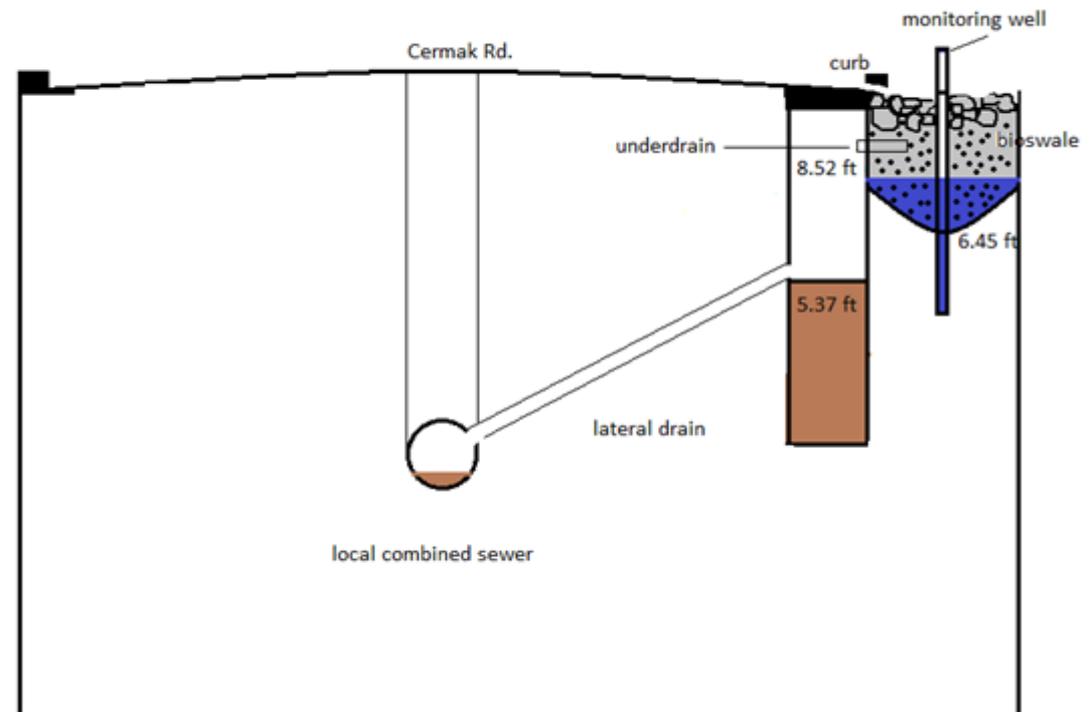


In 3 years of monitoring, the bioswale never returned water to the catch basin through the underdrain.

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

Not to scale

Cross section view



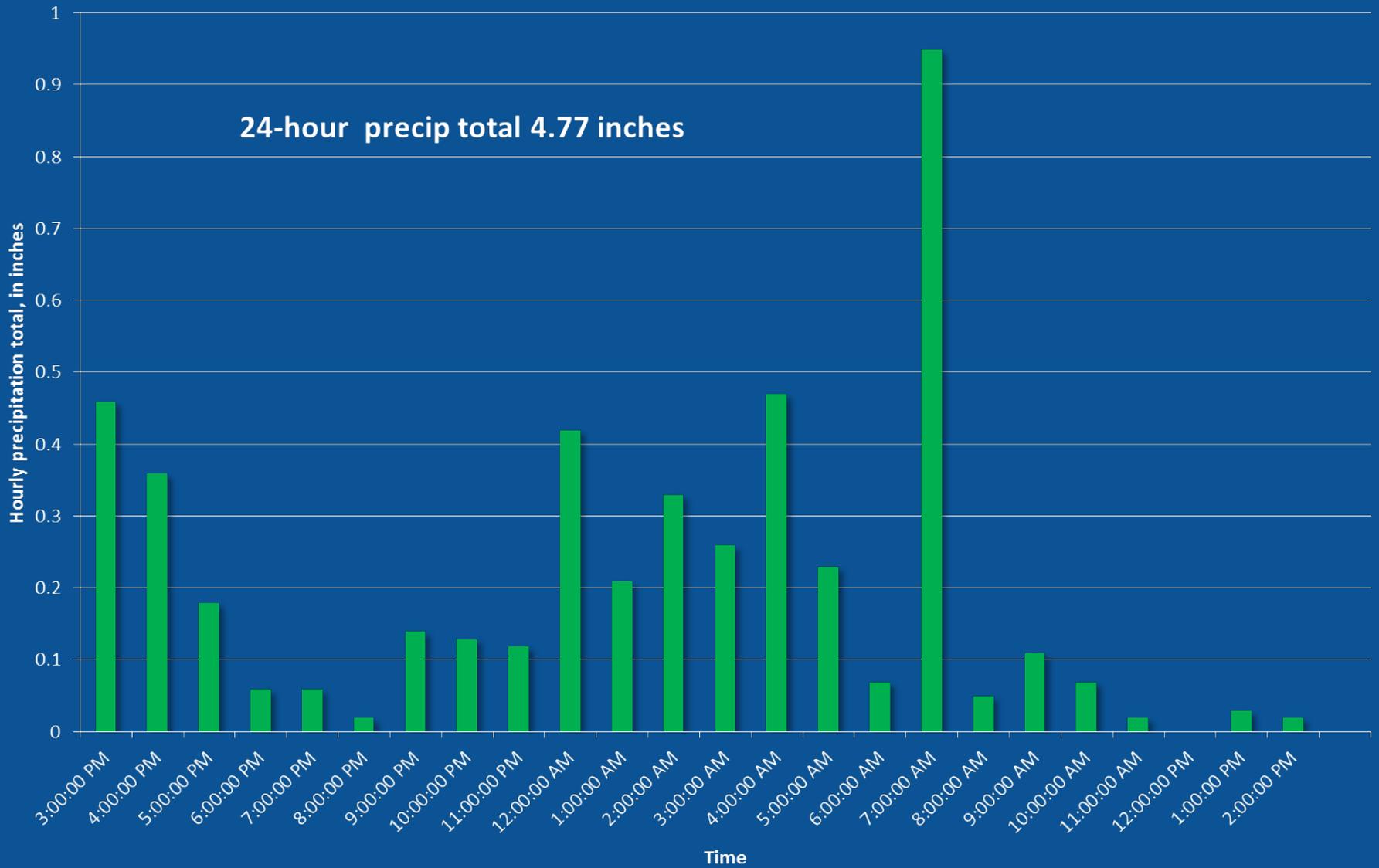


**Bioswale  
monitoring  
well**

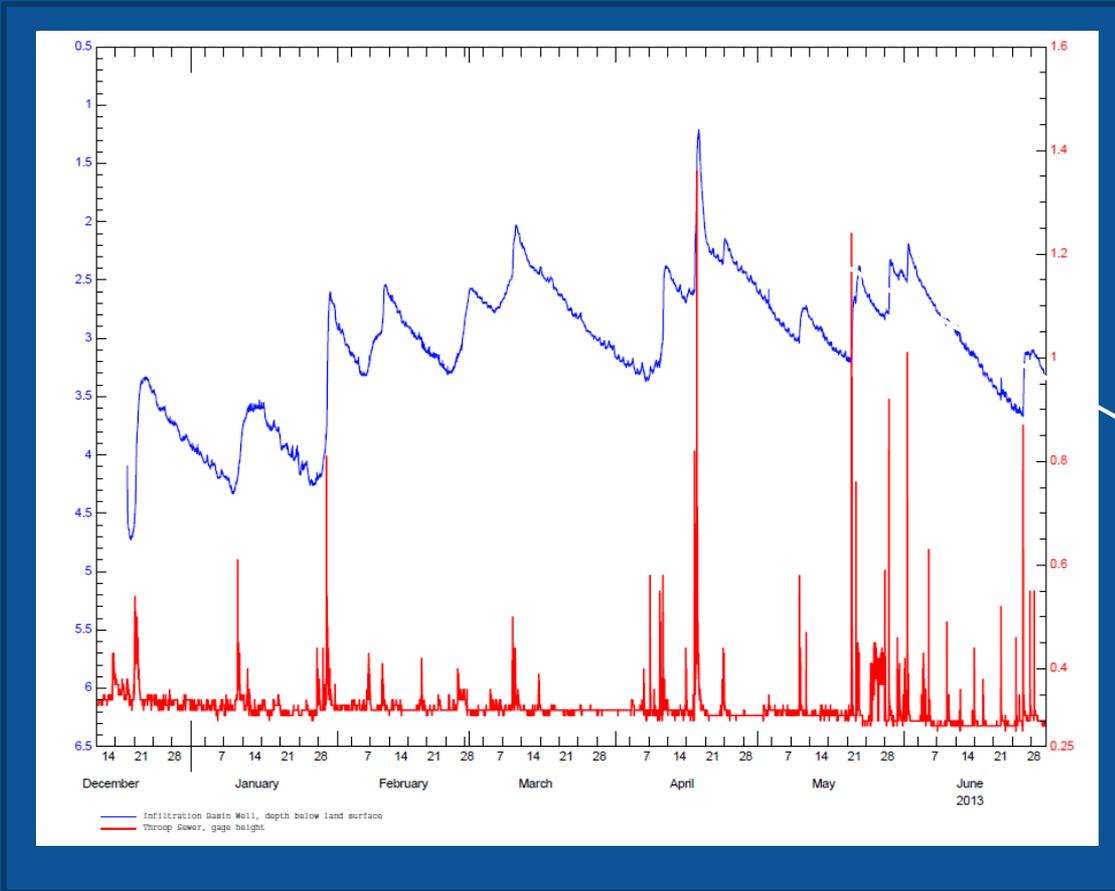
# Hourly Precipitation Distribution-RG # 9

## April 17-18, 2013

24-hour precip total 4.77 inches

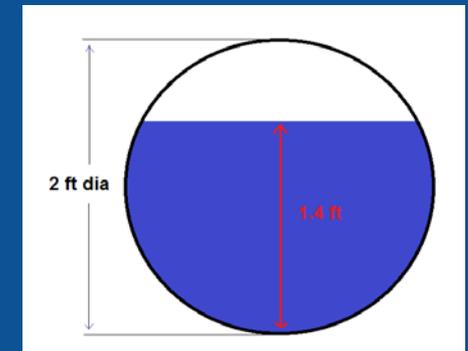


# Bioswale performance



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

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

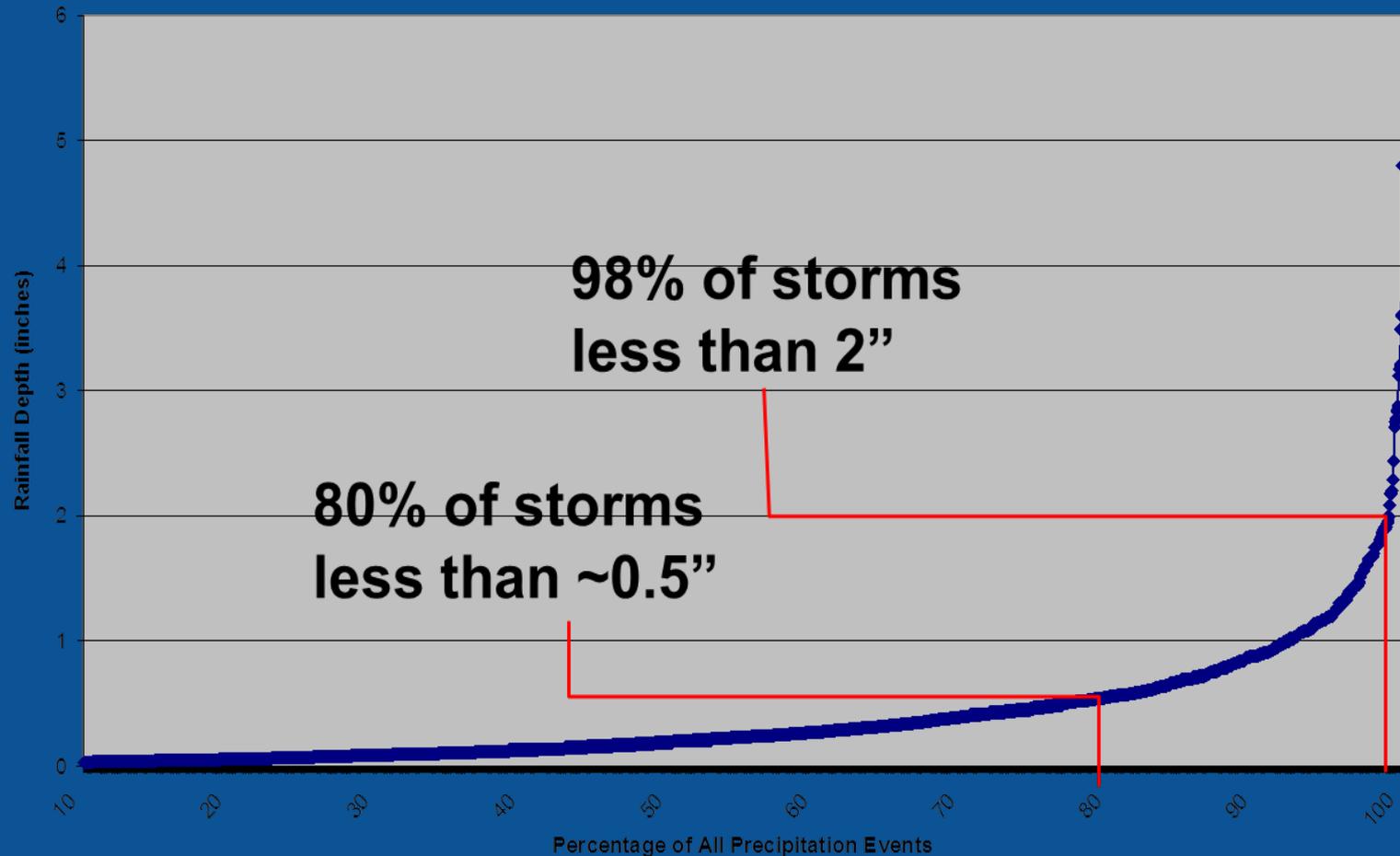


- Chicago sewers designed for 5-yr event.

# 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
<b>Pavers Cleaned</b>	<b>No</b>	Yes; July, 2013	Yes; July, 2013
August, 2013	3 ± 1	45 ± 7	170 ± 22
May, 2014	2 ± 1	21 ± 6	63 ± 14
<b>Pavers Cleaned</b>	<b>No</b>	Yes; July, 2014	Yes; July, 2014
August, 2014	2 ± 1	43 ± 11	140 ± 22
May, 2015	2 ± 1	2 ± 1	3 ± 1
<b>Pavers Cleaned</b>	<b>No</b>	Yes; May, 2015	Yes; May, 2015
June, 2015	1.6 ± 0.5	21 ± 12	7 ± 4





# Average Soil Percolation Rate (inches/hr)

## Bioswale

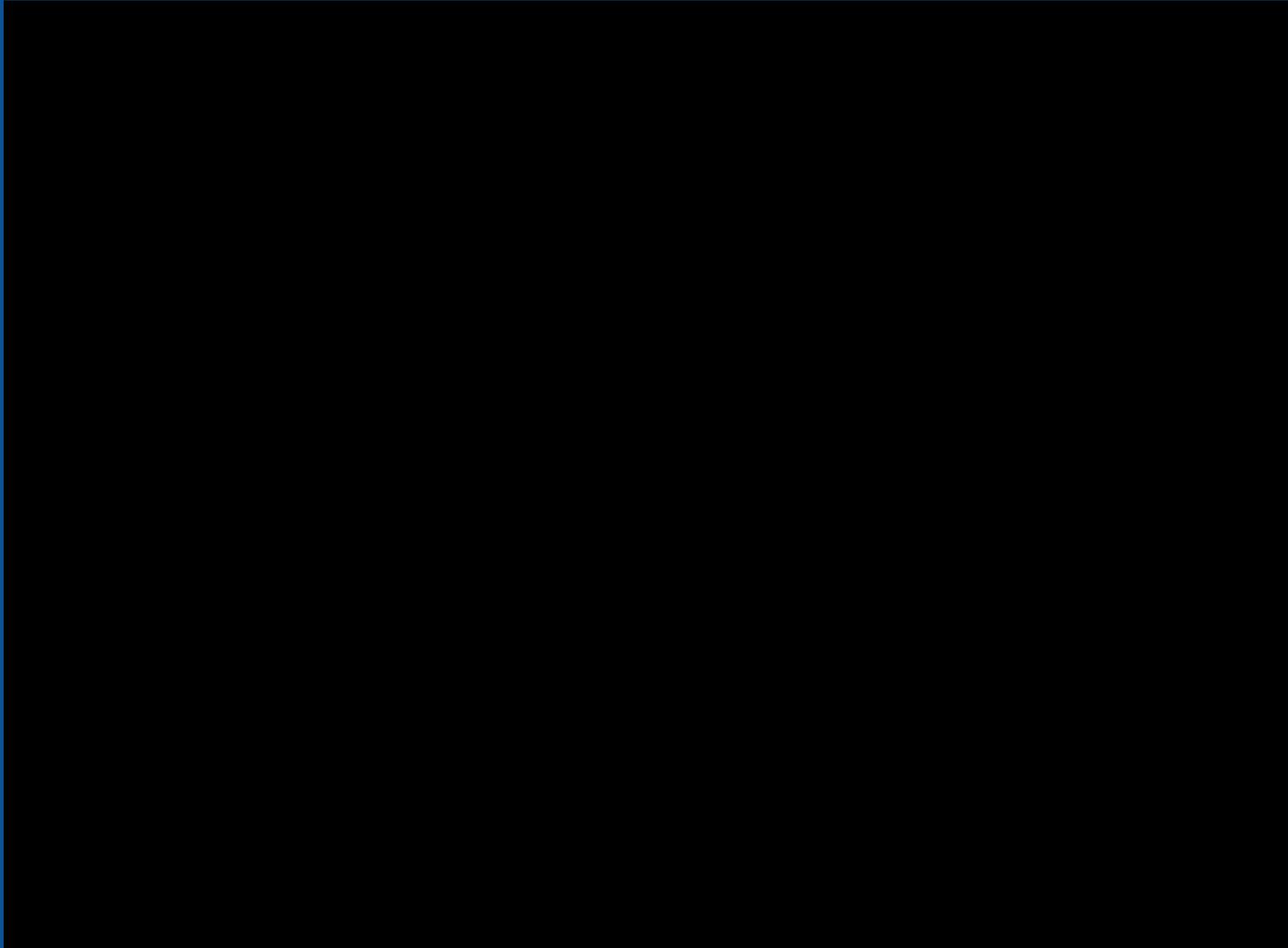
Date	Near Curb-cut	Center
Oct, 2012	$11 \pm 4$	$61 \pm 18$
June, 2013	$9 \pm 3$	$55 \pm 15$
Aug, 2013	$8 \pm 4$	$50 \pm 12$
May, 2014	$6 \pm 2$	$21 \pm 7$
Aug, 2014	$5 \pm 2$	$18 \pm 7$
May, 2015	$3 \pm 1$	$11 \pm 6$
June, 2015	$3 \pm 2$	$9 \pm 5$



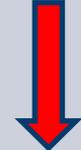
## Planter Boxes

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

# 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)

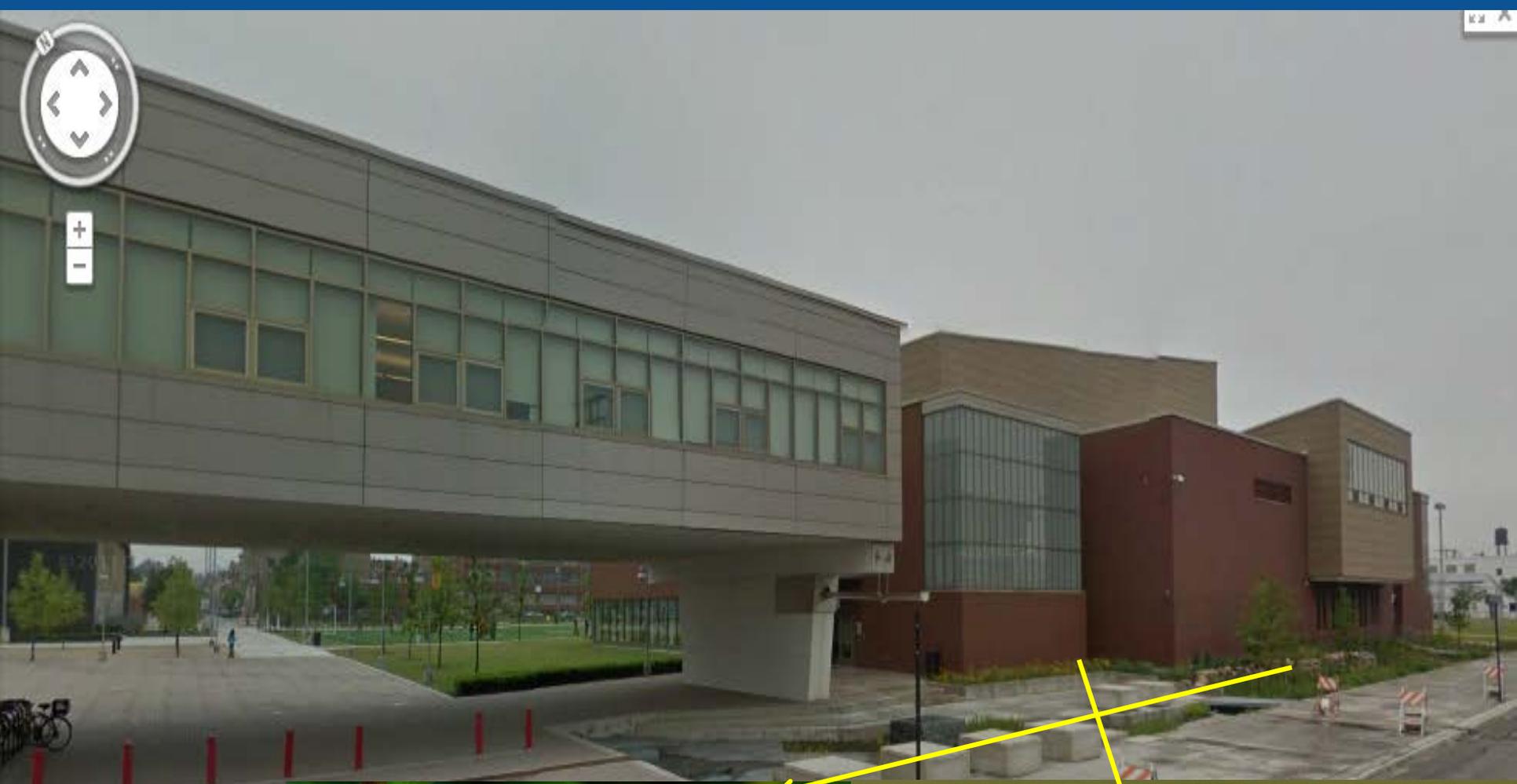
BMP	Cu	Mn	Ni	Pb	Zn
<b>Blue Island Ave. (Catchment area – 7500 Sq. ft.)</b>					
Pavers/Planter Boxes (lbs/yr)	2.0	2.3	1.7	1.8	4.3
<b>Cermak Rd. (Catchment area – 80,100 Sq. ft.)</b>					
Bioswale (lbs/yr)	6.0	8.5	2.2	3.9	32.2
<b>Stickney WRP Influent (lbs/day)</b>					
	1212	1527	180	374	3018

# Plant Performance in BMPs – Third Year Results

## 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	

- 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



## NEWS & NOTES

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

May 2, 2013  
by Theresa Riley

[Like](#) 11k [Tweet](#) 115 [814 points](#) [+1](#) 8 [rp repost](#) [Share](#)

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 Headlines

House approves back pay for furlough workers

Report: Chicken nuggets aren't made of "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

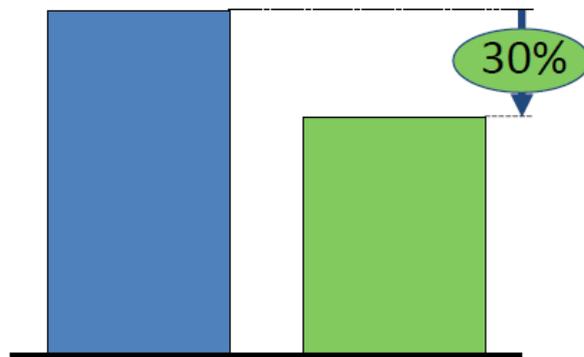
- Photocatalytic, permeable, high albedo Pavers
- New recycled Aggregates
- 30% recycled content concrete – slag, aggregates, wash water
- 40% to 50% recycled content warm mix asphalt -slag, FRAP, RAS, GTR,
- Micro-thin Concrete overlay



# Cost Benefits

Cost is 30% less than projected...

Cermak total project cost (\$)

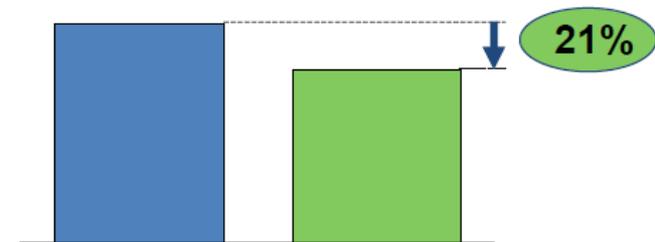


•Cermak  
projected  
cost

•Actual  
bid

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

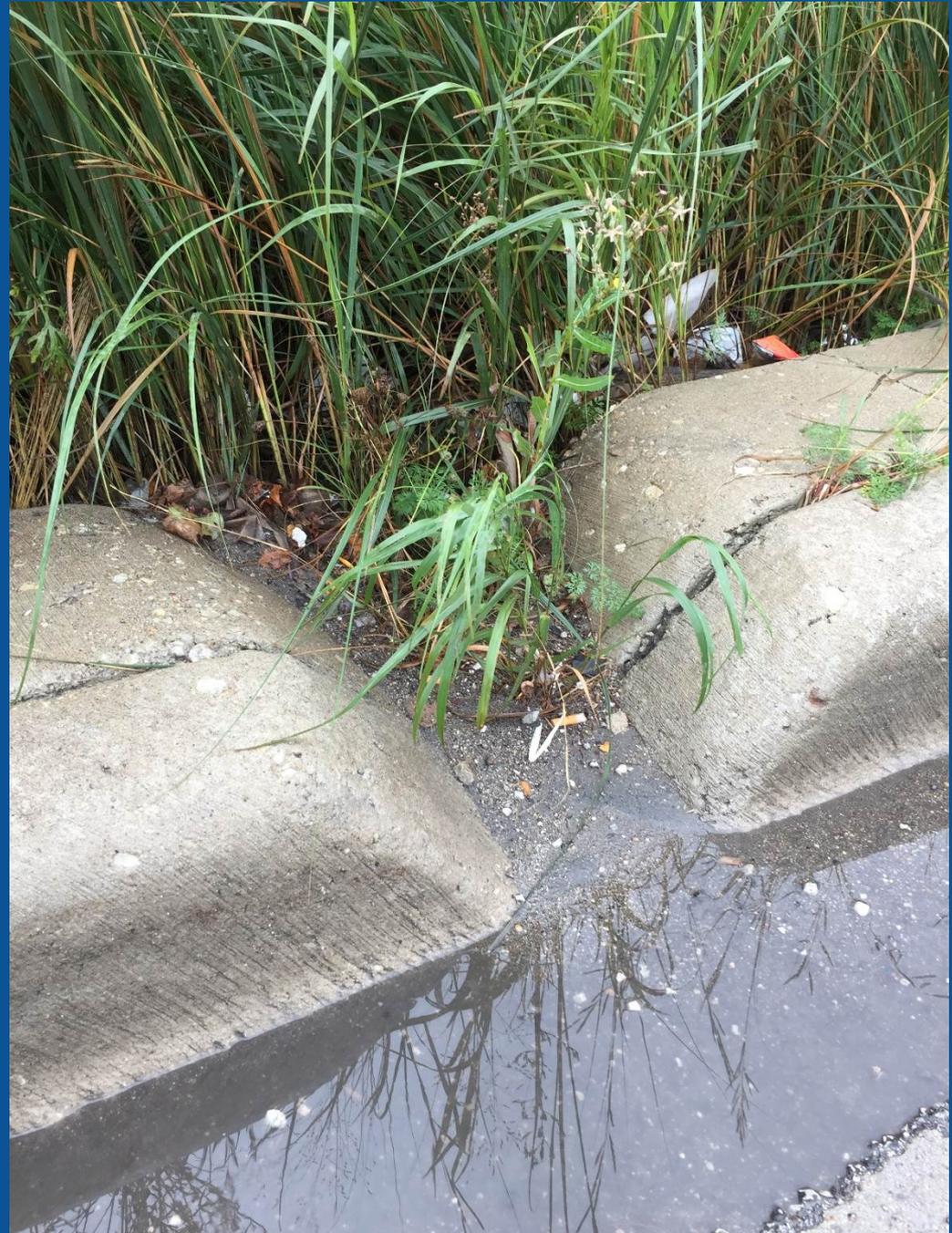
Average per block cost (\$)



•Average  
construction  
cost per  
block in  
2010

•Cermak  
cost per  
block

# 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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