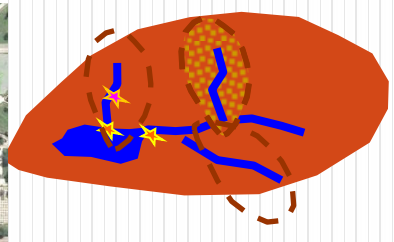
Green Infrastructure for CSO Control:
Kansas City, MO

Presented by:
Richard Field, PE, BCEE, D.WRE



KC's Project Team

- **EPA ORD:** R. Field, T. O'Connor, A. Tafuri
- **EPA R7:** K. Herndon, M. Whitsitt
- **Tetra Tech:** S. Struck
- **MARC**
- **UMKC:** D. O'Bannon
- **UAL, Tuscaloosa:** R. Pitt
- **Consultant:** M. Ports
- **Partnerships:** KCMO WSD, neighborhood, watershed, regional levels

Kansas City's CSO Challenge

- **Problem**
  - Fully developed combined sewer area: 58 mi^2
  - Rainfall: 37 in./yr
  - 36 sewer overflows/yr by rain > 0.6 in.
  - ✓ 6.4 B gal overflow/yr
  - Aging wastewater infrastructure
  - Sewer backups
  - ✓ Poor receiving water quality
- **Goal**
  - Reduce CSOs to 1.4B gal
  - Capture 88% of annual WWF
  - Reduce CSO frequency by 65%

KC GI Pilot Project

- **Primary Objectives**
  - Data collection (Pre-**GI** installation)
    - Land characterization & soil surveys
  - System modeling & design (multiple scales)
  - Post-**GI** installation; "system" performance; O&M
  - Economic analyses
  - Community education & outreach
- **City Implementation**
  - Design & placement of **GI** in public ROWs ($1.3 M)
  - Construction ($4.2 M)

Middle Blue River- Pilot Project

- 100 acre pilot
- 87 acre control
- **GI** to reduce storage tanks
- **GI** need: 290K gal capture for design storm
- Goal: ≤7 overflows annually

Completed & Ongoing Tasks

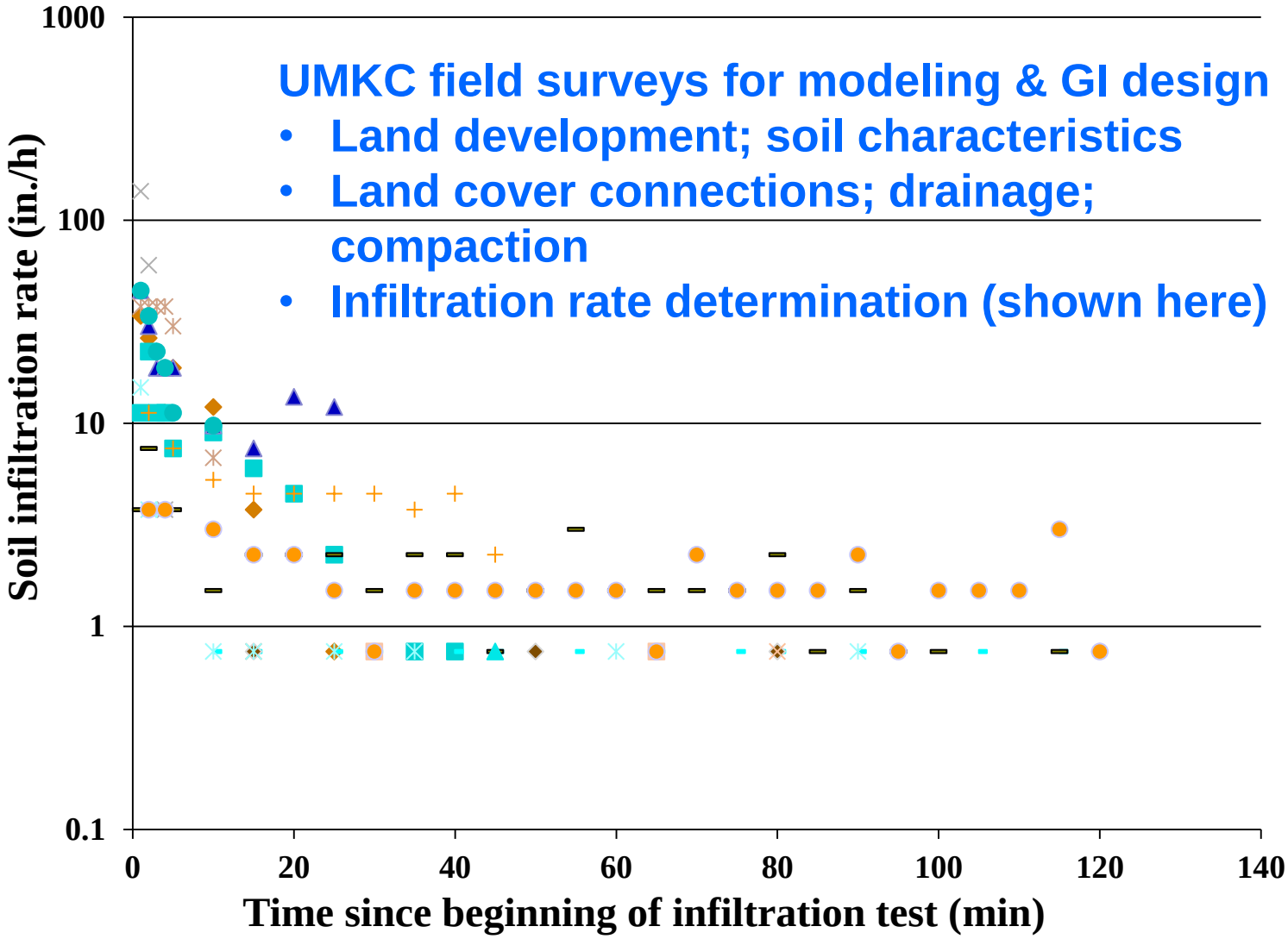
Completed

- QAPP & Monitoring Plan
- √ Pre-**GI** monitoring (2+ yr)
- Public outreach
- **GI** Design assistance (monitoring & review)
- √ Model setup & pilot
  - WinSLAMM
  - SUSTAIN
- **GI** construction on private property

Ongoing & Near Future

- √ Post-**GI** monitoring
- Public outreach
- √ Calibrate/validate models (scale-up studies)
  - WinSLAMM
  - SUSTAIN
- Private **GI** performance
- O&M needs/performance
- Economic evaluation

Land Characterization

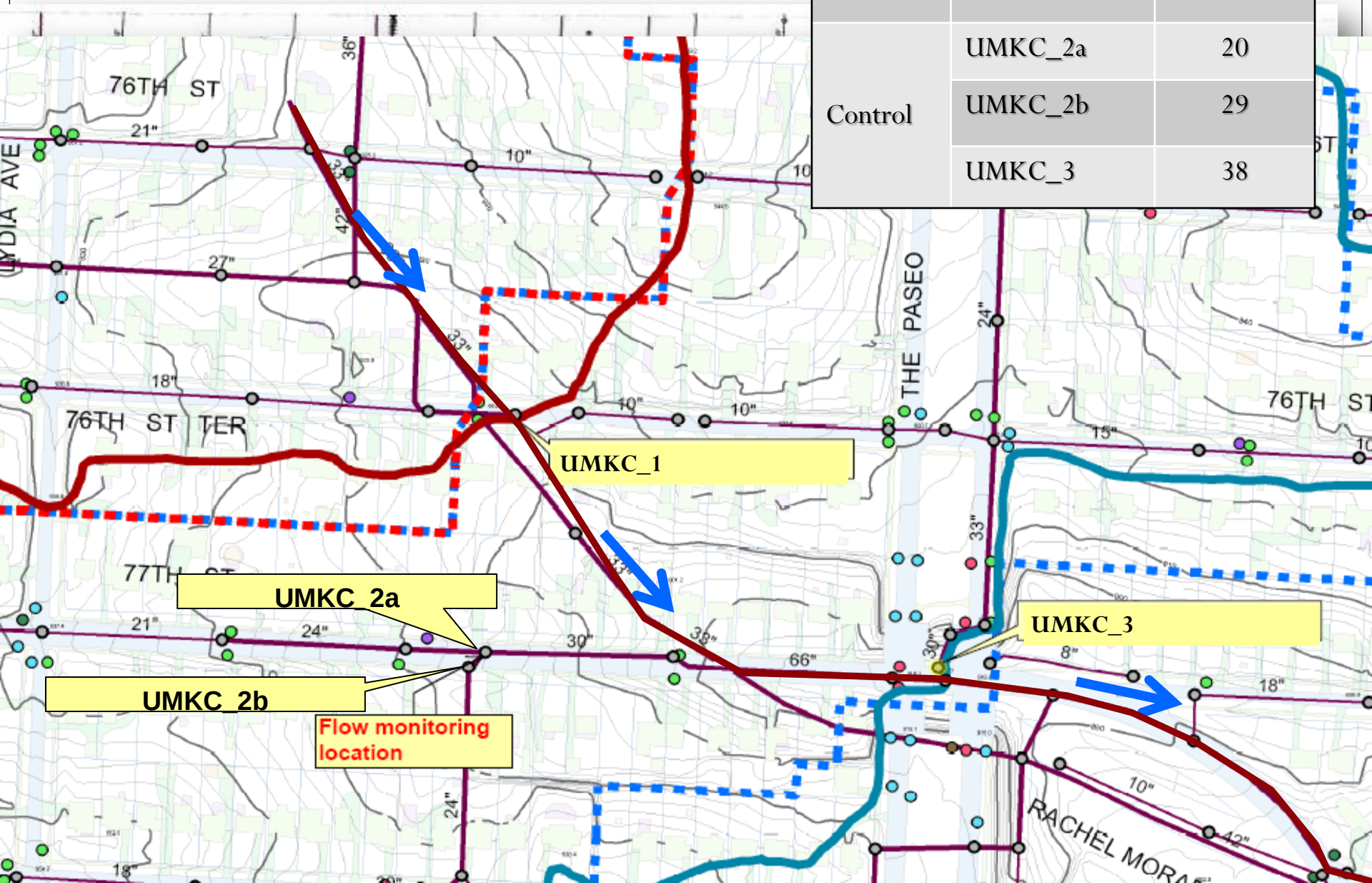


UMKC field surveys for modeling & GI design

- **Land development; soil characteristics**
- **Land cover connections; drainage; compaction**
- **Infiltration rate determination (shown here)**

Flow Monitoring

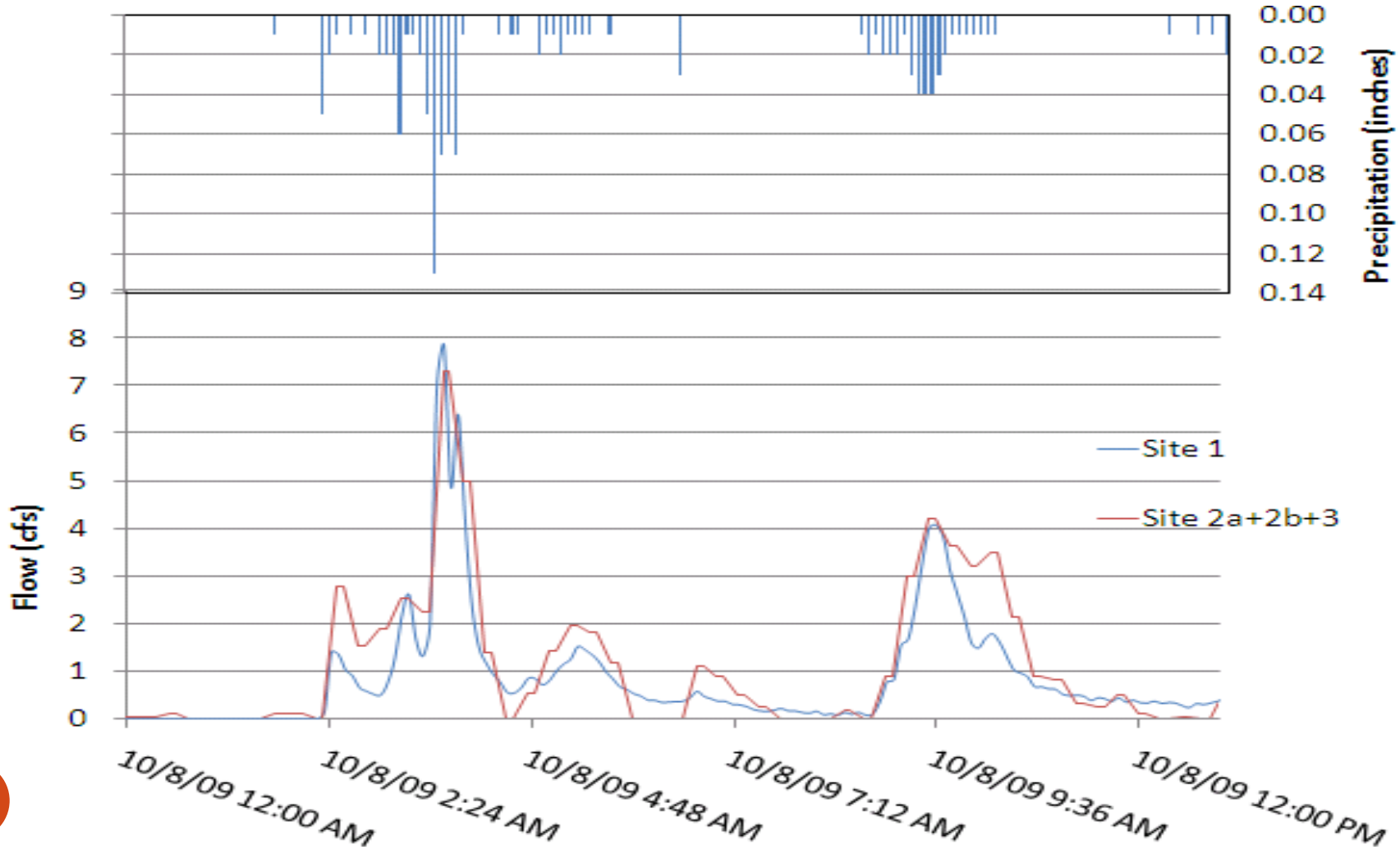
Catchment		Area (acre)
Pilot	UMKC_1	100
Control	UMKC_2a	20
	UMKC_2b	29
	UMKC_3	38



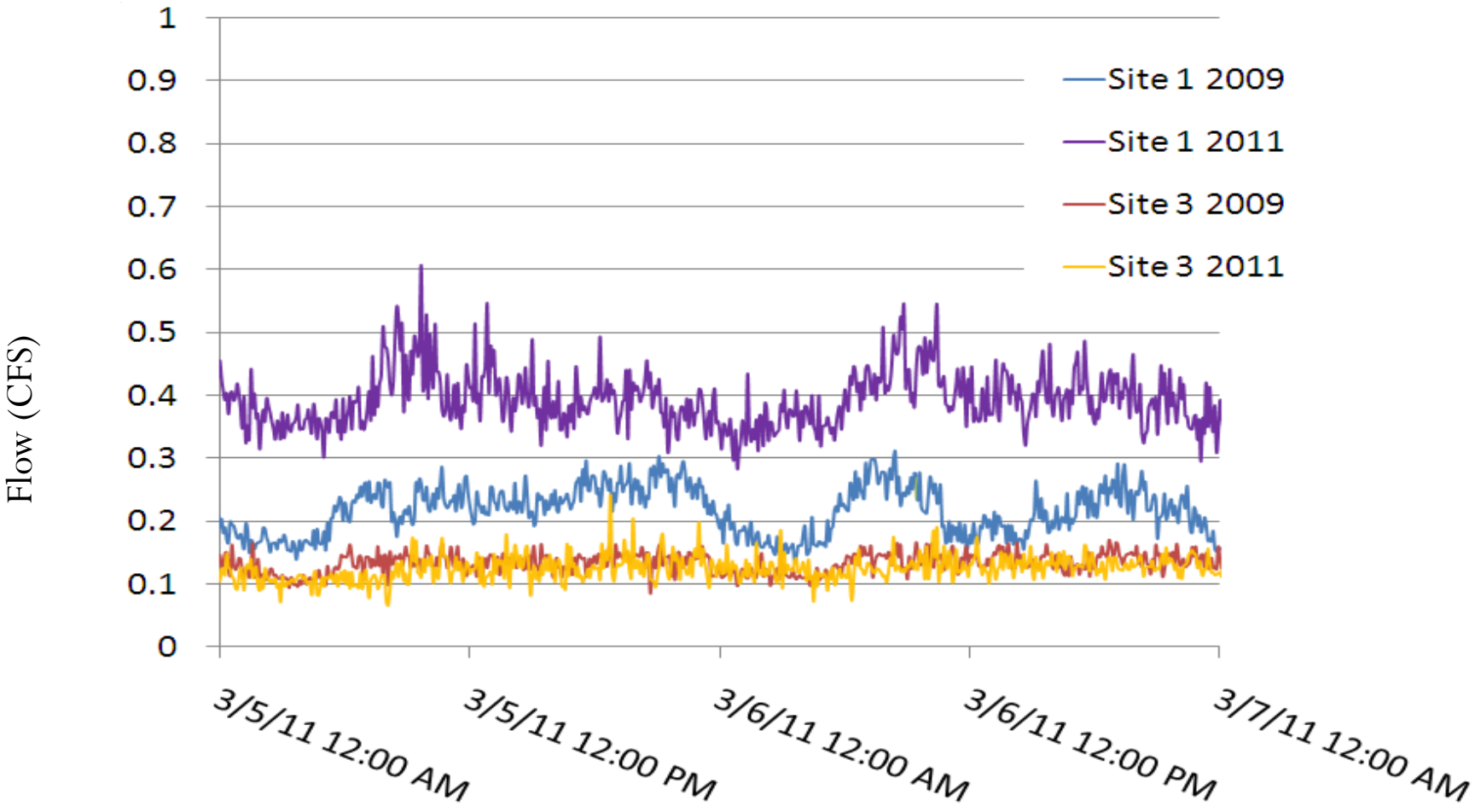
Example Hydrograph

Storm Event Profile

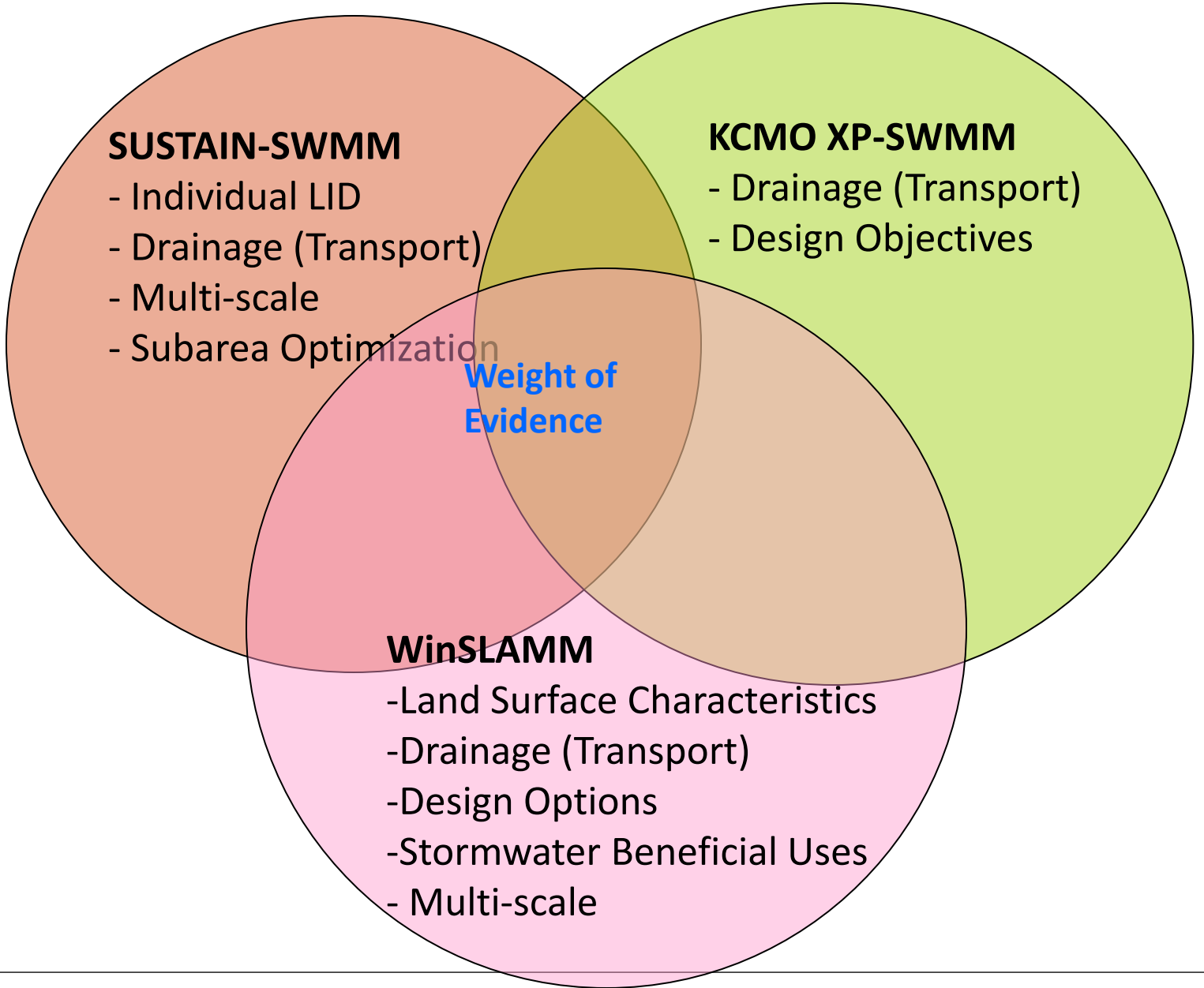
Start: 10/8/2009 2:15
End : 10/8/2009 23:25
Total Precipitation: 2.06 in.
Total Event Duration: 11h 10min
Antecedent Dry Period: 4d 15h



KC's Flow Flow Monitoring: Dry-Weather

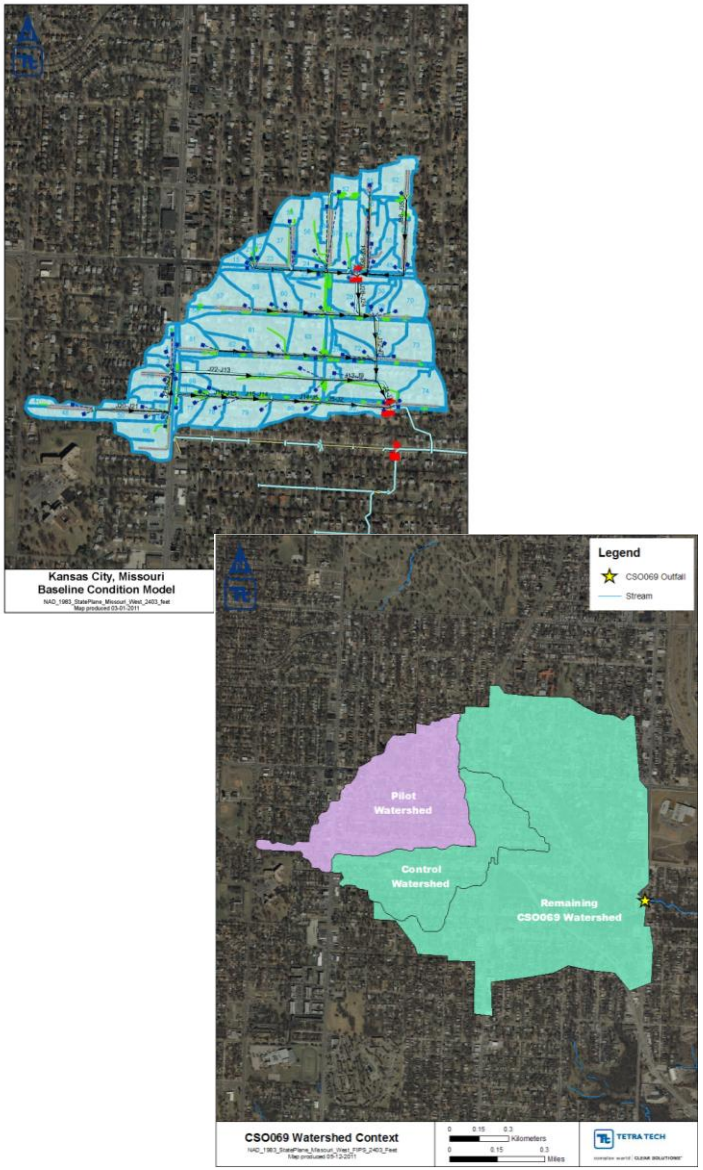


KC's Modeling Connections

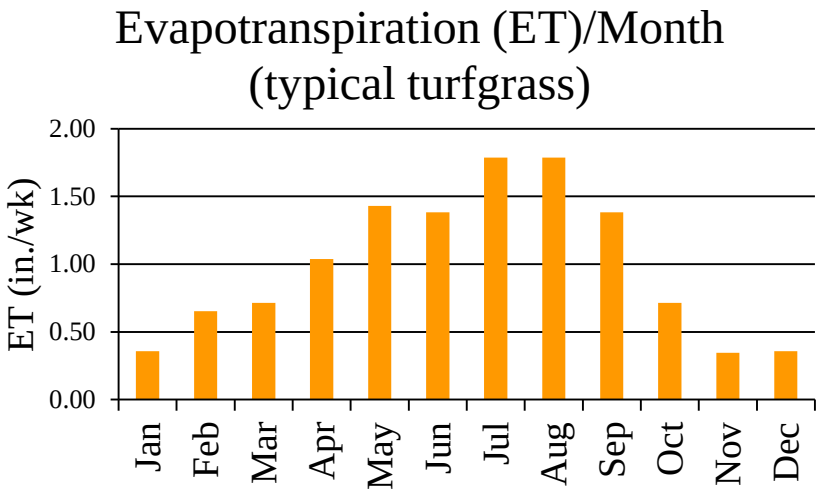


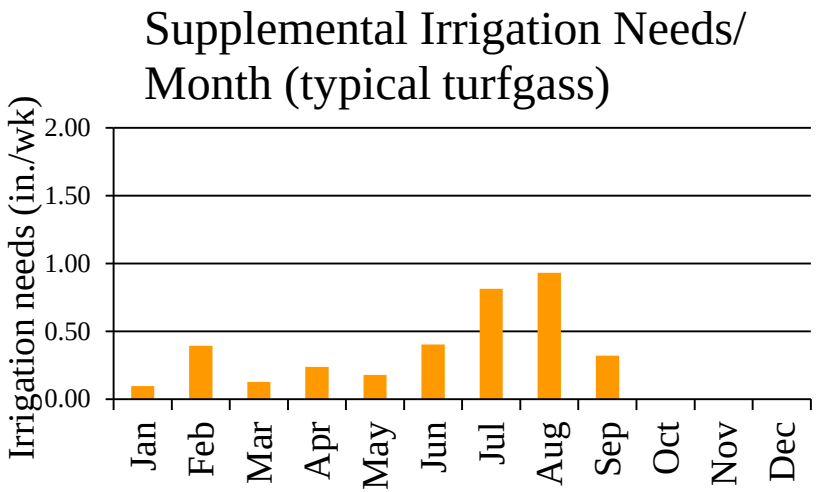
KC's SUSTAIN

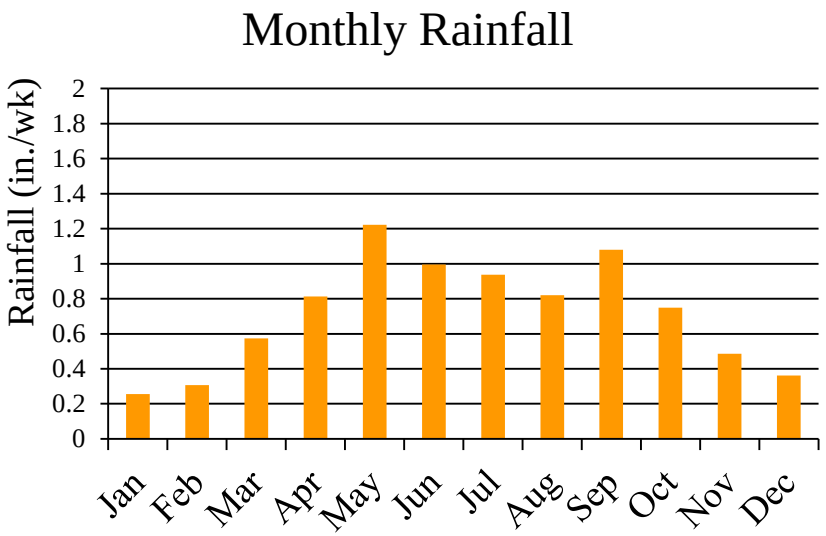
- Compare fully articulated routing network to aggregate **GI** approach
- Optimize for **GI** opportunities in extended CSO 069 watershed
  - Fix designed **GIs** in pilot watershed
  - Extrapolate to remaining 380 acres
  - Use rules from aggregate **GI** approach



WinSLAMM Water-Harvesting Potential of Roof Runoff

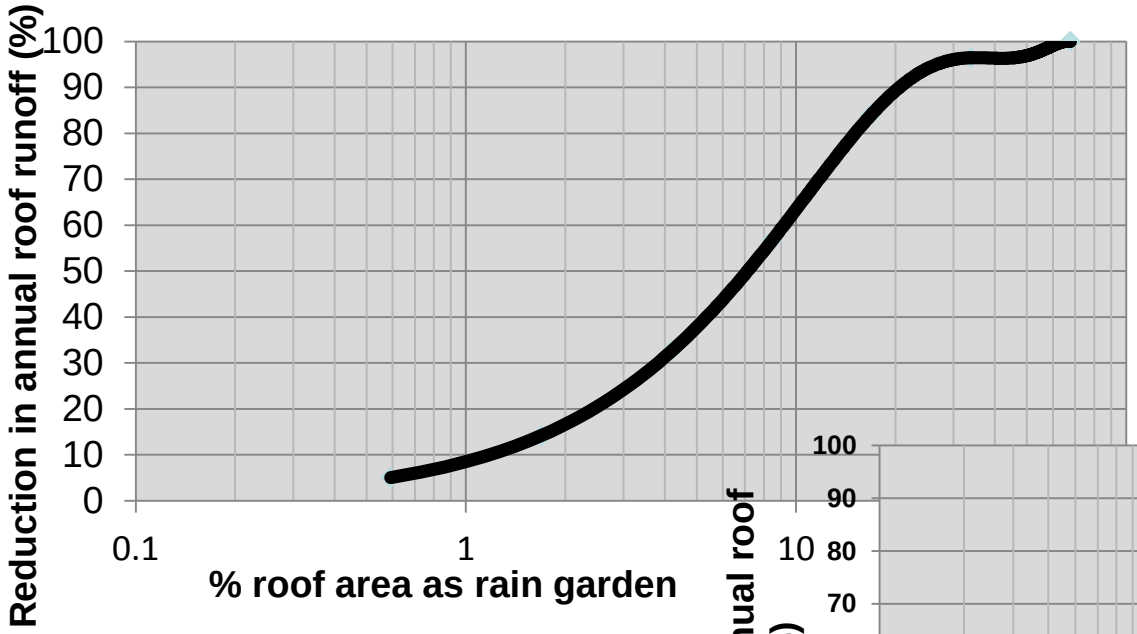


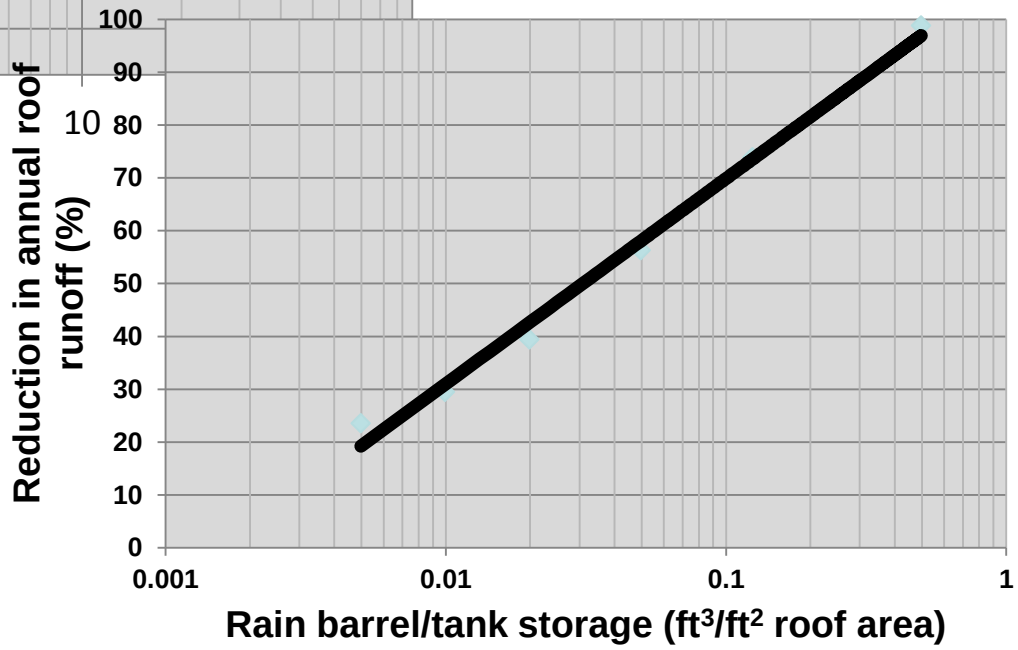




Irrigation needs for home landscaped areas calculated by subtracting long-term monthly rainfall from the regional ET demands for turf grass.

Win-SLAMM Reductions in Annual Flow from Roofs





WinSLAMM: Runoff Reduction Benefits of Rain Barrels & Rain Gardens

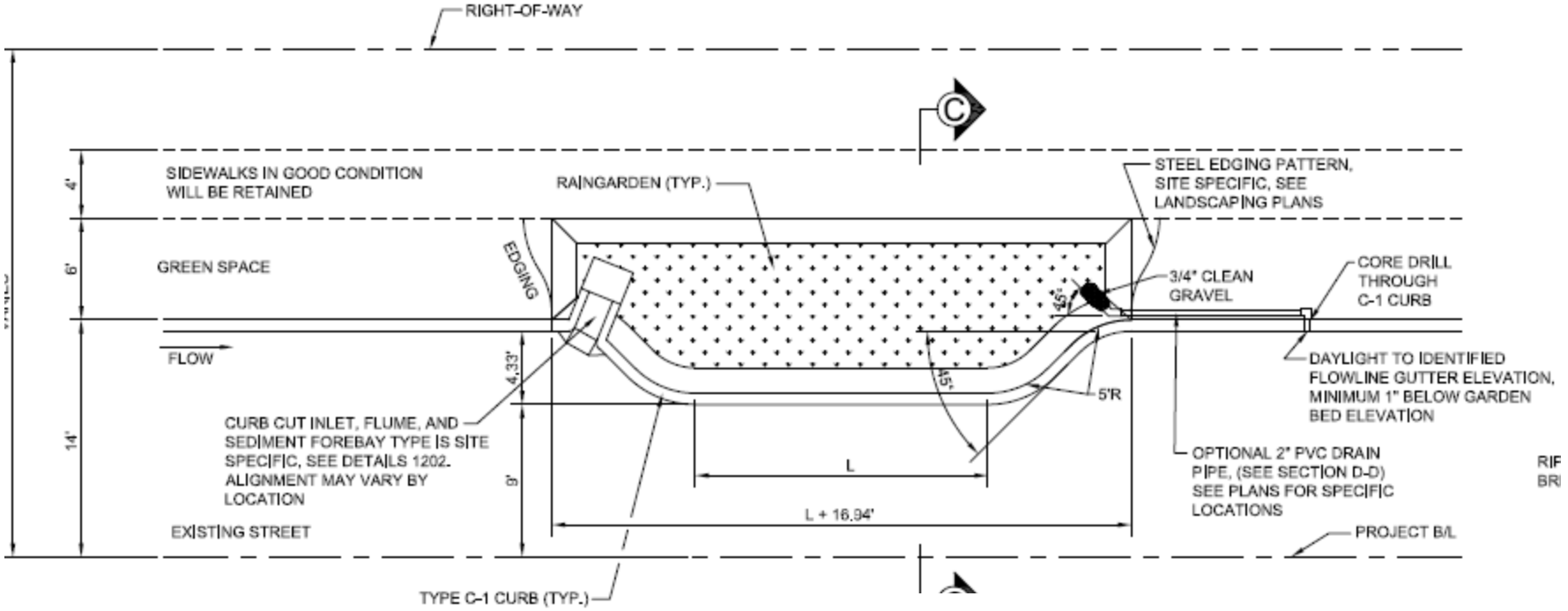
Rain Barrel Storage (Gal) \ Rain Garden Surface Area (ft^2; 1-ft depth)	**0**	**6**	**16**	**40**	**80**	**160**	**320**	**640**
0	0	5	14	33	57	84	96	100
35	24	27	36	52	68	89	99	100
70	29	33	41	55	71	**90**	99	100
140	39	43	49	61	75	91	99	100
350	56	58	62	71	81	92	100	100
875	74	75	78	82	87	94	100	100
3500	99	99	99	99	100	100	100	100

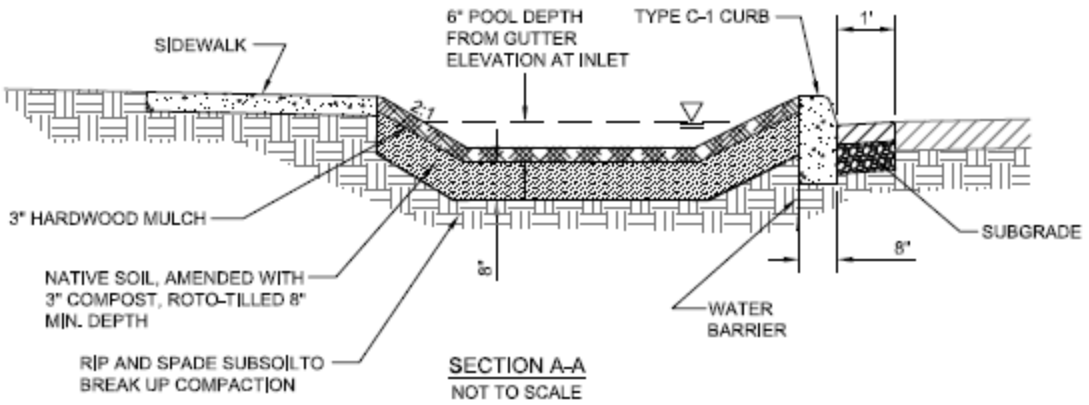
70 gal rain barrel storage plus 160 ft^2 rain garden per house reduces annual runoff quantity from directly connected roofs by 90%

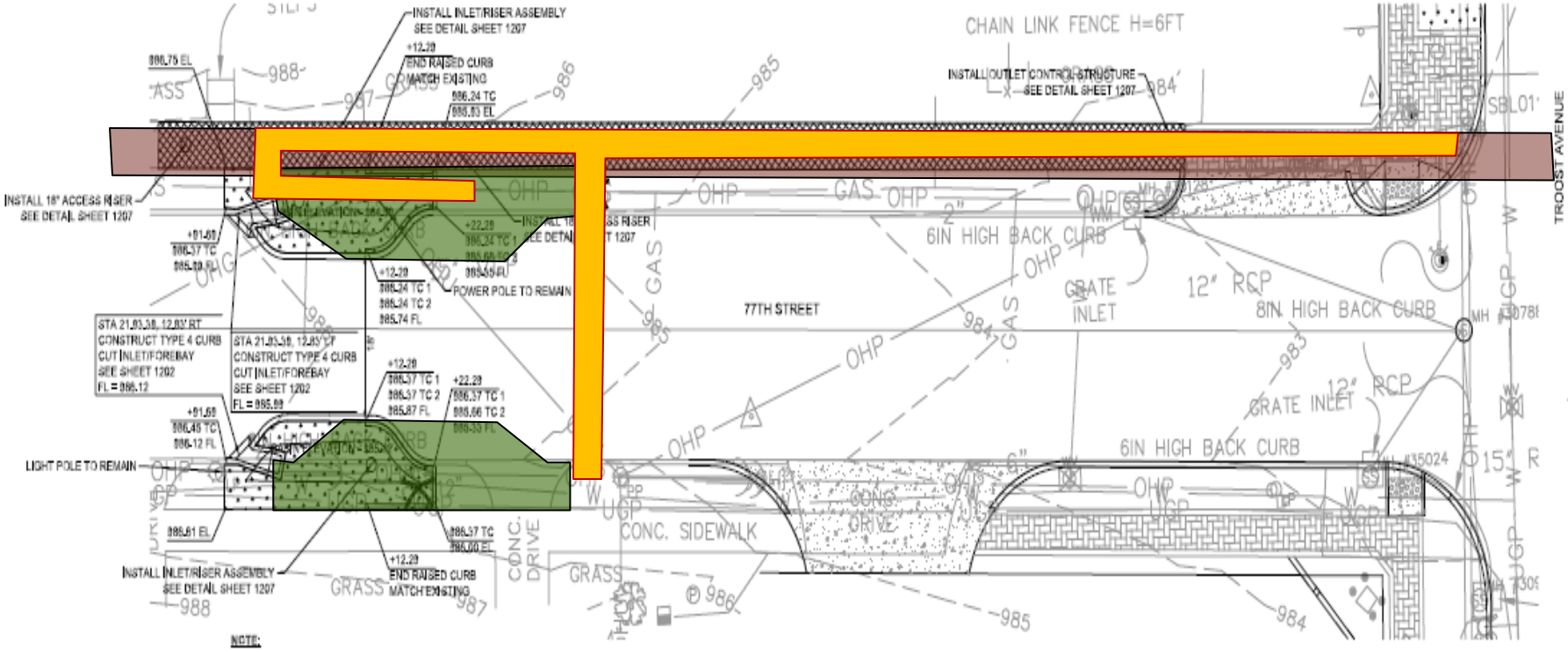
Significant Project Features

- 2+ yr of pre-**GI** installation monitoring
  - Existing & rehabilitated (lined)
  - Monitored 75+ events for pilot/control watersheds
- Detailed land use & collection system characterization (public & private)
- Multiple applied models
- Inclusion of monitoring needs in **GI** design
- Public & private application of **GI**
- O&M requirements & costs

Typical Bioretention Curb Extension






INSTALL INLET/RISER ASSEMBLY
SEE DETAIL SHEET 1207
+12.29
END RAISED CURB
MATCH EXISTING
986.24 TC
986.83 EL
986.75 EL
CHAIN LINK FENCE H=6FT
INSTALL OUTLET CONTROL STRUCTURE
SEE DETAIL SHEET 1207
INSTALL 18" ACCESS RISER
SEE DETAIL SHEET 1207
6IN HIGH BACK CURB
GRATE INLET
12" RCP
8IN HIGH BACK CURB
77TH STREET
POWER POLE TO REMAIN
STA 21+03.38, 12.83' RT
CONSTRUCT TYPE 4 CURB
CUT INLET/FOREBAY
SEE SHEET 1202
FL = 986.12
STA 21+03.38, 12.83' LT
CONSTRUCT TYPE 4 CURB
CUT INLET/FOREBAY
SEE SHEET 1202
FL = 985.99
LIGHT POLE TO REMAIN
6IN HIGH BACK CURB
CONC. SIDEWALK
CONC. DRIVE
GRASS
TROOST AVENUE
NOTE:

Importance of Continued Monitoring

- Robust data collection for pre-implementation baseline comparison
  - Includes before & after for pilot watershed & comparative control watershed data
  - Met stringent QA for number & type of events
  - No other **GI** studies of this size have all this
- Complete system-wide or watershed comparison, not just individual practices
- Comparison of benefits on public & private property
- Pilot results tied to LTCP **GI** performance

FY 2011 Deliverables

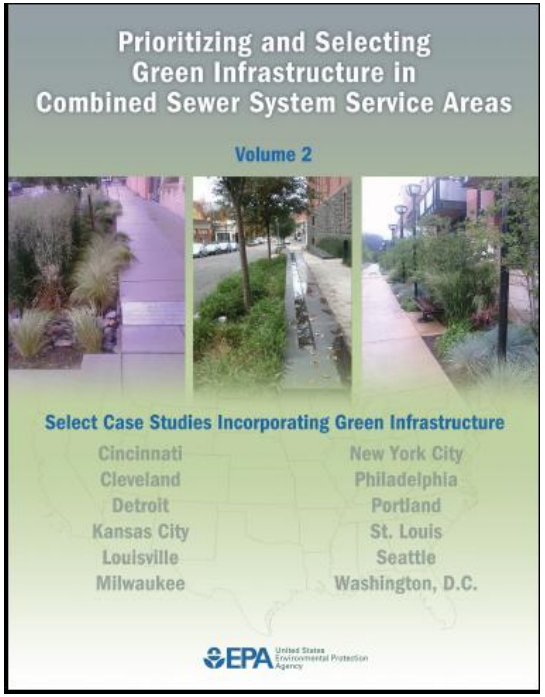
Final Report: KC Pilot Study

- Introduction of **GI** & its use in combined sewerage systems
- Modeling to determine benefits of **GI** (Public & Private)
- Site & system (watershed) benefits of private rain gardens, rain barrels, & downspout disconnections
- Public & private education & outreach

FY2011 Deliverables

Guidance Document: Selection of GI in Combined Sewer System Service Areas

- Assessment Methodologies for **GI** Prioritization
- Selection Constraints (Criteria & Considerations)
- Implementation Opportunities
- Implementation Success: Case Studies
  - NYC; Philadelphia; Washington, DC; Cincinnati; Milwaukee; KC; Seattle; Portland; Louisville, St. Louis; Cleveland; Detroit



OTHER PRODUCTS

- Over 20 presentations & proceedings at national/international conferences/workshops (WEFTEC; ASCE/EWRI; ICUD; etc.)
- EPA Region/Program Office presentations
- Peer Reviewed Journal Article:

  "Life-Cycle Cost Analysis for Bioretention: A Comparison of Traditional Gray Infrastructure vs. Green/Gray Combination", publication in *ASCE Journal of Irrigation and Drainage Engineering, June 2012*

Future Deliverables

GI Performance Report

- Detailed individual **GI** practice performance
  - 3 types each of public & private **GI** practices
- Collective system-wide (pilot sub-watershed) **GI** performance
  - Over 150 practices
- Cost evaluation
- O&M monitoring & performance evaluation
- Comparisons to before implementation & control watershed