Catchment-scale Hydrologic and Water Quality Modeling Using SWMM to Validate Lake Tahoe TMDL Implementation Pollutant Load Estimates

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Measured data courtesy of Russell Wigart, El Dorado Co. DOT, Tahoe Engineering Division

Introduction

- Watershed modeling plays a central role in water quality assessment & TMDL
- Model provides concise estimates of pollutant loads
  - e.g., annual average Fine Sediment Particle Load

Introduction

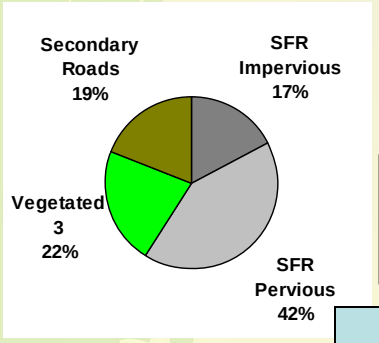
- Need for closer look into model results vs. measured data
- Modeling and monitoring data require analysis
  - Grab sample reveals snapshot in time
  - Instant concentration vs. annual load
  - Need for long-term flow data and meteorology

TMDL Context

- Mandate: % reduction in fine sediment runoff
- Jurisdiction responsibilities:
  - New stormwater general permit
  - Delineate stormwater catchments (2009)
  - Estimate pollutant loads and report to Water Board
  - Earn “credits” for reducing loads
- Pollutant Load Reduction Model (PLRM) is basis for estimating pollutant loads
  - Developed by nhc for Lahontan RWQCB

PLRM: How does it work?

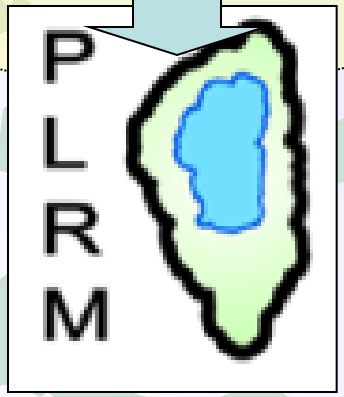
LAND USE



SOIL TYPE

SLOPE

ROAD & PARCEL CONDITIONS



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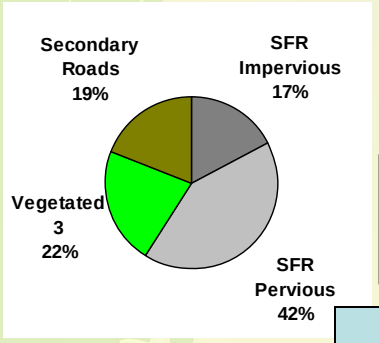

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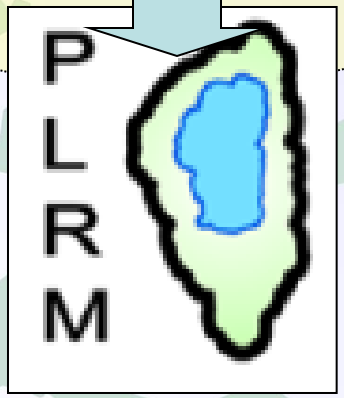

EPA SWMM

Version 5.0

Build 5.0.022

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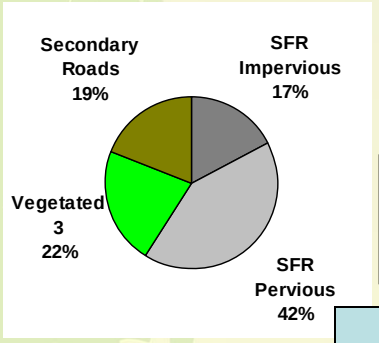

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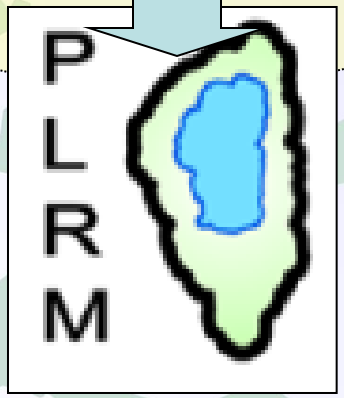

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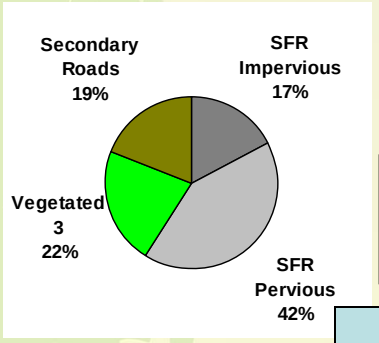

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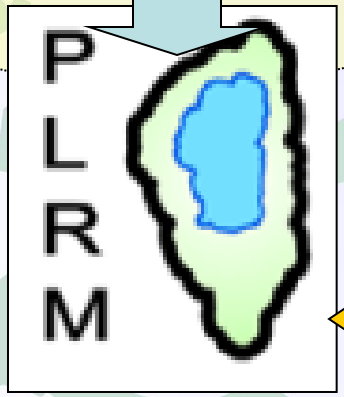

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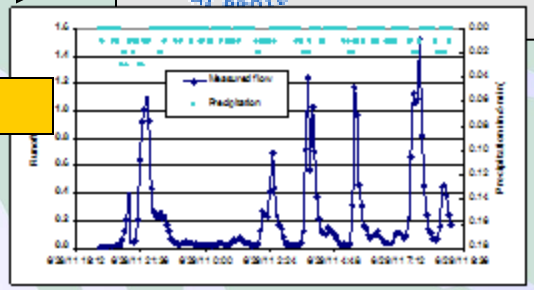

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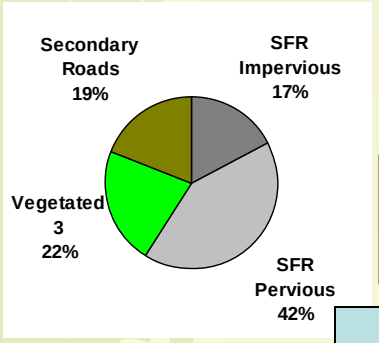

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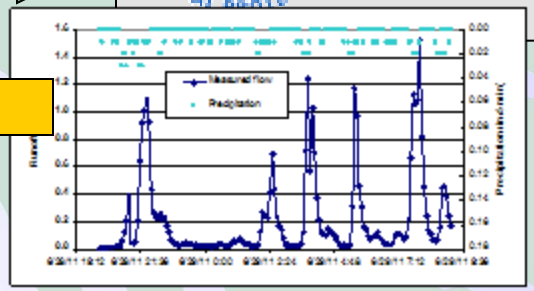
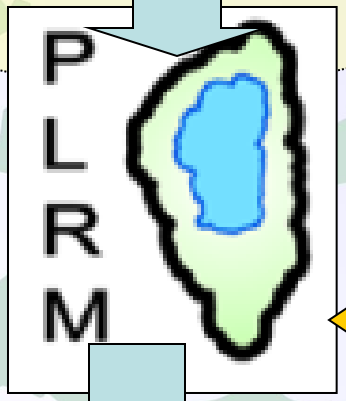
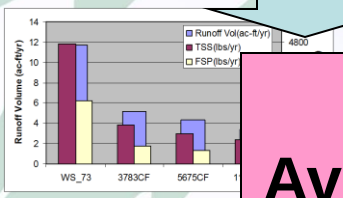






Annual Average Load!!

PLRM Refinement Process

1) Set up catchment in PLRM interface

2) Run SWMM5 for ***event basis***

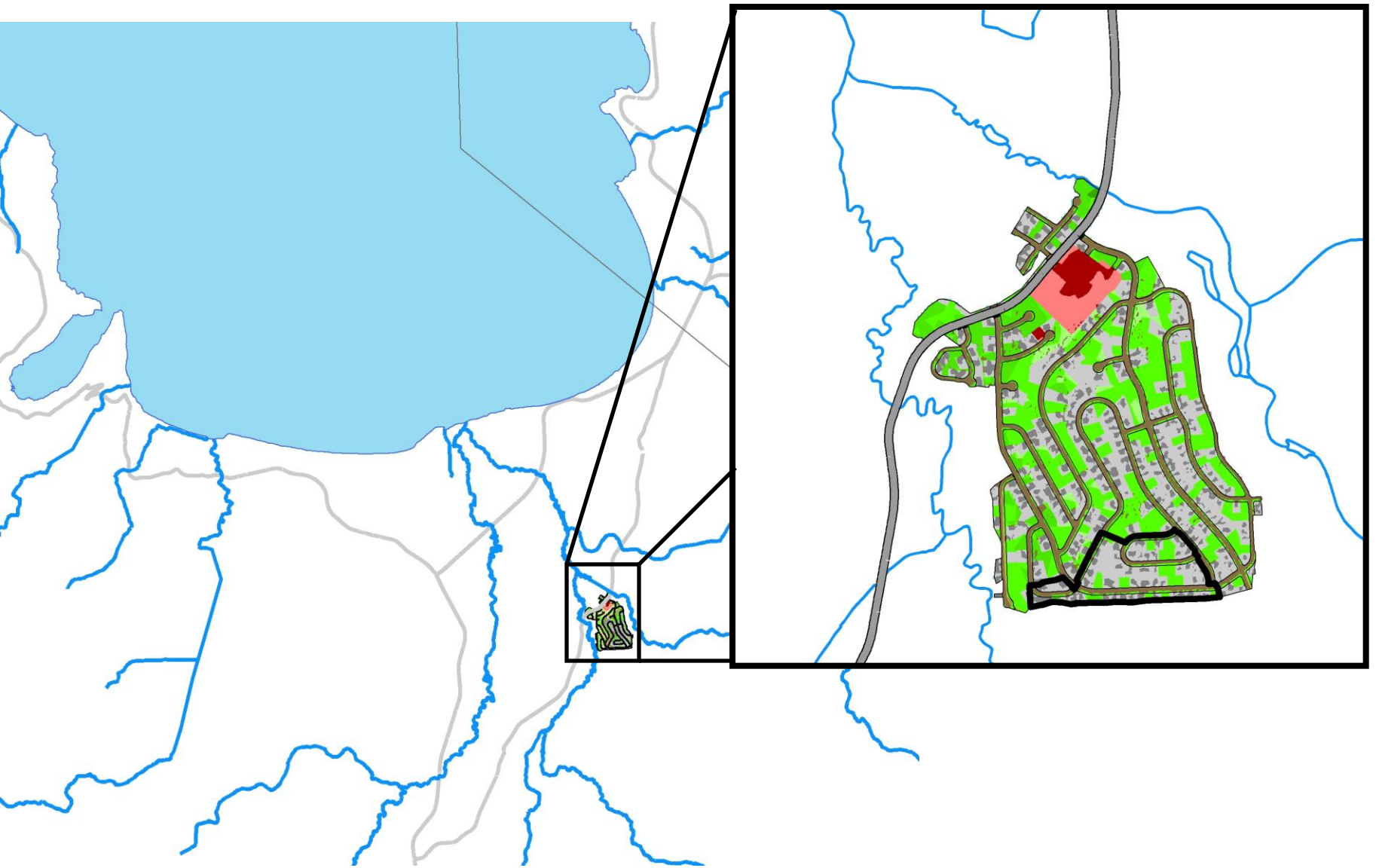
   Calibrate / reduce errors

EPA SWMM
Version 5.0
Build 5.0.022

3) Run revised parameters in PLRM

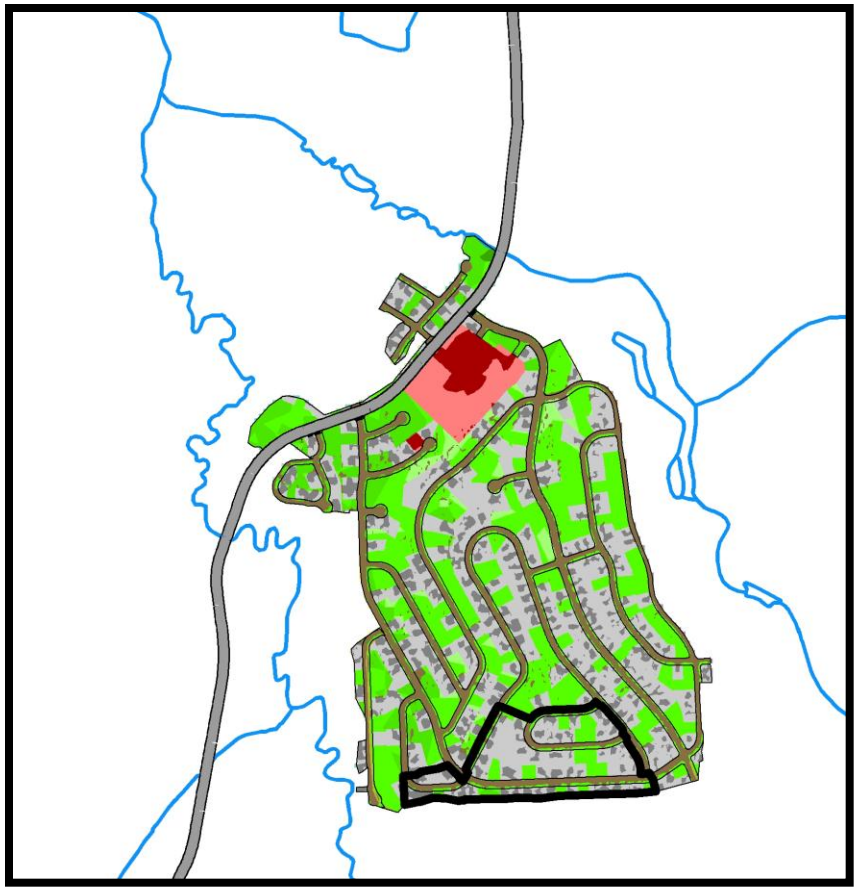
   for catchment load crediting

Catchment in Montgomery Estates



Catchment characterization

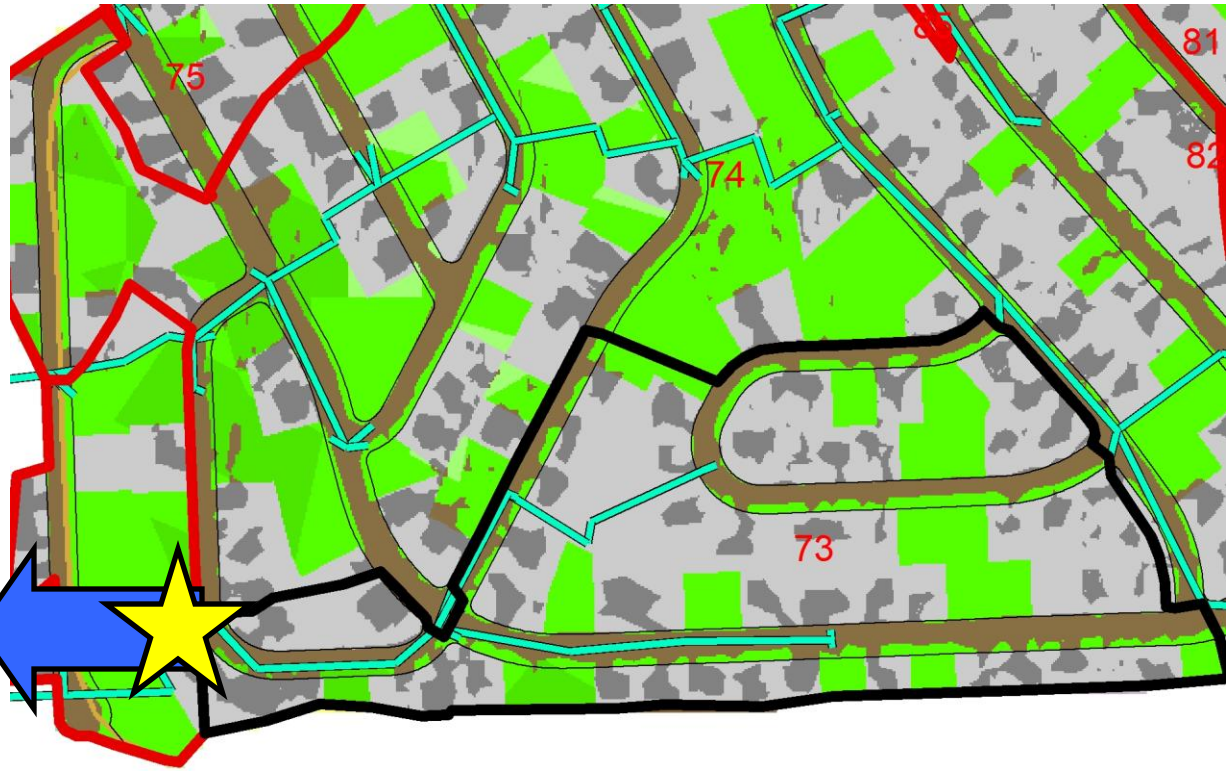
- 18.5 acres
- 11.3 % slope
- Residential/ secondary roads
- Fast-draining soils
- Curb and gutter:
  - All stable shoulders
  - Moderate to high risk due to slope
  - Conveys stormwater flows directly to Trout Creek

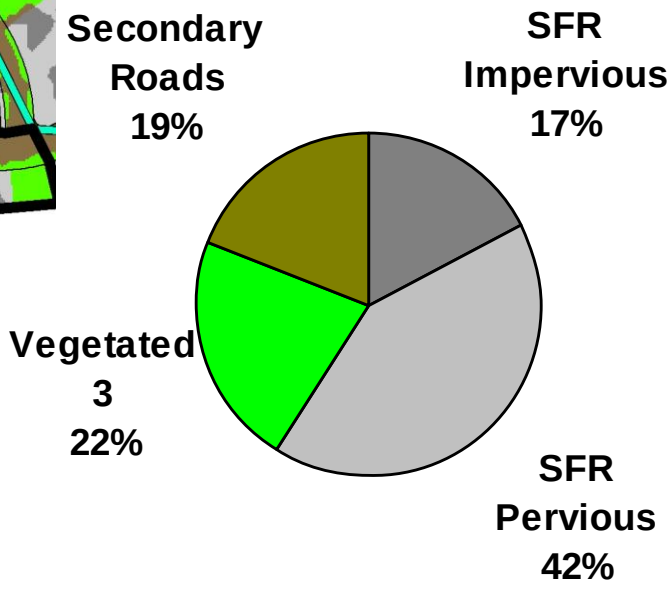


Marshall Trail: rolled curb and cut slope

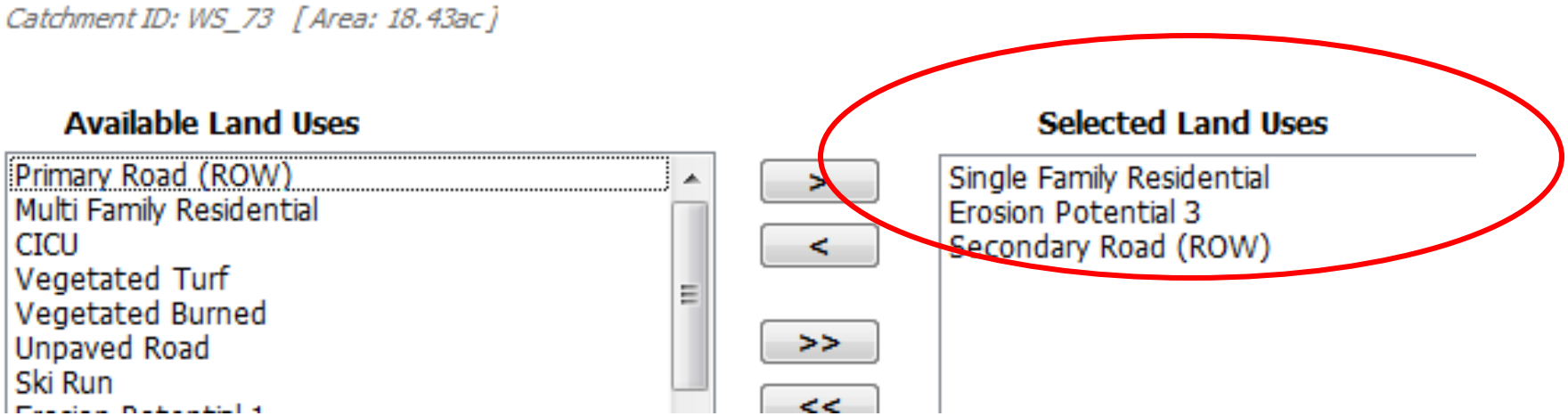
Catchment Land Use Distribution:

Single Family Residential & Secondary Roads





PLRM Land Use Configuration



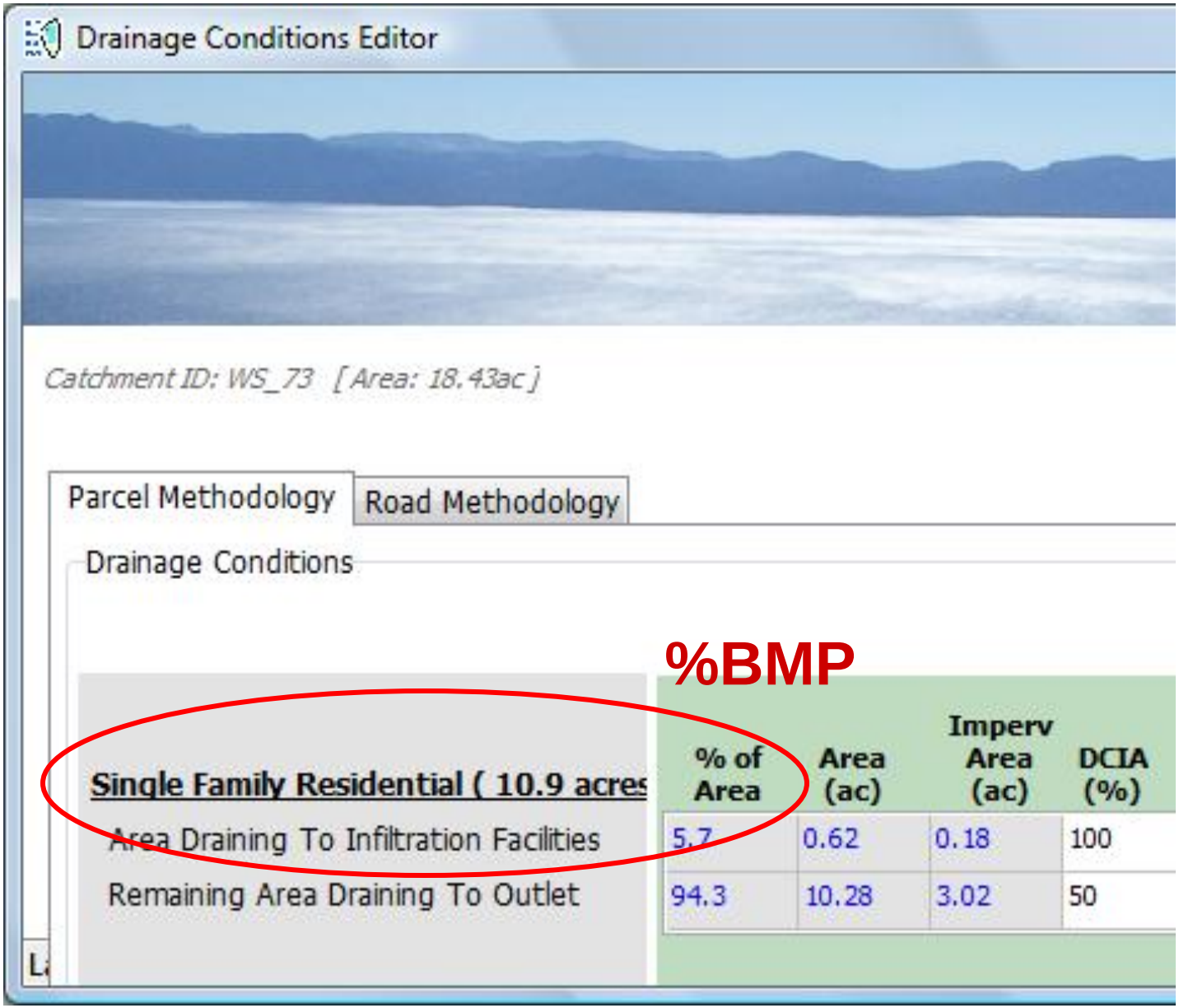
PLRM Land Use Configuration

Land Use	% of Catchment Area	% Impervious	Acres
Sub-totals	100.00	36.2	18.5
Single Family Residential	59.0	29.4	10.9
Erosion Potential 3 **(Vegetated)**	22.0	0	4.1
Secondary Road (ROW)	19.0	100	3.5

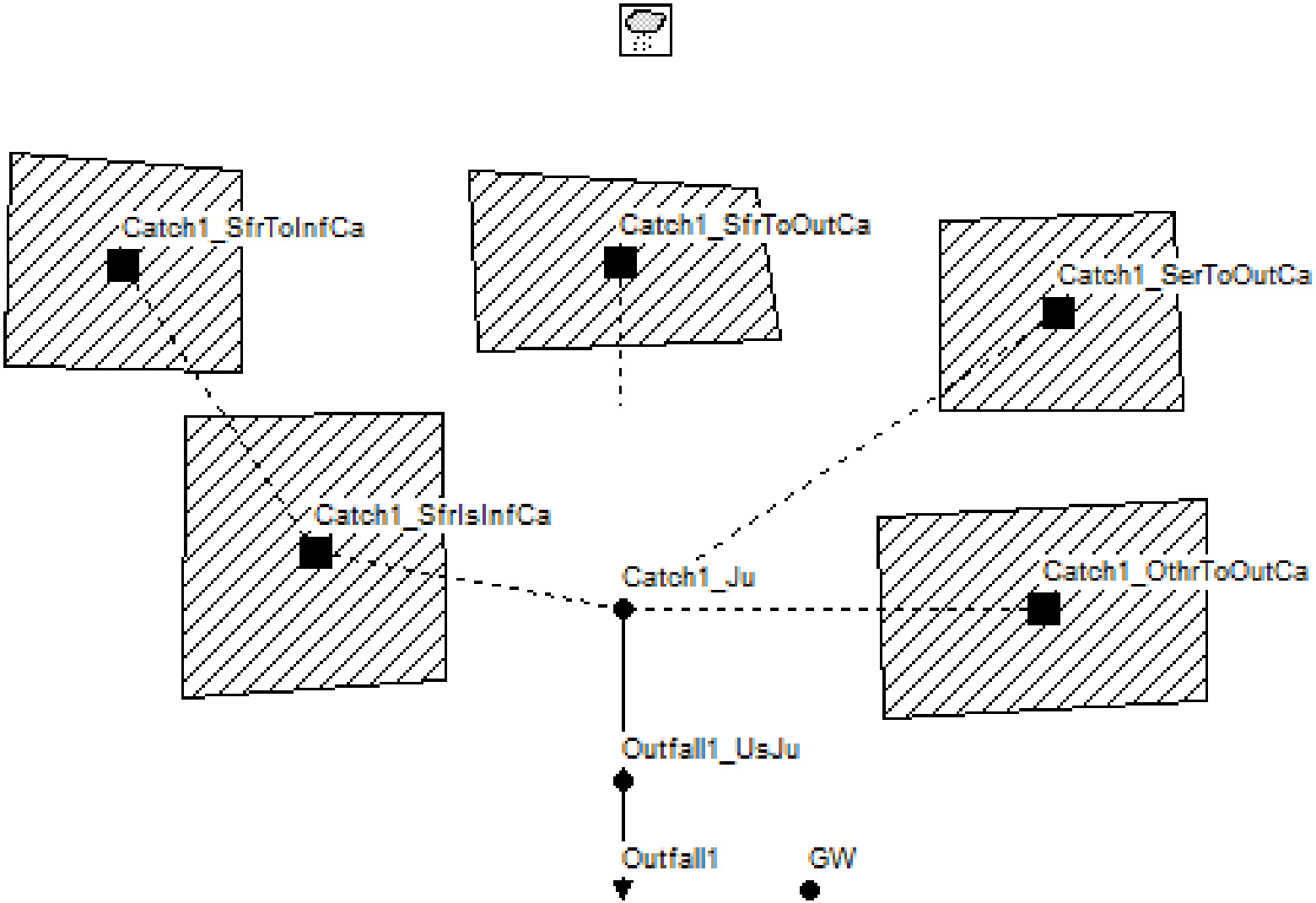
BMP Driveway Survey

- 70 total parcels
- 5.7 % BMP certificate/working
- 20 % need maintenance (i.e. source control only)

PLRM Drainage Conditions



Each Land Use Becomes Subcatchment in SWMM5



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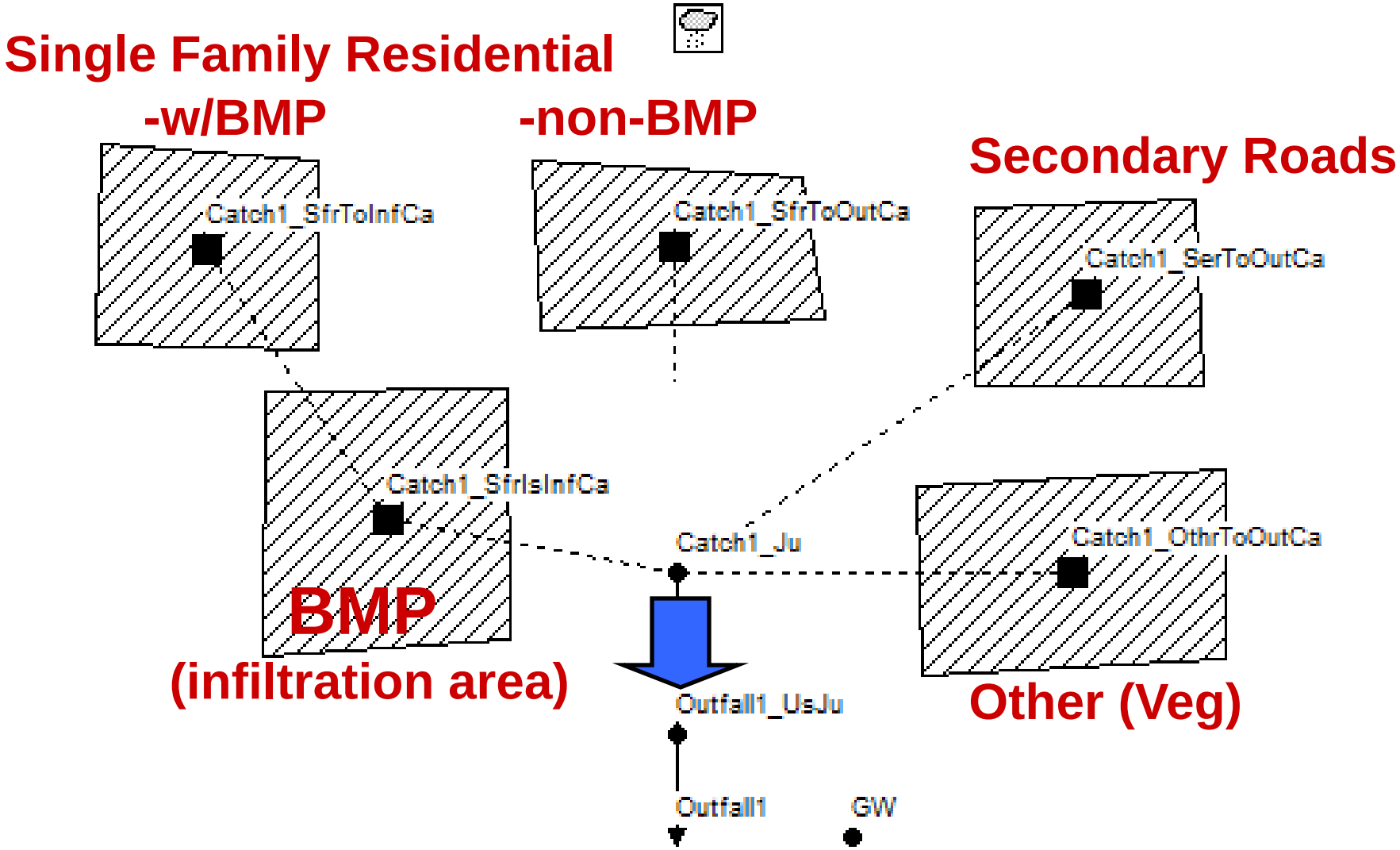

Russ Wigart, El Dorado Co. DOT-TED installing field equipment— Sigma flow-weighted auto sampler

June 28, 2011 Storm Event

- *El Dorado Co. DOT-TED fieldwork by Russ Wigart*
- *Flow gage and water quality sampler in storm drain manhole, 5-minute rainfall*
- *<u>Forecast:</u> ~1 inch total precipitation*
  - *Known runoff yield →interval to set Sigma*
- *<u>Recorded:</u> 0.93 inch rain, 9905 cu. ft. runoff over 13 hours*

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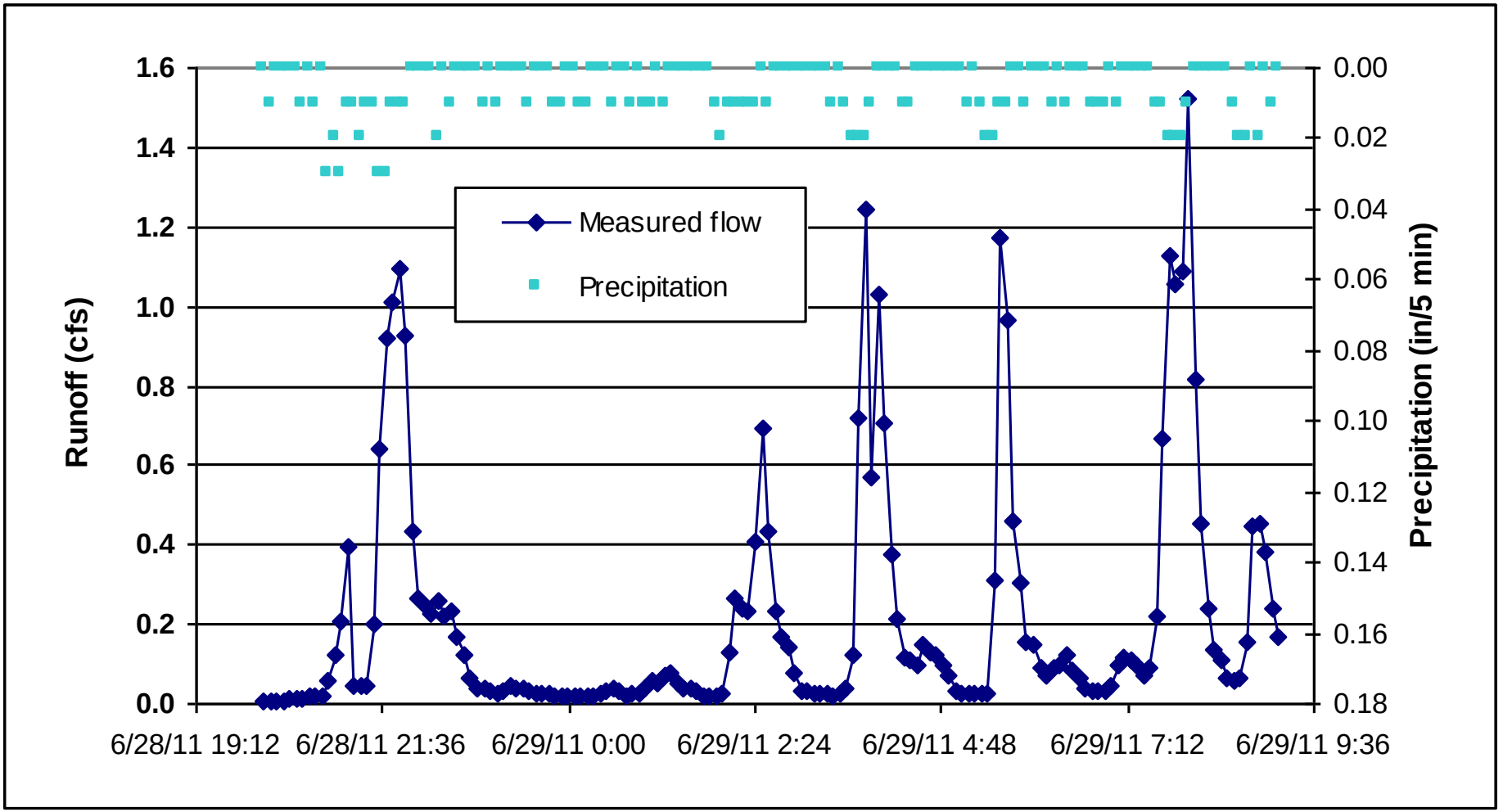
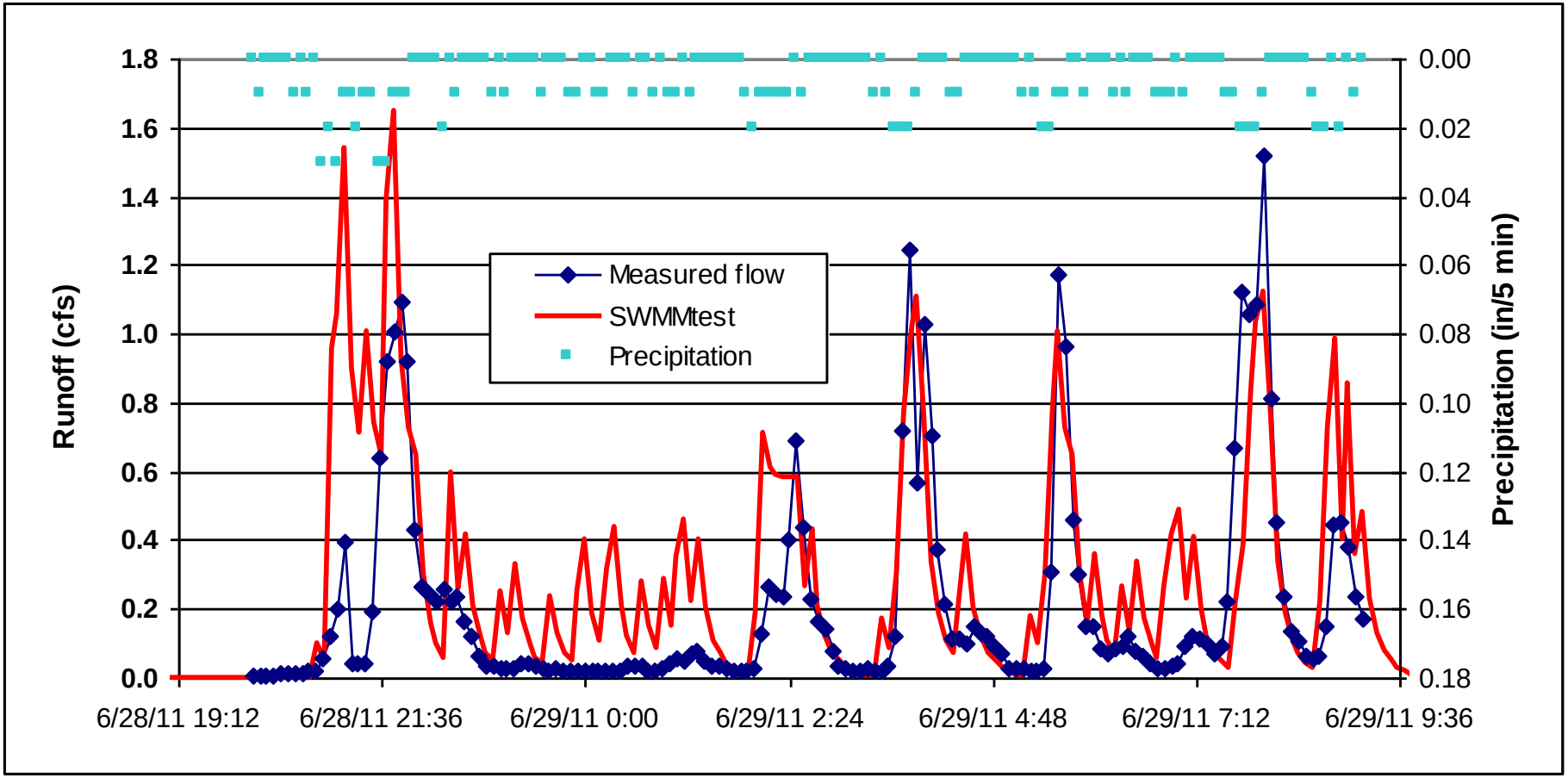
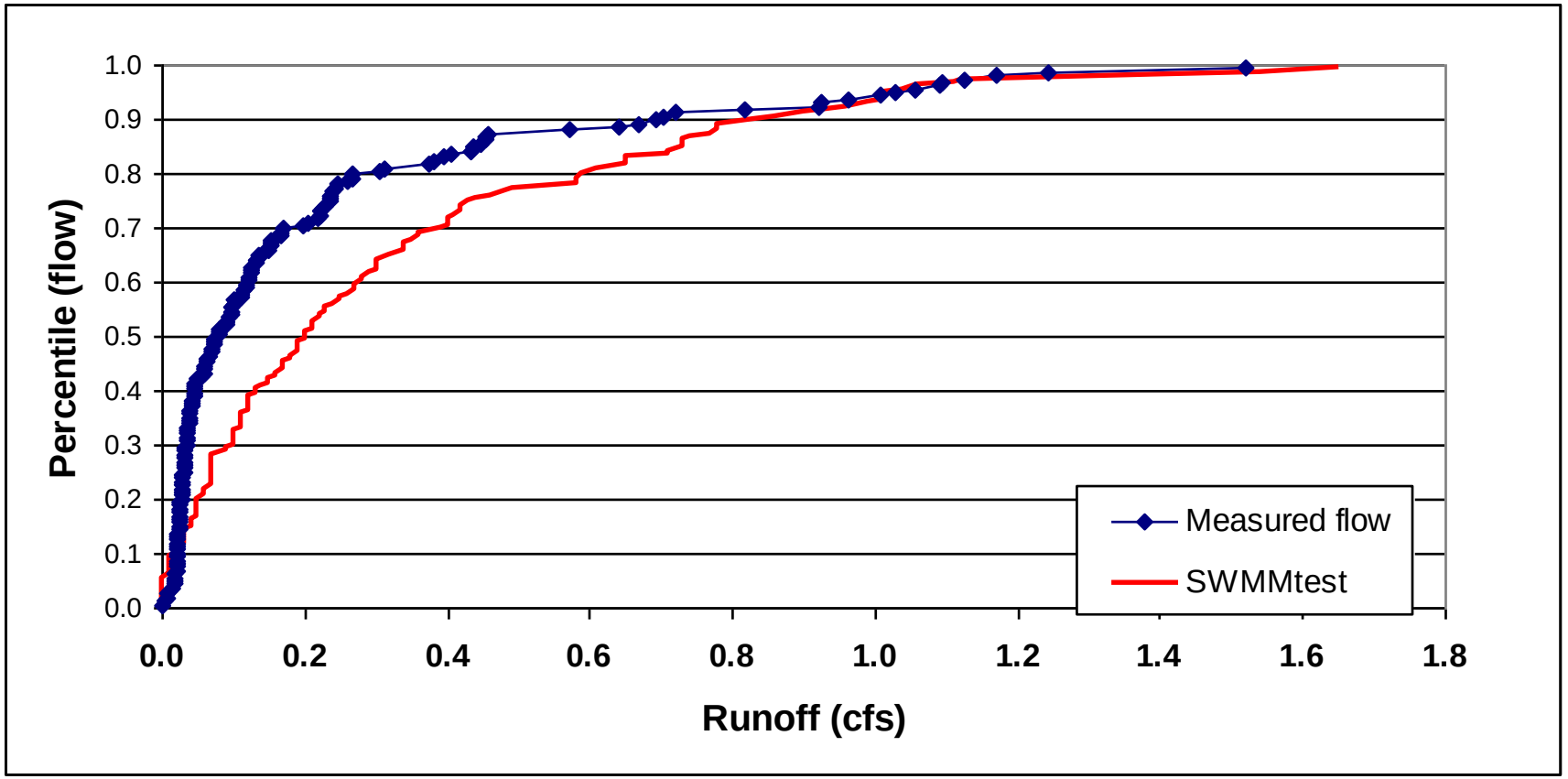


SWMM5 runoff vs. measured



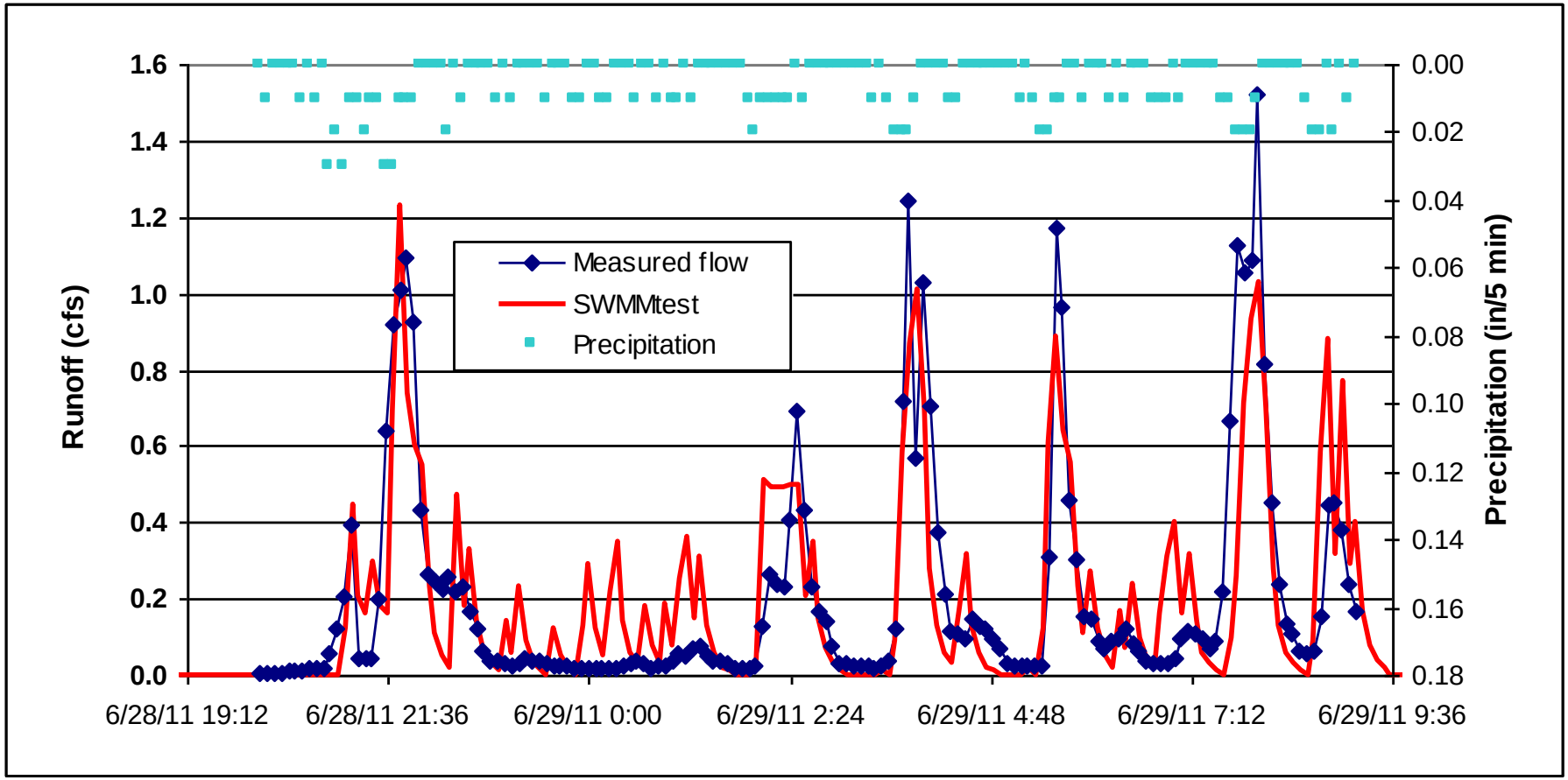
Flow-duration curve



"OK, so now what?"

- Modeled flow shows good response to precipitation
- Peak flows and timing look good
- Total volume predicted by PLRM 26% higher than measured
- Parameter adjustment?
  - Measured flows do not respond to 0.01 inch /5min events (seems to be loss from surface or pipes)
  - Initial peak flow over-estimated (initial storage)

SWMM5 runoff vs. measured (adjusted parameters)



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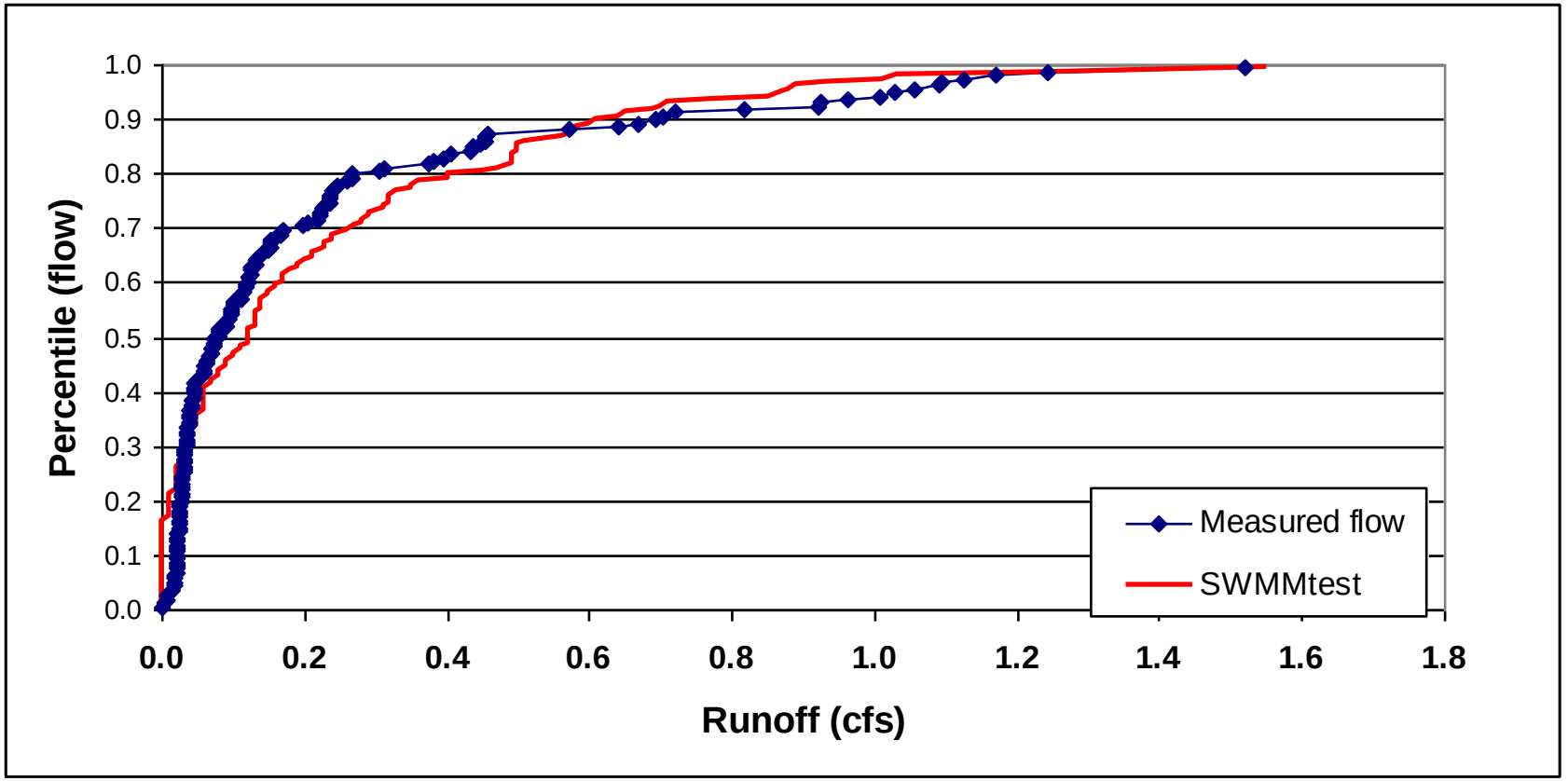
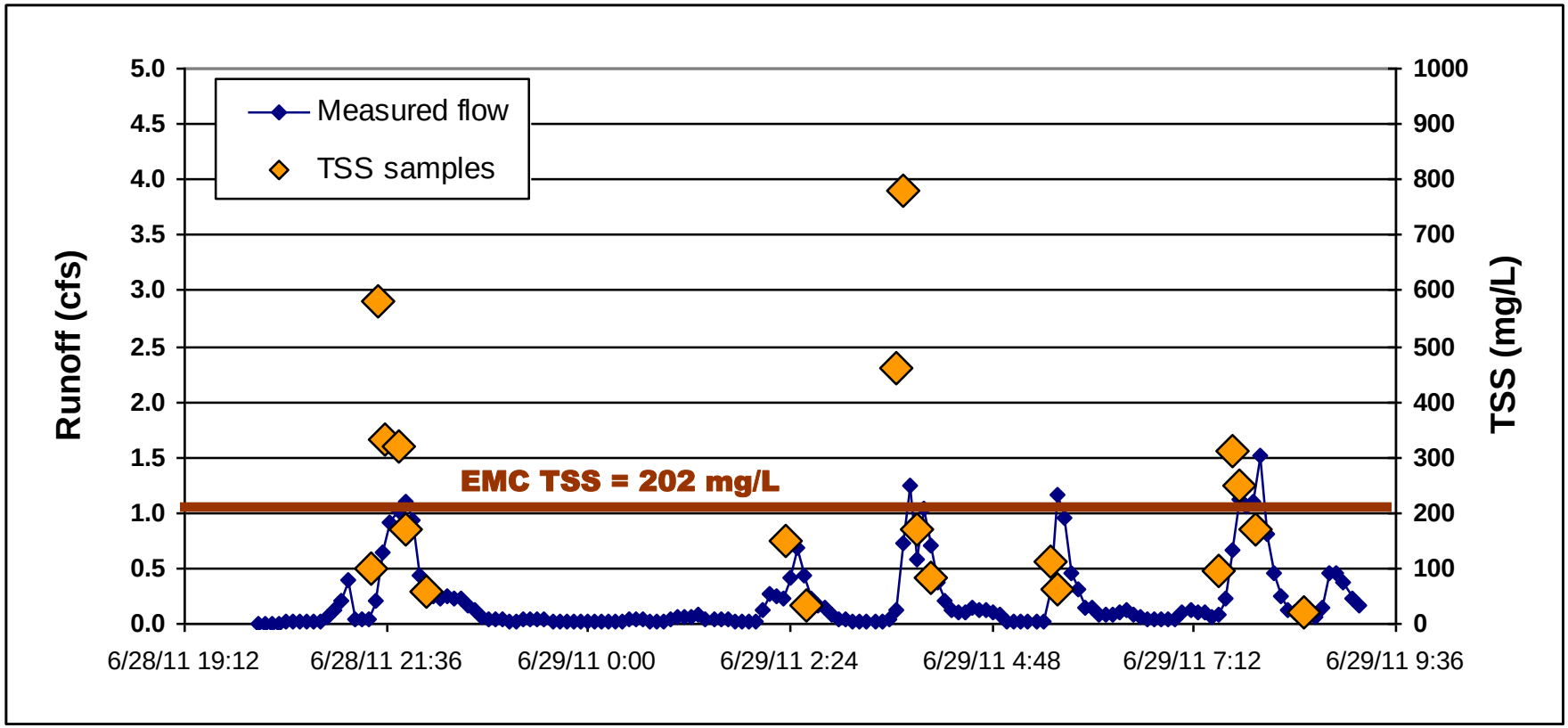


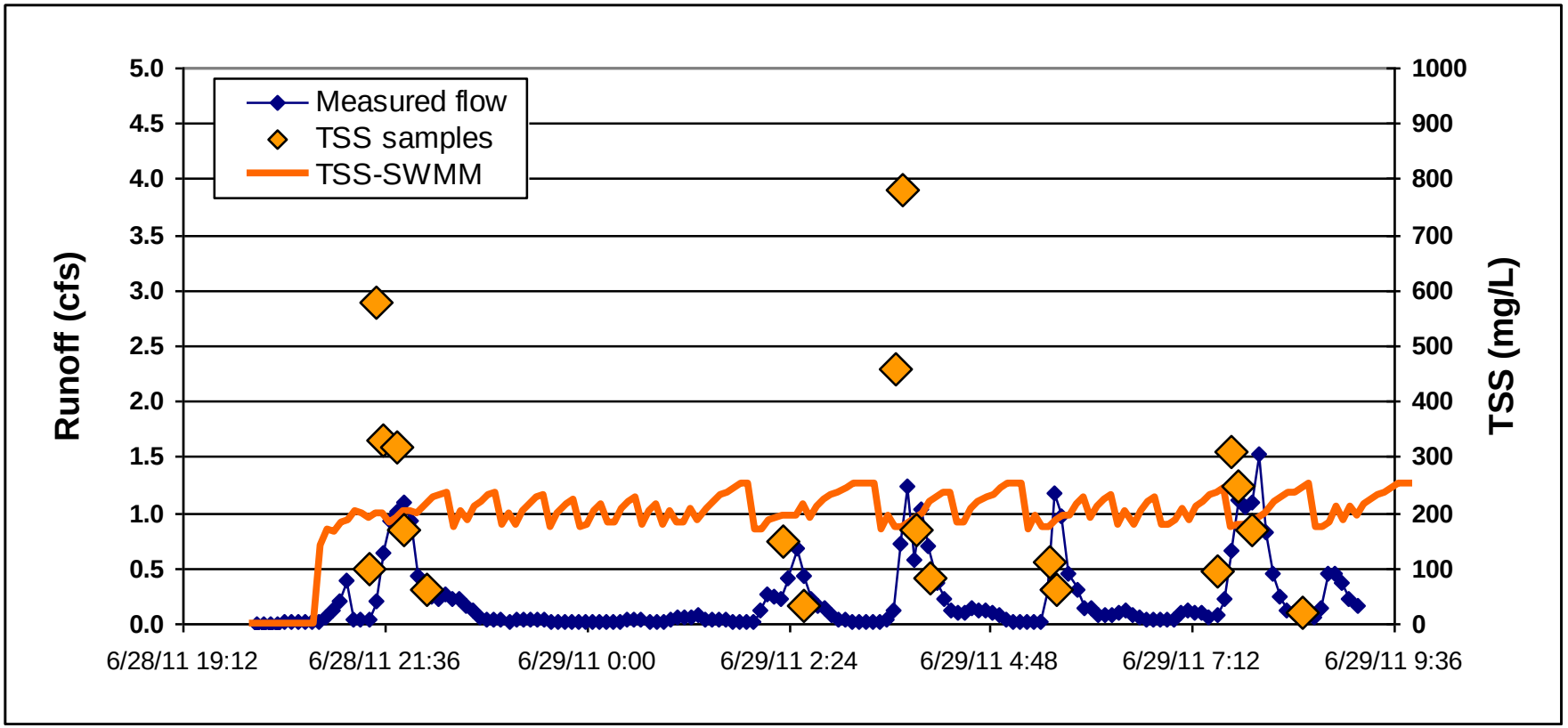
Water Quality Results: Measured TSS, n=19

flow-weighted EMC TSS = 202 mg/L



SWMM5 Water Quality – TSS

mean = 207 mg/L

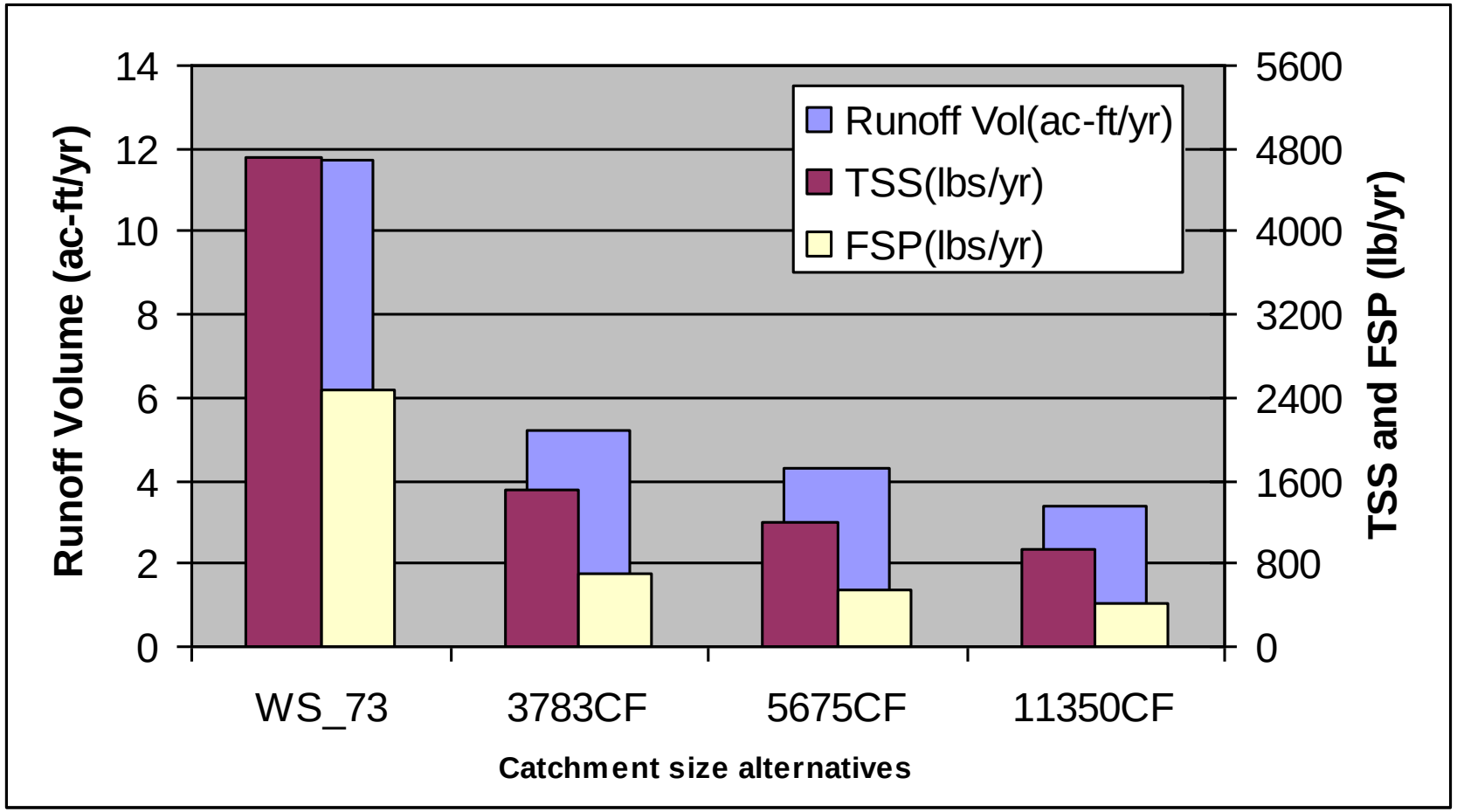


Pollution reduction strategies

- Pollutant source control treatments
  - Parcel-scale BMPs
  - Road maintenance and sweeping
  - Site-specific conditions, e.g. eroding cut slopes
- Catchment-scale treatments
  - Dry basin, infiltration basin, wet basin, storm filters, etc.
- El Dorado Co. DOT-TED example
  - Infiltration basin design in catchment
  - How big?? 33% of runoff volume typical

PLRM Infiltration Basin Results:

Size alternatives—Based on flow yield from 1-inch storm



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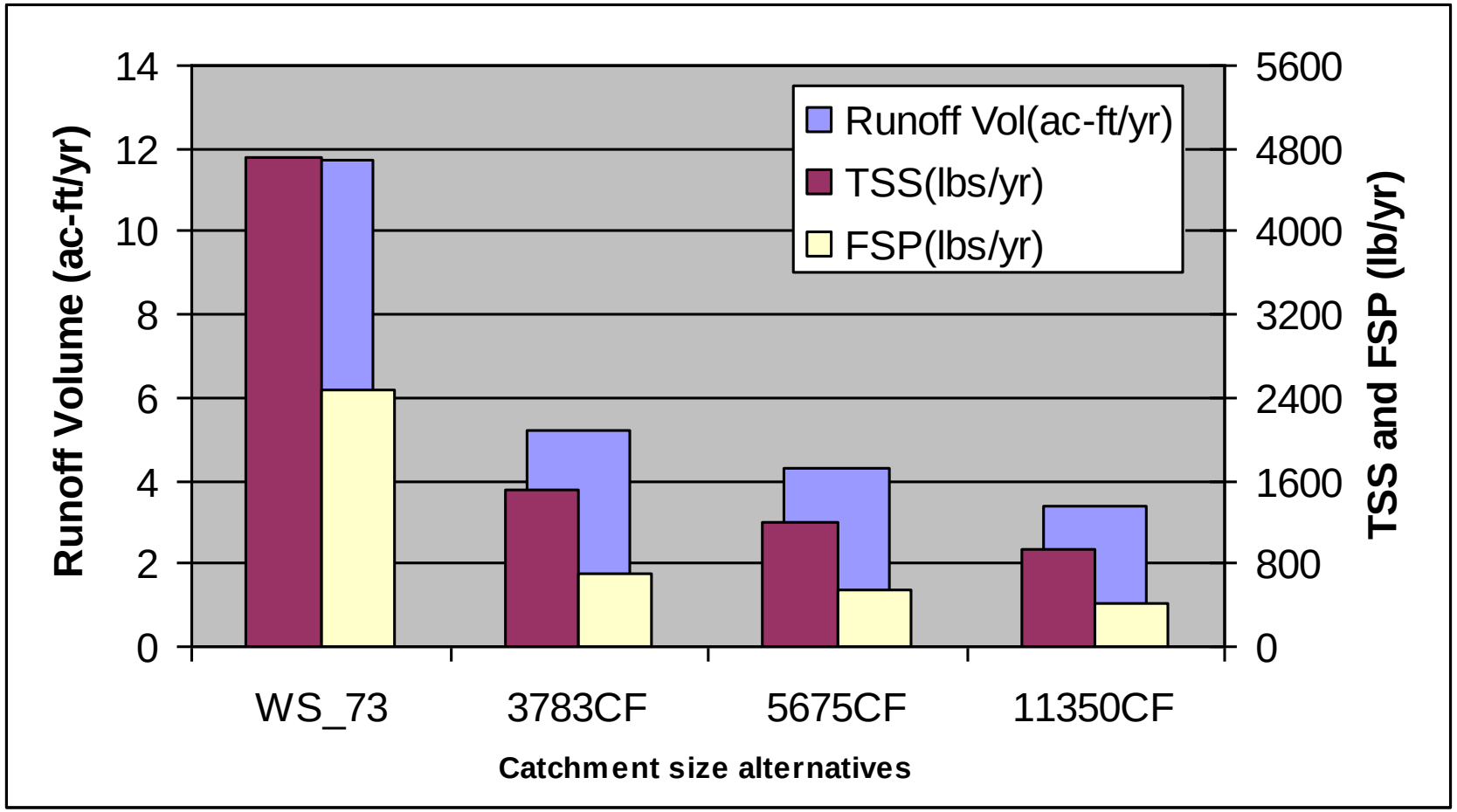

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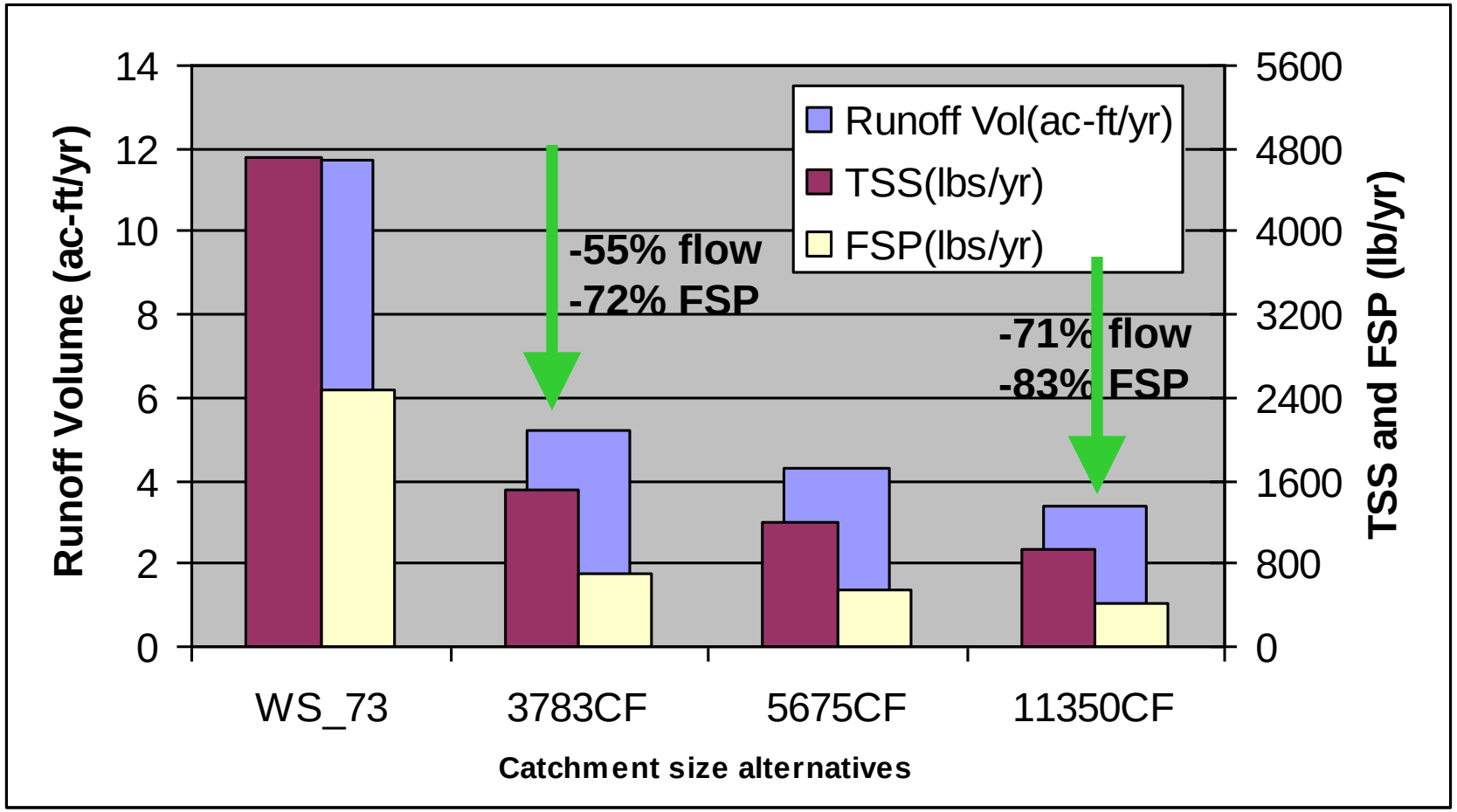

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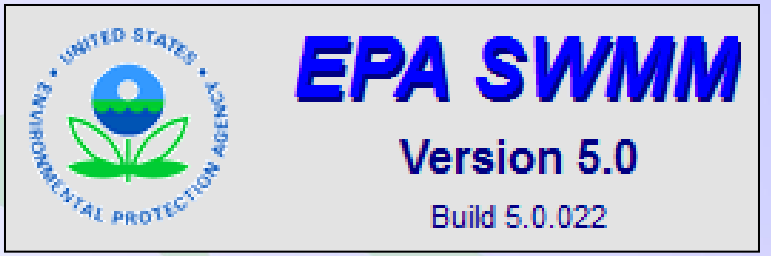

3) Run revised parameters in PLRM for catchment load crediting