

AUTOMATED BASEFLOW SEPARATION AND LOAD CALCULATION

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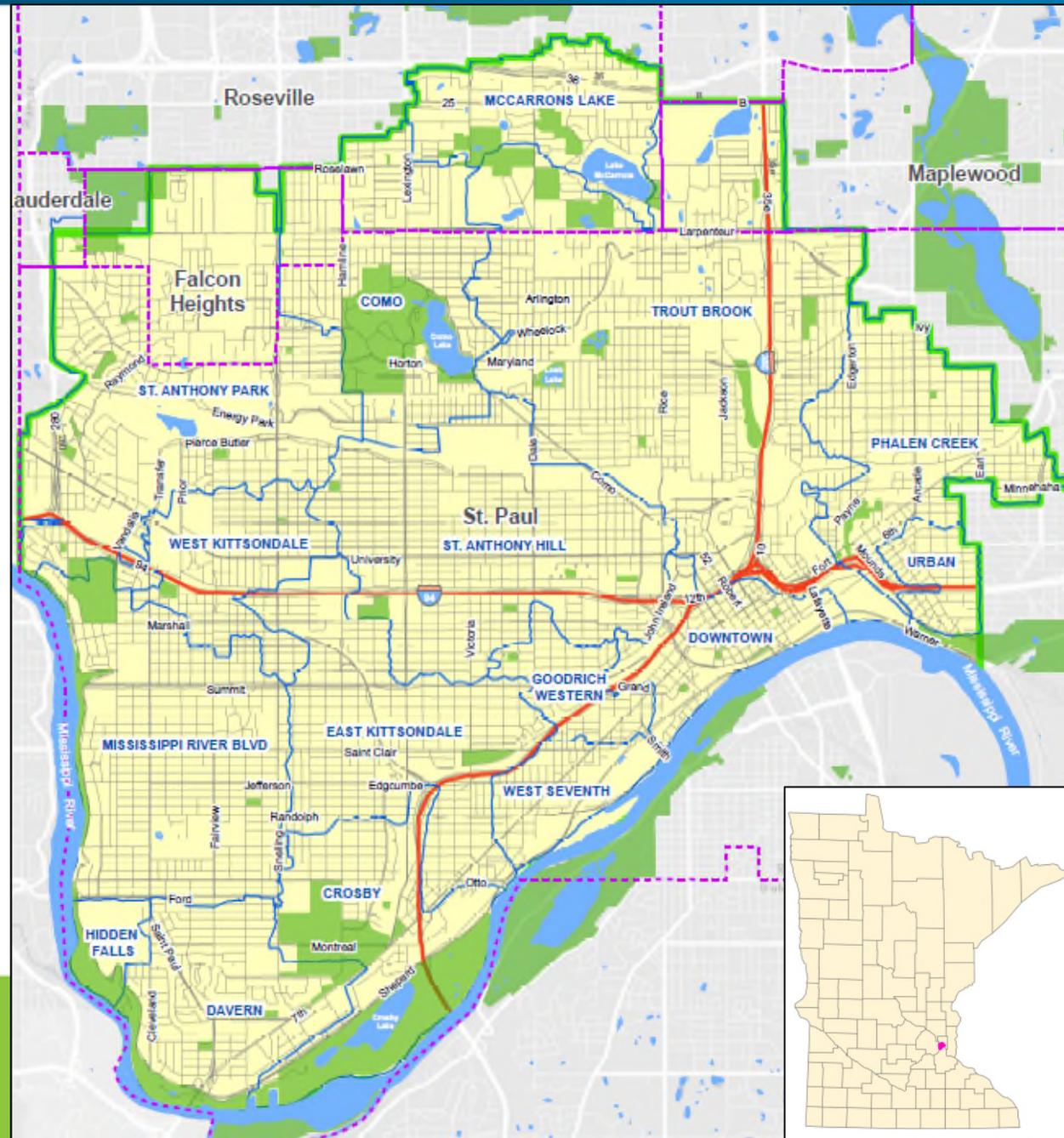
Presentation Outline

1. CRWD background
2. Former calculation method and challenges
3. Automated calculation method
4. Outcomes and caveats



Capitol Region Watershed District

- St. Paul, Minnesota
- Local unit of gov't
- Drainage area: **41 mi²**
 - Storm sewer network
 - 5 lakes
 - 13 mi. of Mississippi
- Population: **245,000**
- Highly urbanized
 - **42%+** impervious



CRWD Monitoring Program

- Monitoring data foundation of CRWD
 - 12-yr program
- Quantify runoff pollutant loading to Mississippi R.
- Identify water quality problem areas
- Evaluate BMP performance
- Data for model calibration
- Track changes over time – trend analysis



CRWD Monitoring Program

- 18 Monitoring stations
- Storm sewers
- Continuous discharge data at 5 – 15 minute intervals
- Flow weighted composite and discrete grab samples
 - Event flow(storm, snowmelt, illicit discharge)
 - Baseflow – continuous, groundwater driven



Data Reporting

CRWD Annual Stormwater Report

7 subwatersheds comprising 10 monitoring stations

- Annual Discharge
 - Baseflow and Event Flow
- TP and TSS Annual Loads
 - Baseflow and Event Flow



Load Calculation

$$\text{Load} = \text{Volume} * \text{Concentration}$$

Volume is a critical component of the calculation!

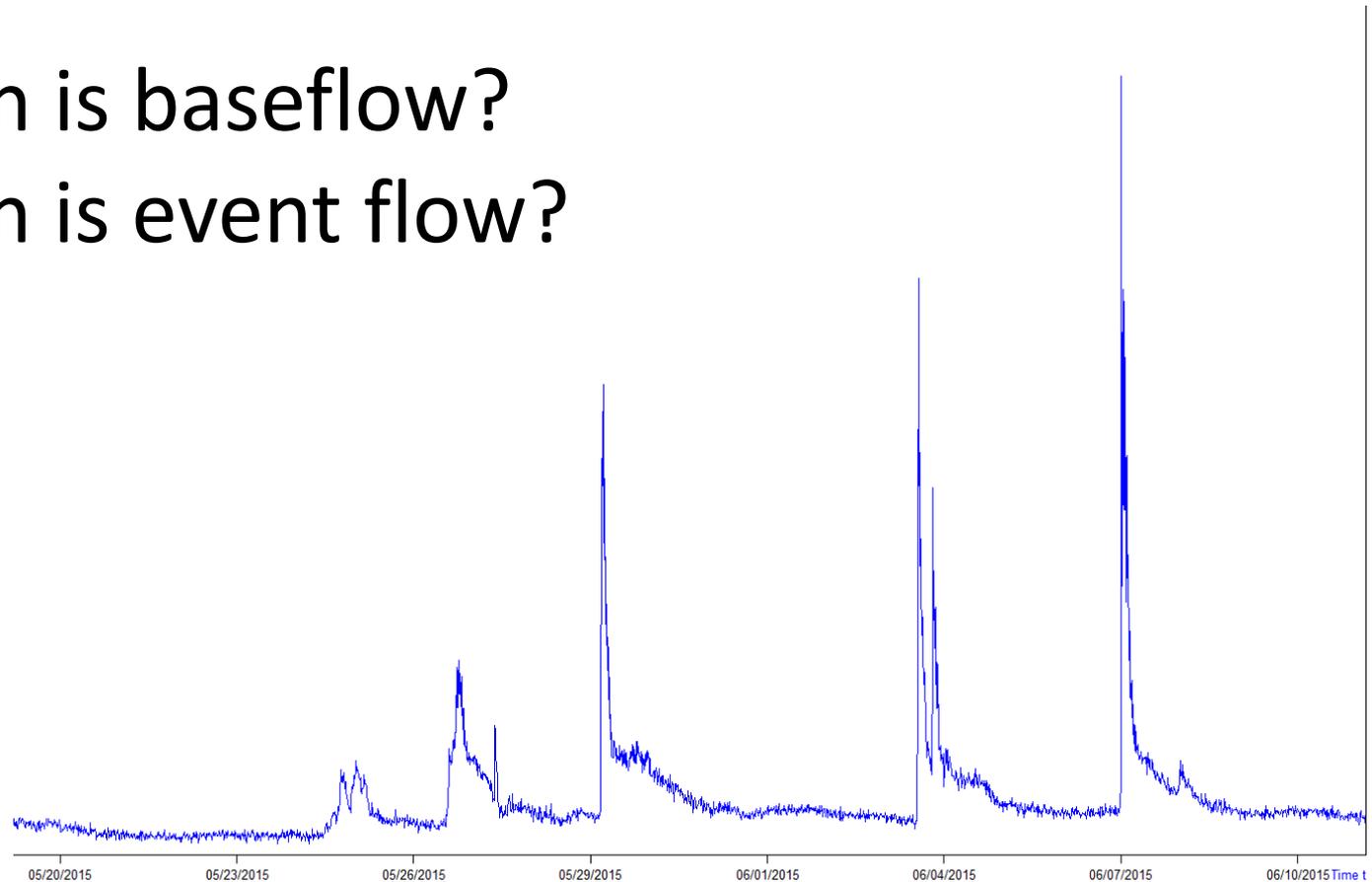
$$\text{Event Load} = \text{Event Volume} * \text{Event Concentration}$$

$$\text{Base Load} = \text{Base Volume} * \text{Base Concentration}$$



Flow Separation

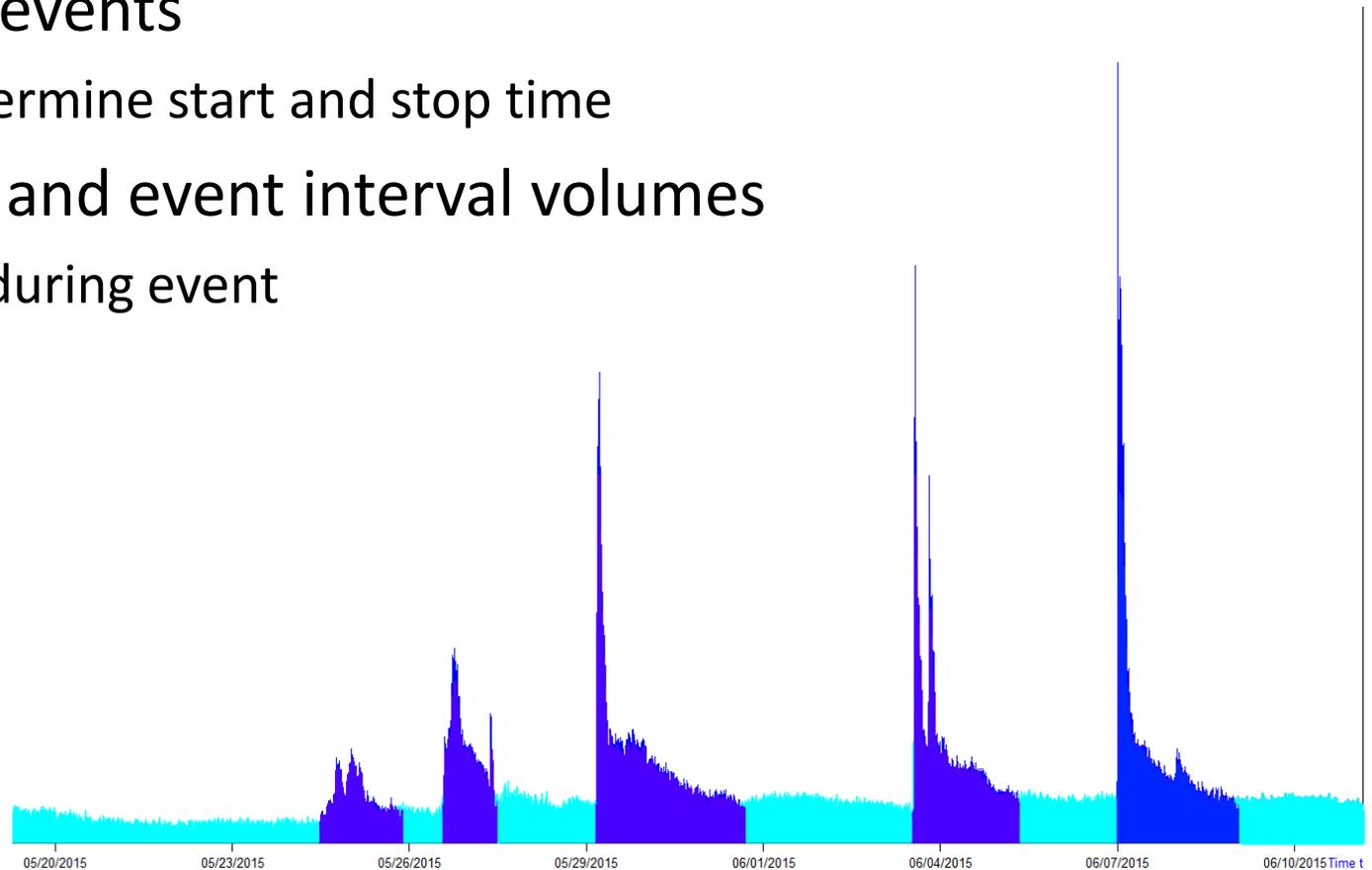
Which portion is baseflow?
Which portion is event flow?



Flow Separation

Former Method:

1. Identify storm events
 - Manually determine start and stop time
2. Calculate base and event interval volumes
 - No baseflow during event

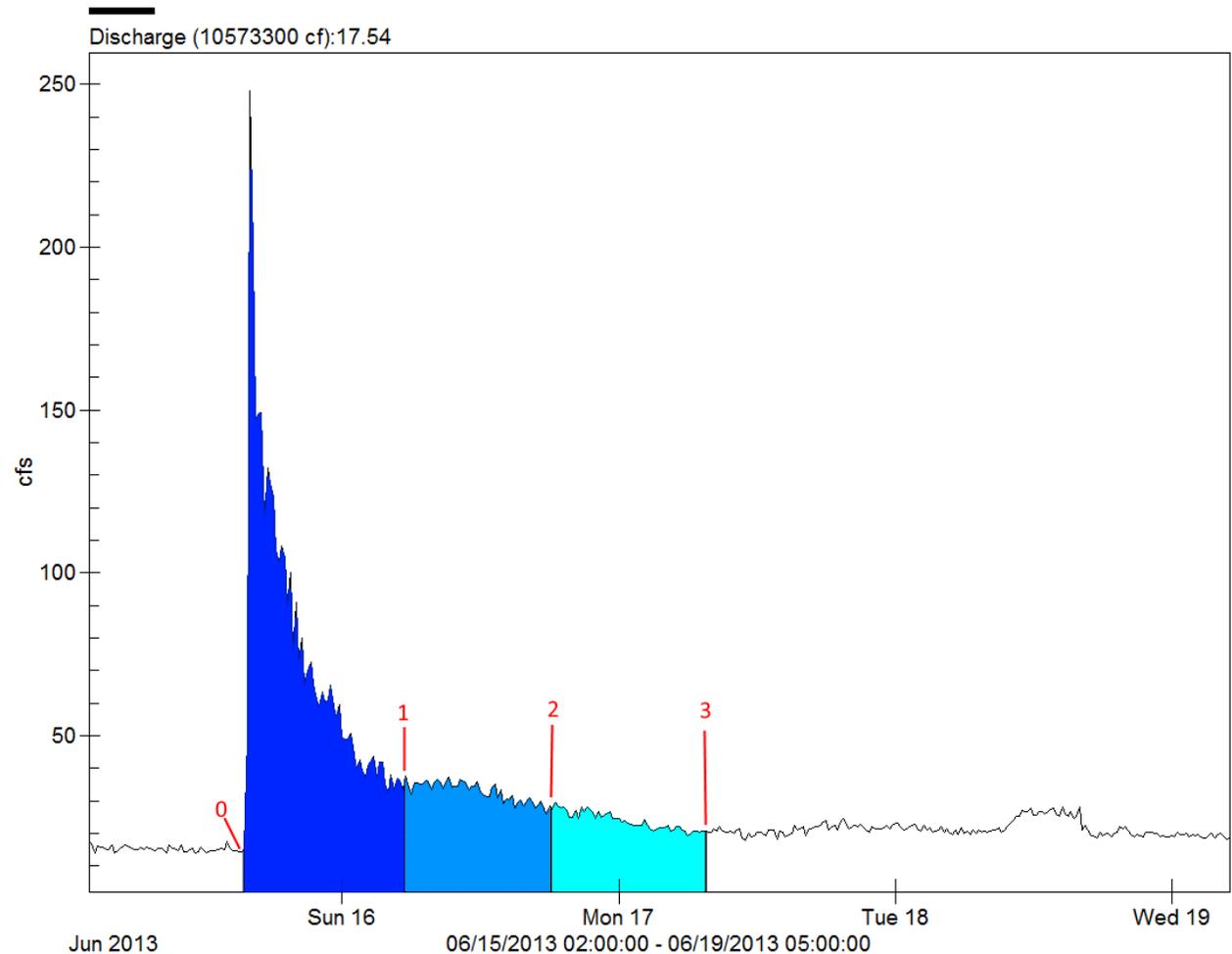


Flow Separation (Former Method)

- Storm Load calculations require separation of baseflow and stormflow volume
- Separation was subjective and could be a source of error
- This method defined time period as either storm or base – we know this isn't entirely correct

- Where does the storm *Start*?
- Where does the storm *End*?

2013 TBO Q FINAL
Flowlink 5



Flow Separation Challenges

- Time intensive
- Moderate level of subjectivity
 - Results could vary from person to person
- No accounting for baseflow during events
 - Underestimate annual baseflow
 - Overestimate annual event flow
- Accuracy compromised due to time/tool constraints



Automated Flow Separation Script

Script Goals:

- Reduce time and manual steps
- Eliminate subjectivity
- Provide consistency year to year
- Improve accuracy of reported data



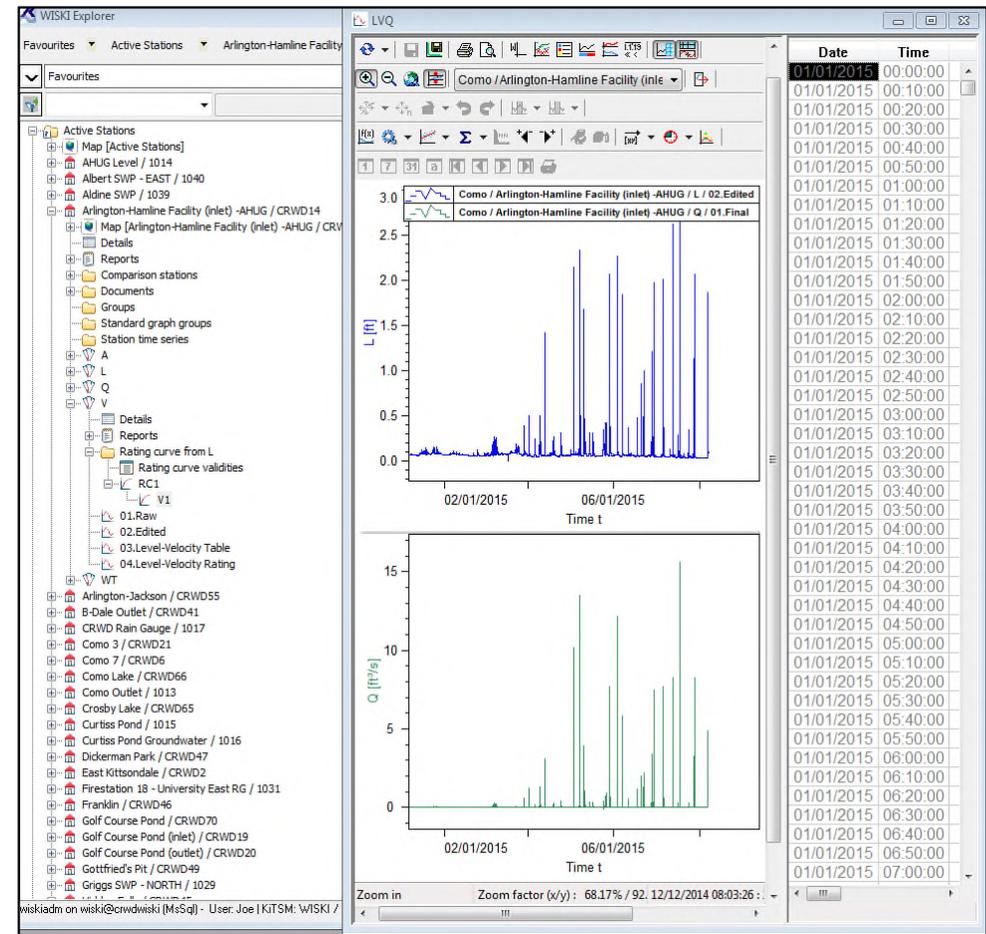
Kisters WISKI

Water data management software

- Continuous and discrete data
- Data analysis
- Data editing
- Custom scripting

Front end for relational database

- MS SQL or Oracle



Script Mechanics

1. Identify Event Start

- Evaluate rate of change (slope) of hydrograph within a moving window

2. Identify Event Stop

- Event ends when flow returns to a given % of pre-event flow

or

- Event reaches maximum allowed duration

3. Generate continuous baseflow and event flow time series



Script Mechanics

- Evaluate rate of change (slope) of hydrograph within a moving window
- Event ends when flow returns to a given % of pre-event flow
- Event reaches maximum allowed duration

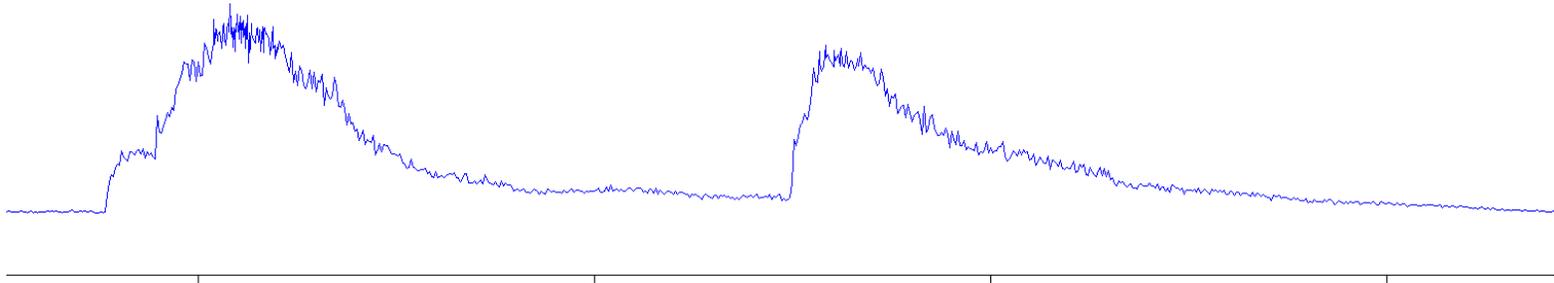
Script settings

RateOfChangeSlope:	<input type="text" value="0.02"/>
RateOfChangeMinutes:	<input type="text" value="90"/>
PercentOfFlow:	<input type="text" value="125"/>
Max Storm Duration in Hours:	<input type="text" value="336"/>

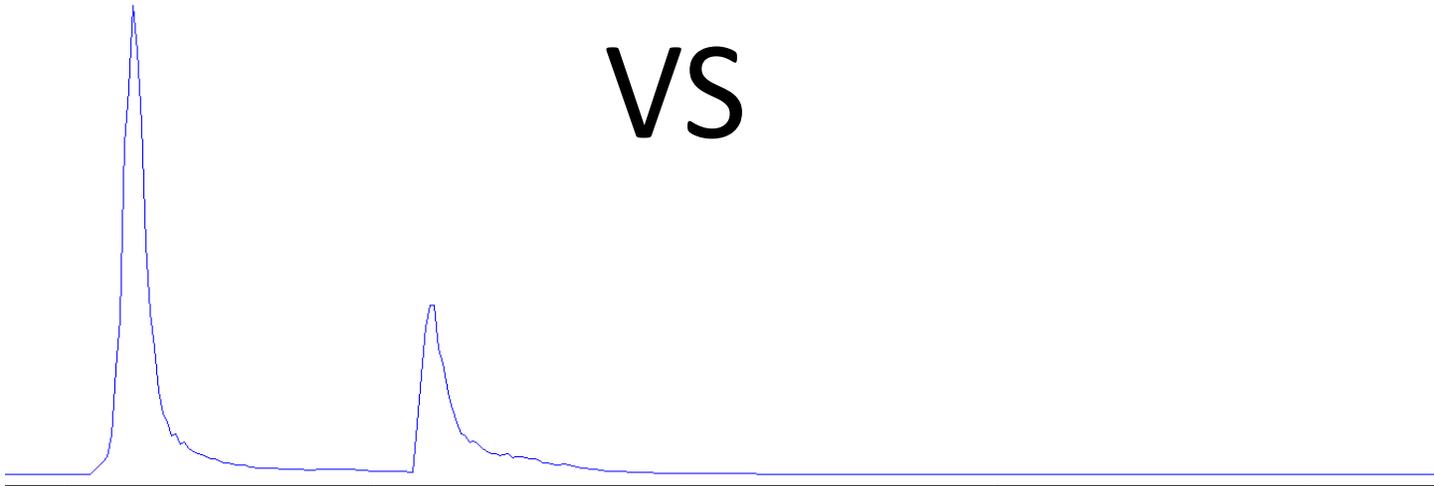
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Adjust to Site Characteristics



VS



Baseflow Estimation

- Baseflow during events estimated using constant slope method
- Interpolates between flow at beginning and end of event

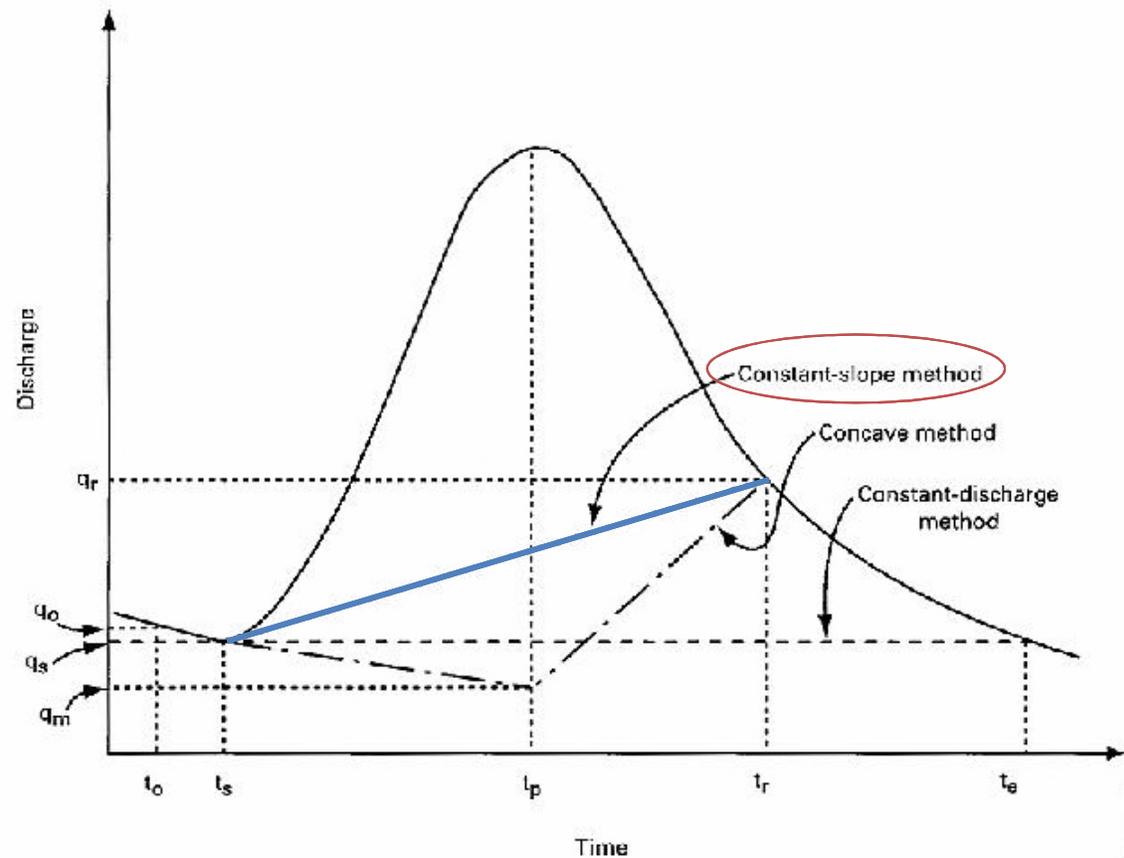


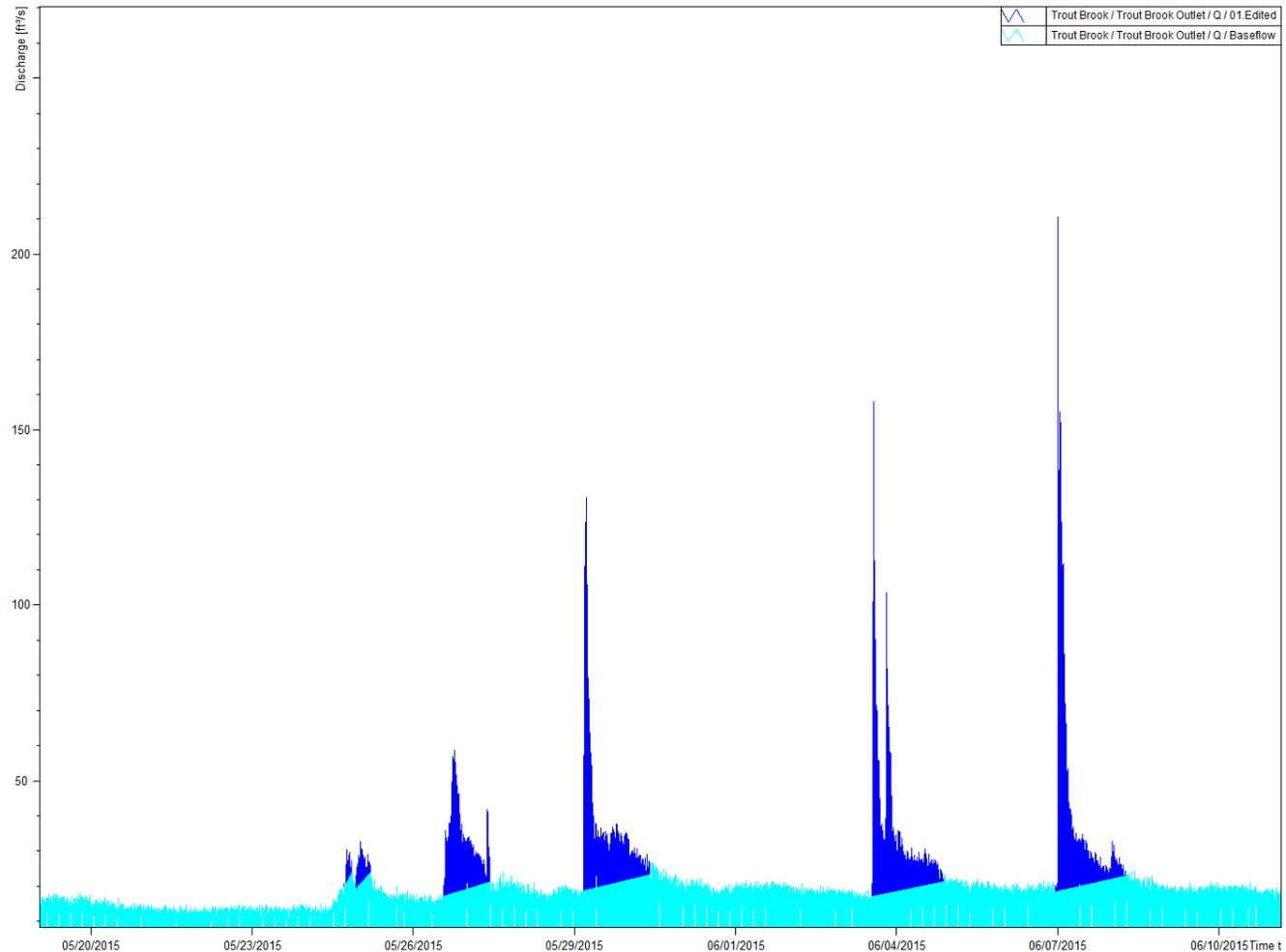
FIGURE 9-2 Baseflow separation methods.

H. McCuen. "Hydrologic Analysis and Design." 3rd edition, 2004.

Automated Separation (Current Method)

- Separates baseflow and stormflow volume
- Can be “tuned” to each specific site
- Consistency eliminates subjectivity
- More accurate representation of baseflow

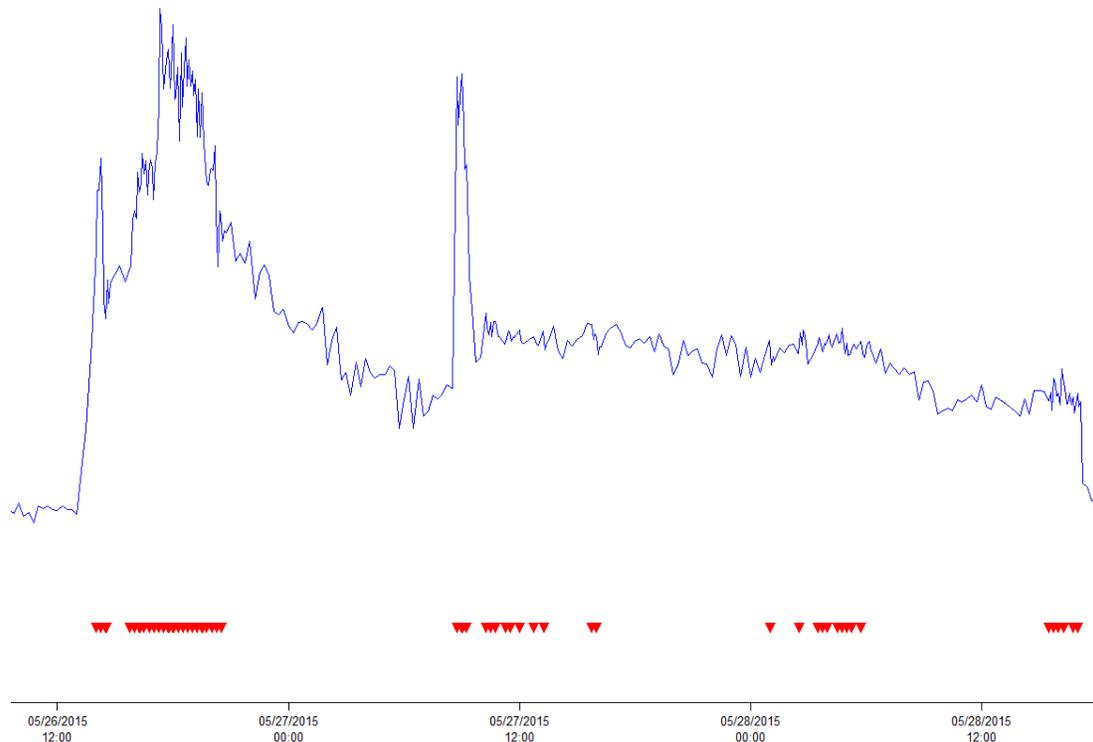
Custom WISKI Script



Load Calculation

Samples

- Flow weighted composite samples
- Samples represent concentration of mixed discharge
- Not every event is sampled



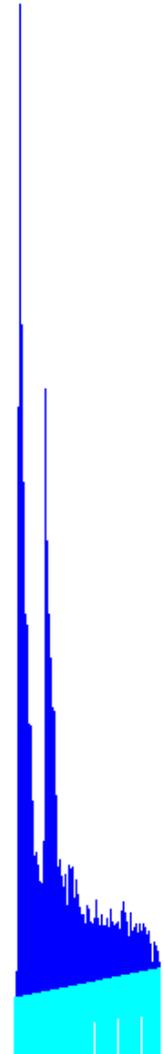
Load Calculation Script

Total Load = Event Load + Base Load

Event Load = Total Load – Base Load

Total Load = Interval Volume * Sampled Concentration

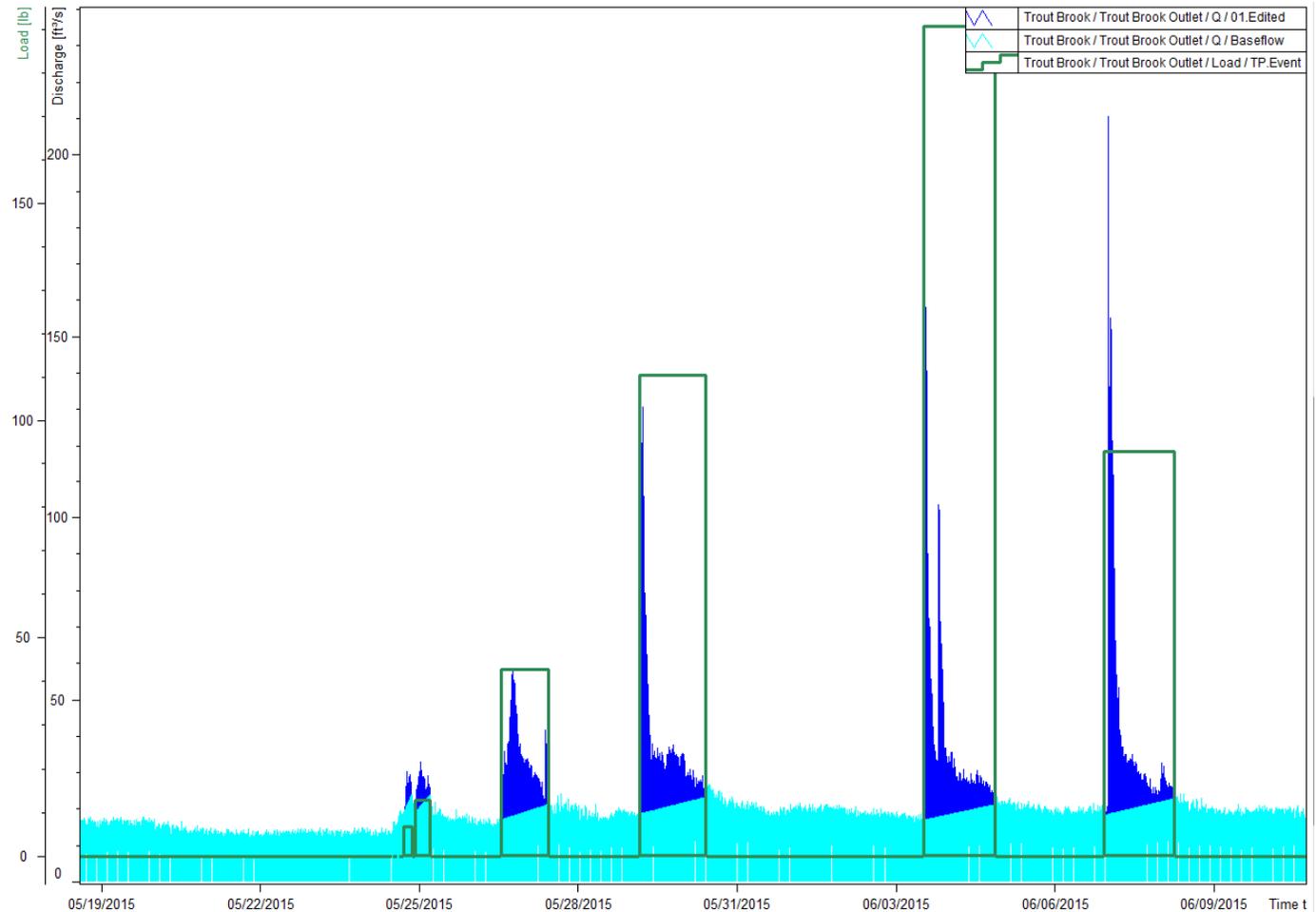
Base Load = Interval Base Volume * Monthly Base Concentration



Event Load Calculation

Load Calculation

- Un-sampled event loads estimated using medians calculated from entire period of record
- Baseflow volume and concentration taken into account when calculating event load
- Better annual stormflow vs baseflow load comparison



Base Load Calculation

Annual Base Load = Sum of Monthly Loads

- Monthly loads calculated using historical monthly median baseflow concentration and monthly total baseflow volume
 - Monthly values account for seasonality
 - Generally observe very little variation in baseflow concentration year to year



Highlights

- Automated time consuming manual processes
- Consistent method reduces subjectivity and eliminates inconsistencies
 - Loads calculated using identical method for all years
 - Improved trend analysis
- Improved accuracy of reported data
- Better inform management decisions



Caveats

- Garbage in = garbage out
 - Clean your flow data
 - Screen lab data for outliers
- No “one size fits all” solution
 - Script should be tailored to each site’s flow characteristics
- Accept a degree of error
- Assumptions about baseflow



Questions?



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