Alcorn State University
Water Resources Characterization

Amy Mayedo

Mentor: Dr. Jairo Diaz

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Mentor Profile: Dr. Jairo Diaz

- Director, Mississippi River Research Center, Alcorn State University
- Water Resource Engineer
  - Watershed and hydrological transport modeling
- Universidad Nacional de Colombia (Civil Engineering, B.S.)
- University of Puerto Rico (Civil Engineering, M.S.)
- Mississippi State University (Civil Engineering, Ph.D.)

Outline

- Equipment cataloguing and inventory
- Education for middle and high school student visitors
- Miscellaneous activities
- Field work
- Research
  - Runoff Quantity Assessment
  - Runoff Quality Characterization

Equipment cataloguing

YSI Sonde 6600

Outdated Equipment and Solutions

Outreach

June 20th: AgDISCOVERY Camp Students

July 22nd: U.S. Virgin Islands Students

Additional Activities

June 6th: Ag Field Day in Preston, MS

June 30th: Dissertation defense in Starkville, MS


RESEARCH OUTLINE

ASU Land and Water Resources

- Lorman, Mississippi
- 1,700 acre campus
- Low elevation
- ~3,500 student population
- On-site water treatment plant

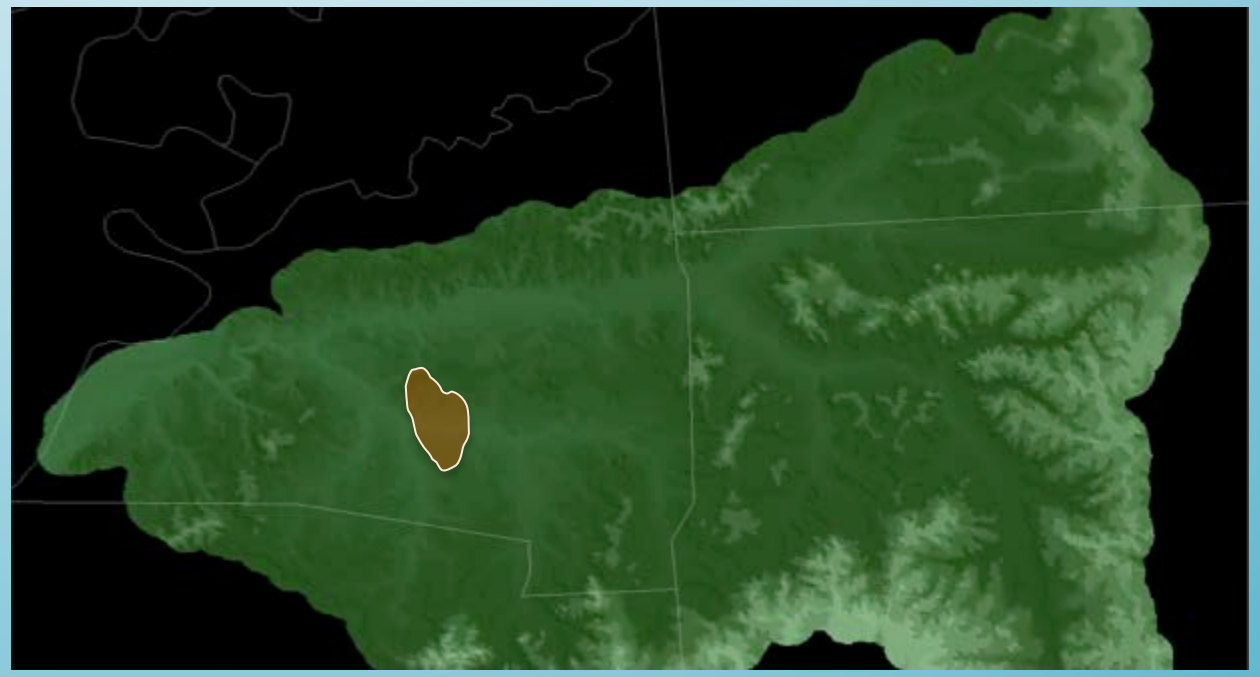


Image credits: Google Earth, BASINS

Stormwater Management

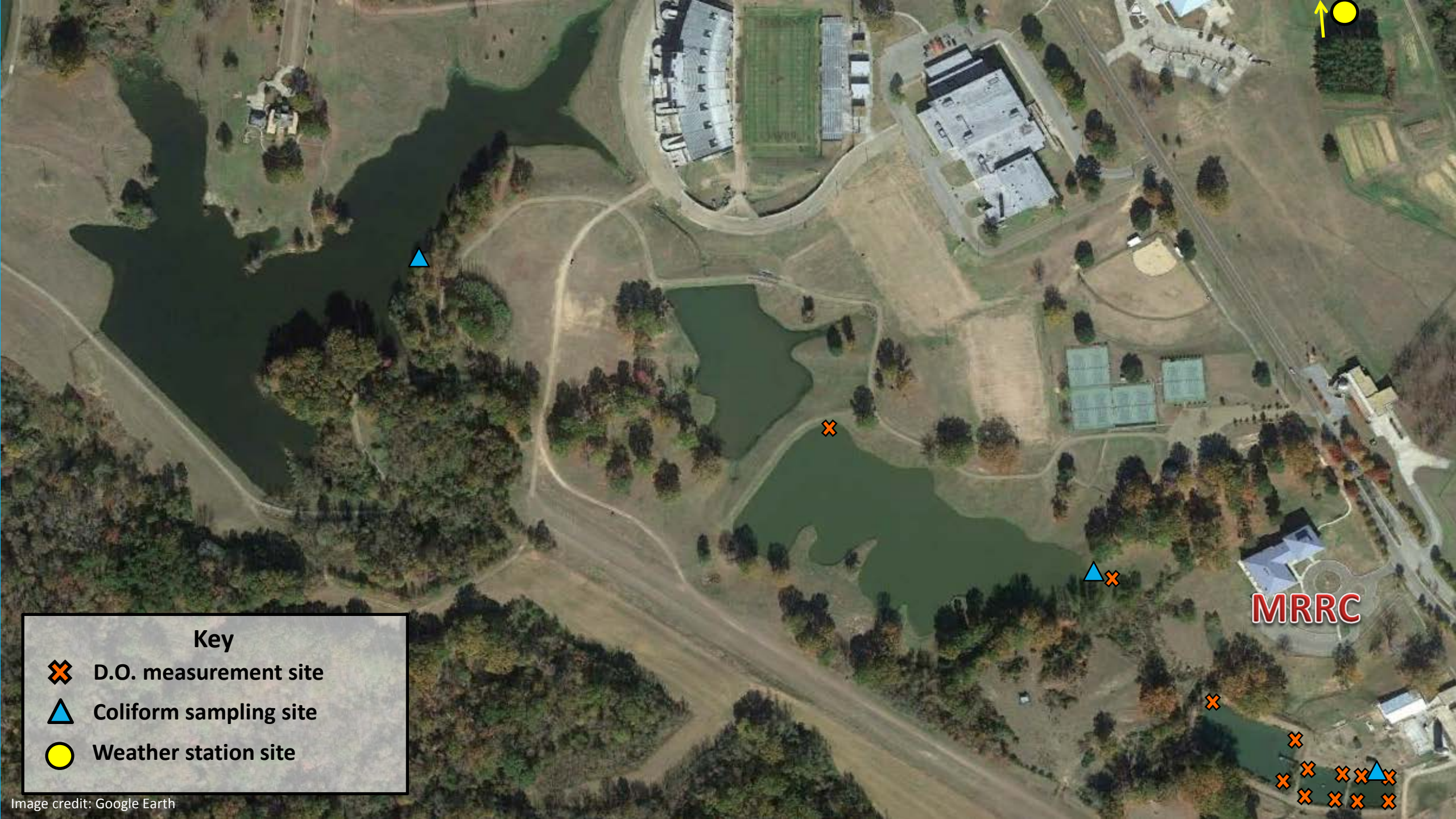
- Agricultural runoff
  - Crops
  - Cattle
- Urban runoff
  - Impervious surfaces

Mississippi Water Quality Standards
MS Department of Environmental Quality

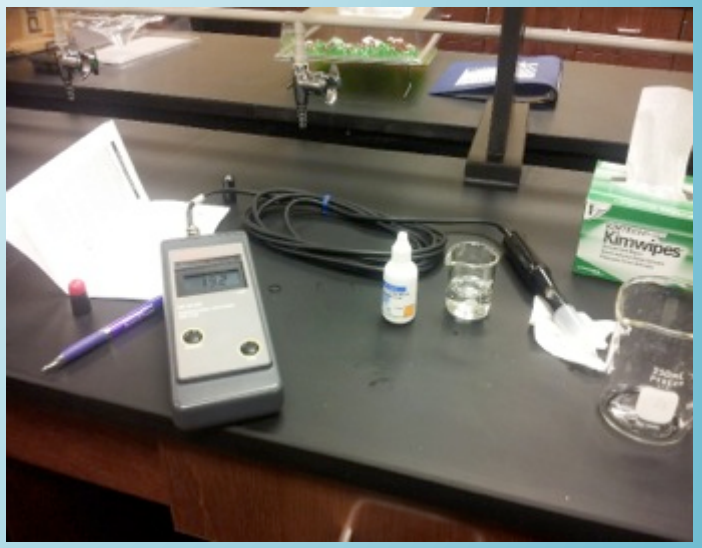
- Standards for *dissolved oxygen* concentrations:
  - Daily average at or above **5.0 mg/L**
  - Instantaneous measurement at or above **4.0 mg/L**

- May – October standards for *fecal coliform bacteria* concentration
  - Colony maximum at geometric mean of **200 per 100 mL**

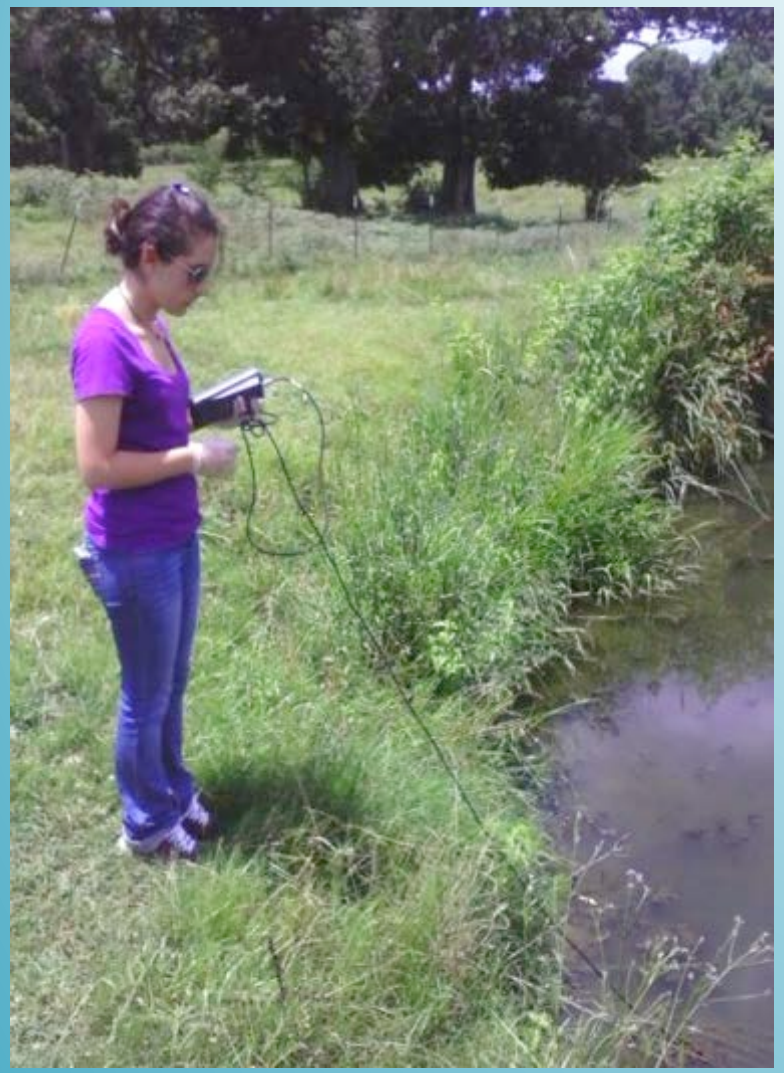

FIELD WORK


Key
D.O. measurement site
Coliform sampling site
Weather station site
MRRC
Image credit: Google Earth

Equipment Used in Field Work



Field Work



Field Work Continued


RESEARCH
General Information

Alcorn Experiment Station Watershed
61, 200 sq. ft.

Animal Science Farm Watershed
183, 049 sq. ft.

Image credit: Google Earth

Equations Used

Turc Method

- *Potential Evapotranspiration (PET)*

Water Balance

- $R = P - ET - \Delta S$

Root zone water content

- *%VWC → mm*

Unit Conversions

- F → C → K
- wat/ m^2 → cal/cm^2 /day
- in → cm → mm
- sqft → acres

Averaging between intervals

- Daily
- Weekly
- Monthly

Topographic map

- Area
- Slope

RH < 50 percent

$$PET = 0.013\left(\frac{T}{T+15}\right)(R_s + 50)\left(1 + \frac{50 - RH}{70}\right)$$

RH > 50 percent

$$PET = 0.013\left(\frac{T}{T+15}\right)(R_s + 50)$$

Image credit: Journal of the American Water Resources Association

Weather Station 7 data calculating pet daily - Microsoft Excel Preview

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Amy Mayedo

A5556 5/1/2013 2:15:00 PM

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	weather station 7																
2		Soil Moist-VWC (%VWC	Soil Moist-VWC (%VWC)	Soil Moist-VWC (%VWC)	Solar Rad (wat/m2	Solar Rad (	RH (%)	Temperature (°F	Temperature (°C	Temperature (°K)	Rainfall (In)	Dew Point (°F)	PET (mm/day)	SRD Average W	SRD Average MI	TMPF Average '	TMPF Aver.
3		%VWC	%VWC	%VWC	wat/m2	cal/cm2/d	%	°F	°C	°K	In	°F	mm/day				
4	Date and Time	VWCC	VWCD	VWCE	SRD	SRD	HMD	TMP	TMP	TMP	RNF	DEW	PET				
5	3/4/2013 06:30 PM	70.3	70.1	69.7	0		55.9	66.4	19.1	292.3	0	50.3	0.364	35.597	41.658	55.093	
6	3/4/2013 06:45 PM	70.3	70.1	69.7	0		57.5	65.9	18.8	292.0	0	50.6	0.362				
7	3/4/2013 07:00 PM	70.3	70.1	69.7	0		58.4	65.7	18.7	291.9	0	50.8	0.361				
8	3/4/2013 07:15 PM	70.3	70.1	69.7	0		60.6	65.2	18.4	291.6	0	51.4	0.358				
9	3/4/2013 07:30 PM	70.3	70.1	69.7	0		61.8	65.2	18.4	291.6	0	51.9	0.358				
10	3/4/2013 07:45 PM	70.3	70.1	69.7	0		62.7	65.2	18.4	291.6	0	52.3	0.358				
11	3/4/2013 08:00 PM	70.3	70.1	69.7	0		64.2	64.8	18.2	291.4	0	52.6	0.357				
12	3/4/2013 08:15 PM	70.3	70.1	69.7	0		65.4	64.6	18.1	291.3	0	52.9	0.356				
13	3/4/2013 08:30 PM	70.2	70.1	69.7	0		66.2	64.7	18.2	291.3	0	53.3	0.356				
14	3/4/2013 08:45 PM	70.2	70.1	69.7	0		67.5	64.4	18.0	291.2	0	53.6	0.355				
15	3/4/2013 09:00 PM	70.2	70.1	69.7	0		68.7	64	17.8	290.9	0	53.7	0.353				
16	3/4/2013 09:15 PM	70.2	70.1	69.7	0		70.1	63.8	17.7	290.8	0	54	0.352				
17	3/4/2013 09:30 PM	70.2	70.1	69.7	0		71.3	63.6	17.6	290.7	0	54.3	0.351				
18	3/4/2013 09:45 PM	70.2	70.1	69.7	0		72.2	63.5	17.5	290.7	0	54.5	0.350				
19	3/4/2013 10:00 PM	70.2	70.1	69.7	0		73.1	63.3	17.4	290.5	0	54.7	0.349				
20	3/4/2013 10:15 PM	70.2	70.1	69.7	0		73.6	63.3	17.4	290.5	0	54.8	0.349				
21	3/4/2013 10:30 PM	70.2	70.1	69.6	0		74.6	63.1	17.3	290.4	0	55	0.348				
22	3/4/2013 10:45 PM	70.2	70.1	69.7	0		75.1	63	17.2	290.4	0	55.1	0.347				
23	3/4/2013 11:00 PM	70.2	70.1	69.7	0		75.6	63	17.2	290.4	0	55.3	0.347				
24	3/4/2013 11:15 PM	70.2	70.1	69.7	0		75.8	63.1	17.3	290.4	0	55.4	0.348				
25	3/4/2013 11:30 PM	70.2	70.1	69.7	0		76	63.2	17.3	290.5	0	55.6	0.348				
26	3/4/2013 11:45 PM	70.2	70.1	69.7	0		76.4	63.1	17.3	290.4	0	55.7	0.348				
27	3/5/2013 12:00 AM	70.2	70.1	69.7	0		76.6	63	17.2	290.4	0	55.6	0.347				
28	3/5/2013 12:15 AM	70.2	70.1	69.7	0		78.1	62.8	17.1	290.3	0	56	0.346				
29	3/5/2013 12:30 AM	70.2	70.1	69.7	0		78.2	62.7	17.1	290.2	0	55.9	0.346				
30	3/5/2013 12:45 AM	70.2	70.1	69.7	0		78.5	62.7	17.1	290.2	0	56	0.346				
31	3/5/2013 01:00 AM	70.2	70.1	69.7	0		79.3	62.6	17.0	290.2	0	56.2	0.345				
32	3/5/2013 01:15 AM	70.2	70.1	69.7	0		80	62.5	16.9	290.1	0	56.3	0.345				
33	3/5/2013 01:30 AM	70.2	70.1	69.7	0		80.5	62.4	16.9	290.0	0	56.4	0.344				
34	3/5/2013 01:45 AM	70.3	70.1	69.7	0		81.1	62.2	16.8	289.9	0	56.4	0.343				
35	3/5/2013 02:00 AM	70.2	70.1	69.7	0		81.3	62.2	16.8	289.9	0	[illegible]	0.343				
36	3/5/2013 02:15 AM	70.2	70.1	69.6	0		81.3	62.1	16.7	289.9	0	[illegible]	[illegible]				
37	3/5/2013 02:30 AM	70.2	70.1	69.7	0		81.5	62.1	16.7	289.9	0	[illegible]	0.343				
38	3/5/2013 02:45 AM	70.2	70.1	69.7	0		81.5	62.1	16.7	289.9	0	56.4	0.343				
39	3/5/2013 03:00 AM	70.2	70.1	69.7	0		81.5	62.2	16.8	289.9	0	56.5	0.343				
40	3/5/2013 03:15 AM	70.2	70.1	69.6	0		81.2	62.4	16.9	290.0	0	56.6	0.344				
41	3/5/2013 03:30 AM	70.2	70.1	69.7	0		81.2	62.4	16.9	290.0	0	56.6	0.344				
42	3/5/2013 03:45 AM	70.2	70.1	69.7	0		81.5	62.3	16.8	290.0	0	56.6	0.344				
43	3/5/2013 04:00 AM	70.2	70.1	69.7	0		81.3	62.4	16.9	290.0	0	56.6	0.344				
44	3/5/2013 04:15 AM	70.2	70.1	69.6	0		81.5	62.2	16.8	289.9	0	56.5	0.343				
45	3/5/2013 04:30 AM	70.2	70.1	69.7	0		81.9	62.2	16.8	289.9	0	56.6	0.343				

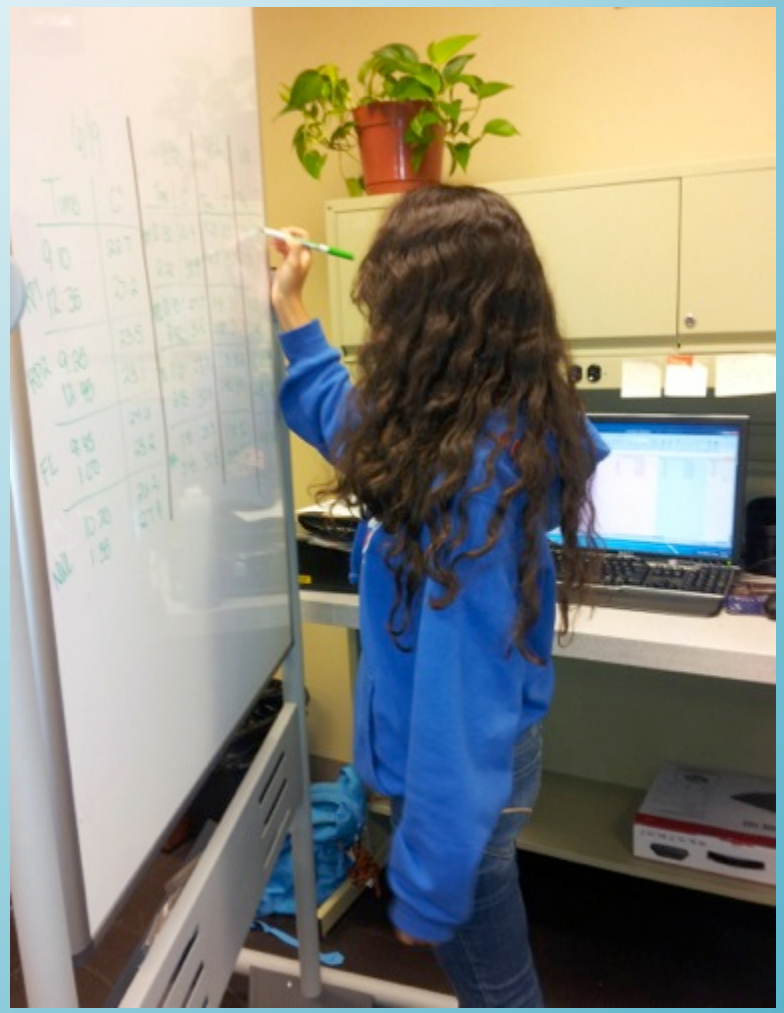
RESEARCH

Runoff Quantity Assessment

Chart4 Sheet1 Sheet2 Sheet3 Sheet4 Sheet5

READY AVERAGE: 5/1/2013 10:22 PM COUNT: 66 SUM: 4/25/9380 12:45 PM 60%

Data Collection and Analysis



Data Analysis: Potential Evapotranspiration

- Defined as the amount of water that could evaporate and transpire without restriction other than atmospheric demand
  (Lu, Sun, McNulty, & Amatya, 2005, p. 621)
- Quantification of water lost to the atmosphere
- PET data calculated for high humidity season (March – June)

RH < 50 percent

$$PET = 0.013\left(\frac{T}{T+15}\right)(R_s + 50)\left(1 + \frac{50 - RH}{70}\right)$$

RH > 50 percent

$$PET = 0.013\left(\frac{T}{T+15}\right)(R_s + 50)$$

where, PET is the daily PET (mm/day); T is the daily mean air temperature (°C); R_s is the daily solar radiation (ly/day or cal/cm^2/d) and RH is the daily mean relative humidity (percent).

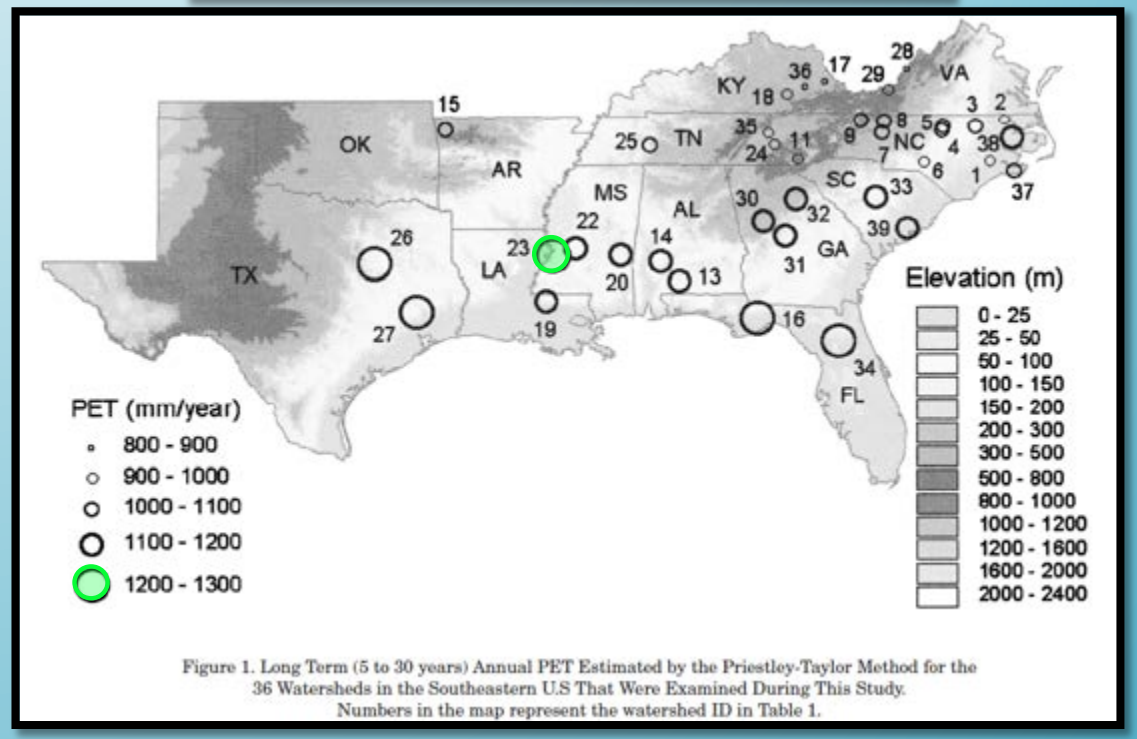
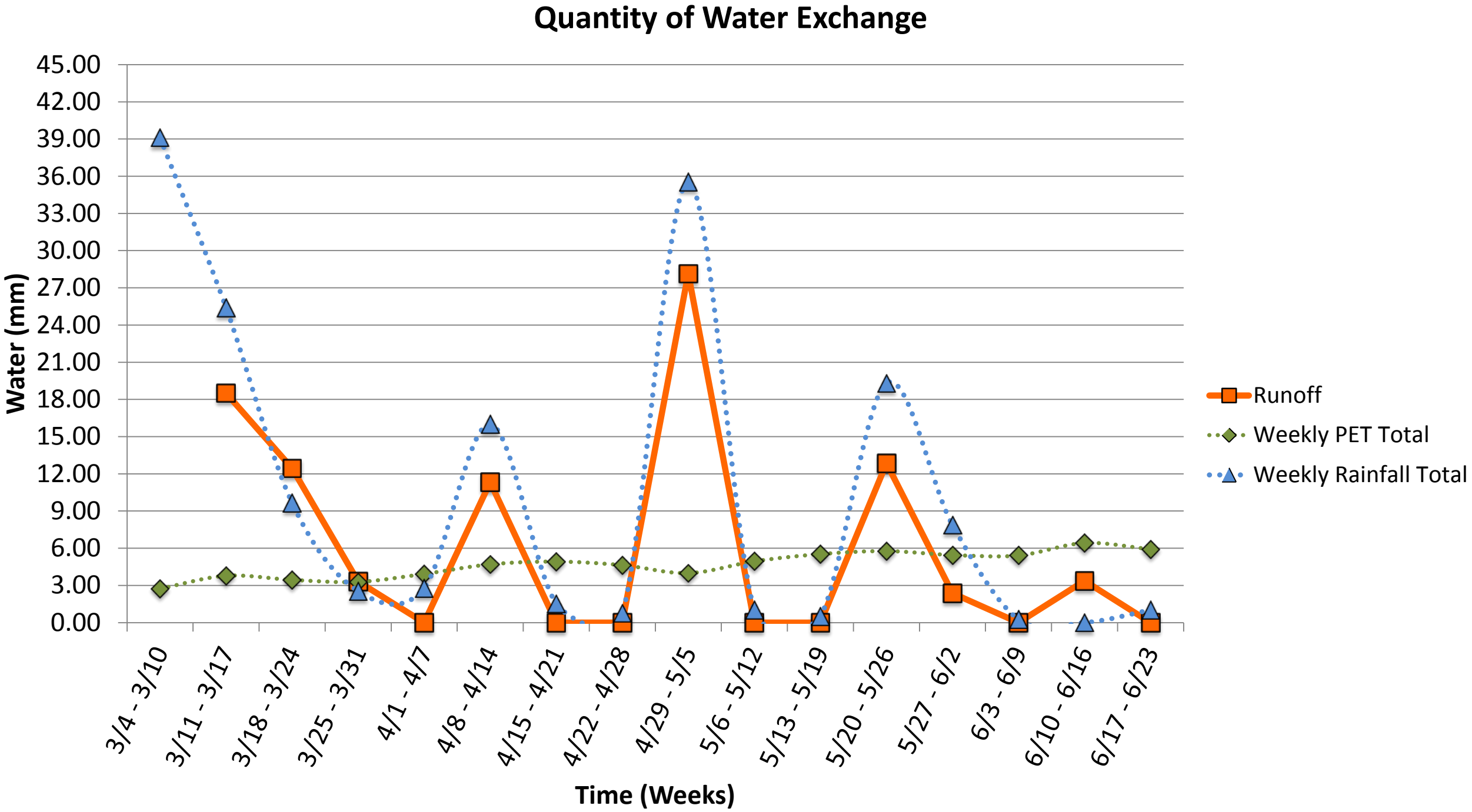


Figure 1. Long Term (5 to 30 years) Annual PET Estimated by the Priestley-Taylor Method for the 36 Watersheds in the Southeastern U.S That Were Examined During This Study. Numbers in the map represent the watershed ID in Table 1.

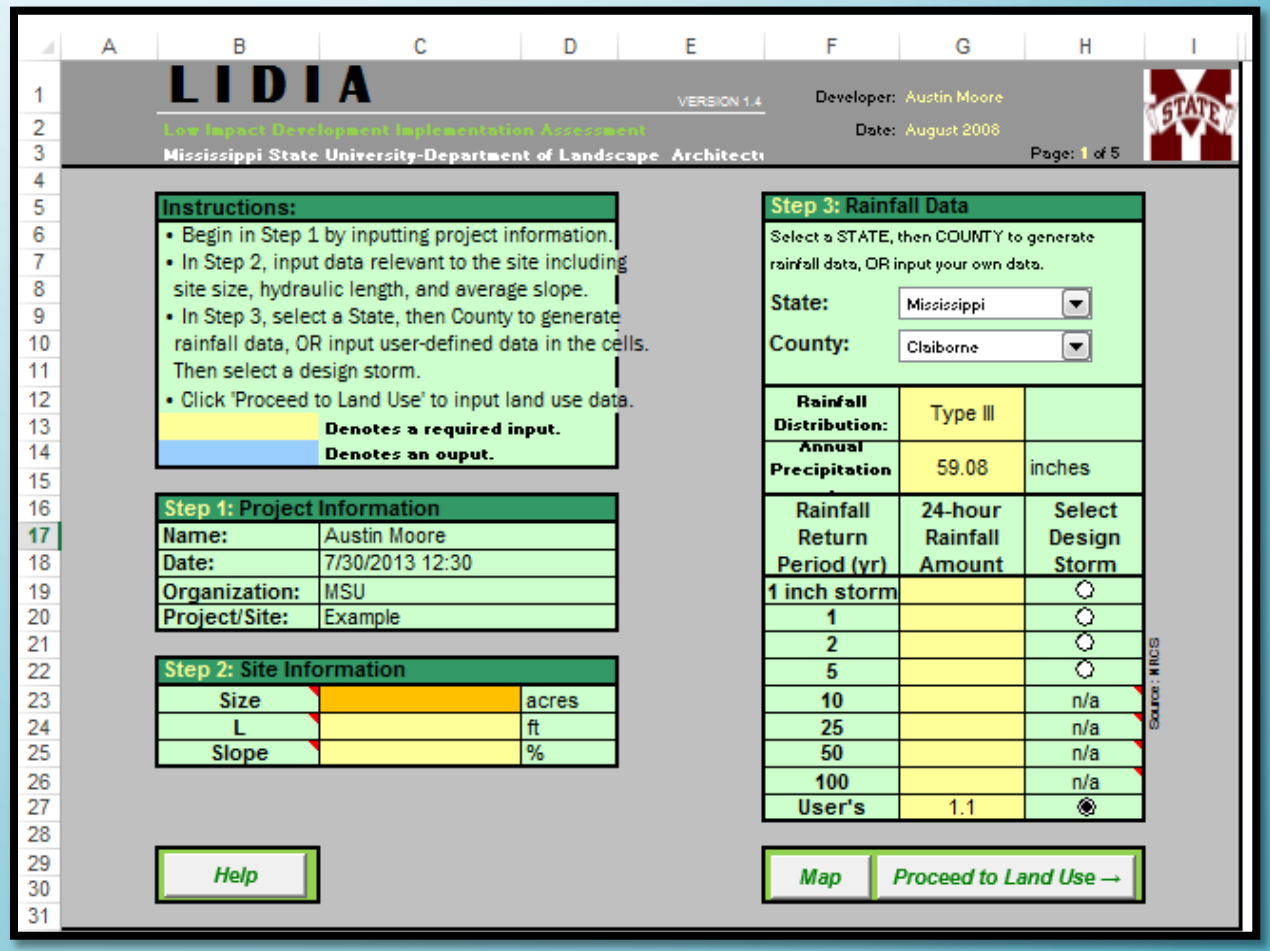
Data Analysis: Water balance

- Defined as a calculation of the inputs and outputs of water in a system
- Considers precipitation, PET, and storage changes of water
  - $R = P - ET - \Delta S$
- Quantification of runoff

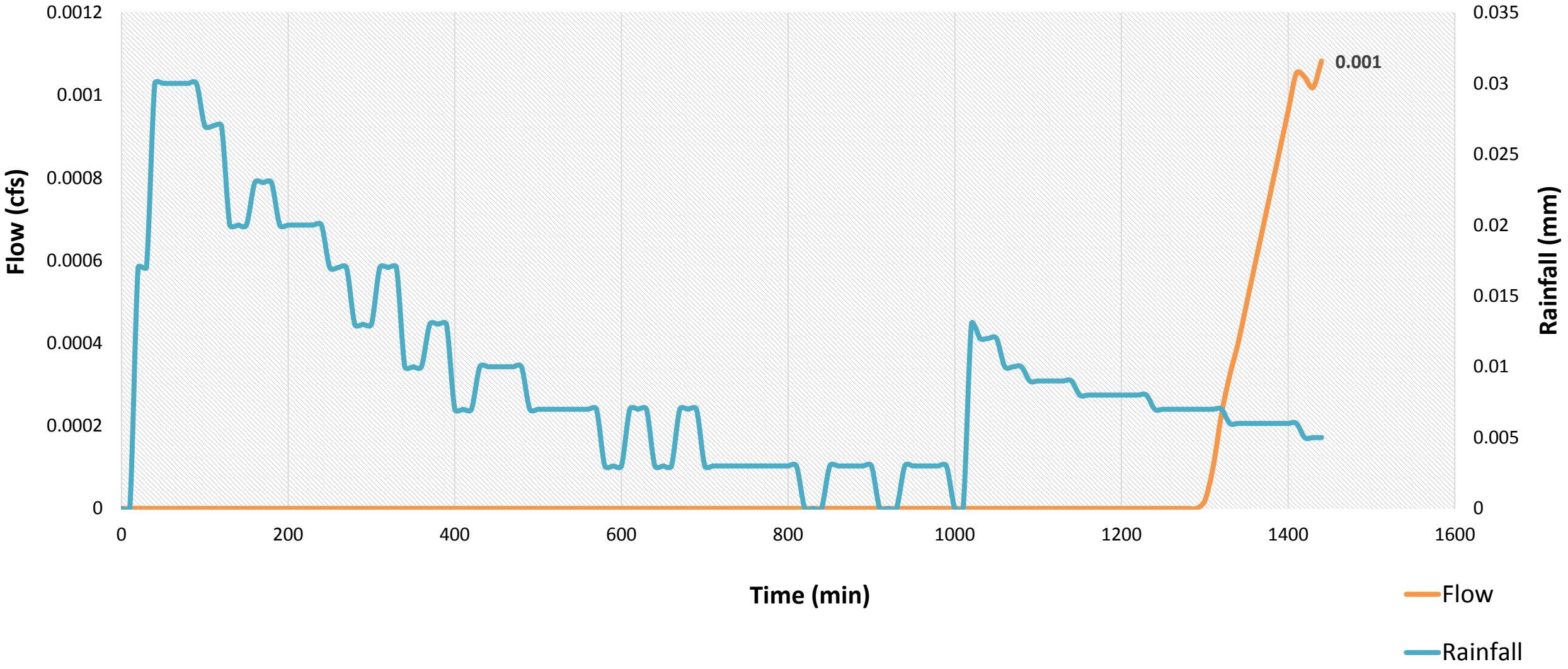

Quantity of Water Exchange
Water (mm)
45.00
42.00
39.00
36.00
33.00
30.00
27.00
24.00
21.00
18.00
15.00
12.00
9.00
6.00
3.00
0.00
3/4 - 3/10
3/11 - 3/17
3/18 - 3/24
3/25 - 3/31
4/1 - 4/7
4/8 - 4/14
4/15 - 4/21
4/22 - 4/28
4/29 - 5/5
5/6 - 5/12
5/13 - 5/19
5/20 - 5/26
5/27 - 6/2
6/3 - 6/9
6/10 - 6/16
6/17 - 6/23
Time (Weeks)
Runoff
Weekly PET Total
Weekly Rainfall Total

Modeling: Runoff Hydrograph

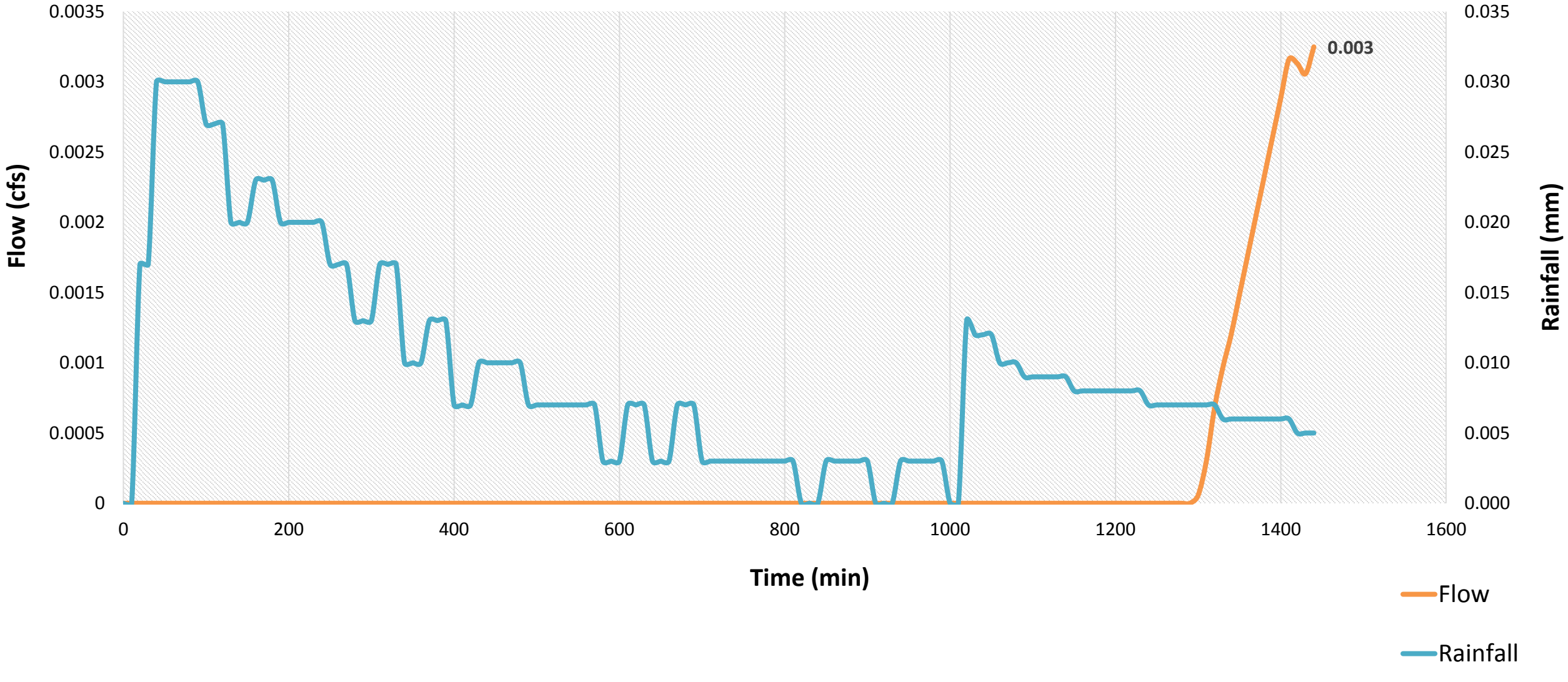
- Measures the water flow of a precipitation event over time
- Performed with LIDIA
  (Low Impact Development Assessment)
- Key to understanding relationship between precipitation and runoff
- May 1st – 2nd precipitation event modeled for each watershed
  - 16 hour event



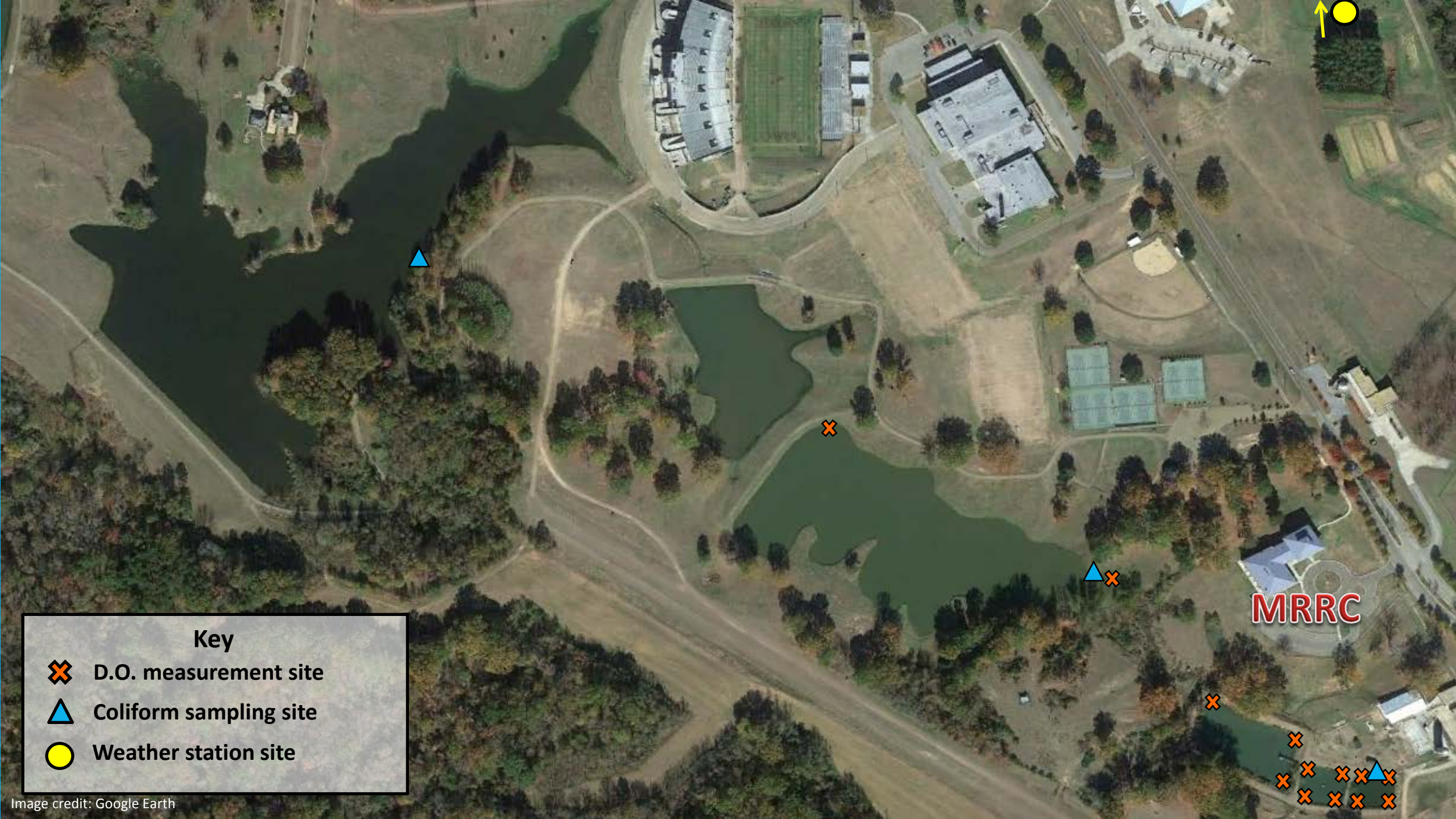
Experiment Farm Hydrograph
May 1st - 2nd Precipitation Event



Animal Science Farm Hydrograph
May 1st - 2nd Precipitation Event

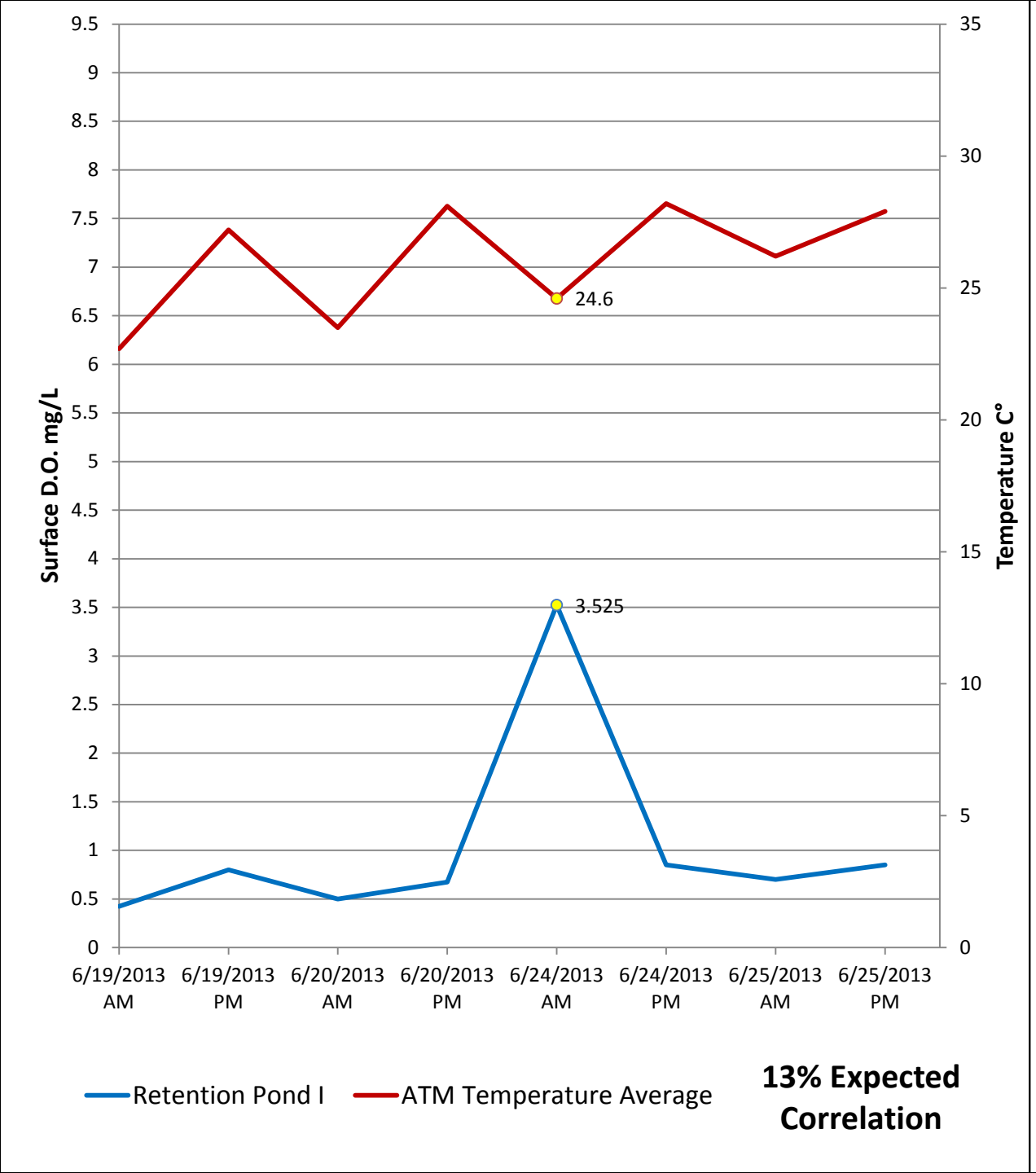


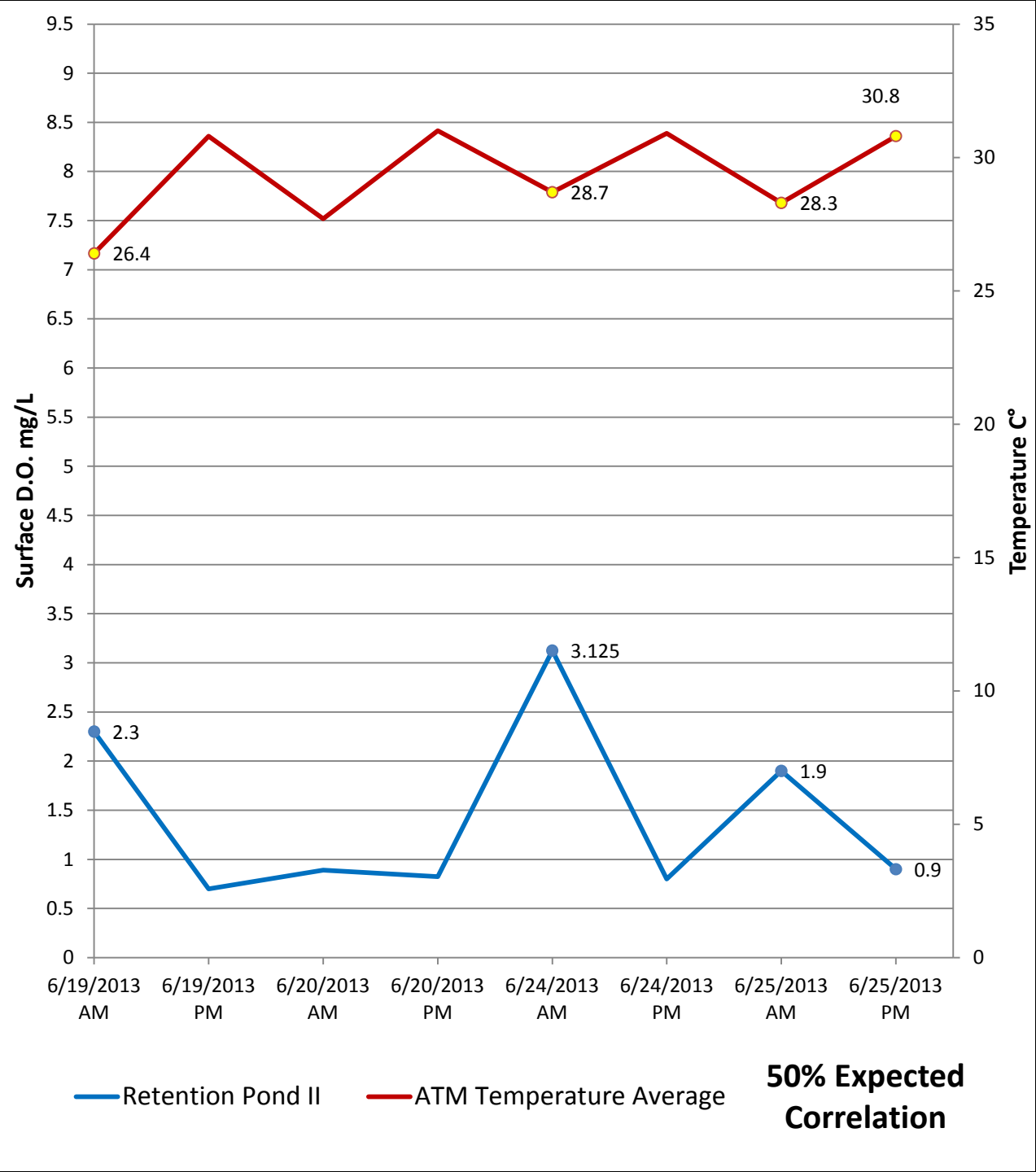

RESEARCH
Runoff Quality Characterization

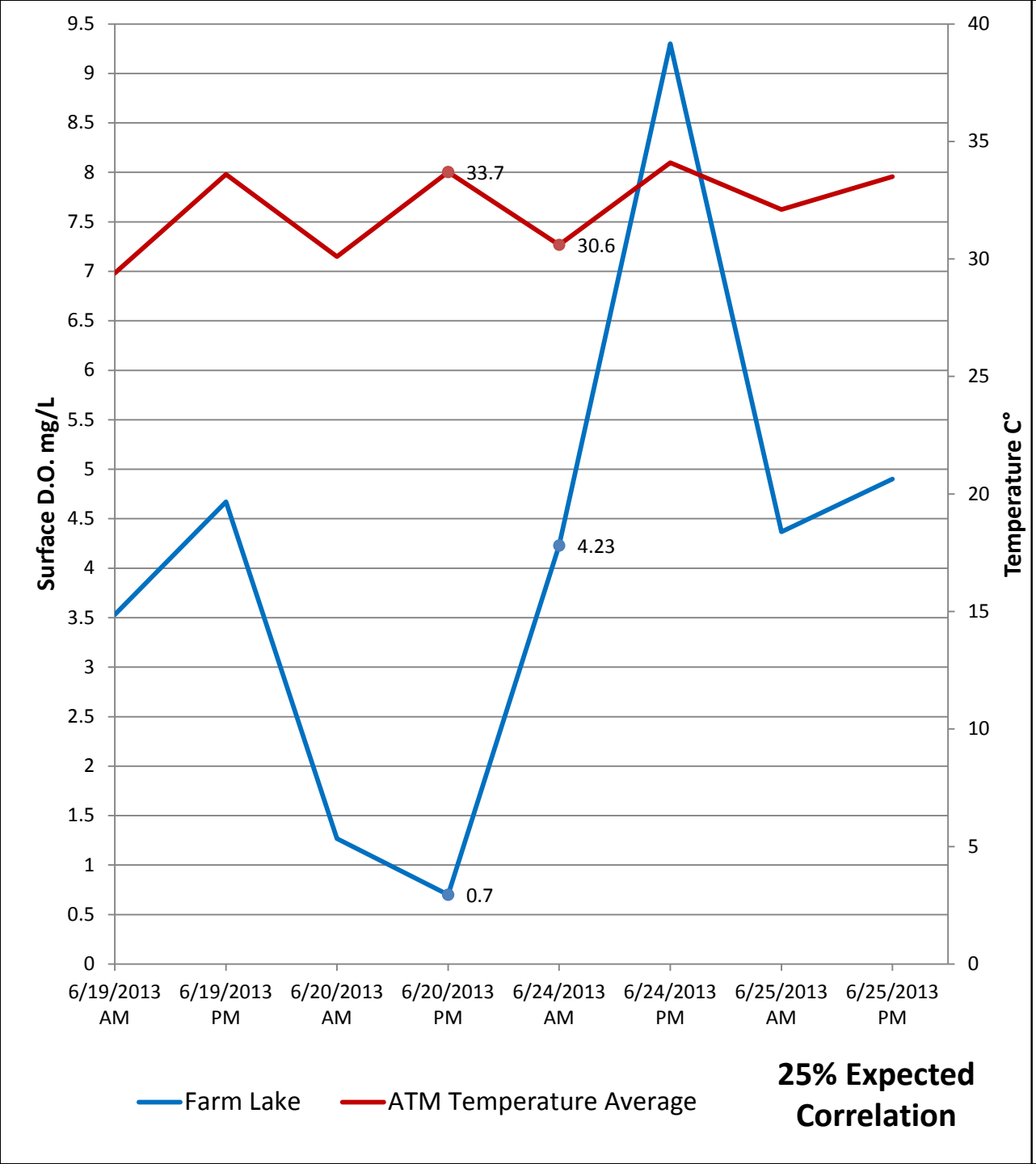

Key
D.O. measurement site
Coliform sampling site
Weather station site
MRRC
Image credit: Google Earth

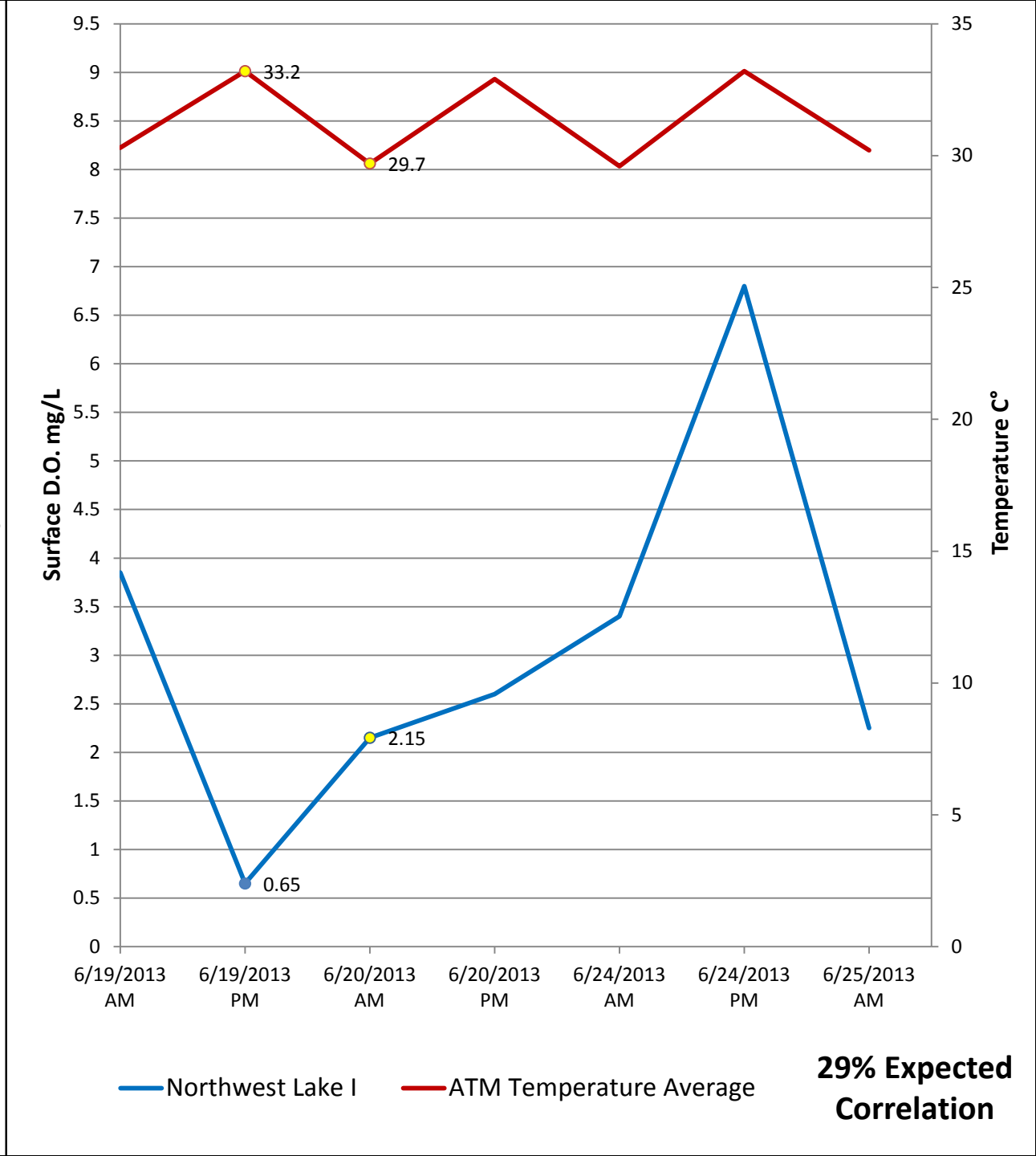
Dissolved Oxygen

- Dissolved molecular oxygen content of water
  - DO concentration is affected by many environmental factors
- Measured using an amperometric instrument
  - Probe with temperature sensor and membrane
- Surface D.O. defined as <5 feet of depth
  - My measurements were taken between 6 – 18 inches of depth

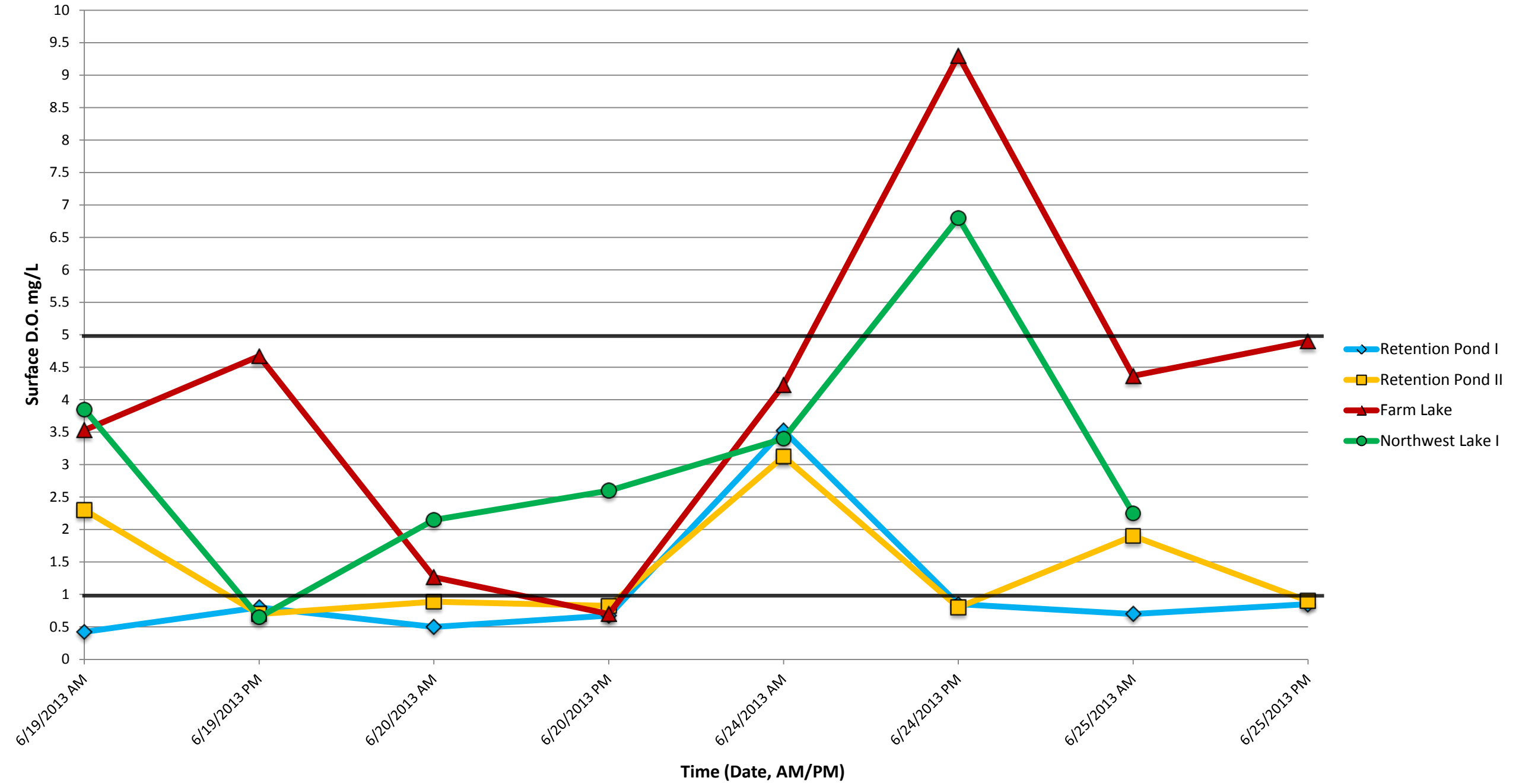

Surface D.O. mg/L
Temperature C°
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
35
30
25
20
15
10
5
0
24.6
3.525
6/19/2013 AM
6/19/2013 PM
6/20/2013 AM
6/20/2013 PM
6/24/2013 AM
6/24/2013 PM
6/25/2013 AM
6/25/2013 PM
Retention Pond I
ATM Temperature Average
13% Expected Correlation


Surface D.O. mg/L
Temperature C°
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
35
30
25
20
15
10
5
0
30.8
28.7
28.3
26.4
3.125
2.3
1.9
0.9
6/19/2013 AM
6/19/2013 PM
6/20/2013 AM
6/20/2013 PM
6/24/2013 AM
6/24/2013 PM
6/25/2013 AM
6/25/2013 PM
Retention Pond II
ATM Temperature Average
50% Expected Correlation

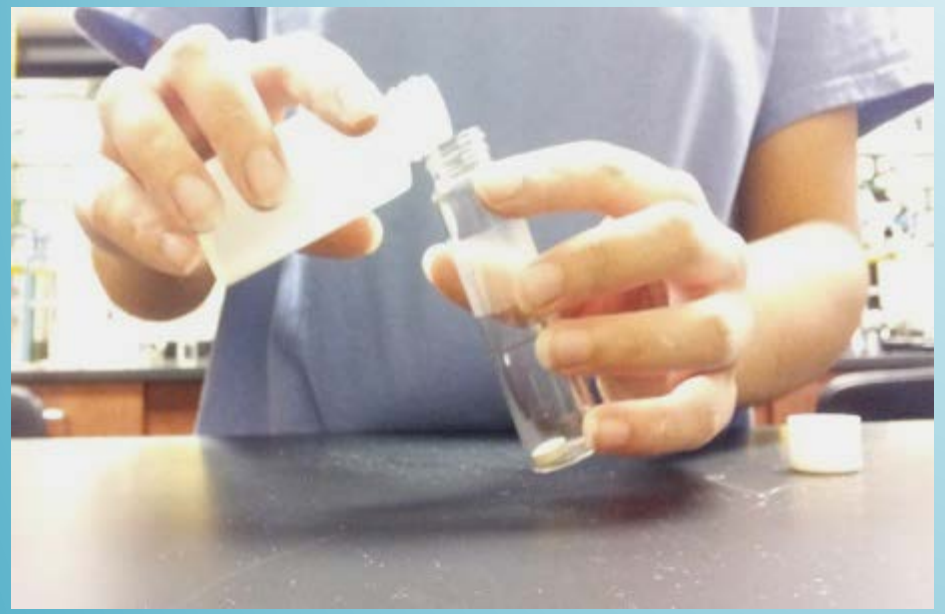

Surface D.O. mg/L
Temperature C°
33.7
30.6
4.23
0.7
6/19/2013 AM
6/19/2013 PM
6/20/2013 AM
6/20/2013 PM
6/24/2013 AM
6/24/2013 PM
6/25/2013 AM
6/25/2013 PM
Farm Lake
ATM Temperature Average
25% Expected Correlation


Surface D.O. mg/L
Temperature C°
33.2
29.7
2.15
0.65
6/19/2013 AM
6/19/2013 PM
6/20/2013 AM
6/20/2013 PM
6/24/2013 AM
6/24/2013 PM
6/25/2013 AM
Northwest Lake I
ATM Temperature Average
29% Expected Correlation

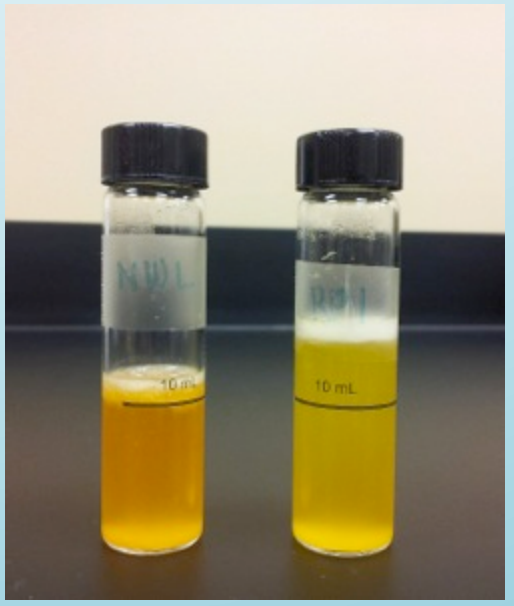
Average Surface Dissolved Oxygen Content



Presence of Coliform



48 Hour Incubation Period



Primary Sedimentation Pond
West Lake
Samples taken July 17, 1:30PM

Northwest Lake
Sample taken July 22, 10:00AM

Research Conclusions

- ASU agricultural operations contribute significant volumes of runoff to wastewater retention bodies.
- A significant amount of dissolved oxygen measurements taken between June 24th– 28th were consistently below MDEQ standards at the time of measurement.
- Fecal coliform was present in the wastewater retention body samples on July 17th and 22nd.

My results suggest a relationship between low quality agricultural runoff and a decline in water quality.

Accomplishments

- Exposure to equipment maintenance and calibration
- Exposure to software and professionals relevant to my field of interest
- First time hands-on experience with GIS and modeling
- First time conducting field work
- Minority youth STEM outreach

Citations

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Acknowledgements

MRRC Staff: Dr Jairo Diaz, Ms. Germania Salazar, Ms. Nancy Morehead


Questions