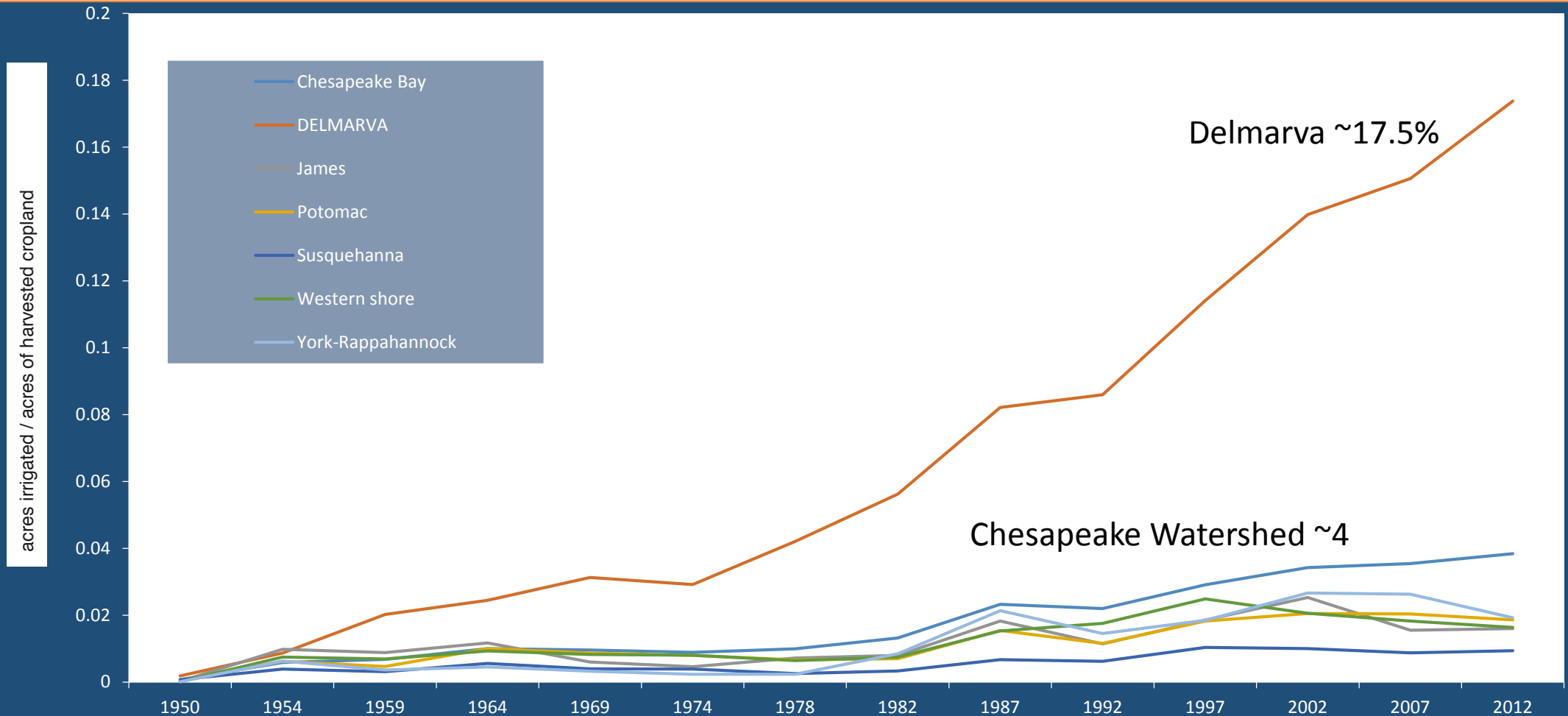


# The Effects on Irrigation on Nitrate Transport to Groundwater Delmarva Peninsula

Delaware Inland Bays STAC Meeting  
September 8, 2017

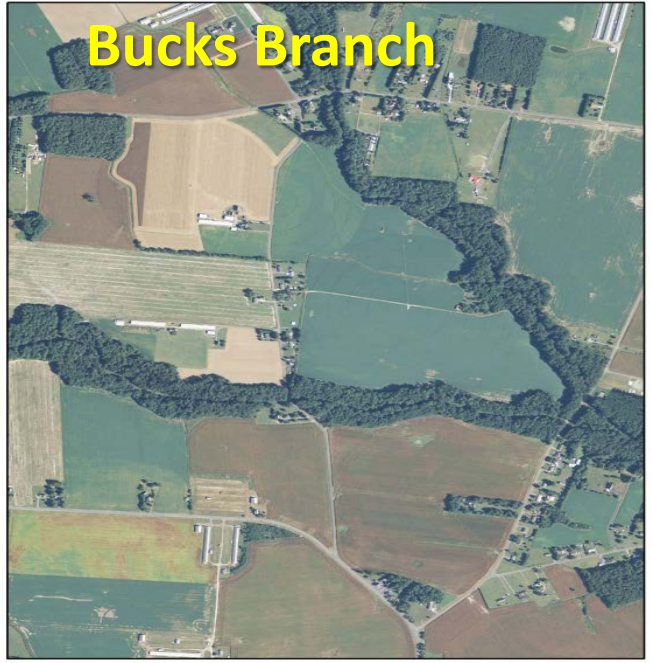
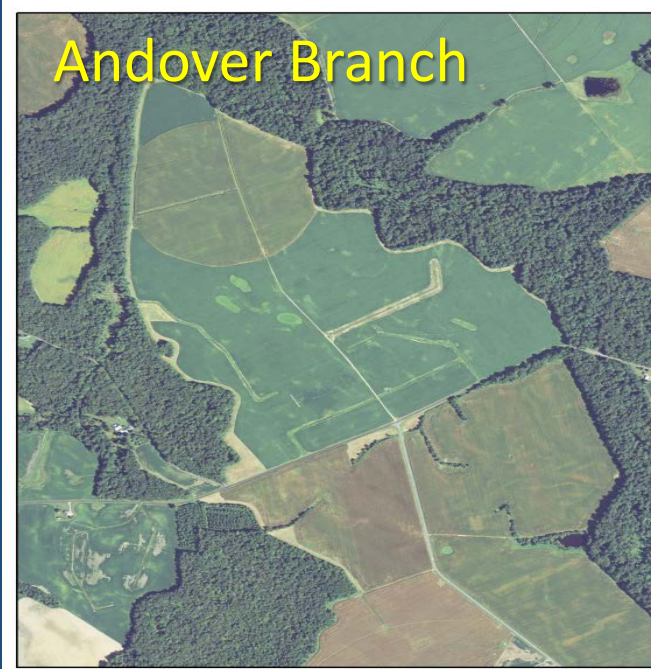
# Chesapeake Bay Watershed Percent Irrigated Acres/Cropland Harvested, 1950-2012



# BMP Hypothesis

- Nitrogen use efficiency is generally greater with irrigated than dryland farming resulting in less residual nitrogen in soils that can leach to groundwater

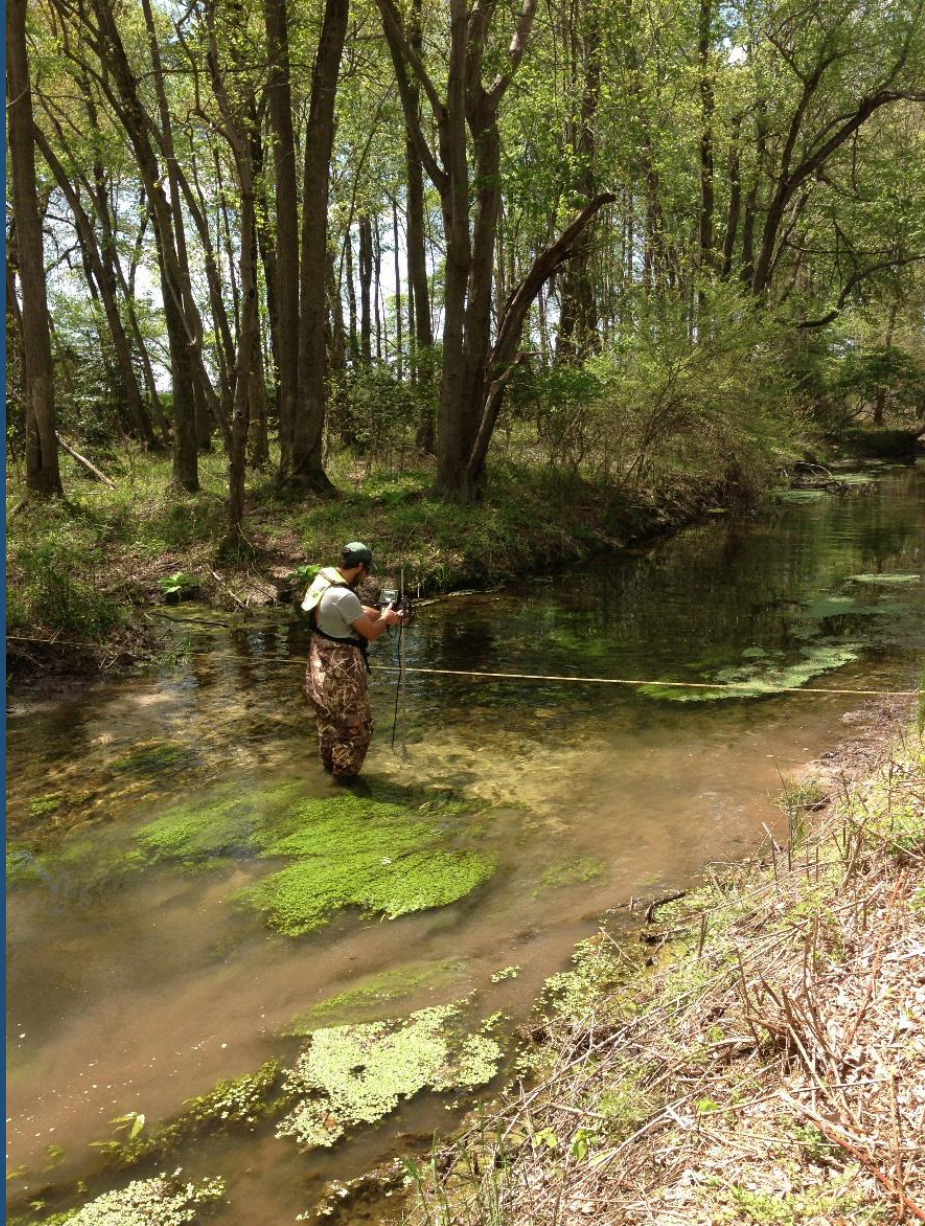
# Study Sites

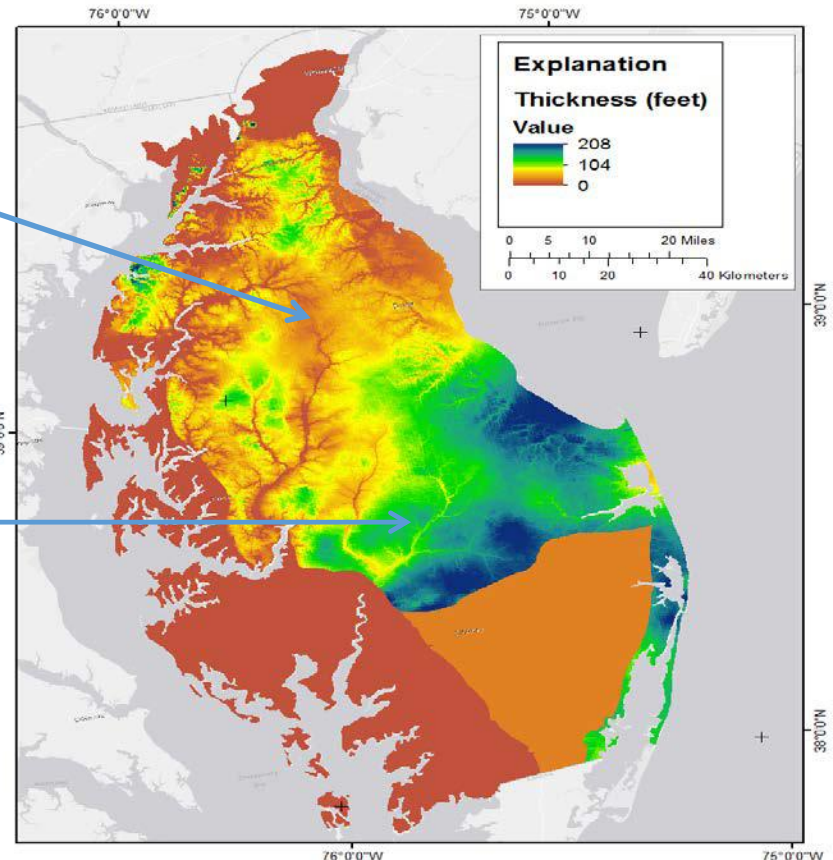
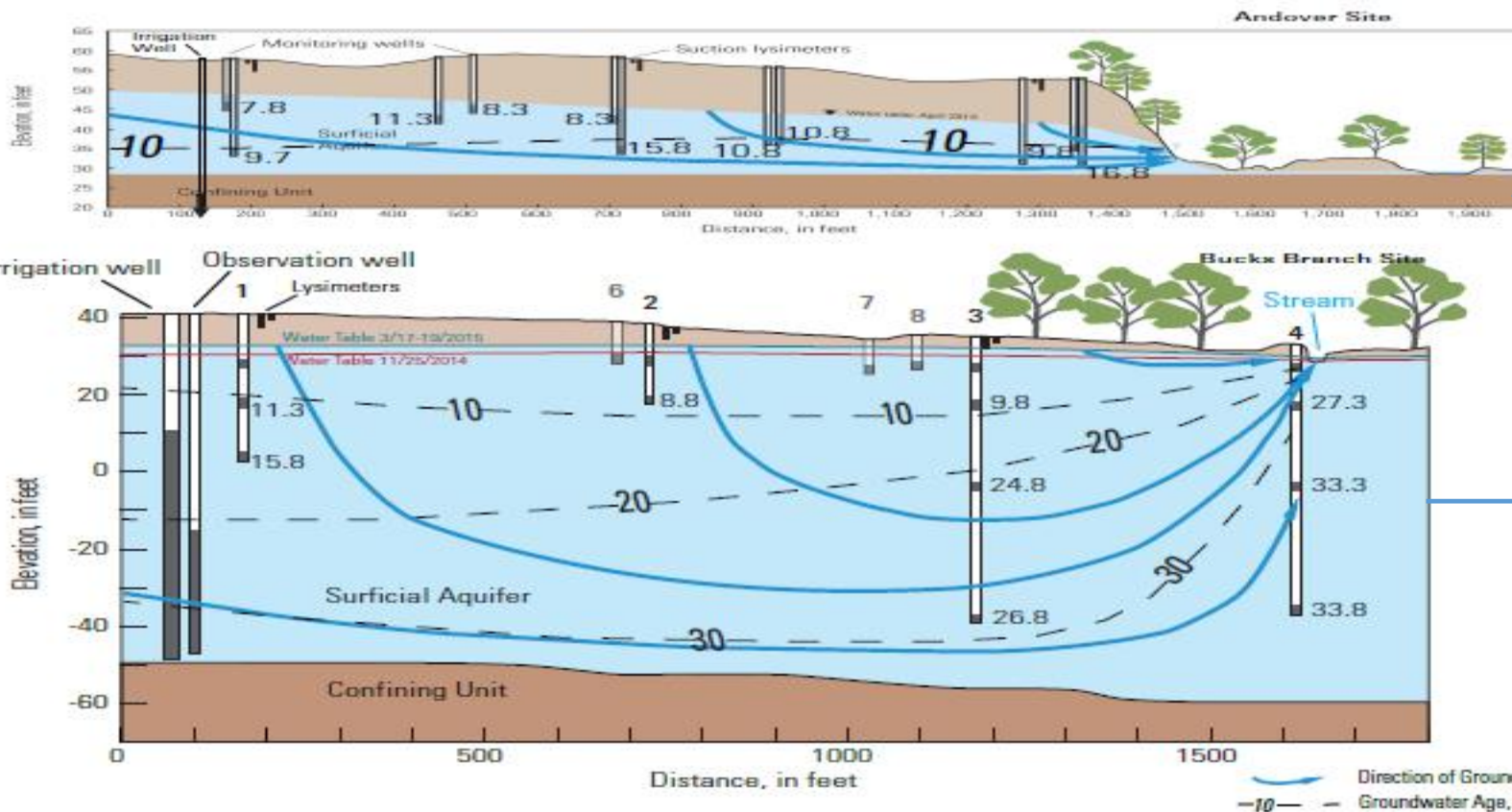


# Andover Branch



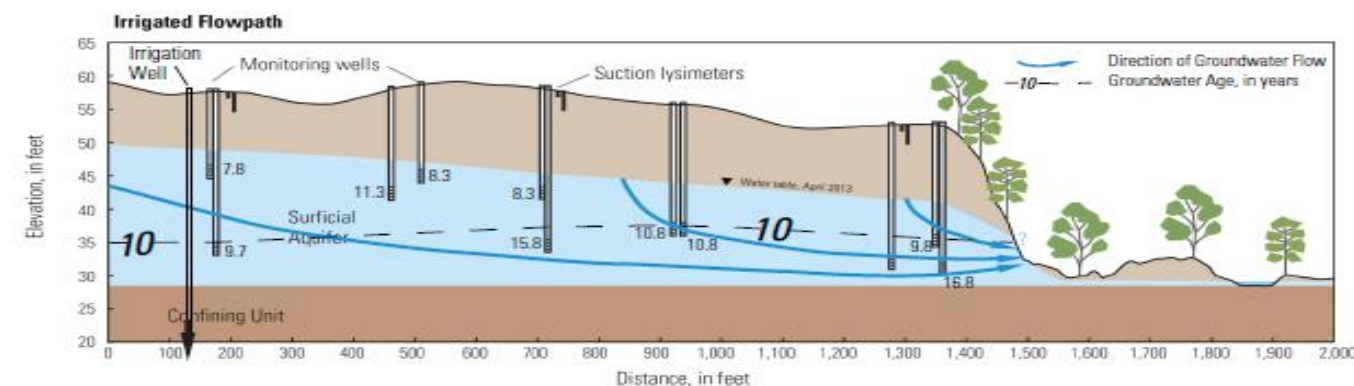
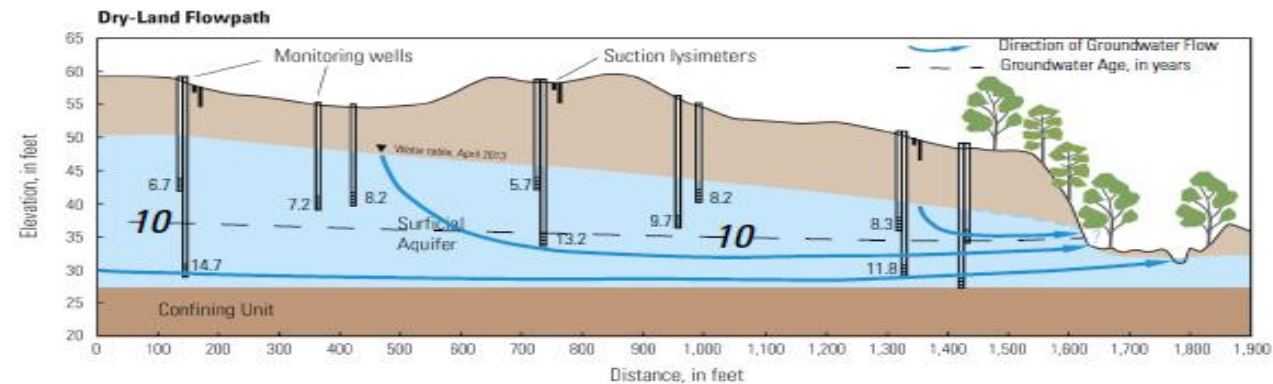
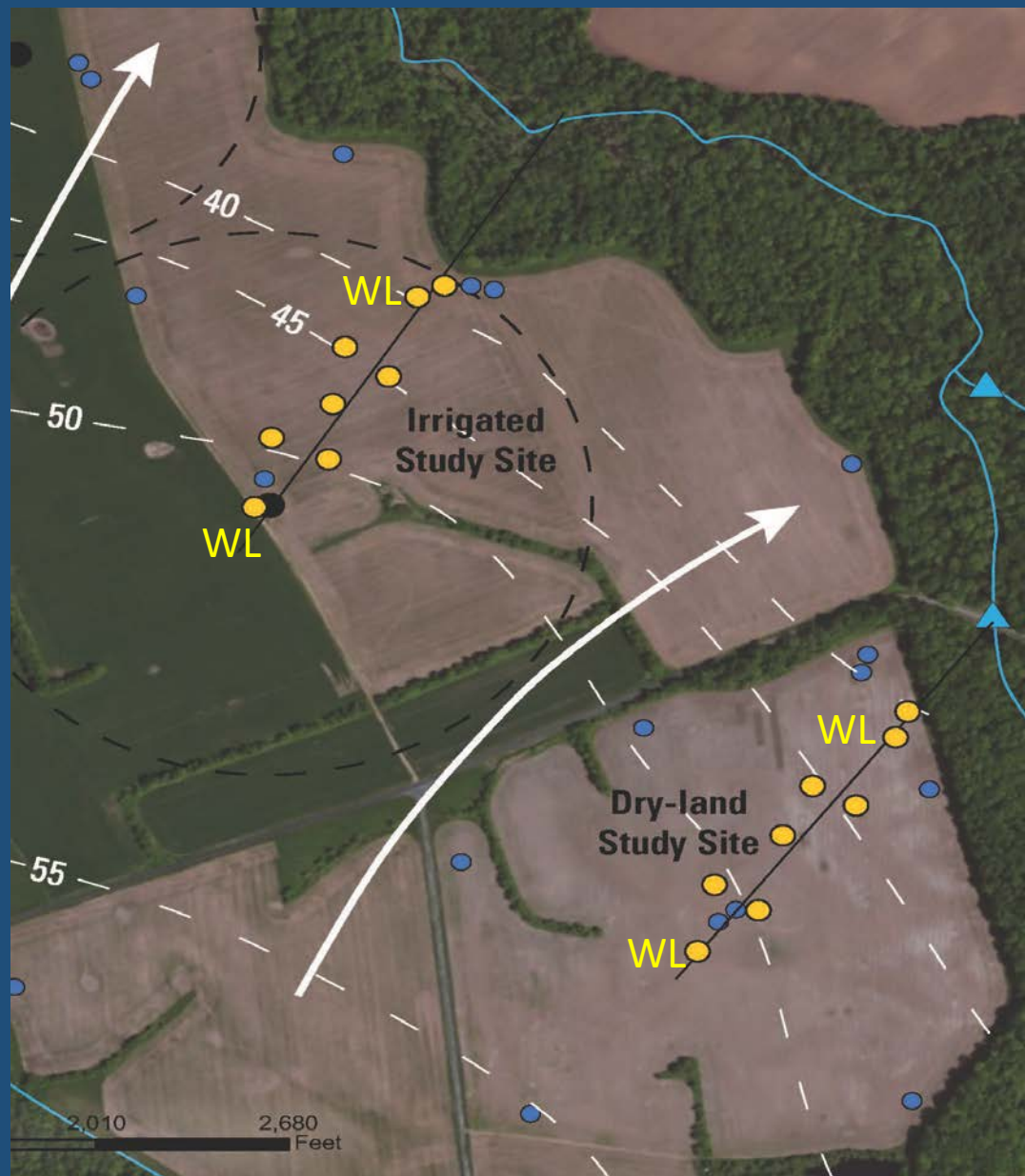
# Bucks Branch





- Hydrogeologic setting is variable across the Coastal Plain of the Delmarva Peninsula
  - Effects the response time of groundwater and streams to changes in land management
  - Effects natural processes that may mitigate nutrient transport
- Understanding local setting can help producers and other resource managers optimize BMP implementation.

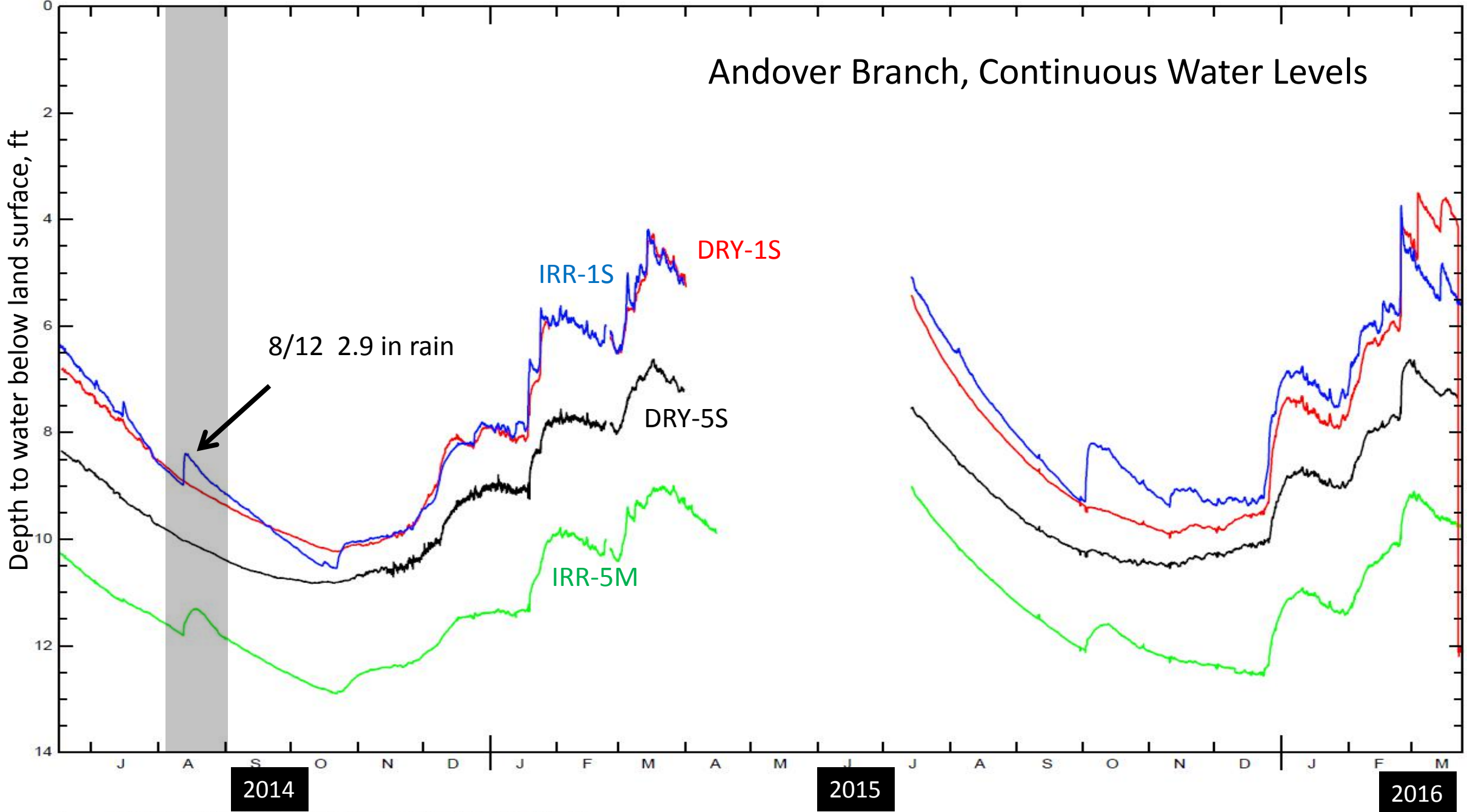
# Andover Branch



- Surficial aquifer is about 30 ft thick (land surface to underlying fine-grained sediments)
- Groundwater flows from uplands towards stream—discharge is mostly to seeps
- Maximum time of travel of groundwater to the stream is less than 20 years
- Well-drained soil
- Dissolved oxygen present in groundwater



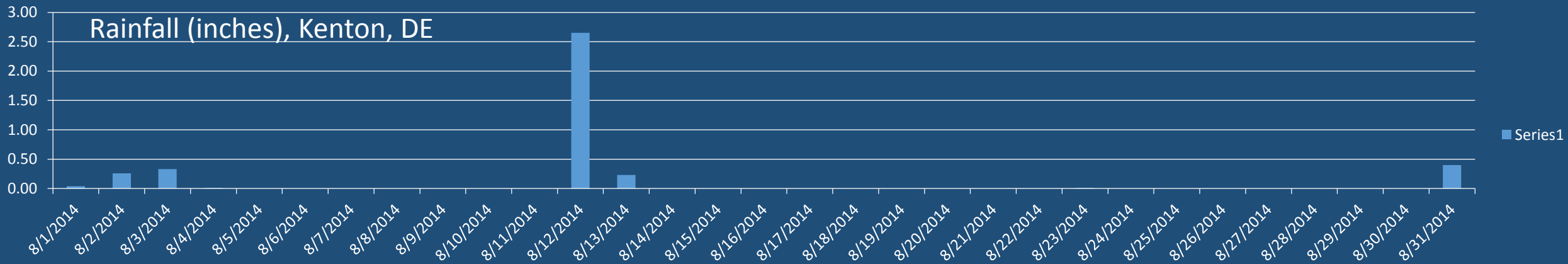
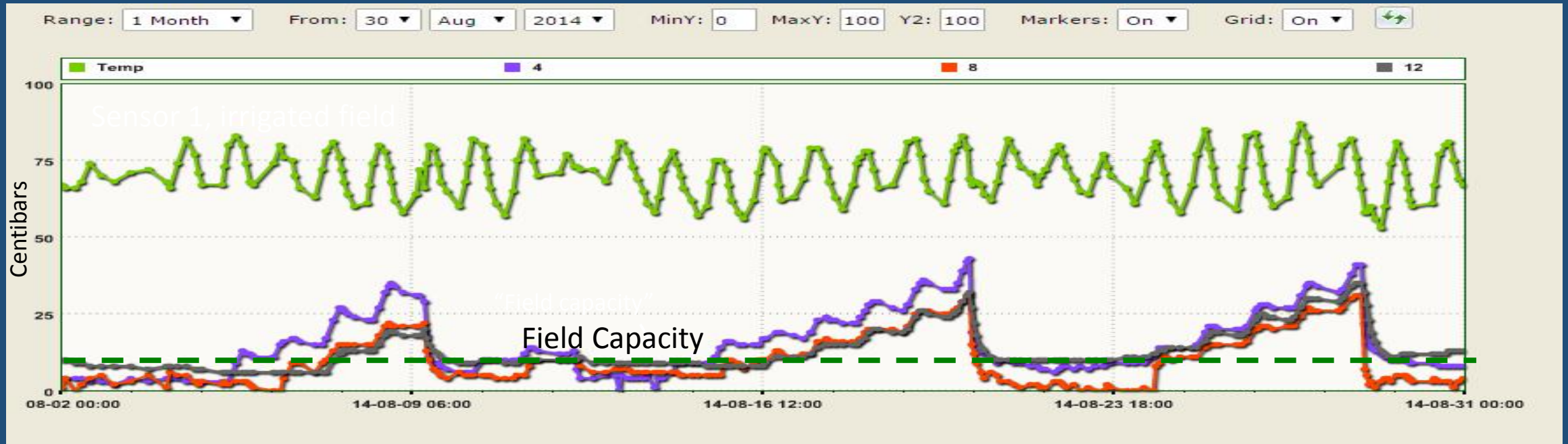
# Andover Branch, Continuous Water Levels



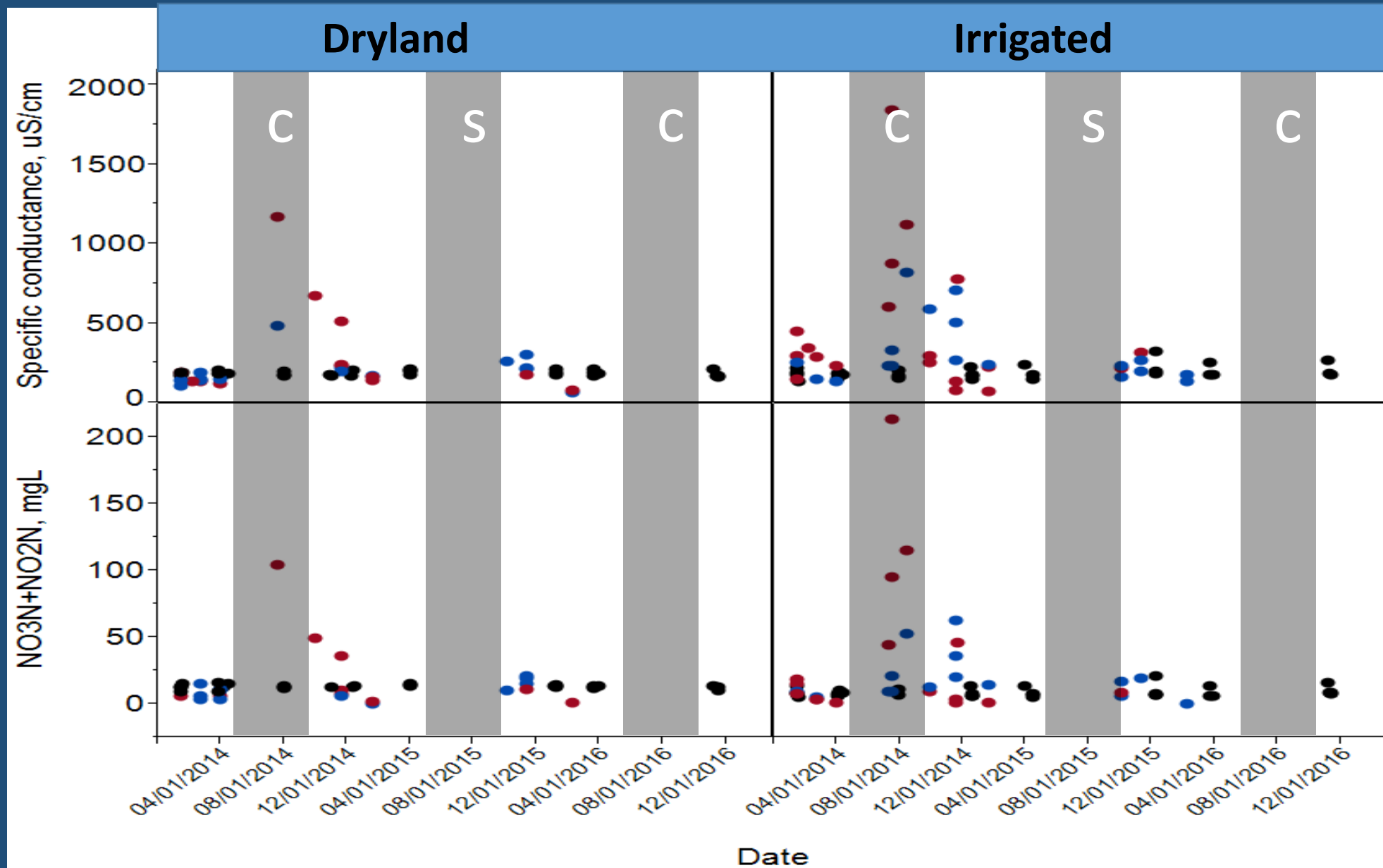
391303075460801 AND-DR-W-5S (Water level, depth L (ft), COMPUTED) \* 1  
 391320075463201 AND-IR-W-5D (Water level, depth L (ft), COMPUTED) \* 1  
 391253075461701 AND-DR-W-1S (Water level, depth L (ft), COMPUTED) \* 1  
 391311075463801 AND-IR-W-1S (Water level, depth L (ft), COMPUTED) \* 1

# Andover Branch

## Soil Moisture and Rainfall, 8/2/2014-8/31/2014

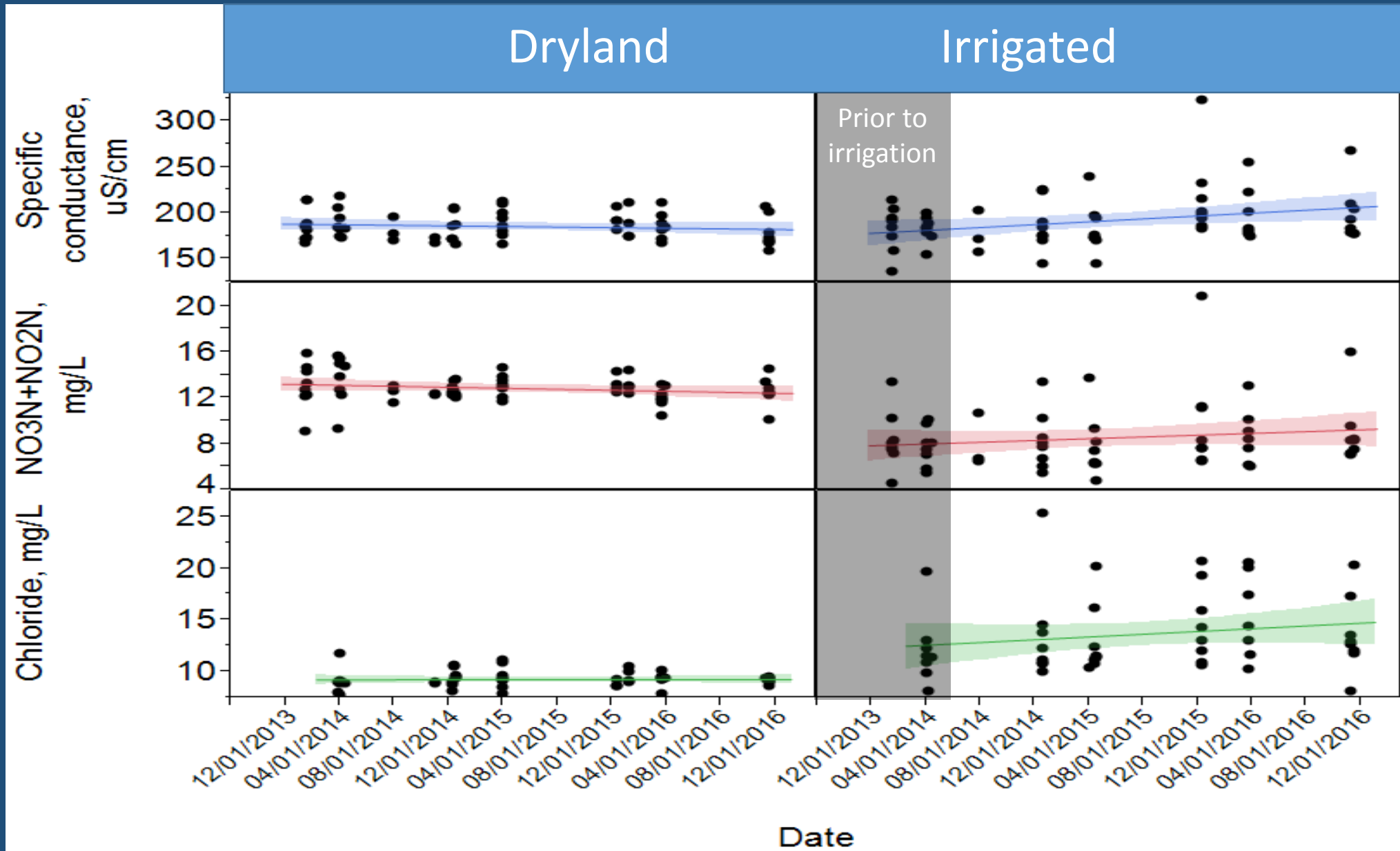


# Andover Branch Lysimeter and Shallow Groundwater Data



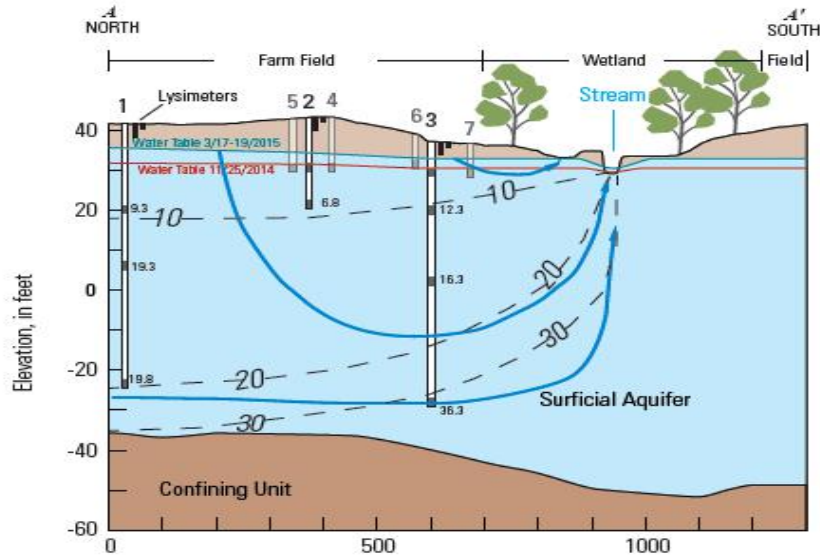
(Lysimeters: red = 1 ft, blue = 3 ft; Shallow well samples: black)

# Andover Branch, Shallow Groundwater

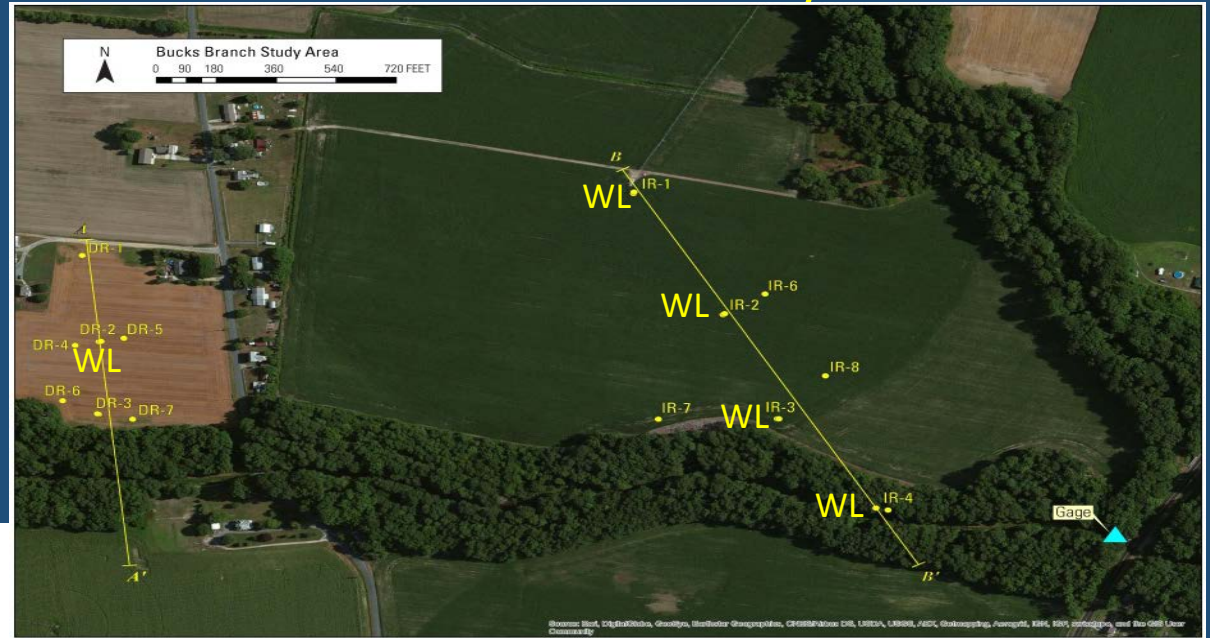
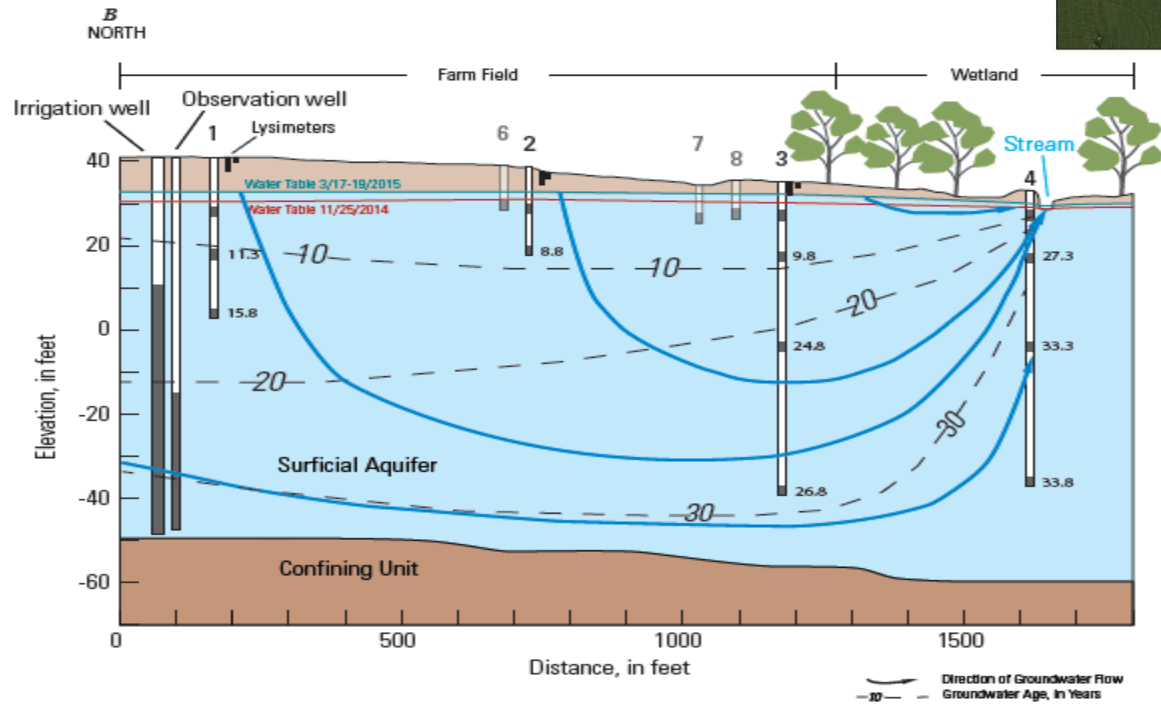


# Bucks Branch Study Site

**Bucks Branch Dry-Land Flowpath**



**Bucks Branch Irrigated Flowpath**

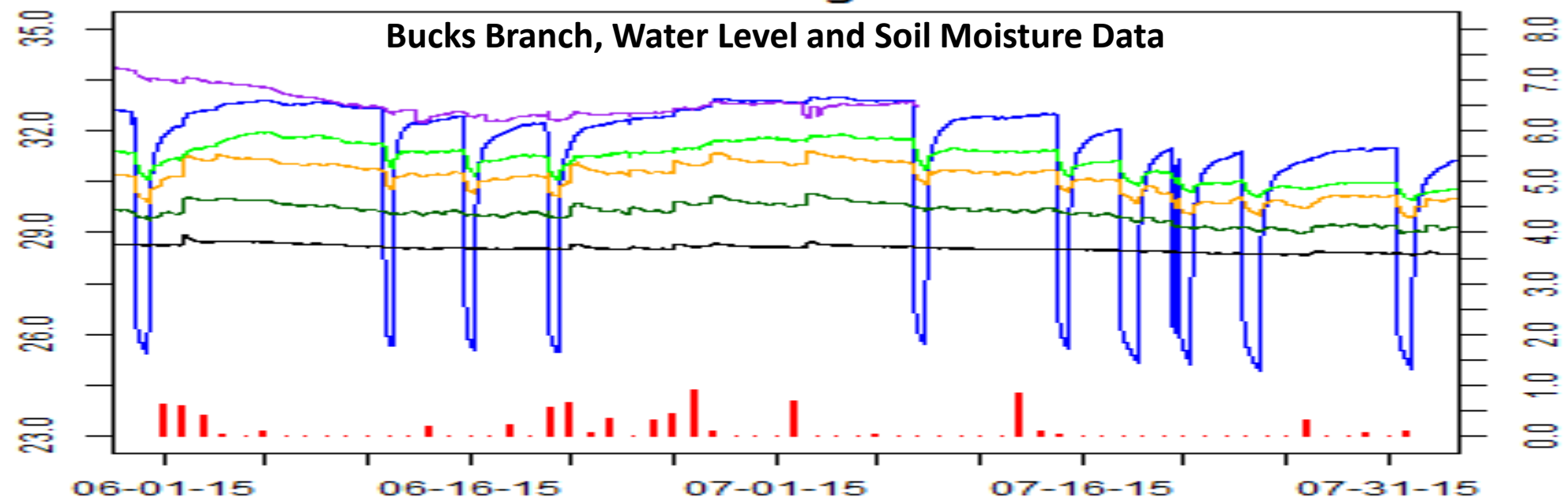


- Surficial aquifer 80-90 ft thick
- Groundwater discharges through the stream bed, with some shallow flow to wetlands; over **90%** of streamflow is from groundwater
- Groundwater age exceeds 30 years along the deepest longest
- Predominant soils: Ingleside (IeA) and Rosedale (RoA) loamy sands; well drained

2015-06-01 Through 2015-08-01

### Bucks Branch, Water Level and Soil Moisture Data

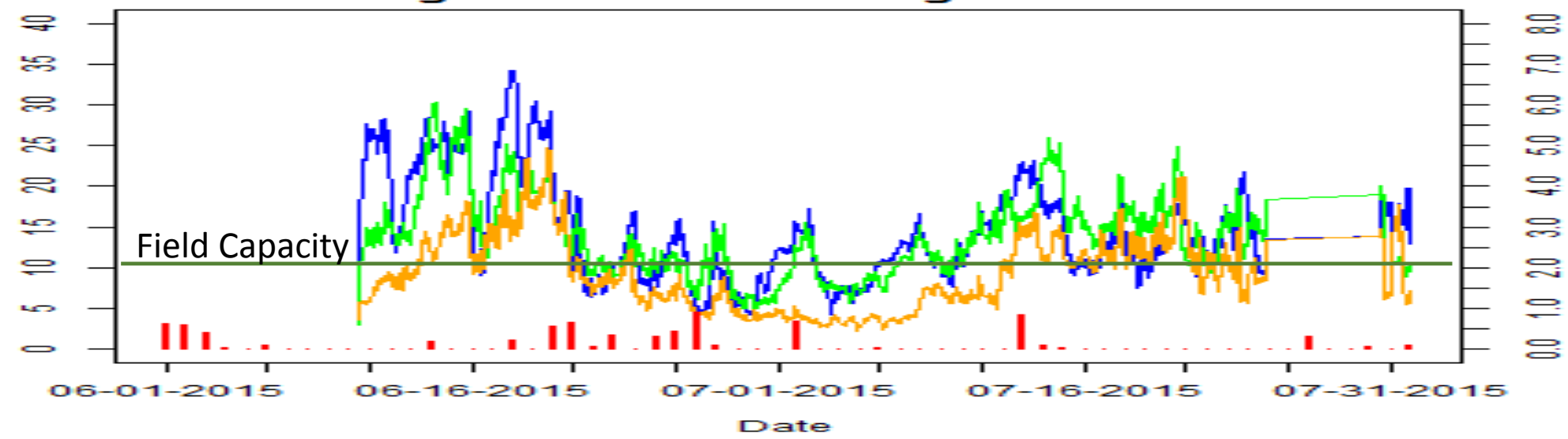
Water Level Elevation, FT, NAVD88



- IRW-1M
- IRW-2S
- IRW-3S
- IRW-4S
- DRW-2S
- Bucks Gage
- Rain DEOS Bridgville

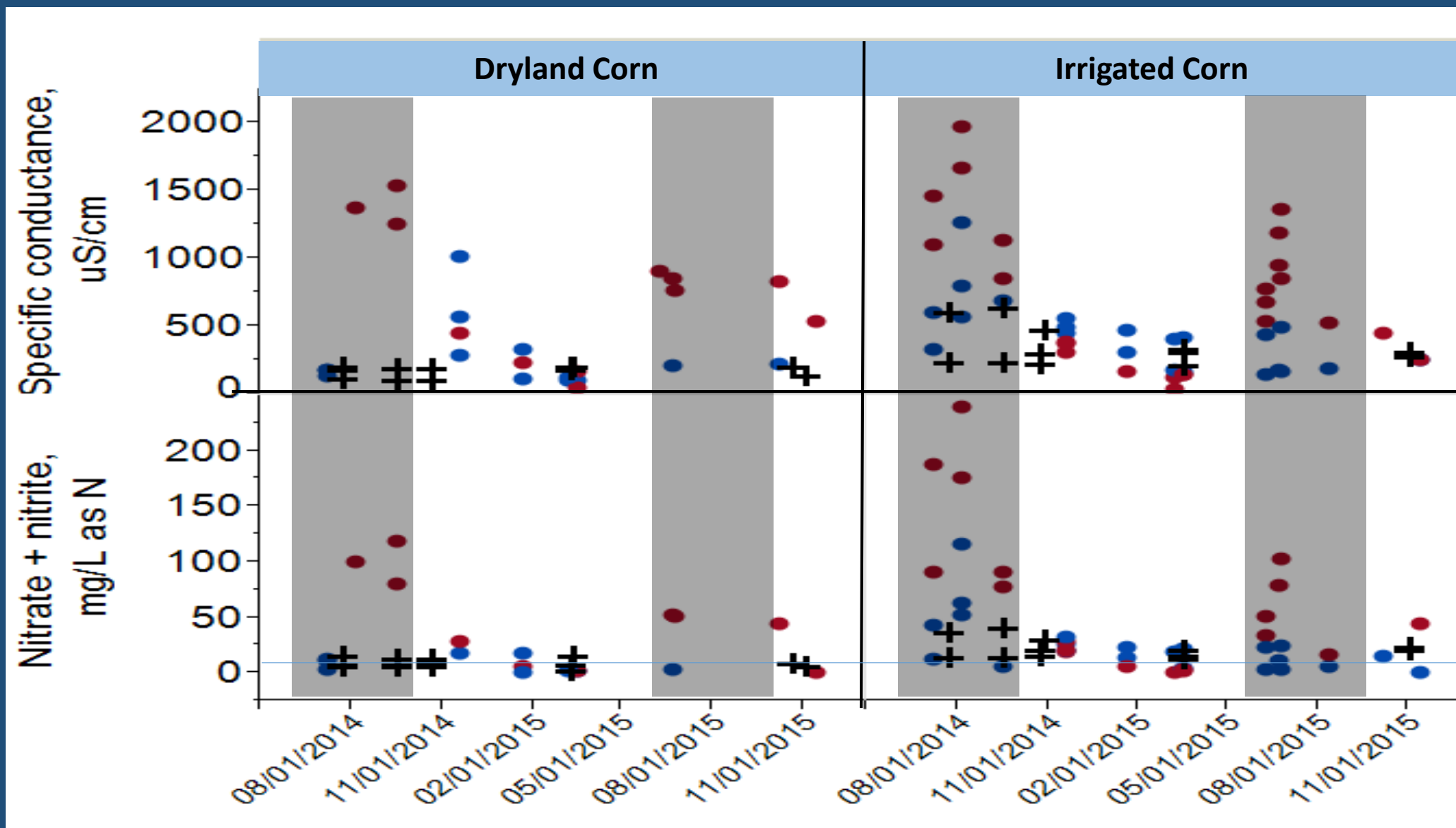
irravg1 2015-06-01 through 2015-08-01

Soil Moisture Content



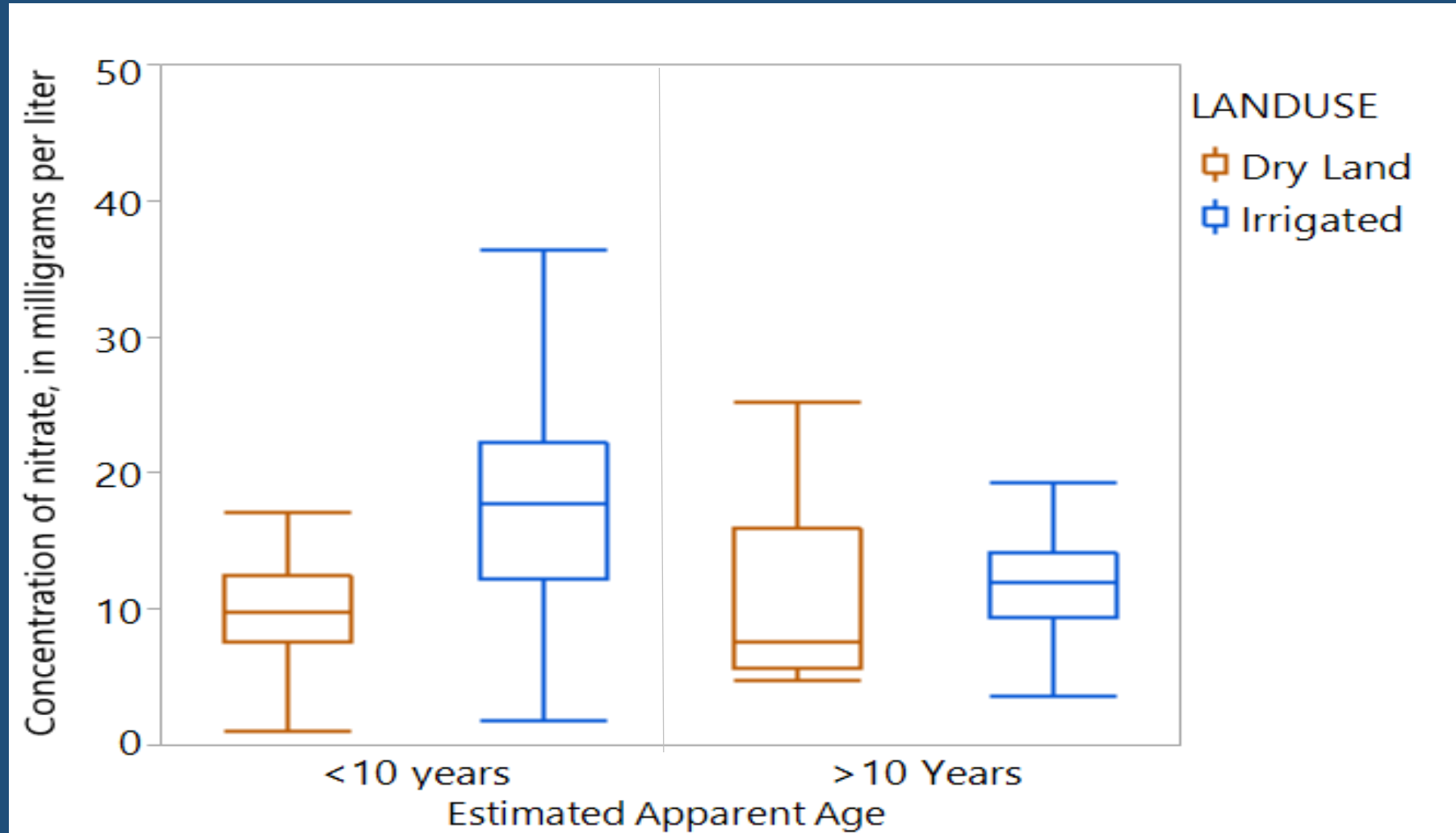
- Six Inches Below Surface
- Twelve Inches Below Surface
- Eighteen Inches Below Surface
- Rain DEOS Bridgville

# Bucks Branch, Lysimeter and Shallow Groundwater Data



(Lysimeters: dots, red = 1 ft, blue = 3 ft; Shallow well samples: +)

# Bucks Branch, Nitrate Concentrations Relative to Apparent Age of Groundwater





# Conclusions

- Leaching of nitrate beyond zone of plant uptake occurs during growing season
  - Nitrate concentrations in soil water are higher than during other times of the year
  - Higher nitrate concentrations in leachate with irrigation because of greater amount available from recent nitrogen application and greater soil saturation
- *Question is: What is the significance of the increased amount of nitrate leached through the soil zone during the growing season to the total nitrate load to groundwater?*

# In Progress

- **Modeling of leaching load during growing season at Bucks Branch and Andover Branch**
  - Unsaturated zone transport (VFM)
    - Preliminary results from Bucks Branch: VFM predicts an unsaturated zone velocity of 3 m/yr beneath the irrigated field, and 2 m/yr beneath the dryland field (based on 2014 and 2015 sampling)
  - Threshold for groundwater recharge (ERM)
  - Soil-water balance (SWB)
- **Bucks Branch/Andover Branch combined journal article on unsaturated zone transport of nitrate to groundwater (draft by Dec 2017)**

This information is preliminary or provisional and is subject to revision. It is being provided to meet the need for timely best science. The information has not received final approval by the U.S. Geological Survey (USGS) and is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.