

# Effects of surface runoff of landfills containing coal ash on water chemistry in adjacent surface water in Perry County, Alabama

Jeff Cole\* and E. G. Dobbins, Ph.D.

Dept. of Biological and Environmental Science, Samford University, Birmingham, AL 35229-2234.

## Introduction

- Coal ash is a form of coal combustion residue that is one of the byproducts of coal-powered power plants (Ruhl et al, 2012).
- In 2008 the coal ash dike at TVA Kingston Fossil Plant's solid waste containment area ruptured and released 2.3 million m<sup>3</sup> of coal ash into the Emory River (H. Rep., 2009)
- Perry County LLC landfill became the recipient of this coal ash.
- Coal ash disposal areas have been found to contain high concentrations of heavy metals such as Ca, As, Tl, Mg, Sr, Li, B, V, Cr, Se, Mo, F, Cl, Br, SO<sub>4</sub><sup>2-</sup> (Ruhl et al, 2012).
- Conductivity measurements of water is a helpful way of determining the presence of ionic contaminant concentrations such as the contaminants associated with coal ash discharge (Down & Lehr, 2005).
- EPA guidelines consider streams with conductivity of 150-500 uS to be suitable for fish and macroinvertebrates.
- Rain water drains from the landfill into an unregulated drainage ditch that joins Chilatchee Creek.
- We expected the surface water from the landfill to 1) significantly change water quality parameters such as pH, Cond, Total dissolved solids (TDS) and 2) to contain large amounts of indicators of coal ash such as arsenic, boron, chromium, and sulfide.

## Methods

- All samples were collected weekly between June and July 2013 within 150m east, 500m west, and 350m downstream of Perry LLC landfill discharge (Fig.1).
- Water sample tests were taken at 9 different locations: at the discharge, 10m downstream of it, 14m and 150m east of the discharge, 4.7m west of the discharge, at Mr. Gipson's ditch, 500m downstream of Mr. Gipson's ditch where it meets Chilatchee Creek, 9m downstream of Chilatchee, and two controls were taken at the Co Rd. 1 entrance of the landfill and at a stream 150m east of the entrance.
- pH readings were measured at each site using a Extech that was calibrated to 7.00. Specific conductivity and Total Dissolved Solids (TDS) was measured using a Extech and HACH HQ14d conductivity meter calibrated at 84uS, 1413uS, and 12,880uS.
- Water samples were collected from each site and tested using a HACH DR/890 Colorimeter for Boron, Chromium, Sulfide. Arsenic concentrations were tested using a HACH Arsenic Low Range Test Kit.
- One way ANOVA tests were used as well as Tukey HSD to determine significant difference between mean water quality parameters.



Figure 1: Site Map of Perry County LLC (Google Earth). Gate and Control sites acted as our controls. Mr. Gipson's ditch is 425m west from Gate. Red arrow indicates landfill discharge site.

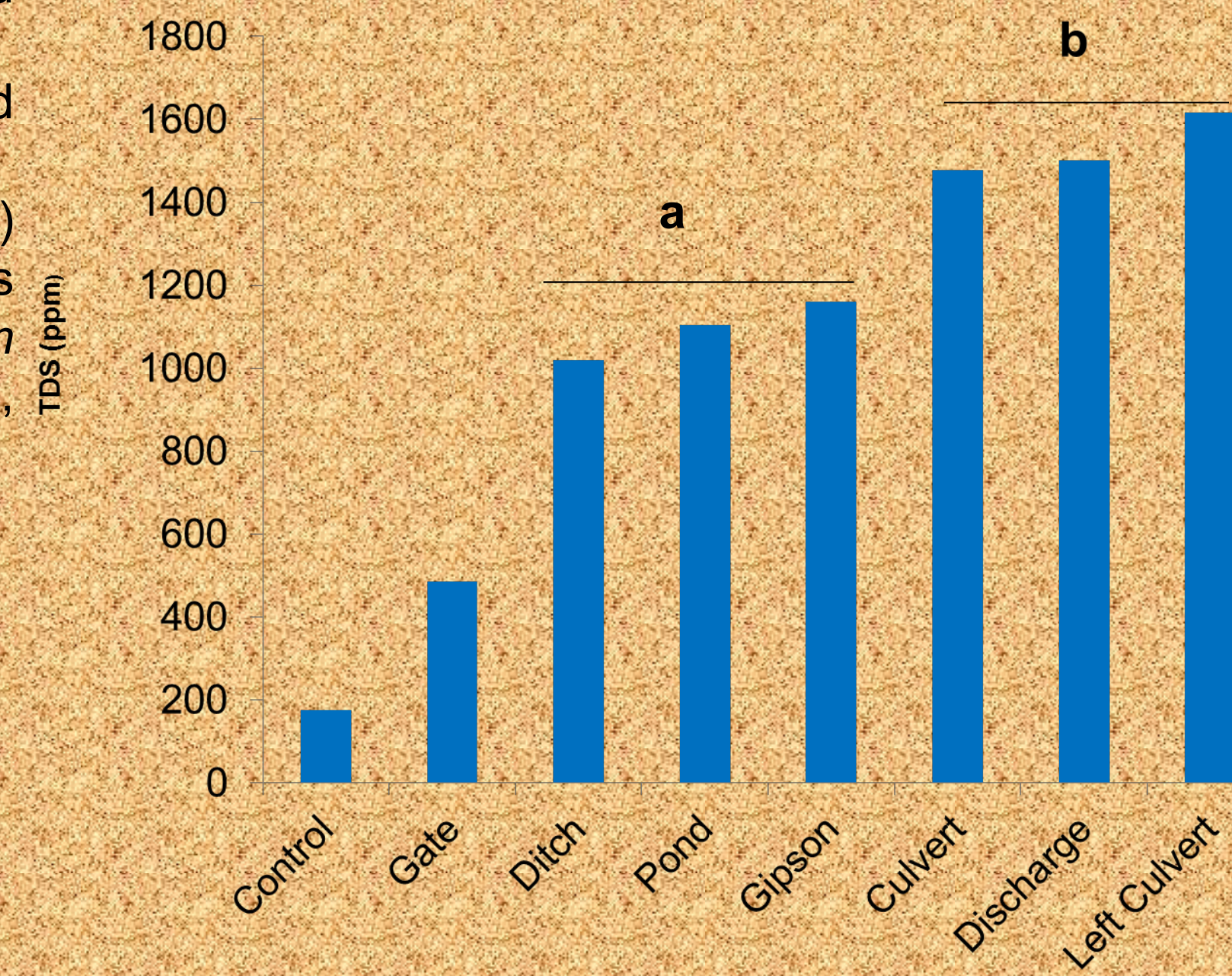


Figure 2: Mean TDS of each sites were significantly different (p<0.01) except where indicated(a,b)

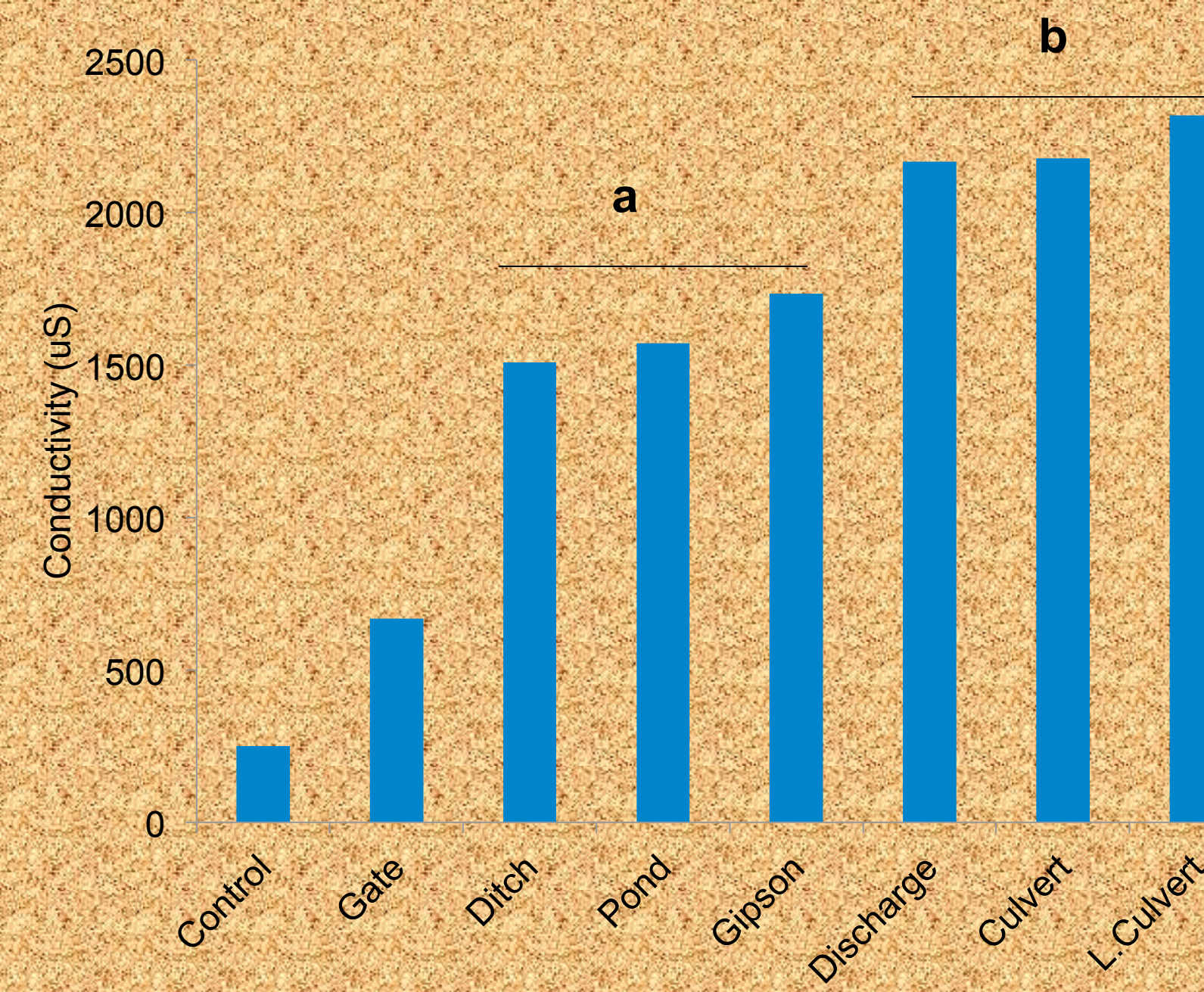


Figure 3: Mean Conductivity were significantly different (p<0.01) except where indicated(a,b)

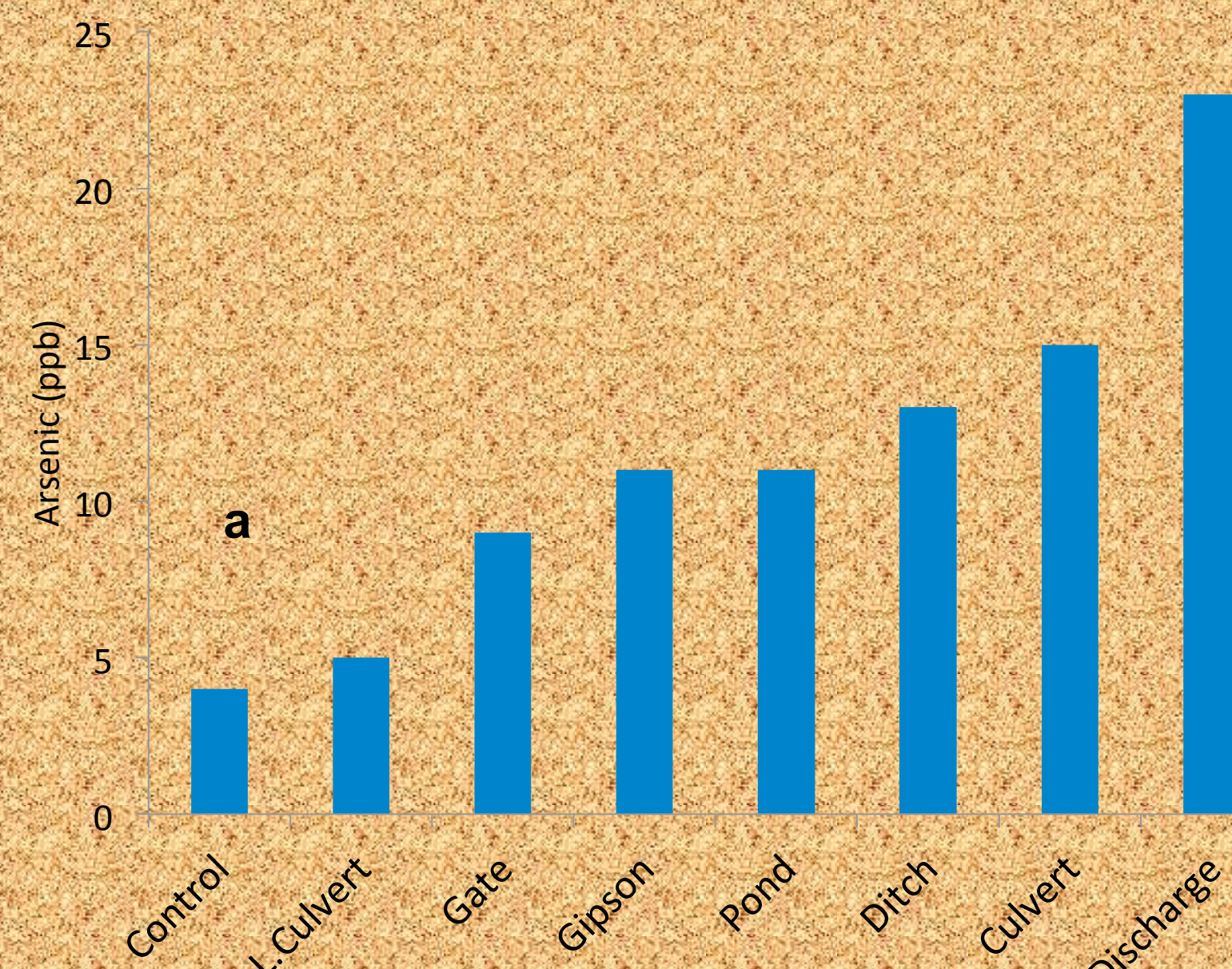


Figure 4: Mean Arsenic of each site were significantly different (p<0.01) except where indicated

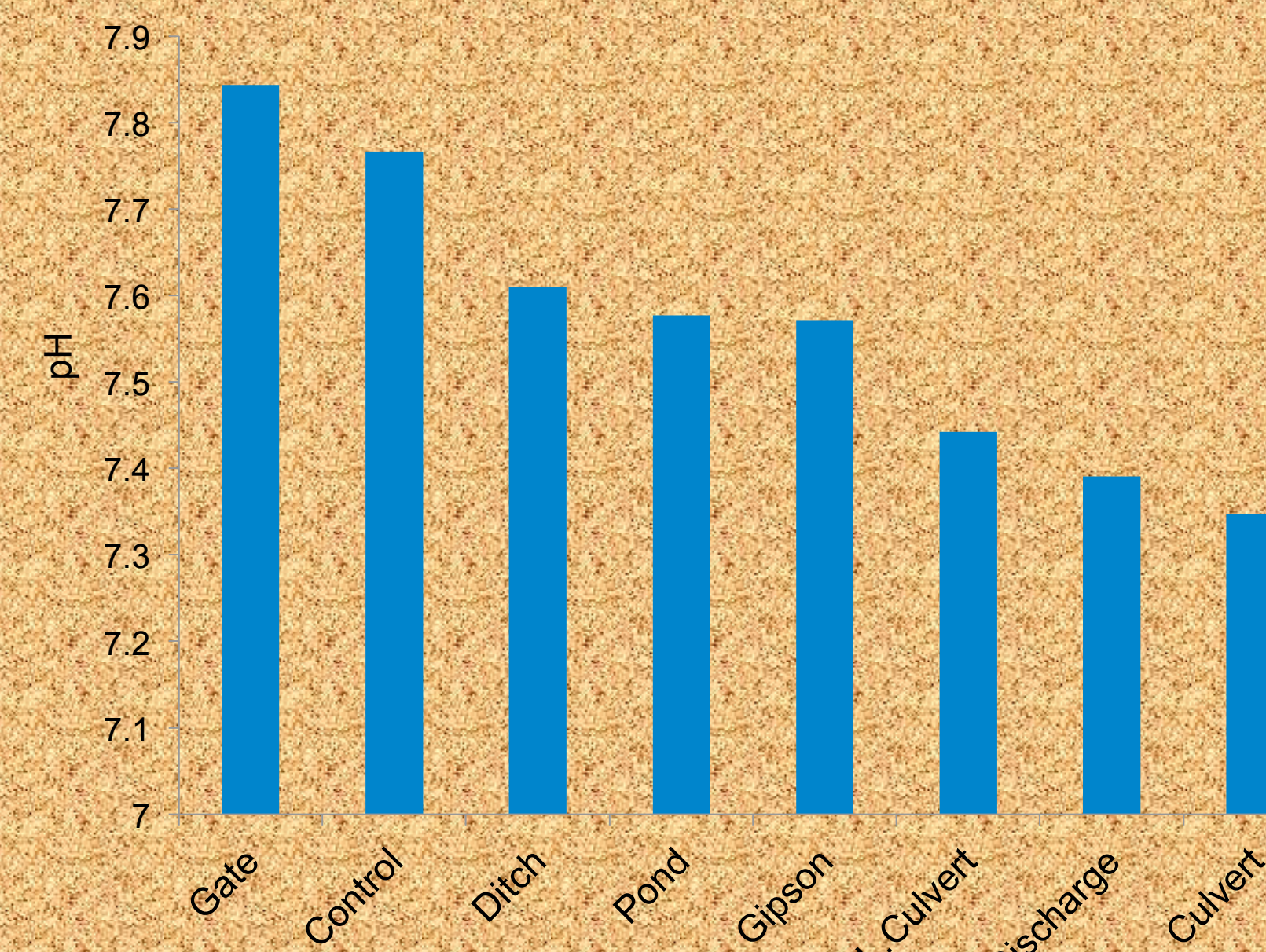


Figure 5: Mean pH of each site were significantly different (p<0.01) except where indicated

## Results

- There were consistent changes in water quality parameters associated with the landfill discharge.
- TDS was significantly elevated near the landfill discharge compared to control. Sites within 10m of the discharge had TDS levels eight times higher than the control (Figure 2).
- Conductivity levels of the sites within 10m of the discharge were nine times higher than the control stream (Figure 3).
- The pH levels of the discharge were significantly lower than the control.
- Arsenic concentrations were four times higher than the control (Figure 4).
- There were no difference in mean levels of boron, chromium, and sulfide between the control and discharge sites.
- 500m downstream of Mr. Gipson's ditch the water's conductivity had reduced by 60%, but contributed to a 40% increase of the Chilatchee Creek as it entered it.

## Discussion

- The discharge coming off of Perry LLC landfill has contributed to significant changes in water quality of adjacent surface waters.
- These high levels of conductivity and TDS creates osmotic pressures for the organisms in the aquatic organisms in that area.
- Impacts
- Despite differences between discharge and control, the pH in the creek fell within the guidelines for a Fish and Wildlife classified stream 6.5 ≤ pH ≤ 8.5 (ADEM, 2012).
- Arsenic levels were higher around the discharge but they were not as high as we had anticipated.
- Arsenic low – bioaccumulates and biomagnifies.

## Acknowledgements

I would like to thank Dr. Dobbins and Samford's Propst Summer Scholar Program for giving me the opportunity to work on this project.

## Literature Cited

- House of Representatives (H. Rep) (2009). *The one year anniversary on the Tennessee Valley Authority's Kingston ash slide: evaluating current cleanup progress and assessing future environmental goal* (111-81). Washington D.C: Government Printing Authority.
- Gray, J. R. (2005). Conductivity Analyzers and Their Application. In D. R. Down & J. H. Lehr (Eds.), *Environmental Instrumentation and Analysis* (pp. 491-510). Hoboken, NJ: Wiley & Sons.
- Ruhl, L., Vengosh, A., Dwyer, G. S., Hsu-Kim, H., Schwartz, G., Romanski, A., & Smith, S. (2012). The Impact of Coal Combustion Residue Effluent on Water Resources: A North Carolina Example. *Environmental Science & Technology*, 46(21).