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L. Murdoch

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Evaluation of the Hydrology of the Hunnicutt Creek Wetland

Brian Bastian, Emily Thompson, Thomas Vaughn, Dr. Larry Murdoch

Clemson Hydrogeology

Abstract:

The storage capacity of the wetlands is comprised of groundwater flux measurements of both in and out of the wetland estimated by computer system Groundwater modeling Software. The inflow average for February was using the float method was $7.08*10^{-3}$ m^3/s. The surface water levels have fluctuated over time of months. The average outflows were 0.026 m^3/s in November, 0.039 m^3/s in January, and in February $0.034 m^3/s$. Reference evapotranspiration (ETo) was calculated using the Penman-Monteith equation. These values were correlated to surface water fluctuation. In the fall ETo values were approximately 1.4 mm/day and in the winter they were 1.1 mm/day. The actual surface water fluctuation was 4.5 mm/day in the fall and 1 mm/day in the winter.

Introduction:

Hunnicutt Creek is located off Perimeter Road, behind Clemson Bottoms, and East of Walker Golf Course. The Hunnicutt Creek restoration is part of a mitigation process for the commercial development of lands which impacted a stream system in the Clemson area. This water saturated land mass is a hydrological maze and one that if answered can be essential to understanding and quantifying wetland functions and processes. A functional classification of wetlands requires knowledge of water budget, hydrodynamics and the relationship with the surrounding landscape of the wetlands. The water budget components comprise of the inflow of water entering the wetland through noticeable seeps along the dike and groundwater movement. Outflow components consist of groundwater movement, streams and seeps that flow from the wetland and drain out to Hunnicutt Creek, and evapotranspiration.

Material and Methods:

Water enters the wetland through 13 visible seeps at the base of the dike. To determine the flow rate the collection pan method was used. A plastic container was made into a collection pan and inserted into the seep. A 192 fl. Oz. or 32 fl. Oz. container was used to gather water and a stopwatch was used to determine how fast water filled the container. This flow rate is determined using the equation in **Figure 1**. Seeps at surface water level were measured using the float method. A channel was dug to regulate flow, and then a distance is measured, usually two or three feet, depending on the speed of the flow. This flow rate is determined using the equation below in **Figure 2.**

The surface water of the wetland is measured bi-weekly at 8 different areas strategically placed at points within the wetlands. To measure the surface water within the wetlands meter sticks cut in half were hammered into the subsurface of the water channels. At 3 of the surface level meter sticks, are drainage seeps where the flow rate is measured as well. The flow rate is determined by using the equation in **Figure 2.**

There are a total of five monitoring wells. The first set of 3 wells have transducers in them at all times, collecting pressure data, that are hooked up to a MoteStack that is monitored by the Clemson Intelligent River research. This collects real time data from these wells all the time. The other 2 wells will have transducers placed in them as well that also measured pressure in the wells.

Pressure was converted into water level and daily water table fluctuations were compared to daily Reference evapotranspiration (ETo) calculations. ETo is the rate at which readily available soil is vaporized from vegetated surfaces. Temperature, radiation, wind speed, and humidity data was collected at a nearby weather station. This information was used in the Penman-Monteith (FAO-56 Method) equation to estimate ETo.

Figure 1:

$$Flow\ rate\left(\frac{ft^3}{s}\right)=\left(\frac{1.04*10^{-3}ft^3}{Fl.Oz}\right)*\frac{1}{Time\ (s)}$$

Figure 2:

$$Flow\ rate\left(\frac{ft^3}{s}\right)=\frac{Length\ (ft)}{Time\ (s)}*Width_{Avg}\ (ft)*Depth_{Avg}\ (ft$$

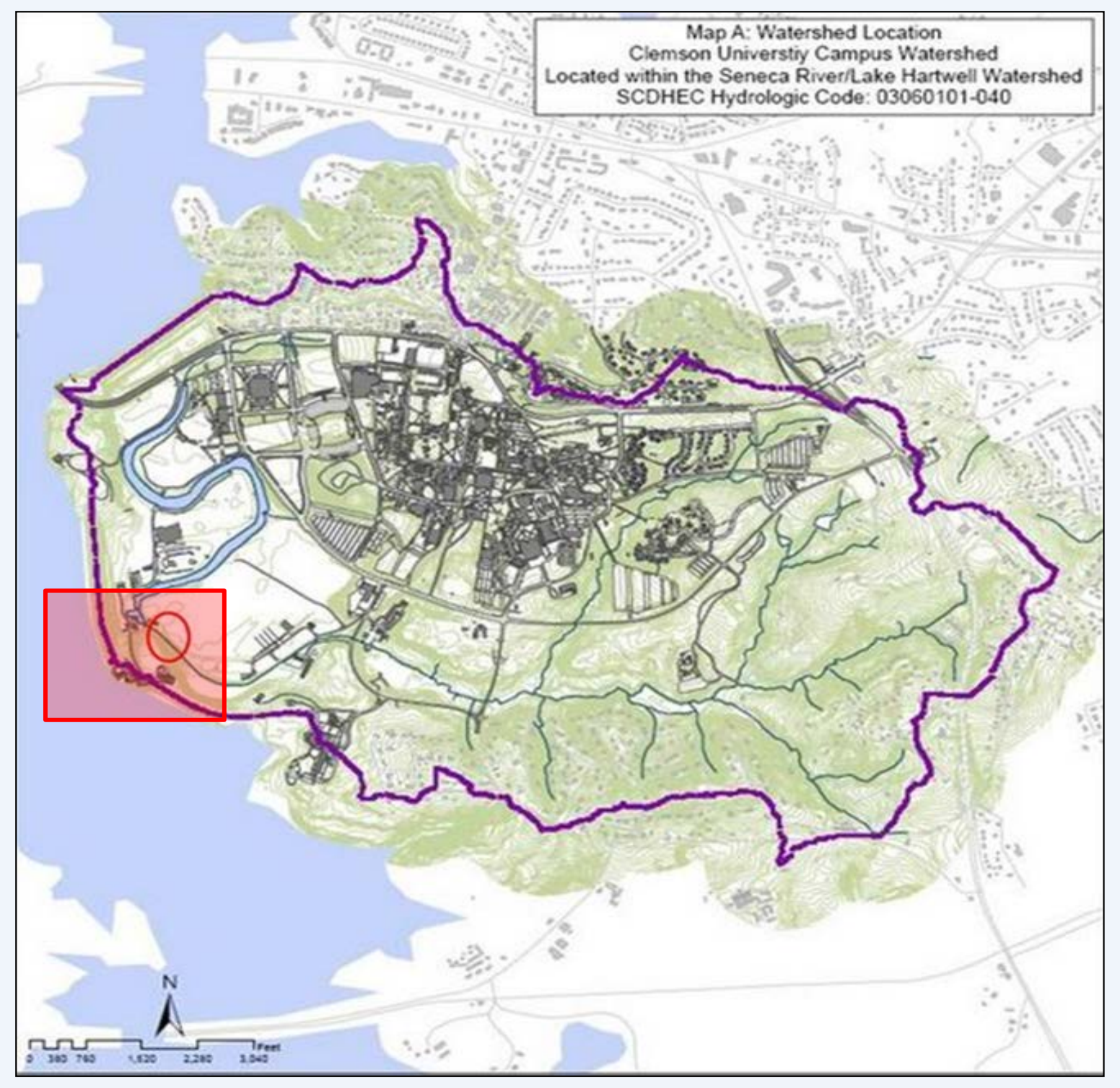

Figure 3. Clemson Watershed

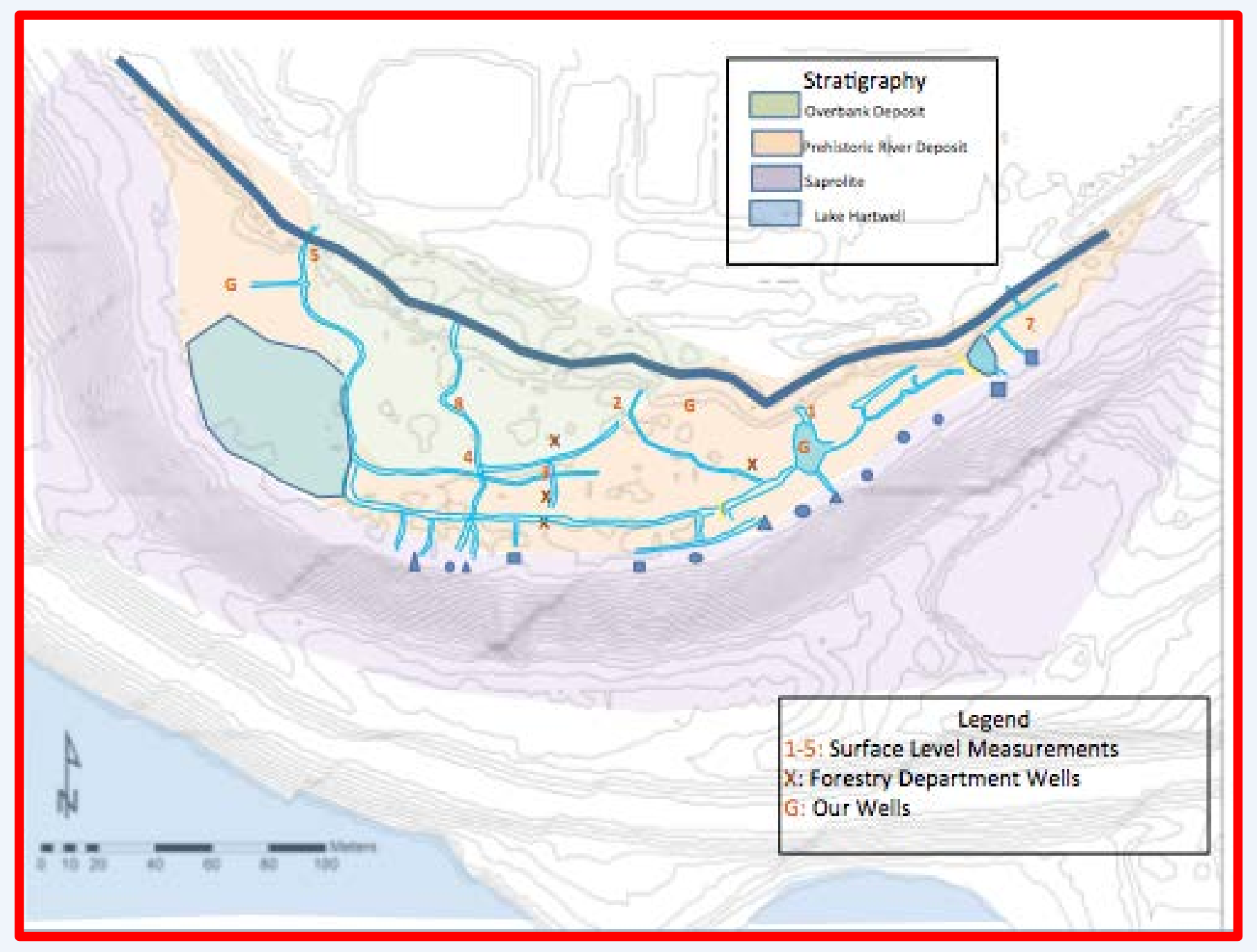

Figure 4. Field Map

Figure 5. Aerial Photograph of Wetland

Results:

On November 10, 2013 the total effluent surface flow from all three locations was $1.90*10^{-2}$ m^3/s, and the observed surface level fluctuation was $1.76*10^{-3}$ m^3/s. On this same day, the inflow calculated from seeps was $7.06*10^{-3}$ m^3/s. On this date the rate outflow+observed water level fluctuation is about 2.9x inflow rate.

One thing we observed while collecting data were hot spots of algae growing within the surface water streams. After analyzing infrared images we located where water was seeping in. Within these same areas algae was growing resulting in algae being a good indicator for locating these groundwater seeps into the surface water streams.

The ETo was in August was 1.2 mm/day while the observed water level change was 4.5 mm/day. In September a value of 1.43 mm/day was calculated for the ETo, and the observed water level fluctuation was 4.5 mm/day. October's ETo was 1.3 mm/day, and the observed change in water level 3.3 mm/day. The ETo in November was 1.4mm/day while is actual water level change was 1 mm/day. In December the calculated ETo was 1.2 mm/day, and the observed fluctuation was 1mm/day.

Measurements for four above ground seeps began in November; seep 1 is $5.95*10^{-4}$ m^3, seep 2 is $1.73*10^{-4} m^3$, seep 3 is $3.96*10^{-5}$ m^3, and seep 4 is $1.56*10^{-4}$ m^3. In February Measurements concluded with seep 1 being $6.23 *10^{-4}$ m^3, seep 2 is $2.18*10^{-4}$ m^3, seep 3 little to no flow, seep 4 $1.25*10^{-4}$ m^3. Nine surface level seeps were measured beginning in February with a combined total flow of $6.22*10^{-3}$ m^3. The total flow of all the seeps is $7.08*10^{-3}$ m^3.

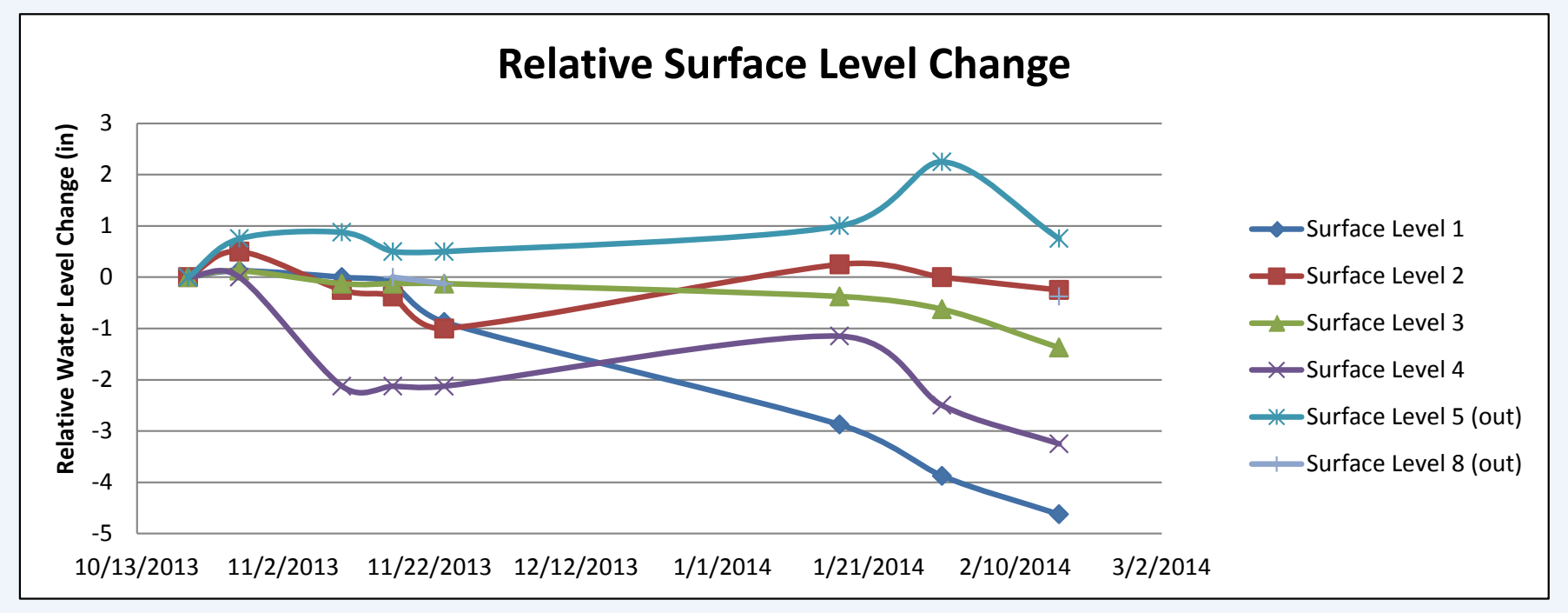

Figure 6. Surface Water Fluctuation

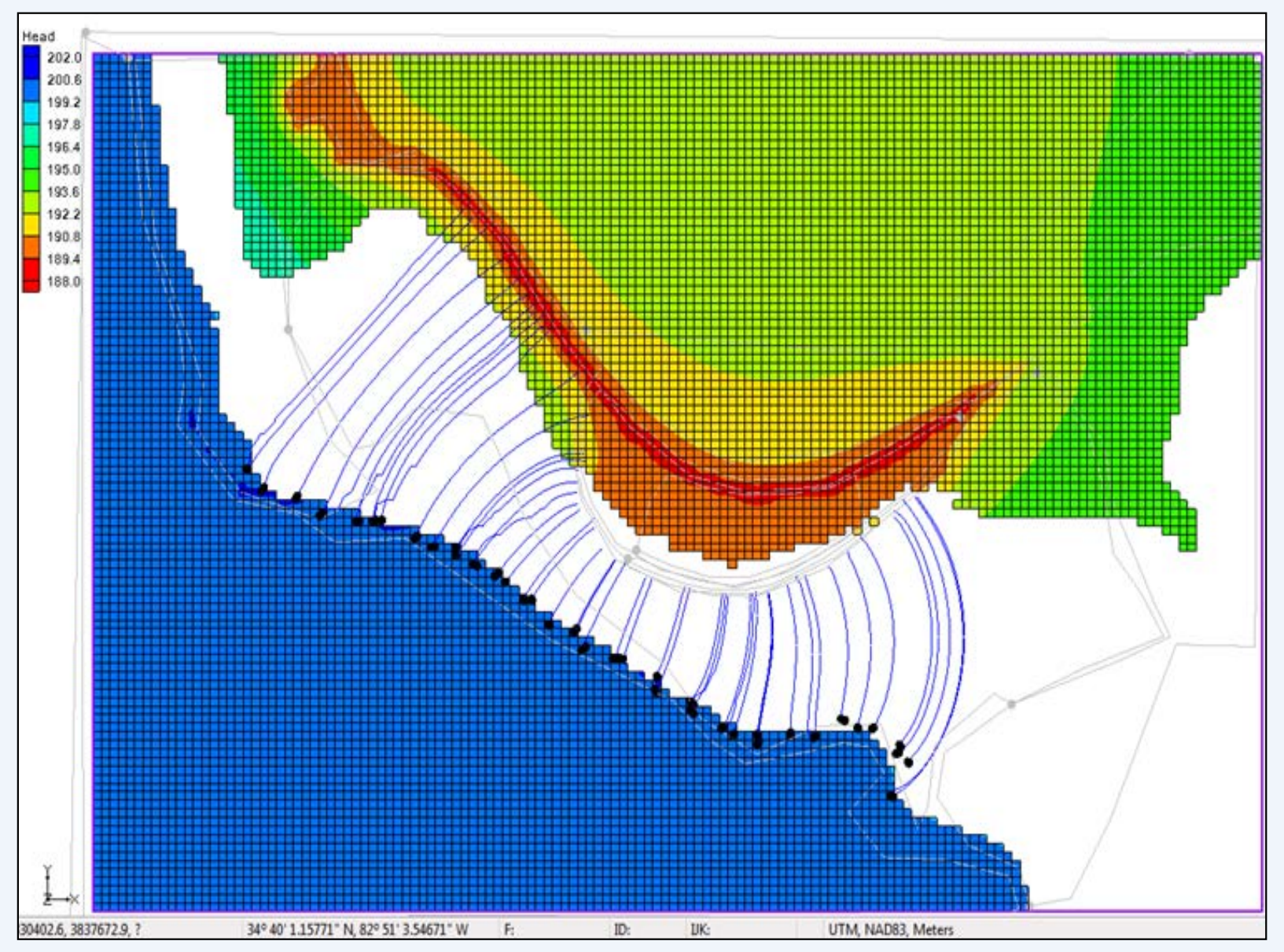

Figure 7: Potential water particle flow paths

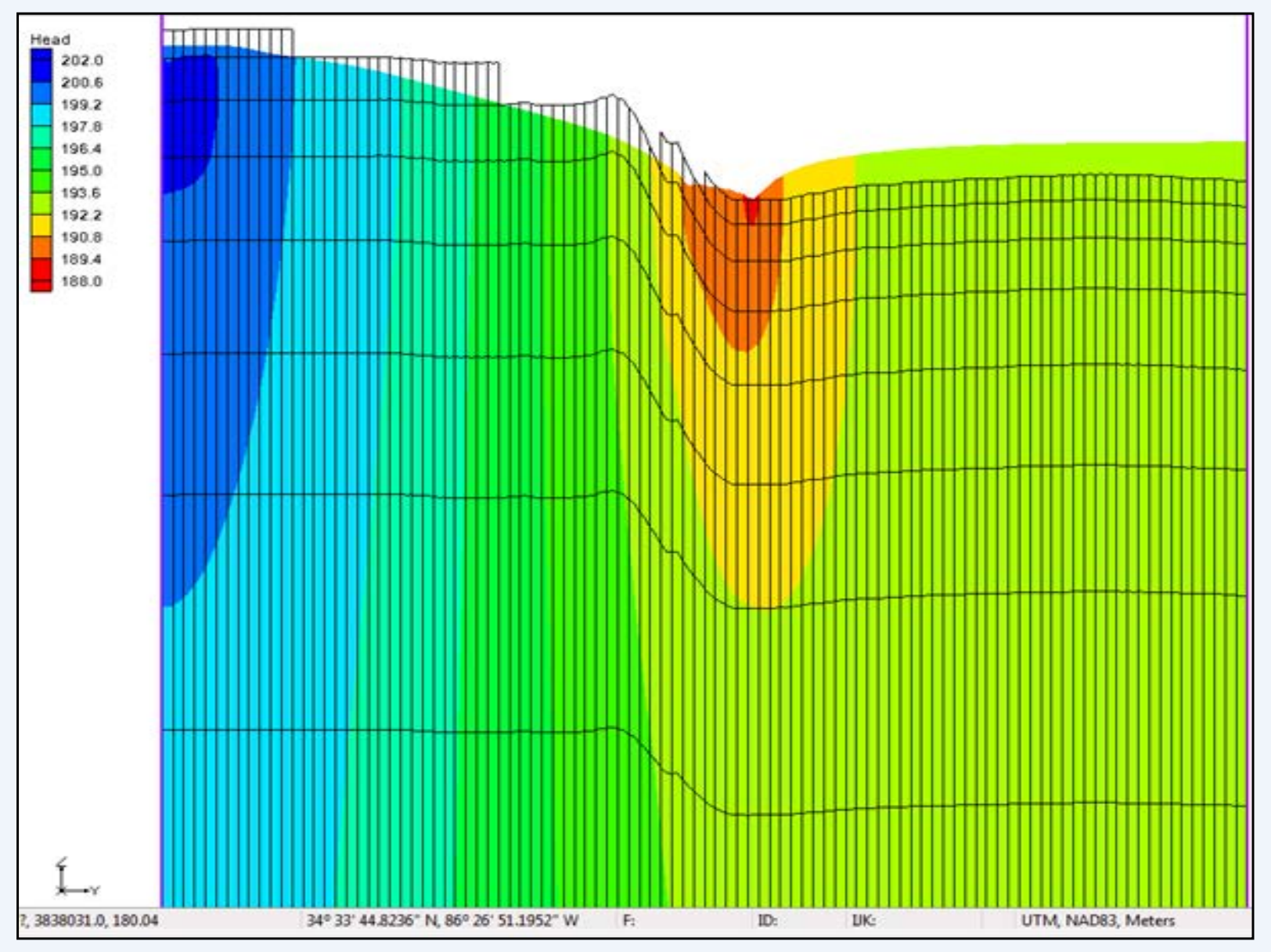

Figure 8: Cross-section of hydraulic heads

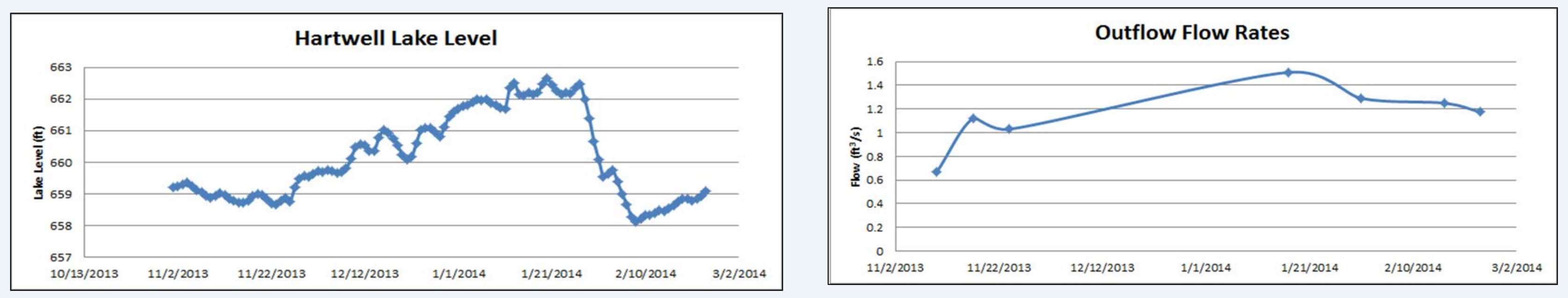

Figure 9 & 10: Correlation of lake level to outflow rates

Conclusion:

The primary source of water in the wetland is groundwater through small crevices in the clay layer instead of seeps in the side of the dike. Based on the GMS model, water that enters the sub-surface through the dike enters the wetland through seeps on the other side of the dike. The flow entering the wetland through groundwater is about three times that of the seeps. The lake level is correlated to the volume of water in the wetland at all times. Seeps 3 and 4 flow have decreased from November to February while seeps 1 and 2 have slightly increased in the same amount of time. This can be due to a fracture in the dike that is near part of these seeps which can explain the different changes in flow.

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