Title: Enhancement Wetlands Hydraulic Assessment Using Ammonia, Nitrate, and Dissolved Oxygen as Indicators

Author: Teresa Garrison

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Field and lab work: Teresa Garrison, Mary Burke, and Andy Lee

Data analysis: Teresa Garrison, Mary Burke

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Objective: Determine the current conditions of the enhancement wetlands and identify areas within the wetlands that are not functioning efficiently
Objective

The purpose of the study was to assess the current conditions of the enhancement wetlands and identify areas within the wetlands that were not functioning efficiently using water quality parameters including dissolved oxygen (DO), temperature, pH, ammonia, and nitrate.

Introduction and Background

Beginning in June of 2009, measurements and samples were taken once a week by canoe at various locations within the wetlands. Figure 1 shows the sample sites in the wetlands, the green areas indicate vegetated islands and the green lines indicate vegetated areas along the banks. The measurements and samples were taken in the morning between the hours of 8am and 12pm. On August 18th, a morning and an evening run were conducted to determine the effects solar gain has on water quality parameters. DO, pH, and temperature measurements were taken in the field and 300 mL water samples were collected to be analyzed in the lab for ammonia and nitrate. DO measurements were taken at three vertical locations: approximately 10 cm below the surface, mid-depth, and approximately 10 cm from the bottom. A depth gage was used to determine the depth at each location so that DO could be measured at the described locations. The remaining water quality parameters and the samples were taken approximately 20 cm below the surface.

Data were evaluated to determine areas within the wetlands that significantly vary from the normal trends. Values were identified that were comparatively higher or lower than average concentrations and standard deviations. Box plots for the parameters are shown in Appendix A. Sites that were identified as significant are defined as an area of interest due to potential hydraulic inefficiency. These areas are where water is stagnant and are functionally removed from the treatment volume. Figures 2, 3, and 4 show areas of interest related to average values for ammonia, nitrate, and DO. The areas shaded in red indicate above average levels, the darkest areas having the highest values. The blue shades indicate lows with the darkest color have the lowest values.

Combining the information provided by Figures 2, 3, and 4, areas that have certain combinations of high and low characteristics can be identified as hydraulically inefficient zones (Figure 5). Site 1 (west corner of Allen) is identified as a hydraulically inefficient due to low levels of ammonia, high levels of nitrate, and high DO. This combination shows there is sufficient oxygen to convert from ammonia to nitrate, but then the high nitrate levels remaining indicate the water in and around that area is stagnant. Sites 5 and 6 (east corner of Allen), 12 (south corner of Gearheart), and 20 (east corner of Hauser) can be identified as hydraulically inefficient with high levels of ammonia and low levels of DO. This combination indicates there is insufficient oxygen moving into the system for the conversion of all the ammonia. Site 15 (northwest corner of Gearheart) has the same characteristics as Site 1 and can thus be classified as hydraulically inefficient.
Figure 1: Site locations within the enhancement wetlands.
Figure 2: Ammonia area of interest where the site concentrations are higher or lower than the average concentration for that wetland (red shade - higher than average: blue shade – lower than averages).
Figure 3: Nitrate areas of interest where the site concentrations are higher or lower than the average concentration for that wetland (red shade – higher than average; blue shade – lower than averages).
Figure 4: Middle DO areas of interest where the site concentrations are higher or lower than the average concentration for that wetland (red shade - higher than average: blue shade – lower than averages).
Conclusions and Recommendations

The hydraulically inefficient zones are located in the corners of the wetlands. Increasing flow to these areas may allow for better treatment. Allen Wetland has old weirs along the east bank, if the weirs are not rust damaged it would be beneficial to partially open one at the southeast corner. A weir box exists at the west corner of Allen Wetland that if opened would increase the flow through the area. Other adjustments would be to readjust inlet and outlet locations and manage vegetation for hydraulic efficiency. Before such adjustments are made it is recommended that a tracer study is conducted on the enhancement wetlands to identify the flow pattern as well as the hydraulic detention time.
Appendix A

Box plots of the parameters sampled are shown below. For each value the box contains 50% of all the values, the lines indicate the minimum and maximum values except when there is an outlier which is indicated with an open dot.

Figure 6: Ammonia levels throughout the enhancement wetlands

Figure 7: Nitrate levels throughout the enhancement wetlands.

Figure 8: pH levels throughout the enhancement wetlands.
Figure 9: Dissolved Oxygen levels vertically stratified in the enhancement wetlands.