2011 Annual Wetland Monitoring Report

for the

Platte West Water Production Facilities Project

Project No. 60787

January 2012
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0</strong> INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td><strong>2.0</strong> SAMPLING METHODOLOGY</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1 Wetland Monitoring in the Well Fields</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1.1 Vegetation Sampling</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 Wetland Monitoring in the Cones of Depression</td>
<td>2-6</td>
</tr>
<tr>
<td>2.3 Hydrological Monitoring</td>
<td>2-6</td>
</tr>
<tr>
<td>2.3.1 Groundwater Monitoring Wells</td>
<td>2-9</td>
</tr>
<tr>
<td>2.3.2 Production Wells</td>
<td>2-9</td>
</tr>
<tr>
<td>2.3.3 Piezometers</td>
<td>2-9</td>
</tr>
<tr>
<td>2.3.4 Bathymetric Monitoring of Ponds</td>
<td>2-10</td>
</tr>
<tr>
<td>2.3.5 Other Hydrological Data</td>
<td>2-11</td>
</tr>
<tr>
<td><strong>3.0</strong> DATA ANALYSIS</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1 Wetland Monitoring in the Well Fields</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1.1 Vegetation Data</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1.2 False-color Infrared (CIR) Aerial Photography</td>
<td>3-5</td>
</tr>
<tr>
<td>3.2 Wetland Monitoring in the Cones of Depression</td>
<td>3-5</td>
</tr>
<tr>
<td>3.3 Hydrological Monitoring</td>
<td>3-5</td>
</tr>
<tr>
<td>3.3.1 Groundwater Monitoring Wells</td>
<td>3-6</td>
</tr>
<tr>
<td>3.3.2 Production Wells</td>
<td>3-6</td>
</tr>
<tr>
<td>3.3.3 Piezometers</td>
<td>3-6</td>
</tr>
<tr>
<td>3.3.4 Bathymetric Monitoring of Ponds</td>
<td>3-6</td>
</tr>
<tr>
<td>3.3.5 Other Hydrological Data</td>
<td>3-7</td>
</tr>
<tr>
<td><strong>4.0</strong> THRESHOLDS</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1 Levels of Wetland Monitoring Intensity</td>
<td>4-1</td>
</tr>
<tr>
<td>4.2 Method For Determining Wetland Impacts</td>
<td>4-1</td>
</tr>
<tr>
<td><strong>5.0</strong> RESULTS</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1 Wetland Monitoring in the Well Fields</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1.1 Vegetation Sampling</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1.2 False-color Infrared (CIR) Aerial Photography</td>
<td>5-6</td>
</tr>
<tr>
<td>5.2 Wetland Monitoring in the Cones of Depression</td>
<td>5-6</td>
</tr>
<tr>
<td>5.3 Hydrological Monitoring</td>
<td>5-6</td>
</tr>
<tr>
<td>5.3.1 Groundwater Monitoring Wells</td>
<td>5-7</td>
</tr>
<tr>
<td>5.3.2 Production Wells</td>
<td>5-7</td>
</tr>
<tr>
<td>5.3.3 Piezometers</td>
<td>5-7</td>
</tr>
<tr>
<td>5.3.4 Bathymetric Monitoring of Ponds</td>
<td>5-7</td>
</tr>
</tbody>
</table>
5.3.5 Other Hydrological Data ................................................................. 5-8

6.0 DISCUSSION AND RECOMMENDATIONS ....................................... 6-1
6.1 Discussion .......................................................................................... 6-1
  6.1.1 Wetland Monitoring in the Well Fields ......................................... 6-1
  6.1.2 Wetland Monitoring in the Cones of Depression ......................... 6-2
  6.1.3 Hydrological Monitoring ............................................................... 6-2
6.2 Recommendations .............................................................................. 6-2

7.0 REFERENCES ..................................................................................... 7-1

APPENDIX I - WETLAND MONITORING DATA FOR THE DOUGLAS COUNTY
AND SAUNDERS COUNTY WELL FIELDS (FIGURES, TABLES,
PHOTOGRAPHS, DATA SHEETS)

APPENDIX II - WETLAND MONITORING DATA FOR THE DOUGLAS COUNTY
AND SAUNDERS COUNTY CONES OF DEPRESSION (FIGURES)

APPENDIX III - HYDROLOGICAL DATA

APPENDIX IV - COMPREHENSIVE VEGETATION SPECIES LIST BY WETLAND,
2005-2011

** ** **
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2-1</td>
<td>Modified Daubenmire Cover Class Scale</td>
<td>2-5</td>
</tr>
<tr>
<td>Table 5-1</td>
<td>Summary of 2011 Wetland Vegetation Data Analysis</td>
<td>5-1</td>
</tr>
<tr>
<td>Table 5-2</td>
<td>Wetland 68 Comparison of 2011 Vegetation Data to Baseline Averages</td>
<td>5-2</td>
</tr>
<tr>
<td>Table 5-3</td>
<td>Record of Thresholds Evaluation by Sampling Season for Wetland 68</td>
<td>5-3</td>
</tr>
<tr>
<td>Table 5-4</td>
<td>Wetland 25 Comparison of 2011 Vegetation Data to Baseline Averages</td>
<td>5-3</td>
</tr>
<tr>
<td>Table 5-5</td>
<td>Record of Thresholds Evaluation by Sampling Season for Wetland 25</td>
<td>5-4</td>
</tr>
<tr>
<td>Table 5-6</td>
<td>Wetland 100 Comparison of 2011 Vegetation Data to Baseline Averages</td>
<td>5-5</td>
</tr>
<tr>
<td>Table 5-7</td>
<td>Record of Thresholds Evaluation by Sampling Season for Wetland 100</td>
<td>5-5</td>
</tr>
</tbody>
</table>

LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2-1</td>
<td>Monitoring Locations Douglas County Well Field</td>
<td>2-3</td>
</tr>
<tr>
<td>Figure 2-2</td>
<td>Monitoring Locations Saunders County Well Field</td>
<td>2-4</td>
</tr>
<tr>
<td>Figure 2-3</td>
<td>Monitoring Locations Douglas County Cone of Depression</td>
<td>2-7</td>
</tr>
<tr>
<td>Figure 2-4</td>
<td>Monitoring Locations Saunders County Cone of Depression</td>
<td>2-8</td>
</tr>
<tr>
<td>Figure 4-1</td>
<td>Name of Figure 4-1</td>
<td>4-2</td>
</tr>
<tr>
<td>Figure 4-2</td>
<td>Name of Figure 4-2</td>
<td>4-3</td>
</tr>
</tbody>
</table>

* * * * *
1.0 INTRODUCTION

The Metropolitan Utilities District (District), Omaha, Nebraska, was issued a Section 404 Individual Permit (Permit) on May 16, 2003, from the U.S. Army Corps of Engineers, Omaha District (Corps), for the Platte West Water Production Facilities Project (Project) (U.S. Army Corps of Engineers 2003). As part of the terms and conditions included in the Corps Section 404 Permit, the wetlands located in the well fields and projected cones of depression must be monitored to determine the extent of any impacts to wetlands that may take place as a result of Project operation. To comply with this condition, a Wetland Monitoring Plan was prepared and approved in 2005 and is now being implemented (Burns & McDonnell 2005a).

As stated in Permit Condition 37: “The purpose of the monitoring is to identify any changes in the existing or future wetlands or aquatic sites impacted as a result of project development and operation.” Both temporary and permanent impacts to wetlands are expected to result from the construction and operation of the Project, which is located in Douglas and Saunders Counties, Nebraska. The 2005 Wetland Monitoring Plan presents a systematic, multi-tiered approach to monitor wetlands within the Douglas County and Saunders County well fields and their associated cones of depression to evaluate any impact due to the operation of the Project.

Wetlands selected for monitoring were chosen from those identified during the delineations conducted in the well fields (Burns & McDonnell 2004) and in the cones of depression (Burns & McDonnell 2005b). Monitoring of wetlands in accordance with the Wetland Monitoring Plan was initiated in June 2005. Annual monitoring reports, characterizing each year’s monitoring effort (2005 through 2007) and culminating in the Baseline Wetland Monitoring Report, were submitted for each year of baseline monitoring (Burns & McDonnell 2006a, 2007a, 2008, 2009). Monitoring through spring of 2008 was conducted to characterize the baseline conditions of the wetlands prior to initiation of Project operation. The Project began producing water for municipal use during the summer of 2008; therefore, the monitoring efforts starting in fall 2008 are considered post-operational.

This report summarizes the 2011 monitoring efforts and provides some comparisons to the pre- and post-operation conditions.

* * * * *
2.0 SAMPLING METHODOLOGY

The goal of monitoring wetlands within the Douglas County and Saunders County well fields and associated cones of depression is to evaluate the impact that operation of the Project may have on the existing wetlands. To accomplish this goal, a wetland monitoring approach consisting of a systematic, multi-tiered vegetation sampling procedure has been developed, approved, and implemented. In developing this vegetation sampling procedure, numerous literature sources and references were reviewed. Several discussions with personnel from the Corps and the District occurred during the preparation of this plan and the synthesis of the approach. Key references and sources used included:

- performance standards for wetland creation and restoration (Streever 1999 and Environmental Law Institute 2004)
- vegetation sampling and analysis methodologies (U.S. Environmental Protection Agency 2002 and Tiner 1999)
- wetland mitigation guidelines (Taylor and Krueger 1997)

Wetland monitoring, as stated above and described in the following paragraphs, began during Project construction in 2005, prior to initiation of Project operation. Monitoring will continue until the Corps agrees that any impacts to wetlands as a result of Project operation are either completely mitigated for or are not likely to occur. If the results of the monitoring program indicate that no wetland impacts are occurring, long-term monitoring can either be decreased or stopped, in accordance with the thresholds analysis discussed in Section 4.0 Thresholds. If the results of the monitoring indicate effects are occurring to wetlands that have not been previously mitigated, discussions with the Corps will be initiated to determine what additional mitigation may be required.

2.1 WETLAND MONITORING IN THE WELL FIELDS

The types of data that were collected, the methods used, and the analyses completed during the wetland monitoring process in the well fields are described in the paragraphs that follow.

2.1.1 Vegetation Sampling

Vegetation was sampled in selected wetlands in the two well fields to characterize the major wetland and adjacent upland plant communities and the variation between them. Wetlands where vegetative change will most likely be detected first were selected for vegetation sampling; these wetlands are referred to as
“primary” wetlands. In past years, vegetation sampling in these primary wetlands occurred twice each year, in mid-June and in late September. In 2011, the monitoring intensity decreased from Level 1 (monitoring of select wetlands twice yearly) to Level 2 (monitoring of select wetlands once yearly) based on the data collected during monitoring to date. The discussion of threshold levels in Section 4.0 details the criteria for a switch between monitoring levels and the procedures followed at each level.

If Project operation-induced impacts to wetland vegetation are observed and documented in any of the primary wetlands, the monitoring of nearby secondary wetlands will be initiated. The monitoring of the secondary wetlands, in addition to the primary wetlands, will help determine if the observed impact is localized and confined to the primary wetland, or is spreading to the adjacent or surrounding wetlands. The primary and secondary wetlands that are being or will be monitored in the Douglas County and Saunders County well fields are shown in Figures 2-1 and 2-2. The wetlands in the Saunders County well field are monitored more extensively than wetlands in the Douglas County well field due to the presence of the 95-acre Wet Meadow in Saunders County. However, the proposed monitoring plan is flexible and can be adjusted to meet specific identified needs for monitoring if they develop.

Vegetation sampling methods used vary depending on the type of wetland vegetation being sampled. These differences in methodologies are described in the following sections.

2.1.1.1 Palustrine Emergent Wetlands

The vegetation in a palustrine emergent (PEM) wetland is normally comprised of herbaceous plant species. However, seedlings of woody plants less than one meter tall may also be included in the PEM wetland vegetation. Herbaceous plant species were sampled using gradient-oriented transects, or “gradsects”. A gradsect is defined as a transect that is placed perpendicular to the baseline transect along the ecotone gradient. The ecotone is the distinct area where one plant community changes or intergrades into another separate, distinct plant community. Sampling units are located in the center of each vegetation community and at each ecotone. The sampling unit consists of five, three-foot-diameter circular sample plots placed along the gradsect. Three baseline transects with between two and seven gradsects have been placed in each PEM wetland.

Vegetation and wetland monitoring in the PEM wetlands began in 2005. During the first sampling period in June 2005, each permanent transect, gradsect, and sample plot was located and recorded using a global positioning system (GPS; Trimble Pro XRS sub-meter GPS unit). The beginning and end of each transect and gradsect were permanently marked in each wetland using two-foot sections of 3/8-inch re-bar,
Figure 2-1
Monitoring Locations
Douglas County Well Field
Metropolitan Utilities District

Legend
- Piezometer (PZ)
- Production Well (PW)
- Monitoring Well (MW)
- Pipeline
- Road
- Well Field Boundary
- Cone of Depression

Wetlands
- MOSAIC (50/50)
- PAB
- PEM
- PEM/PSS
- PSS
- PSS/PFO
- PFO
- PUB
- Sediment Basin
- Mitigation Site
- Drainage Swale

Source: National Agriculture Imagery Program (NAIP) Aerial Photography (2010)
Figure 2-2
Monitoring Locations
Saunders County Well Field
Metropolitan Utilities District

Source: National Agriculture Imagery Program (NAIP)
Aerial Photography (2010)
painted orange and flagged. These permanent markers also serve as photograph stations. A photographic record is being maintained for each sampling period at each gradsect and transect. This photographic record will provide a repetitive visual record of the wetland vegetation monitoring during seasons and over years.

Vegetation and plant species data that were collected during the PEM wetland vegetation monitoring effort include the identification, to species when possible, of each plant located within the three-foot diameter sample plot. The percent cover for each plant species occurring in a sample plot was estimated using a modified Daubenmire cover-class method. In this methodology, percent canopy cover is visually estimated for each plant species either rooted within or extending into each 3-foot diameter plot. The plant species is placed into one of a series of cover classes using the estimated percent canopy cover. These classes are based on the mid-point of canopy coverage per the modified Daubenmire canopy cover method shown in Table 2-1 (Daubenmire 1959; Bailey and Poulton 1968).

<table>
<thead>
<tr>
<th>Cover Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range (%)</td>
<td>0-1</td>
<td>1-5</td>
<td>5-25</td>
<td>25-50</td>
<td>50-75</td>
<td>75-95</td>
<td>95-100</td>
</tr>
<tr>
<td>Midpoint (%)</td>
<td>0.5</td>
<td>3.0</td>
<td>15.0</td>
<td>37.5</td>
<td>62.5</td>
<td>85.0</td>
<td>97.5</td>
</tr>
</tbody>
</table>

A cover class was also estimated for the non-vegetated area in the three-foot diameter plot because sample plots are often not completely vegetated. Non-vegetated areas can include bare soil, rocky surface, open water, or litter. Quantifying the bare area provides an indication of the potential for additional vegetation in the sample plot. Even with bare area in a plot, the total cover of vegetation may be greater than 100 percent, because plants often overlap in a plot.

If standing water is present within the sample plot, the water depth (in inches) at the center of each plot will be recorded. The percentage of the plot that is inundated will also be estimated and assigned a cover class value that is recorded on the data entry forms.

2.1.2 False-color Infrared (CIR) Aerial Photography

False-color infrared (CIR) aerial photography was initially taken in 2005 and was obtained annually through 2009. In accordance with the reduced monitoring intensity level, as described in Section 4.0 Thresholds, CIR aerial photography was not obtained in 2010, but was obtained in 2011 (Appendix II). The CIR photographic coverage typically includes both well fields and the associated cones of depression in Douglas and Saunders Counties. The annual CIR aerial photography is used to monitor the overall
size, shape and condition of the wetlands and different types of vegetation occurring in the well fields over time.

### 2.2 WETLAND MONITORING IN THE CONES OF DEPRESSION

The Douglas County and Saunders County well fields are owned in fee title by the District. As a result, access to the well fields for vegetation and groundwater monitoring is available at all times. The land surrounding or adjacent to the well fields is projected to potentially experience some groundwater drawdown during Project operation. Groundwater modeling is conducted annually to incorporate data collected from the monitoring and production wells (HDR 2011). The groundwater model is able to predict the area of land surrounding the well fields that is expected to experience a one-foot drawdown of local groundwater during project operation. These areas are designated as “cones of depression” and are larger than the well fields. The originally modeled cones of depression are included in Figures 2-3 and 2-4.

The land outside the well fields but within the cones of depression is not owned by the District. As such, seasonal and annual access to that portion of the cones of depression for consistent wetland monitoring cannot be assured. Therefore, the monitoring methodology for the wetlands within the cones of depression but outside of the District-owned well fields is based on the interpretation and comparison of the annual CIR aerial photography. The CIR aerial photography for the cones of depression will be obtained per the methods described in Section 2.1.2 above for the wetland monitoring in the well fields.

A total of eight wetlands in the cones of depression have been selected for secondary monitoring from those that were delineated (Burns & McDonnell 2005b; Figures 2-3 and 2-4). Six of these eight wetlands are emergent wetlands (W-9, W-514, and W-519 in Douglas County and W-306, W-321, and W-700 in Saunders County), one is a PFO/PEM wetland complex (W-5 in Douglas County), and one is a PFO wetland (W-8 in Douglas County). More emergent wetlands are being monitored than other types of wetlands due to the fact that more emergent wetlands were delineated in the cones of depression than any other type of wetland.

### 2.3 HYDROLOGICAL MONITORING

Several different types of hydrological data are being collected and analyzed. This hydrological data is being used to document the effect the existing water table has on wetlands in the two well fields and the potential effect Project operation may have.
Figure 2-3
Monitoring Locations
Douglas County Cone of Depression
Metropolitan Utilities District

Project Location

Monitoring Locations


Legend

- Piezometer
- Production Well (PW)
- Monitoring Well (MW)
- Pipeline
- Road
- Cone of Depression
- Well Field Boundary

Wetlands

- MOSAIC (50/50)
- PAB
- PEM
- PEM/PSS
- PSS
- PSS/PFO
- PFO
- PUB
- Sediment Basin
- Mitigation Site
- Drainage Swale
2.3.1 Groundwater Monitoring Wells

Permanent monitoring wells designed to measure local groundwater levels have been installed at specific locations in and around the Douglas County and Saunders County well fields and cones of depression (Figures 2-1 through 2-4). The location of these groundwater monitoring wells was recorded using GPS. Data loggers have been installed at the monitoring wells so that groundwater levels can be measured and recorded on a daily basis. Groundwater data from the monitoring wells will be correlated with the other hydrological data that is being collected to evaluate if any Project-induced groundwater system changes are occurring.

2.3.2 Production Wells

The Project production wells that are pumped to provide raw water to the new water treatment facility during Project operation are located in the Douglas County and Saunders County well fields (Figures 2-1 and 2-2). These water production wells have also been fitted with data loggers that measure and record the depth to the water table at each well head whether or not the well is actively being pumped. In addition, the rate at which each well is being pumped is measured in millions of gallons per day (MGD). The locations of these water production wells were recorded using GPS. Data from the water production wells (production rate, drawdown, cone of depression, etc.) during Project operation will be correlated with the other hydrological data that is being collected to evaluate if Project-induced changes to wetlands are occurring.

2.3.3 Piezometers

A total of 18 piezometers were installed in five wetlands in the Saunders County well field (Figure 2-2). Twelve of these were installed in three existing wetlands (four piezometers per wetland) already being monitored as part of the Wetland Monitoring Plan (Burns & McDonnell 2005a). Four piezometers were installed in the Phase I Mitigation Site located adjacent to the Wet Meadow and described in the Phase I Wetland Mitigation Plan (Burns & McDonnell 2005d). The remaining two piezometers were installed in the Phase II Wet Meadow Mitigation Site (Burns & McDonnell 2007c). In July 2010, eight of the existing piezometers were replaced by installing a new piezometer adjacent to the old ones. The replacement of some piezometers was necessary due to the undermining of existing piezometers due to frost heave, erosion, or animal activity. A modified installation approach was implemented during the replacement of the eight piezometers. Additional rebar was driven into the ground at divergent angles before the concrete base was poured. This additional rebar should help stabilize the piezometers against frost heave. The locations of the installed piezometers have been recorded using GPS.
In each of the five wetlands being monitored with piezometers, one of the piezometers was located near the center or low point. Since subsurface groundwater flow is generally from north to south, one piezometer was installed at the northern edge of each wetland; the remaining two piezometers were installed along the southern edge of each wetland.

The piezometers installed in two existing wetlands in the Wet Meadow (W-5 and W-25) and the created Phase I and Phase II Wet Meadow Mitigation Sites adjacent to the Wet Meadow are designed to monitor the shallow, perched water table between the soil surface and the clay layer before and after Project operation begins. Piezometers were also installed in a PEM wetland (W-100) in the southern portion of the Saunders County well field that is outside of the Wet Meadow boundary (and also outside of the perched water table located above the shallow clay layer) to monitor the shallow groundwater prior to and during Project operation. All piezometers are being monitored on an approximately monthly basis during the growing season to assess the seasonal and annual fluctuation in the shallow water table, and the variation between years. For additional information on the installation and monitoring of the piezometers, please refer to Burns & McDonnell’s Wetland Monitoring Plan (2005a).

2.3.4 Bathymetric Monitoring of Ponds

Bathymetric monitoring of ponds located in the Douglas County and Saunders County well fields and associated cones of depression was initiated in 2004 (Burns & McDonnell 2005c). Using GPS and a boat-mounted sonar recorder, bathymetric maps were developed for each of the 45 ponds being monitored. These maps established baseline conditions by depicting each pond’s water surface area and water depth contours. Prior to initiation of Project operations, water surface elevations at each pond were monitored four times (March, August, September, and October) each year. The pond surface water elevation data collected provides a basis for comparing the seasonal pre-project changes with the changes that may occur with operation of the Project.

Permanent benchmarks and elevations were established near each pond above the high water mark during the early summer of 2005. The location and elevation of each permanent benchmark was established using a survey-grade GPS. Water surface elevations were measured from the established permanent benchmark using a surveyor’s level. The 2005 bathymetric monitoring also included the contour mapping of one pond that was overlooked during the 2004 mapping effort (Burns & McDonnell 2006b). During the 2006 bathymetric monitoring effort, an additional pond was surveyed at the request of the landowner (Burns & McDonnell 2007b). In 2008, two ponds were added and two ponds were removed. An additional pond, DG-11, was added by request of the landowner in 2009 and is being monitored by
photographic documentation only at this time. In 2010, pond DG-02A was added to the monitored ponds at the request of the landowner. Currently, a total of 47 ponds are being monitored.

The seasonal variation in surface water elevation of the 47 ponds will be compared between baseline and operational conditions and evaluated in concert with the other hydrologic data that are being collected. The bathymetric data collected from the ponds will be used to indicate if Project operation is resulting in water level fluctuations for a specific pond or ponds and if these fluctuations are different than would normally occur under baseline conditions.

2.3.5 Other Hydrological Data

Additional hydrological data is also collected during the annual monitoring effort each year. This additional data includes monthly total precipitation, monthly average ambient air temperature, and stream gauge data for the Platte and Elkhorn Rivers.

* * * * *
3.0 DATA ANALYSIS

The following sections provide a brief discussion of the data analysis and the results of the 2011 annual wetland monitoring efforts in the well fields and cones of depression.

3.1 WETLAND MONITORING IN THE WELL FIELDS

The spring 2011 monitoring effort in the well fields consisted of the systematic sampling and analysis of wetland and nearby upland vegetation, the collection and comparison of various types of hydrological data, and the review and comparison of natural color aerial photography for the monitored wetlands.

3.1.1 Vegetation Data

Vegetation monitoring of the wetlands in the well fields was conducted in June 2011 to characterize major wetland and upland plant communities and the variation between them. These sampling efforts represent the third year of monitoring during operation of the water treatment plant. Vegetation sampling took place in sample plots established along permanent transects and gradsects established in each wetland ecosystem as described previously. Data obtained during 2011 has been analyzed and compared to baseline data and the results are discussed below and included in Appendix I. Additionally, some comparisons of vegetation data collected during each sampling period during Project operation have also been included.

All of the wetland vegetation data obtained during monitoring was input into a Microsoft Access database that has been designed specifically to accommodate seasons and years of data. The database was also designed for the rapid comparative assessment of selected vegetative characteristics within and among wetlands and wetland types in general. Current nomenclature and plant characteristics were obtained from the USDA PLANTS Database (USDA 2011). A complete list of plant species that have been identified in each of the monitored wetlands has been compiled and is included in Appendix IV. The vegetative characteristics that were analyzed are described below.

In the initial data collection process in the field, the percent cover for each plant species observed in each sample plot and macroplot was estimated. As explained in the following paragraphs, these collected vegetative data were used to calculate a weighted average for each sampling unit in addition to calculating the species richness; species diversity; percent native species; percent invasive species; the percentage of perennial, biennial, and annual species; the mean coefficient of conservatism (c-value); and the Floristic Quality Index (FQI).
3.1.1.1 Change in Wetness

Species abundance and the wetland indicator status for each species can be used to calculate a measure of how wet an area is. This measure of wetness is referred to as the weighted average (Tiner 1999) or the Prevalence Index (Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0, 2010)). For the current year’s data, the average or mean weighted average ($\text{WA}_M$) was calculated for each wetland as a whole and for each gradsect located in the emergent wetlands. The $\text{WA}_M$ is calculated using the following formula:

$$\text{Mean Weighted Average } (\text{WA}_M) = \frac{\sum I \times E}{\sum I}$$

where $I =$ importance value for the species (e.g., percent cover)
$E =$ ecological index for the species

The importance value used for this evaluation is the percent cover for the species in the sample plot. The ecological index is a value between 1 and 5 that corresponds to the wetland indicator status for the given species. An ecological index value of 1 corresponds to an obligate or wetland plant and a value of 5 corresponds to an upland plant. The calculated $\text{WA}_M$ should be equal to or less than 3.0 in order for a specific site to be considered a wetland if hydric soils and sufficient hydrology are present. In transitional areas, a $\text{WA}_M$ should approach 3.5, depending on landscape position, hydrology, and other related features.

When multiple years of data are available after the start of Project operation, a non-parametric statistical analysis will be used to determine if any changes in $\text{WA}_M$ observed are statistically significant. If the $\text{WA}_M$ for a wetland exhibits a significant change, then a recommendation for monitoring to be expanded to additional surrounding wetlands to determine the extent of the impact may be made. Adjustments to the monitoring intensity will occur according to the guidelines outlined in Section 4.0, Thresholds.

3.1.1.2 Change in Species Composition

Change in species composition over time will be analyzed by comparing the various vegetative indices that are being calculated each year. These indices were calculated from the collected data to assist in interpreting any changes observed in the vegetation communities. These additional calculations are explained in the following paragraphs and include:

- Species richness
- Species diversity
- Percent of native vegetation
- Percent of invasive species
- Percent of perennial/annual/biennial vegetation
- Floristic Quality Index (FQI)
- Mean c-value

Species richness is the count of the number of different species identified in a plant community. This parameter is used to help characterize the plant community being examined, and is often used in concert with species diversity indices (Greig-Smith 1983). In most cases, a higher species richness value is obtained from a better quality or more diverse plant community.

Species diversity is an index that combines species richness and equitability (the evenness of the contribution of different species to the community) in order to investigate the heterogeneity of a plant community that is more a measure of the functional or apparent number of species rather than the absolute number of species as in species richness (Greig-Smith 1983). Species diversity in this study is the number of different species in an area weighted by some measure of abundance. Here, the measure of abundance used is the number of occurrences of each species in each wetland out of the total number of plots. The formula for species diversity follows Simpson (1949) and is included below:

$$\text{Species Diversity}(D) = \frac{N(N-1)}{\sum n(n-1)}$$

where $N = \text{total number of occurrences for all species in all plots}$

$n = \text{number of occurrences for each individual species}$

Simpson’s Reciprocal Index (1/D) is calculated and included in the data analysis. In general, diversity increases with increasing heterogeneity; so, the higher the diversity value, the more diverse the plant community.

Assessing the abundance of native and invasive species provides an indication of the quality of the plant community and, when used long-term, provides an indication of whether there is a shift in quality over time. For this study, the percent of native vegetation is the percent of plant species out of the total species occurring in the wetland that are considered to be native to the United States. The percent of invasive vegetation is the percent of plant species out of the total species occurring in the wetland that are considered to be invasive in the United States or have the potential to dominate a community to the exclusion of more desirable species. Invasive species can be both native and non-native plants.
Additionally, the percentages of the total plant species that are annual, biennial, and perennial are also indicated. This parameter shows the contribution of the different types of plants, and provides, in part, an indication of the diversity of the plant community in question.

A Floristic Quality Analysis (FQA) will also be conducted on the vegetation data. The FQA is typically conducted on vegetation data collected during a pedestrian survey of the whole site. However, because the sampling of these wetlands is so extensive, the FQA calculations will be based on data collected from the sample plots rather than a separate survey. The mean c-value and FQI are calculated using c-values that were assigned for the Nebraska region by Rolfsmeier and Steinauer (2003). The c-value is a number between 0 and 10 that is assigned to each plant species in a region. The c-value assigned is an indication of whether the plant is native to the area and how tolerant to disturbances the species is. For example, a native plant that is found only in intact natural communities would be assigned a value of 10, while an invasive or non-native species commonly found on roadsides, for example, would be assigned a value of 0. The mean c-value is the average of the c-values from the plant species identified in the site.

While the mean c-value provides a measure of the botanical quality of a site that can be compared from year to year, it does not take into account the size of the site or the quality of the surrounding area. Therefore, the FQI is calculated to combine the mean c-value with the total number of species identified in the site. The FQI is calculated using the following formula:

\[
\text{Floristic Quality Index (FQI)} = \bar{c} \sqrt{n}
\]

where \( \bar{c} \) = mean coefficient of conservatism
\( n \) = number of native species

With this calculation, higher FQI numbers correspond to more natural sites that have a higher diversity. Lower FQI values imply a more disturbed or lower quality site.

### 3.1.1.3 Statistical Analysis

Statistical Analysis of the vegetation data was first included in the 2010 Annual Wetland Monitoring Report, since a sufficient number of sampling efforts had taken place since the beginning of operation to allow for an evaluation of the vegetative characteristics. To determine whether any observed changes in the vegetative indices that are calculated each year are significant, a statistical analysis is conducted to compare the baseline data, which captured some of the natural variation in the wetlands, to the operational data to determine if project operation is having any significant effect on the wetlands. Statistical Analysis is again included in the 2011 Annual Wetland Monitoring Report.
Through discussions with the District, Corps, and Burns & McDonnell, the Repeated Measures ANOVA was selected as the statistical test appropriate for this analysis. The statistical add-on package to Microsoft Excel that was utilized for this analysis is the EZAnalyze program (www.ezanalyze.com). The Repeated Measures ANOVA is able to compare multiple sampling seasons of data against the baseline average for a given vegetative index. A post-hoc analysis is also included when a significant difference is detected to determine which sampling efforts were significantly different. A Bonferroni correction is then applied to the p-values to decrease the error that may occur when comparing multiple data sets amongst each other. The final p-Bonferroni values are reviewed to determine if any of the sampling efforts are significantly different from the baseline average value. This indication of significance is the analysis used when triggering thresholds for monitoring intensity or identifying possible impacts to the wetland due to project operation.

The Repeated Measures ANOVA test is conducted on each of the vegetative indices that are calculated for each sampling effort: WAM, FQI, c-Value, Species Richness, and Species Diversity.

### 3.1.2 False-color Infrared (CIR) Aerial Photography

In accordance with the reduced monitoring intensity level, as described in Section 4.0, Thresholds, CIR aerial photography was not obtained in 2010, but was obtained in 2011. CIR and natural color aerial photography was flown by Wilson & Co. on August 1, 2011. Photography coverage was obtained for the well fields, cones of depression, and the water treatment plant.

### 3.2 WETLAND MONITORING IN THE CONES OF DEPRESSION

As stated above, CIR aerial photography was obtained in 2011 for the first time since 2009. The eight wetlands routinely monitored in the cones of depression (W-5, W-8, W-9, W-514, and W-519 in Douglas County and W-306, W-321, and W-700 in Saunders County), were again evaluated against the CIR photography. CIR aerial photography of the monitored wetlands in the cones of depression are included in Appendix II. Future monitoring of these wetlands will continue according to the monitoring requirements as described in Section 4.0 Thresholds.

### 3.3 HYDROLOGICAL MONITORING

Several different types of hydrological data were collected during the 2011 monitoring efforts. The collected data, their sources, and any analyses performed are discussed below and included in Appendix III.
3.3.1 **Groundwater Monitoring Wells**

Permanent wells designed to measure groundwater levels before and during Project operation have been monitored by the District using the installed data loggers. A total of 23 monitoring wells were monitored during 2011. Water level readings were measured and recorded on a regular basis using an electronic datalogger. The collected data in 2011 have been graphed over time and are presented for each monitoring well in Section A of Appendix III.

3.3.2 **Production Wells**

The Project production wells that are pumped to provide raw water to the new water treatment plant during Project operation were monitored in 2011 using installed data loggers. The total production well pumping rates by month, the total volume pumped per month, and the average monthly pumping rates for each production well have been included in Tables 1 and 2 in Section B, Appendix III. These data will be evaluated and analyzed to provide corroborating information should any changes be detected in the other monitoring data.

3.3.3 **Piezometers**

Sixteen piezometers were installed in four wetlands in the Saunders County well field in 2005. Twelve of the piezometers were installed in May and four piezometers (located in the Phase I Wet Meadow Mitigation Site, WM-1, adjacent to the Wet Meadow) were installed in late October. In May of 2009, two additional piezometers were installed in the Phase I Wet Meadow Expansion Mitigation Site, WM-2, for a total of 18 piezometers. As described in Section 2.3.3, eight of the piezometers were reinstalled adjacent to their original position in July of 2010. The collected data from the 2011 monitoring efforts have been graphed over time and are presented in Section C, Appendix III.

The piezometers installed in PEM W-25 (PZ-01 through PZ-04), PFO W-5 (PZ-05 through PZ-08), PEM WM-1 (PZ-13 through PZ-16), and PEM WM-2 (PZ-17 and PZ-18) are all located above the shallow clay layer associated with the Wet Meadow (Figures 1, 3, and 4; Section C, Appendix III). Piezometers installed in PEM W-100 (PZ-09 through PZ-12) are outside of both the Wet Meadow boundary and the perched water table located above the shallow clay layer (Figure 2, Section C, Appendix III). These readings are used to provide corroborating hydrological evidence should any changes be detected in the wetland vegetation data.

3.3.4 **Bathymetric Monitoring of Ponds**

The post-operation bathymetric monitoring of ponds located in the Douglas County and Saunders County well fields and associated cones of depression was completed during 2011 as planned. The data collected
from these monitoring efforts is presented in a separate report entitled the *2011 Annual Bathymetric Monitoring Report for the Ponds within the Well Fields and Cones of Depression* (Burns & McDonnell 2012). Pond monitoring is conducted to document the variation in each monitored pond’s seasonal water surface elevation. The data presented in the bathymetric monitoring report will provide corroborating hydrological evidence should any changes be detected in the wetland vegetation data.

### 3.3.5 Other Hydrological Data

Additional hydrological data collected during the 2011 monitoring efforts included monthly total precipitation, monthly average ambient air temperature, and stream gauge data. The monthly total precipitation and monthly average ambient air temperature were both obtained from the weather station at Fremont Municipal Airport in Fremont, Nebraska. The 2011 precipitation and temperature data and the historical average monthly precipitation and temperature have been graphed over time; the graphs are included in Figures 1 and 2 (Section D, Appendix III).

Stream gauge data was obtained from the USGS stream gauge stations on the Platte and Elkhorn rivers. Platte River data was obtained from the recently installed stream gauge near Venice, Nebraska (USGS Stream Gauge No. 06796550). The installation of this stream gauge took place at the request of and through funding by the District. Data collected from this stream gauge is represented in Figure 3 (Section D, Appendix III). The Elkhorn River data was obtained from the stream gauge near Waterloo, Nebraska (USGS Stream Gauge No. 06800500). Data collected from this stream gauge is represented in Figure 4 (Section D, Appendix III).

* * * * *
4.0 THRESHOLDS

According to the Section 404 Permit conditions, the monitoring of wetlands in the well fields and cones of depression will take place during Project operation. To determine whether an impact is taking place at a given wetland, thresholds have been established in accordance with the baseline data that was collected. As monitoring data are evaluated after each sampling effort, thresholds are either met or not met, and the intensity of monitoring may be increased or decreased as a result. The wetland monitoring intensity levels and the process for determining whether a wetland has met the thresholds used to identify potential changes in the wetlands is described below.

4.1 LEVELS OF WETLAND MONITORING INTENSITY

A Wetland Monitoring Plan was developed and implemented in 2005 (Burns & McDonnell 2005a). This Monitoring Plan describes in detail the standard annual monitoring approach. During the years of baseline monitoring and the first several seasons of operational monitoring, the standard approach was considered an appropriate protocol. However, as monitoring continued, it became apparent that it may be beneficial to adjust the amount of data being collected based on whether impacts were being observed or not. If impacts have been documented (“yellow flags”), the intensity of monitoring increases. If no impacts have been documented (“green flags”), then the intensity of monitoring decreases. The five levels of monitoring intensity are listed below and described in detail in Figure 4-1.

- High-Intensity Annual Wetland Monitoring
- Standard Annual Wetland Monitoring
- Level 1 Decreased Annual Wetland Monitoring
- Level 2 Decreased Annual Wetland Monitoring
- Level 3 Decreased Annual Wetland Monitoring

4.2 METHOD FOR DETERMINING WETLAND IMPACTS

A series of evaluations and comparisons to the baseline data will be conducted after each sampling effort during Project operation to determine whether wetland impacts are occurring. The process for these evaluations is outlined in a flowchart included in Figure 4-2. A “green flag” on the chart indicates that no thresholds have been triggered and no impacts to wetlands due to Project operation have been observed. A “yellow flag” on the chart indicates that a change or an anomaly has been detected in either a vegetative index, the aerial photography, or in the hydrological monitoring. This anomaly may be due to an effect of Project operation on the wetland or it may be due to one of many naturally-occurring environmental or climatic factors. A “red flag” indicates that a threshold has been triggered and an impact to wetlands due to Project operation has likely occurred.
High-Intensity Annual Wetland Monitoring:
• Vegetation monitoring in all primary wetlands twice per year
• On-site monitoring in secondary wetlands with vegetation sampling
• CIR Aerial photography obtained every year
• Piezometer readings at least 5 times per year

Standard Annual Wetland Monitoring:
• Vegetation monitoring in all primary wetlands twice per year
• Remote monitoring in secondary wetlands using aerial photography
• CIR Aerial photography obtained every year
• Piezometer readings at least 5 times per year

Level 1 Decreased Annual Wetland Monitoring:
• Vegetation monitoring in PEM wetlands twice per year
• Remote monitoring in PFO/PSS wetlands and secondary wetlands using aerial photography
• CIR Aerial photography obtained every 2 years
• Piezometer readings at least 5 times per year

Level 2 Decreased Annual Wetland Monitoring:
• Vegetation monitoring in PEM wetlands once per year
• Remote monitoring in PFO/PSS wetlands and secondary wetlands using available aerial photography
• CIR Aerial photography obtained every 2 years
• Piezometer readings at least 5 times per year

Level 3 Decreased Annual Wetland Monitoring:
• Vegetation monitoring in PEM wetlands once every 2 years
• Remote monitoring in PFO/PSS wetlands and secondary wetlands using available aerial photography
• CIR Aerial photography obtained every 2 years
• No Piezometer readings

Figure 4-1
Levels of Wetland Monitoring Intensity
Flowchart for Determining Wetland Impacts

Sampling Effort #1
Conduct Standard Intensity Wetland Monitoring and Analyze Data

Does the data analysis for this sampling effort meet one or more of the following criteria?:
- Increase in mean weighted average by more than 0.5 from baseline maximum
- A significant difference in three or more of the following indices: FQI, mean c-value, species diversity, or species richness
- Evident change from baseline variation visible on either CIR or natural color aerial photography

Sampling Effort #2
Increase Monitoring Intensity by One Level or Remain at Standard Intensity
Conduct Wetland Monitoring and Analyze Data

Does the data analysis for this sampling effort meet one or more of the following criteria?:
- Increase in mean weighted average by more than 0.5 from baseline maximum
- A significant difference in three or more of the following indices: FQI, mean c-value, species diversity, or species richness
- Evident change from baseline variation visible on either CIR or natural color aerial photography

**Potential Impact**
- Alert Corps and District of potential change
- Increase monitoring intensity to Standard Monitoring (if it had been decreased)
- Conduct detailed comparison to hydrology/climate data to identify potential cause for observed change

Sampling Effort #3
Increase to Standard Monitoring Intensity
Conduct Wetland Monitoring and Analyze Data

Does the data analysis for this sampling effort meet one or more of the following criteria?:
- Increase in mean weighted average by more than 0.5 from baseline maximum
- A significant difference in three or more of the following indices: FQI, mean c-value, species diversity, or species richness
- Evident change from baseline variation visible on either CIR or natural color aerial photography

No Impact Occurring
Reduce Intensity of Monitoring by One Level (Levels of Wetland Monitoring Intensity Chart)
- 3 consecutive green flags = reduce from Standard to Level 1, or from Level 1 to Level 2 Reduced Monitoring
- 2 consecutive green flags = reduce from Level 2 to Level 3 Reduced Monitoring

**Wetland Impact**
Discussions between Corps and District to determine whether to:
- Take closer look at surrounding wetlands to determine if impact is isolated
- Increase monitoring to High-Intensity Annual Monitoring
- Consider providing additional wetland mitigation

Legend
- No impact occurring. Continue standard monitoring protocol.
- Impacts possible at this wetland. Continue monitoring until three consecutive sampling efforts show change.
- Impacts likely. District will initiate discussion with Corps.
5.0 RESULTS

The following sections provide the results of the data analysis for each of the wetlands monitored during the 2011 effort. The complete set of data (figures, summary tables, ground photographs, and raw data sheets) for each monitored wetland in the well fields is available in Appendix I. In addition, the data collected and analyzed for each of the wetlands in the cones of depression is included in Appendix II. Finally, Appendix III contains all hydrological data collected and analyzed in graphic form.

The various vegetative indices, aerial photography, and other supporting hydrological data that are collected annually have been analyzed to compare 2011 data to baseline averages. To determine whether any differences from baseline averages are significant, further analysis is required to identify if an observed change to a wetland has taken place and if it would be indicative of a Project-induced impact. A discussion of the threshold analysis that was conducted for each wetland is included below.

5.1 WETLAND MONITORING IN THE WELL FIELDS

Data collected during monitoring of the wetlands in the well fields included qualitative vegetation data and natural color and CIR aerial photography. In addition, hydrological data was collected for the area. The results of the data collection are presented in the following sections.

5.1.1 Vegetation Sampling

Three PEM wetlands (W-68, W-25, and W-100) were sampled in June of 2011 as part of the Level 2 decreased monitoring effort. Sampling did not take place in September in 2011 in accordance with the lowered monitoring intensity. Table 5-1 shows the results of the various vegetative indices collected for each of the monitored wetlands in 2011. Detailed results for each wetland are included in the sections that follow.

<table>
<thead>
<tr>
<th>Wetland ID</th>
<th>Mean Weighted Average (WA)</th>
<th>Species richness</th>
<th>Species Diversity</th>
<th>FQI</th>
<th>Mean C Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-68</td>
<td>2.33</td>
<td>52</td>
<td>21.46</td>
<td>26.9</td>
<td>3.8</td>
</tr>
<tr>
<td>W-25</td>
<td>2.47</td>
<td>41</td>
<td>22.87</td>
<td>17.3</td>
<td>2.84</td>
</tr>
<tr>
<td>W-100</td>
<td>2.67</td>
<td>35</td>
<td>21.31</td>
<td>13.36</td>
<td>2.48</td>
</tr>
</tbody>
</table>
5.1.1.1 PEM Wetland 68 – Douglas County

Wetland 68 is a PEM wetland located in Douglas County, Nebraska (Figure 1, Section A-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 12 gradsects, and 60 sample plots. Dominant species observed in this wetland during the 2011 monitoring efforts included sedge (*Carex* sp.), wooly sedge (*Carex pellita*), prairie cordgrass (*Spartina pectinata*), Kentucky bluegrass (*Poa pratensis*), and sawtooth sunflower (*Helianthus grosseserratus*). Wetland 68 (excluding the upland gradsects) had a $W_A^M$ of 2.33 in the spring of 2011 (Table 5-2), indicating that it continues to be dominated by wetland vegetation. The baseline threshold $W_A^M$ for W-68 is 2.78. The $W_A^M$ for Spring 2011 remained below the baseline threshold as illustrated in Figure 2 in Section A-1 in Appendix I. This wetland contained an average of 96 percent native species and 25 percent invasive species in 2011. The FQI for this wetland during the same time period was 26.90, implying a relatively high ecological value. Tables 1 and 2 in Section A-2 of Appendix I contain a summary of the monitoring data and the complete species list from the 2011 monitoring effort.

| Table 5-2: Wetland 68 Comparison of 2011 Vegetation Data to Baseline Averages |
|-----------------------------|----------------|----------------|----------------|
|                             | Spring 2011  | Baseline Mean | Baseline Low |
| $W_A^M$                     | 2.33         | 2.55           | 2.33          |
| Species Richness            | 52           | 56.14          | 46.00         |
| Species Diversity           | 21.46        | 20.43          | 16.63         |
| Mean C Value                | 3.80         | 3.58           | 3.22          |
| FQI                         | 26.90        | 24.62          | 22.50         |
|                             |              |                | 28.89         |

The $W_A^M$ for the 2011 spring sampling effort did not increase by 0.5 or more from the baseline $W_A^M$ of 2.55 as shown above in Table 5-2 and in Figure 2 in Appendix I, Section A-1. The calculated values for FQI, mean c-value, species diversity, and species richness remain very close to the mean baseline values (Table 5-2). The statistical analysis of 2011 species richness, species diversity, mean C Value, and FQI values using the repeated measures ANOVA indicated no statistically significant changes from baseline averages in 2011. Natural color and CIR aerial photography from 2011 show no significant visible change from baseline photography for W-68 (Appendix I, Section A-1). The data gathered during the post-operational monitoring efforts in 2011 did not trigger a yellow or red flag as outlined in Figure 4-2 or illustrated in Table 5-3. It is recommended that monitoring at W-68 continue consistent with the current methodology for Level 2 monitoring for the next monitoring effort.
### Table 5-3: Record of Thresholds Evaluation by Sampling Season for Wetland 68

<table>
<thead>
<tr>
<th>Sampling Season</th>
<th>Increase in WAM by more than 0.5?</th>
<th>A significant difference in three or more of the following indices?</th>
<th>Change visible on aerial photos?</th>
<th>Flag?</th>
<th>Monitoring Intensity Change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 2008</td>
<td>No</td>
<td>No, No, No, No</td>
<td>No</td>
<td>![Flag]</td>
<td>No</td>
</tr>
<tr>
<td>June 2009</td>
<td>No</td>
<td>No, Yes, Yes</td>
<td>No</td>
<td>![Flag]</td>
<td>No</td>
</tr>
<tr>
<td>Sept. 2009</td>
<td>No</td>
<td>No, No, No, No</td>
<td>No</td>
<td>![Flag]</td>
<td>Yes - Decrease to Level 1</td>
</tr>
<tr>
<td>June 2010</td>
<td>No*</td>
<td>No, No, Yes, Yes</td>
<td>No</td>
<td>![Flag]</td>
<td>No - Remain at Level 1</td>
</tr>
<tr>
<td>Sept. 2010</td>
<td>No</td>
<td>No, No, No, No</td>
<td>No</td>
<td>![Flag]</td>
<td>No - Remain at Level 1</td>
</tr>
<tr>
<td>June 2011</td>
<td>No</td>
<td>No, No, No, No</td>
<td>No</td>
<td>![Flag]</td>
<td>Yes – Decrease to Level 2</td>
</tr>
</tbody>
</table>

* = A significant decrease in WAM occurred, indicating that the wetland was wetter than baseline average.

### 5.1.1.2 PEM Wetland 25 – Saunders County

Wetland 25 is a PEM wetland located in Saunders County, Nebraska (Figure 1, Section B-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 15 gradsects, and 75 sample plots. Dominant species observed in this wetland during the 2011 monitoring efforts included fox sedge (*Carex vulpinoidea*), wooly sedge, sawtooth sunflower, reed canarygrass (*Phalaris arundinacea*), and Kentucky bluegrass. Wetland 25 (excluding the upland gradsects) had a WAM of 2.47 in the spring of 2011 (Table 5-4), indicating that it continues to be dominated by wetland vegetation. The baseline threshold WAM prior to Project operation for W-25 is 2.60. WAMs for 2011 remained below the baseline threshold as illustrated in Figure 2 in Section B-1 in Appendix I. This wetland contained an average of 90 percent native species and 44 percent invasive species in 2011. The FQI for this wetland during the same time period was 17.30, implying a moderately high ecological value. Tables 1 and 2 in Section B-2 of Appendix I contain a summary of the monitoring data and the complete species list from the 2011 monitoring effort.

### Table 5-4: Wetland 25 Comparison of 2011 Vegetation Data to Baseline Averages

<table>
<thead>
<tr>
<th></th>
<th>Spring 2011</th>
<th>Baseline Mean</th>
<th>Baseline Low</th>
<th>Baseline High</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAM</td>
<td>2.47</td>
<td>2.24</td>
<td>1.93</td>
<td>2.78</td>
</tr>
<tr>
<td>Species Richness</td>
<td>41</td>
<td>49.86</td>
<td>39.00</td>
<td>55.00</td>
</tr>
<tr>
<td>Species Diversity</td>
<td>22.87</td>
<td>23.12</td>
<td>17.19</td>
<td>28.00</td>
</tr>
<tr>
<td>Mean C Value</td>
<td>2.84</td>
<td>3.19</td>
<td>2.83</td>
<td>3.65</td>
</tr>
<tr>
<td>FQI</td>
<td>17.30</td>
<td>20.46</td>
<td>17.66</td>
<td>24.48</td>
</tr>
</tbody>
</table>
The WA<sub>W</sub> for the 2011 sampling seasons did not increase by 0.5 or more from the baseline WA<sub>W</sub> of 2.24 as shown in Table 5-4 and in Figure 2 in Appendix I, Section B-1. The statistical analysis using the repeated measures ANOVA indicated two statistically significant changes from baseline averages in 2011 (Table 5-5). The mean c-value and FQI in June 2011 were significantly lower than the baseline average. The mean c-value was very near the baseline low of 2.83 and the FQI was below the baseline low value if 17.66. This could indicate colonization by lower quality species; however, the species richness and diversity values did not change significantly in 2011. Traditionally, FQI and c-value have been lower in the spring and higher in the fall. Since only spring monitoring was completed in 2011, it is possible these values could show an increase when monitoring is continued in the fall of 2012; this will be closely monitored. Natural color and CIR aerial photography from 2011 show no significant visible change from baseline photography for W-25 (Appendix I, Section B-1). The data gathered during the 2011 monitoring efforts do not trigger a yellow or red flag as outlined in Figure 4-2. It is recommended that monitoring at W-25 continue consistent with the current methodology for Level 2.

<table>
<thead>
<tr>
<th>Table 5-5: Record of Thresholds Evaluation by Sampling Season for Wetland 25</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sampling Season</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Sept. 2008</td>
</tr>
<tr>
<td>June 2009</td>
</tr>
<tr>
<td>Sept. 2009</td>
</tr>
<tr>
<td>June 2010</td>
</tr>
<tr>
<td>Sept. 2010</td>
</tr>
<tr>
<td>June 2011</td>
</tr>
</tbody>
</table>

5.1.1.3  PEM Wetland 100 – Saunders County

Wetland 100 is a PEM wetland located in Saunders County, Nebraska (Figure 1, Section C-1, Appendix I). The vegetation in this wetland was sampled using 3 transects, 11 gradsects, and 55 sample plots. Dominant species observed in this wetland during the 2011 monitoring efforts included redtop (*Agrostis gigantea*), annual marshelder (*Iva annua*), sedge, and Kentucky bluegrass. Wetland 100 (excluding the upland gradsects) had a WA<sub>W</sub> of 2.67 in the spring of 2011 (Table 5-6), indicating that it continues to be dominated by wetland vegetation. The baseline threshold WA<sub>W</sub> prior to Project operation for W-100 is 2.96. The WA<sub>W</sub> for spring of 2011 remained below the baseline threshold as illustrated in Figure 2 in Section C-1 in Appendix I. This wetland contained an average of 83 percent native species and 49...
percent invasive species in 2011. The FQI for this wetland during the same time period was 13.36, implying a moderate ecological value. Tables 1 and 2 in Section C-2 of Appendix I contain a summary of the monitoring data and the complete species list from both of the 2011 monitoring effort.

| Table 5-6: Wetland 100 Comparison of 2011 Vegetation Data to Baseline Averages |
|-----------------------------|---------------------|---------------------|---------------------|
|                             | Spring 2011 | Baseline Mean | Baseline Low | Baseline High |
| WA<sub>m</sub>              | 2.67       | 2.40         | 1.71         | 2.96         |
| Species Richness           | 35         | 28.71        | 23.00        | 33.00        |
| Species Diversity          | 21.31      | 14.13        | 11.34        | 17.09        |
| Mean C Value               | 2.48       | 3.41         | 3.00         | 3.72         |
| FQI                        | 13.36      | 16.42        | 14.70        | 18.33        |

The WA<sub>m</sub> for the 2011 sampling season did not increase by 0.5 or more from the baseline WA<sub>m</sub> of 2.40 as shown in Table 5-6 and in Figure 2 in Appendix I, Section C-1. The statistical analysis, using the repeated measures ANOVA, indicated three statistically significant changes from baseline averages in 2011 (Table 5-7). The FQI and mean c-value were significantly lower than the baseline average for the second year in a row. That indicates that lower quality species are more dominant in W-100. The third metric, species richness, was significantly higher than the baseline mean. This indicates an increase in the number of different species observed during 2011 monitoring, somewhat counterintuitive given the single sampling effort. As expected, a higher species richness resulted in a higher than average species diversity value as well.

| Table 5-7: Record of Thresholds Evaluation by Sampling Season for Wetland 100 |
|-----------------------------|---------|---------------------|--------------------|---------------------|
|                             | Increase in WA<sub>m</sub> by more than 0.5? | A significant difference in three or more of the following indices? | Change visible on aerial photos? | Monitoring Intensity Change? |
| Sampling Season             | FQI     | mean c-value | species diversity | species richness | Flag? | |
| Sept. 2008                  | No*     | No          | No                | No               | No    | No     |
| June 2009                   | No*     | No          | No                | No               | No    | No     |
| Sept. 2009                  | No      | No          | No                | No               | No    | Yes - Decrease to Level 1 |
| June 2010                   | No      | No          | No                | No               | No    | No - Remain at Level 1   |
| Sept. 2010                  | No      | Yes         | Yes               | No               | No    | No - Remain at Level 1   |
| June 2011                   | No      | Yes         | Yes               | No               | Yes   | Yes - Decrease to Level 2 |

* = A significant decrease in WAM occurred, indicating that the wetland was wetter than baseline average.
The changes observed in the vegetation metrics are likely due to maintenance activities performed at W-100 in 2011. Wetland 100 is part of a larger hay meadow that is routinely mowed and bailed for hay two to three times each growing season. To protect the staking that indicated the locations of the transects and gridsects and to protect the farm equipment from harm when encountering the rebar, each of the three sampling areas in W-100 had been marked off using t-posts. The routine haying continued to take place in the areas surrounding the transects, but not within the transects themselves. In 2010, it became apparent that the composition of the vegetation within each transect was visually much different when compared to the surrounding plant community in the rest of W-100. Therefore, in the early spring of 2011, the fence posts and rebar were removed and all of W-100, including the monitored portion, was mowed. This likely affected the species composition in 2011 when compared to previous years.

Although the maintenance at W-100 likely affected the vegetative matrices, the WA* was still well below the baseline high and the aerial photographs showed no significant change. Therefore, it was determined that W-100 would also be decreased to Level 2 monitoring. The data gathered during the 2011 monitoring effort do not trigger a yellow or red flag as described above. Wetland 100 will continue to be closely monitored in 2012. Natural color and CIR aerial photography from 2011 show no significant visible change from baseline photography for W-100 (Appendix I, Section C-1). It is recommended that monitoring at W-100 continue consistent with the current methodology for Level 2.

5.1.2 False-color Infrared (CIR) Aerial Photography
As described above, CIR aerial photography was scheduled and obtained in 2011. CIR and natural color aerial photography were flown by Western Air Maps on August 1, 2011, and are included for the wetlands in the well fields in Appendix I. No visible deviations from past CIR aerial photography were noted in the 2011 review as described above for each of the wetlands monitored in the well fields in 2011.

5.2 WETLAND MONITORING IN THE CONES OF DEPRESSION
As stated above, natural color and CIR aerial photography were obtained in 2011 for the first time since 2009. Figures depicting the monitoring of the wetlands in the cones of depression based on natural color and CIR aerial photography are included in Appendix II. No visible deviations from past aerial photography were noted in 2011.

5.3 HYDROLOGICAL MONITORING
Several different types of hydrological data were collected during the 2011 monitoring efforts. These collected data have been analyzed and the results are discussed below and included in Appendix III.
5.3.1 **Groundwater Monitoring Wells**

The groundwater monitoring well data collected for 2011 have been graphed and are presented for each monitoring well in Figures 1 through 23 in Section A of Appendix III. Readings from these monitoring wells provide additional hydrological data for comparison should any changes be detected in the wetland vegetation data. A review of the monitoring well data over time indicates that water level elevations appear to be experiencing normal, seasonal fluctuation. Almost all of the monitored wells showed lower elevations in fall 2011 compared to the same period in 2010. The lower 2011 elevations are likely the result of the combination of increased pumping within the well fields and below average precipitation in Fall 2011.

5.3.2 **Production Wells**

The Project production wells are monitored using installed data loggers. The total production well pumping rates by month, the total volume pumped per month, and the average monthly pumping rates for each production well have been included in Tables 1 and 2 in Section B, Appendix III. Project pumping in 2011 reached a new high during the month of September. This increase in volume was required to compensate for the loss of supply when another of the District’s water treatment plants was off-line for maintenance in the fall of 2011. Although the production rate reached a new high during 2011, pumping rates still remained well below the permitted capacity for the plant.

5.3.3 **Piezometers**

Eighteen piezometers have been installed and are being monitored in the Saunders County well field. The collected data from the 2011 monitoring efforts have been graphed over time and are presented in Section C, Appendix III. Many of the 2011 piezometer readings were within inches of the bottom of the piezometers and held steady over multiple readings. The bottom elevation of each piezometer is included in the legend of each figure in Section C, Appendix III. Based on the consistent readings over months indicated by many of the piezometers, it is likely that the readings are the result of residual moisture and sediment retained in the tips of the piezometers rather than an accurate measurement of the local water table elevation. In these cases, the actual water table elevation is assumed to be lower than the reported level. In general, water level elevations taken from the piezometers were lower than those observed during baseline conditions for each of the wetlands monitored.

5.3.4 **Bathymetric Monitoring of Ponds**

The post-operation bathymetric monitoring of ponds located in the Douglas County and Saunders County well fields and associated cones of depression was completed during 2011 as planned. In 2011, most of the pond water levels were highest in March before gradually dropping in August, September, and
October. Of the 46 ponds monitored in 2011, eight ponds showed a statistically significant difference in water level elevation when comparing the 2009 through 2011 operational data to the baseline data (August 2006 through March 2008). Of those eight ponds, five were significantly lower than baseline levels and three were significantly higher than baseline levels. Detailed analysis of these monitoring efforts are included in a separate report entitled the 2011 Annual Bathymetric Monitoring Report for the Ponds within the Well Fields and Cones of Depression (Burns & McDonnell 2012).

5.3.5 Other Hydrological Data

Additional hydrological data collected during the 2011 monitoring efforts included monthly total precipitation, monthly average ambient air temperature, and stream gauge data. The monthly precipitation during 2011 was generally below the monthly historical averages with the exception of the late spring (May and June), during which the monthly total exceeded the historical monthly average by less than one inch (Section D, Appendix III). Almost no precipitation occurred in July and September. Overall, the January to November 2011 recorded precipitation total was 16.7 inches, while the annual historical average during the same period was 28.9 inches indicating a much drier than normal year (The Weather Channel 2011). Overall, the 2011 recorded precipitation total was over 12 inches below normal through November. (Figure 1, Section D, Appendix III). Historically, the amount of precipitation increases from January to a peak in May, declines to a plateau in late summer, and continues to decline through the end of the year.

Average ambient air temperature in 2011 fell within the expected monthly high and low temperature range based on the historical average (Figure 2, Section D, Appendix III). Average monthly temperatures consistently ranged between 17 °F and 76 °F.

Stream gauge data was obtained from the USGS stream gauge stations on the Platte and Elkhorn rivers. Historically, stream elevations are highest in the spring and lowest in late summer and early fall (Figures 3 and 4, Section D, Appendix III). In 2011, the mean stream elevation of the Platte River was approximately a foot above normal for the entire year. The peak recorded in February can likely be attributed to significant snow melt, while the peak in June likely reflects the greater than average precipitation in the area for May and June.

Mean stream elevations in the Elkhorn River in 2011 followed a more normal pattern and did not exhibit the sustained above-average levels described above for the Platte River. Throughout the monitoring year, the stream elevations in the Elkhorn River, for the most part, fell below historic levels. The only month
that did not follow this trend was July which showed a higher average stream elevation compared to the historic data. This increase in stream level does not correlate to the 2011 precipitation data for the area.

* * * * *
6.0 DISCUSSION AND RECOMMENDATIONS

The goal of monitoring wetlands within the Douglas County and Saunders County well fields and associated cones of depression is to evaluate the impact that operation of the Project may have on the existing wetlands. To accomplish this goal, a monitoring approach consisting of a systematic, multi-tiered vegetation sampling procedure has been developed and implemented. Monitoring efforts conducted from the inception of the monitoring program in 2005 through this year's monitoring effort (in 2011) are discussed in the sections below. A review of the thresholds analysis and the current and proposed level of monitoring efforts proposed for next year are also included below.

6.1 DISCUSSION

The following sections discuss the 2011 wetland monitoring efforts for wetlands in the well fields and cones of depression.

6.1.1 Wetland Monitoring in the Well Fields

Data obtained during the 2011 sampling season have been analyzed and the results are included in Appendix I. In 2011, the Level 2 Decreased Annual Wetland Monitoring protocol was conducted for the first time. This required sampling of the wetland vegetation in June only. The calculated values for the WA\textsubscript{M} were within the expected ranges established from the baseline data for all three monitored wetlands and no significant differences from baseline vegetation were documented in 2011.

The WA\textsubscript{M} calculated for each wetland and each sampling season since monitoring began have been graphed and are included as Figure 5 in Appendix I. This vegetative parameter has been accepted as the most likely indicator of change in the monitored wetlands and these graphs provide a useful visual reference of the WA\textsubscript{M} over time. A trend line has also been calculated for each wetland. The trend lines for each wetland have a negative or nearly level slope, which indicates that the wetlands are actually trending towards being wetter rather than drying out as might be anticipated given the operation of the Project.

The statistical analysis of the other vegetative parameters also indicated that the monitored wetlands remain within baseline variation with only one or two indices falling outside of statistical normality. The FQI and mean C-value for W-25 and W-100 are both significantly lower than the baseline averages for these wetlands. In W-100, this change could be due to the mowing that took place early in 2011. For both of these wetlands, these indices will be closely monitored during the 2012 sampling season to evaluate whether the changes continue or return to baseline conditions.
6.1.2 Wetland Monitoring in the Cones of Depression

The wetlands in the cones of depression were monitored using the CIR aerial photography that was obtained in 2011 for both well fields and the associated cones of depression in Douglas and Saunders counties. No discernable changes were noticed during review and comparison of the 2011 aerials to past photography. Project-specific aerial photography will not be obtained in 2012 per the guidelines of the Level 2 Decreased Annual Wetland Monitoring protocol. Natural color and CIR aerial photography will again be obtained in 2013 and compared to previously obtained images. Over time, these photographs will continue to provide documentation of the normal fluctuations in size, shape, or condition of the various wetlands and will be compared to the baseline conditions. No change in the monitoring protocol for the wetlands in the cones of depression is anticipated at this time.

6.1.3 Hydrological Monitoring

In addition to the wetland monitoring efforts, several different types of hydrological data have been gathered and analyzed as part of the ongoing monitoring efforts. These hydrological data include groundwater monitoring wells, piezometers, monthly average precipitation, monthly average ambient air temperature, and stream gauge data for the Platte and Elkhorn Rivers. Each of these pieces of data remain appropriate and relevant to the monitoring effort and no change to the collections or analysis of this data is recommended at this time.

6.2 RECOMMENDATIONS

This report summarizes the 2011 wetland monitoring efforts. As a result of the conditions observed in the wetlands discussed above, it is recommended that wetland monitoring efforts in 2012 continue without changes to the methodology at this time. Level 2 decreased monitoring is conducted once annually and will rotate between the June and September sampling seasons. Since 2011 vegetation monitoring took place in June 2012 wetland monitoring will be conducted in September 2012 at the emergent wetlands only. Aerial photography will not be flown in 2012, but will be flown again in 2013. Data collected in 2012 will continue to be compared to the baseline data in an attempt to determine the effects, if any, of Project operation.

* * * * *
7.0 REFERENCES


* * * * *