2010 Annual Mitigation Site Monitoring Report

Platte West Water Production Facilities Project

Prepared for

Metropolitan Utilities District
Omaha, Nebraska

metropolitan UTILITIES DISTRICT

January 2011

Burns & McDonnell
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2010 Annual Wetland Mitigation Site Monitoring Report

for the

Platte West Water Production Facilities Project

Prepared for:
Metropolitan Utilities District
Omaha, Nebraska

Prepared by:
Burns & McDonnell Engineering Company, Inc.
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Project Number: 56799

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****Cover photograph of (Scirpus atrovirens) taken at Douglas County Backwash Mitigation Site (WM-3) in June 2010****

1.0 INTRODUCTION

The Metropolitan Utilities District (District), Omaha, Nebraska, received 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). The terms and conditions included in the Permit were based to a large degree on the impact analysis and the conceptual mitigation plan included in the Environmental Impact Statement (EIS) completed by the District in 2002 (Burns & McDonnell 2002a and 2002b). As part of the terms and conditions included with the Section 404 Permit, the District has agreed to provide mitigation for both direct and indirect impacts to wetlands and watercourses that may result from the Project. Direct impacts result from the construction of the Project facilities; indirect impacts could occur due to groundwater drawdown during the operation of the Project.

The District, with concurrence from the Corps, decided to pursue wetland mitigation in phases. At least three phases of wetland mitigation were planned. Phase I of the mitigation effort provided measures to compensate for upfront construction impacts (direct impacts). Phase II provided mitigation for anticipated indirect impacts to wetlands in the two well fields due to groundwater drawdown. As currently planned, Phase III mitigation will address any impacts or alterations to wetlands that may occur as a result of drawdown outside of the two well fields in the projected Project cones of depression. Groundwater modeling in the 2002 EIS estimated that a drawdown in the groundwater levels of one foot or more would impact most wetlands. Therefore, the potential cones of depression are the areas predicted to experience a one-foot or greater drawdown of the local water table as a result of Project operation. The projected location of the cones of depression has been revised several times since completion of the 2002 EIS with additional groundwater data and refined modeling procedures. The anticipated boundaries of the potential cones of depression, as calculated in 2010, are shown in Figure 1-1. As stated above, these potential boundaries are updated periodically through refined transient groundwater modeling and will be incorporated into this report as they become available.

In the 2002 EIS, wetland impacts in the well fields due to construction and operation of Project facilities were predicted to total 14.6 acres. Approximately 0.3 acre of wetlands was to be impacted due to construction, while Project operation was estimated to impact 14.3 acres of wetlands in the two well fields. This 14.6 acres included both direct and indirect impacts that

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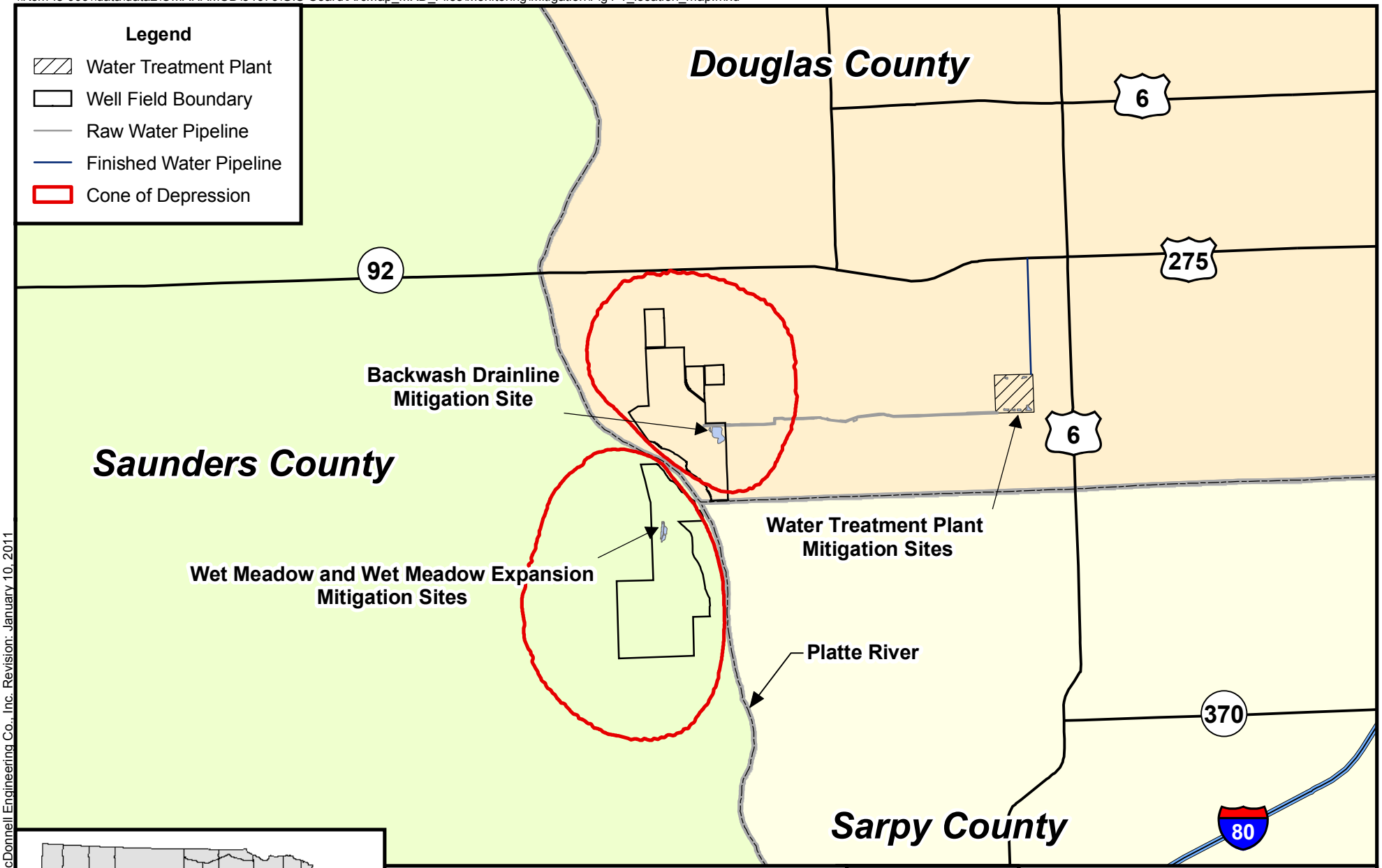

Figure 1-1
Location Map of the Phase I and II Mitigation Sites
Platte West Water Production Facilities Project
Metropolitan Utilities District

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would occur in the well fields (Phases I and II). According to the Section 404 permit conditions, the 14.6 acres predicted to be impacted were to be mitigated at a ratio of 1.5:1.0 (wetlands created to wetlands impacted); this amounts to a total of 21.9 acres of replacement wetlands. In addition, another 141.6 acres of wetland alteration (conversion to a drier wetland type by drawdown of the water table) were estimated to potentially occur in the cones of depression at some time in the future due to Project operation. Since the issuance of the 2002 EIS, a Mitigation Site Selection Study was prepared and finalized (Burns & McDonnell 2007a). This site selection study evaluated a total of 16 separate potential wetland mitigation sites that could be pursued by the District to provide wetland mitigation to compensate for impacts as a result of Project construction and operation.

1.1 MITIGATION SITES

Phase I and Phase II mitigation have been implemented as described above. Phase I mitigation for direct impacts to wetlands was accomplished in two separate locations – the Wet Meadow Mitigation Site (WM-1) and the Water Treatment Plant Mitigation Sites (WM-4 through WM-9) (Figure 1-1). The *Mitigation Plan for Phase I Impacts* (Phase I Mitigation Plan; Burns & McDonnell 2005c) was approved in 2005; that report provides details of the Phase I mitigation efforts.

Phase II mitigation for indirect impacts to wetlands in the well fields was accomplished at two separate locations – the Wet Meadow Expansion Mitigation Site (WM-2) and the Douglas County Backwash Drain Line Mitigation Site (WM-3) (Figure 1-1). As stated above, Phase II mitigation has been implemented to address potential indirect impacts which may occur within the well fields as the result of Project operation. Details of the Phase II mitigation efforts are provided in the *Mitigation Plan for Wetland Impacts* – Phase II (Phase II Mitigation Plan; Burns & McDonnell 2007b), which was approved in 2007.

1.1.1 Wet Meadow Mitigation Site

Phase I mitigation for construction-related impacts from all aspects of the Project, except for the new water treatment plant, was completed in the Saunders County well field near the 95-acre area known as the Wet Meadow (Wet Meadow Mitigation Site, WM-1). A total of 0.3 acre of wetlands was permanently impacted due to the construction of the facilities in the two well fields required for this Project. As described above, these impacts were mitigated at a 1.5:1.0 (created wetlands to impacted wetlands) ratio. As a result, approximately 0.45 acre of wetland was created as mitigation for up-front Project construction impacts in the well fields.

In 2005, WM-1 was constructed on approximately 22 acres of cropland owned by the District (Figure 1-2). WM-1 is an approximately 3.6-acre emergent wetland constructed in a formerly farmed wetland. The surrounding upland area was seeded with native vegetation to create an upland buffer. Approximately 4.7 acres of this upland buffer was later converted to wetland during the Phase II creation of WM-2 described in the Section 1.1.2 of this report. WM-1 provided wetland mitigation in excess of what is required for Phase I construction-related impacts. This excess wetland acreage created was applied to Phase II mitigation for indirect impacts that would occur during Project operation. As mentioned above, construction of WM-1 began late in the summer of 2005; grading of the created wetland and seeding with native vegetation was completed in December 2005. The *As-Built Report for the Wet Meadow Mitigation Site* documents the construction of the mitigation site (Burns & McDonnell 2007c).

1.1.2 Wet Meadow Expansion Mitigation Site

The Wet Meadow Expansion Mitigation Site (WM-2) was constructed in the winter of 2007-2008 east of existing WM-1 in the upland buffer area (Figure 1-2). The two wet meadow mitigation sites (WM-1 and WM-2) are hydrologically connected at the north and south ends, but are otherwise separated by a narrow upland buffer. WM-2 consists of an approximately 4.7-acre emergent wetland divided into two separate wetland cells (Figure 1, Section B-1, Appendix I). Upon the completion of the construction of WM-2, approximately 13.7 acres of upland buffer area have been created surrounding the two wet meadow mitigation sites. The *As-Built Report for Phase II Wetland Mitigation Sites* documents the construction of the mitigation site (Burns & McDonnell 2008a).

1.1.3 Douglas County Backwash Drain Line Mitigation Site

The Backwash Drain Line Mitigation Site (WM-3) was constructed in the Douglas County well field as part of the Phase II mitigation effort in the winter of 2007-2008. WM-3 is located at the outlet of the backwash drain line west of the Elkhorn River (Figure 1-3). The drain line outlet was configured to discharge water into the mitigation site. The backwash water is of suitable quality for discharge into the Elkhorn River; therefore, the quality of water is also suitable for the creation and establishment of an emergent wetland for mitigation. WM-3 is located in an 80-acre former crop field in the southeastern portion of the Douglas County well field (Figure 1-3). Based on the as-built survey, 15.42 acres of emergent wetland were created at WM-3. In addition, 2.78 acres of drainage swales at the site are developing into wetland swales and an additional 58.04 acres of upland buffer were developed. The *As-Built*

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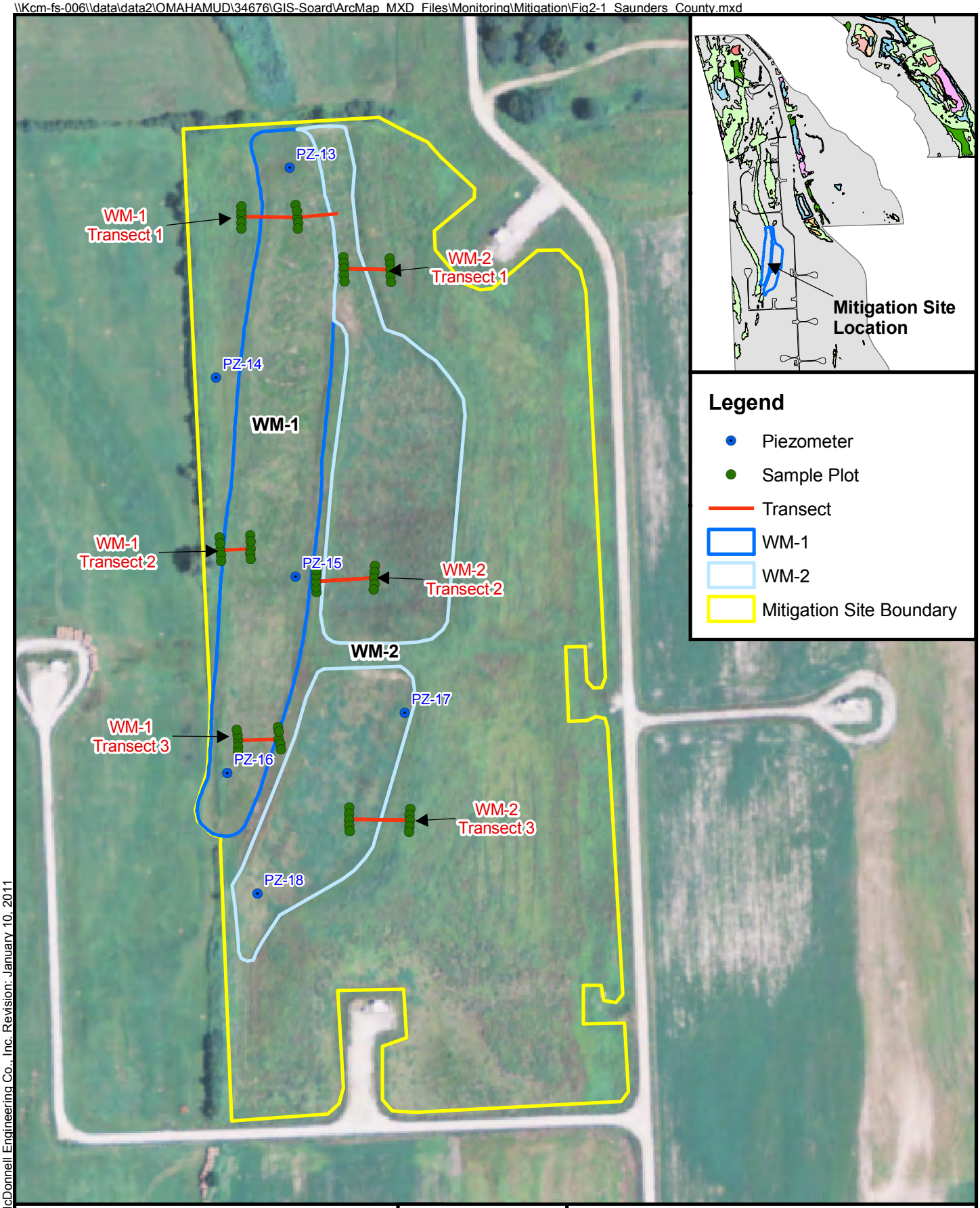

Source: USDA National Agriculture Imagery Program (NAIP) aerial photography for Saunders County, NE (2010)

Figure 1-2
Location Map for
WM-1 and WM-2
Saunders County Wellfield
Metropolitan Utilities District

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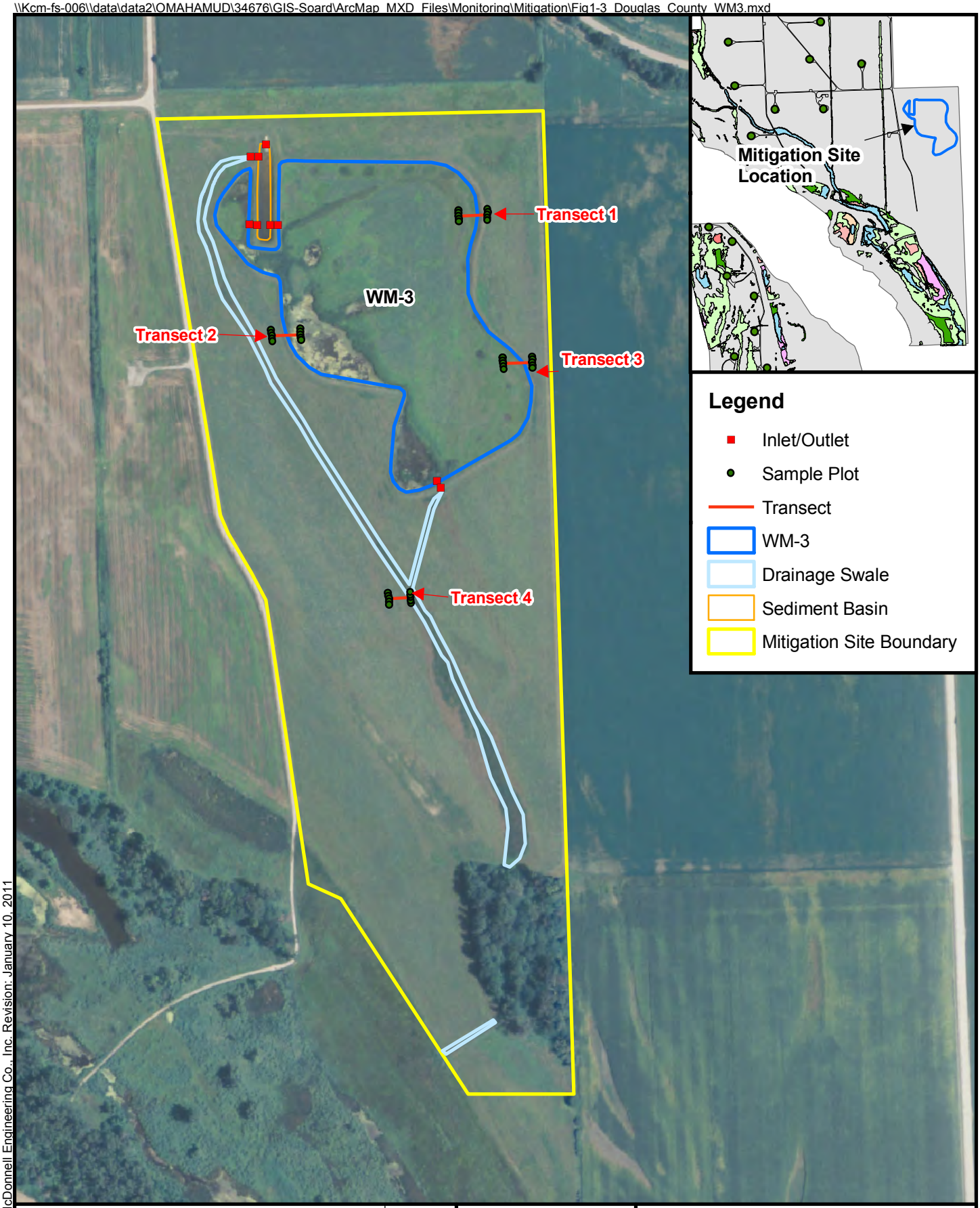

Source: USDA National Agriculture Imagery Program (NAIP) aerial photography for Saunders County, NE (2010)

Figure 1-3
Location Map for
WM-3
Douglas County Wellfield
Metropolitan Utilities District

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Report for Phase II Wetland Mitigation Sites documents the construction of the mitigation site (Burns & McDonnell 2008a).

1.1.4 Water Treatment Plant Mitigation Sites

The mitigation for impacts resulting from construction of the District's new water treatment plant in Douglas County is accomplished on-site at six wetland cells located at the water treatment plant site (Water Treatment Plant mitigation sites, WM-4 through WM-9). The Water Treatment Plant mitigation sites are located on the water treatment plant property owned by the District in Douglas County (Figure 1-4). A total of 3.91 acres of wetlands and 175 feet of intermittent stream was created. Construction of the wetlands and intermittent stream was completed in May 2009. The *As-Built Report for the Phase I Water Treatment Plant Wetland Mitigation Site* was prepared after construction and planting was completed (Burns & McDonnell 2009).

1.2 MONITORING GOALS

The goal of the wetland mitigation monitoring program is to measure the establishment of the wetland mitigation sites and to observe whether the mitigation sites develop similar functions and values as those wetlands and waters of the United States affected by Project construction and operation. According to the EIS, a total of 21.9 acres of wetland mitigation are necessary as a result of direct and indirect Project impacts. Mitigation efforts will be considered successful at a given site if the following criteria occur:

1. Eighty percent cover of native wetland vegetation will be established in the created emergent wetlands and along the banks of the created stream channel.
2. Positive indicators of hydric soils such as low chroma dominant colors, redoximorphic features, or oxidized rhizospheres are found in the created emergent wetlands.
3. Positive indicators of wetland hydrology such as inundation, saturation in the upper 12 inches of the soil, watermarks, and drift lines are found in the created emergent wetlands.

This report summarizes the 2010 monitoring efforts conducted at the Phase I and Phase II mitigation sites. Monitoring of Phase I mitigation site WM-1 was initiated in September 2006. Monitoring at Phase II mitigation sites WM-2 and WM-3 first took place in the fall of 2008. Finally, monitoring at the Phase I Water Treatment Plant mitigation sites (WM-4 through WM-9) began during the fall sampling period in 2009. Monitoring efforts at the mitigation sites will be conducted twice per year for a period of five years from the initial monitoring effort or until

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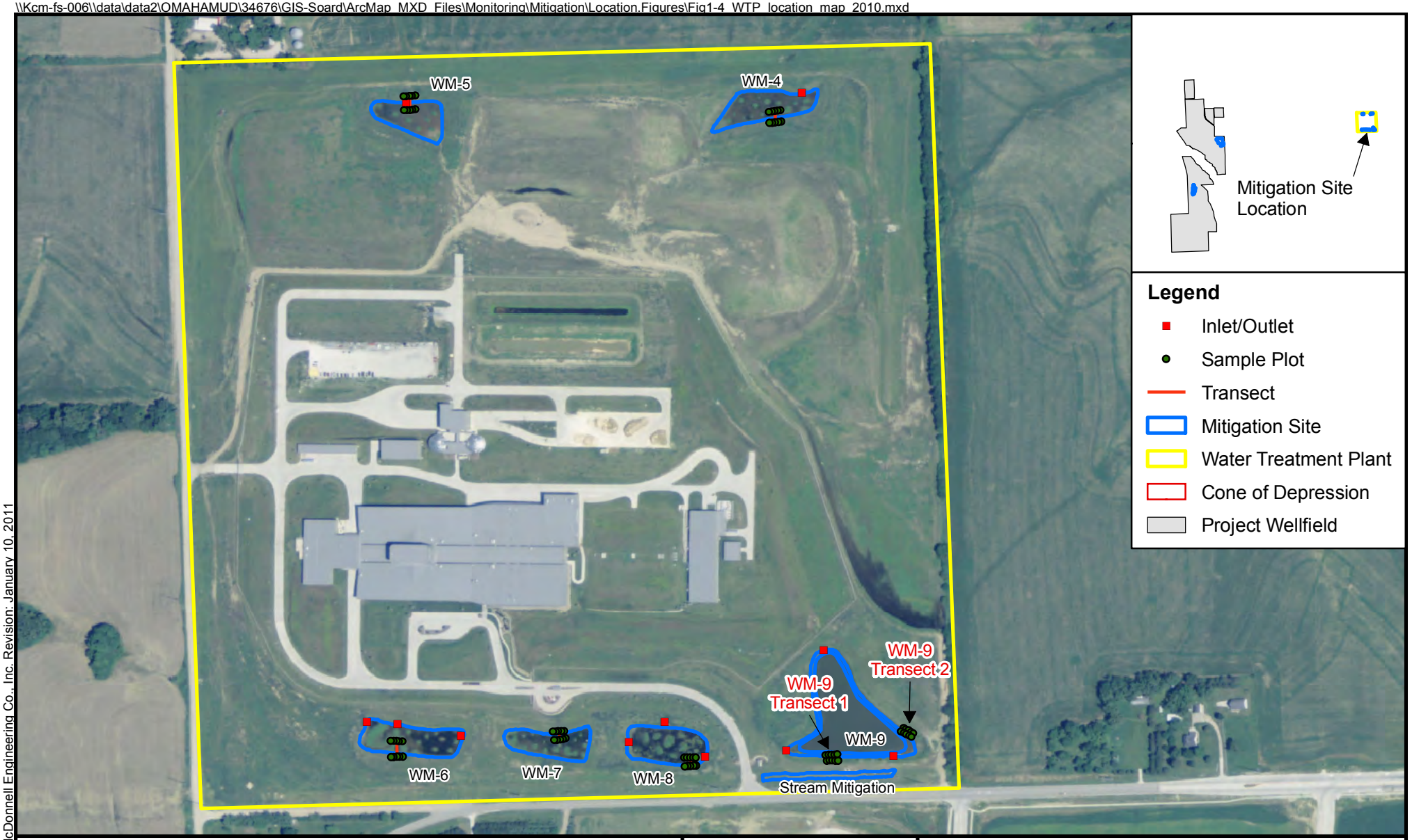

Source: USDA National Agriculture Imagery Program (NAIP) aerial photography for Saunders County, NE (2010)

Figure 1-4
Location Map of the
Water Treatment Plant Mitigation Sites
Douglas County
Metropolitan Utilities District

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mitigation goals have been met. No Phase III mitigation sites have been developed to date or are planned to be developed without mutual agreement between the Corps and the District.

2.0 SAMPLING METHODOLOGY

A wetland monitoring approach consisting of a systematic, multi-tiered, vegetation sampling procedure has been developed and implemented based on the methodology outlined in the Phase I Mitigation Plan. 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. Some of the references and sources used included:

- 1987 Corps and 1989 Federal wetland delineation manuals (Environmental Laboratory 1987 and Federal Interagency Committee for Wetland Delineation 1989)
- performance standards for wetland creation and restoration found in Streever 1999 and Environmental Law Institute 2004
- vegetation sampling methodologies found in U.S. Environmental Protection Agency 2002 and Tiner 1999
- wetland mitigation guidelines found in Taylor and Krueger 1997

Phase I wetland monitoring, as stated above and described in the following paragraphs, began in 2006 at WM-1. In 2008, two Phase II wetland mitigation sites were completed and monitored (WM-2 and WM-3). In 2009, monitoring began at the six wetland mitigation sites located at the water treatment plant (WM-4 through WM-9) as well as the stream mitigation site. Wetland monitoring will continue at these sites for a period of five years from the initial monitoring season or until mitigation goals are met.

2.1 VEGETATION SAMPLING

Herbaceous plant species at the mitigation sites are 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, 3-foot diameter circular sample plots placed along the gradsect.

During the first sampling period at each mitigation site, the placement of each permanent transect, gradsect, and sample plot was established 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 using 2-foot sections of 3/8-inch rebar, painted orange and flagged. These permanent markers also serve as photograph stations. A photographic record is maintained for each sampling period at each gradsect and transect. This photographic documentation provides a repetitive visual record that corresponds to the wetland vegetation monitoring during seasons and over years.

Vegetation and plant species data that were collected during the annual wetland vegetation monitoring effort include the identification, to species when possible, of each plant located within the 3-foot diameter sample plot. Current nomenclature and plant characteristics were obtained from the USDA PLANTS Database (USDA NRCS 2010). 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 2-1: Modified Daubenmire Cover Class Scale

Cover Class	1	2	3	4	5	6	7
Range (%)	0-1	1-5	5-25	25-50	50-75	75-95	95-100
Midpoint (%)	0.5	3.0	15.0	37.5	62.5	85.0	97.5

A cover class was also estimated for the non-vegetated area in the 3-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 areas allows for the determination of the total percent cover of vegetation in the plot by subtracting the percent bare area from 100 percent, the maximum surface area possible in the plot. Even with bare areas in a plot, the total cover of vegetation may be greater than 100 percent, because plants often overlap in a plot. If standing water was present, the water depth was recorded in the center of each plot along a given gradsect.

2.2 HYDROLOGICAL MONITORING

The following sections detail the various types of hydrological data that were collected as part of the monitoring effort.

2.2.1 Piezometers

Four piezometers were installed in the Wet Meadow mitigation site (WM-1) as described in the Phase I Mitigation Plan. The locations of the installed piezometers have been recorded using GPS (Figure 1, Section A-1, Appendix I). Two additional piezometers were installed in WM-2 in 2009. The locations of these piezometers are included in Figure 1, Section B-1, Appendix I.

Each installed piezometer is monitored on a 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 the Phase I and Phase II Mitigation Plans.

2.2.2 Other Hydrological Data

Additional hydrological data is also being 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 AND RESULTS

The following sections provide a brief discussion of the data analysis and the results of the 2010 annual wetland monitoring efforts at the mitigation sites.

3.1 VEGETATION SAMPLING DATA ANALYSIS

Vegetation monitoring of the mitigation sites was conducted in June and September 2010 to characterize major wetland and upland plant communities and the variation between them. Vegetation sampling took place in sample plots established along permanent transects and gradsects. Data obtained during the 2010 sampling efforts have been analyzed and the results are discussed below and included in Appendix I.

All of the vegetation data obtained for the sites were 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. The vegetative characteristics that were analyzed are described below.

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

3.1.1 Average Percent Cover

The average percent cover for a given herbaceous species in a given sampling unit (wetland, transect, gradsect, sample plot) equals the sum of the midpoint values (Table 2-1) of that species for that particular sampling unit divided by the total number of wetland sample plots in that sampling unit. The total number of sample plots is used instead of the count of the cover values. The number of sample plots is a constant at the wetland level. There are additional upland sample plots adjacent to the emergent wetlands; however, the data from these plots has not been included in this analysis. It is available should further investigations into the wetland system be necessary.

3.1.2 Percent Native Species

The percent native species value is the count, or number, of all species listed as "native" or "native and introduced" in that wetland during that sampling effort divided by the total count of species recorded in that wetland during that same sampling effort.

3.1.3 Percent Invasive Species

The percent invasive species value is the count of species listed as "invasive" in that wetland during that sampling effort divided by the total count of species recorded in that wetland during that same sampling effort.

3.1.4 Frequency

Frequency is defined as the total number of plots in which a given species occurs for a given sampling effort. The frequency will be a whole number greater than zero.

3.1.5 Species Richness

Species richness is the count of different herbaceous, shrub, and tree species identified in a given community for a given sampling effort. The species richness will be a whole number greater than zero.

3.1.6 Species Diversity (D)

Species diversity is the number of different species in an area (i.e.: species richness) weighted by a measure of abundance. For this analysis, the frequency is the measure of abundance. In general, species diversity decreases with increasing heterogeneity; therefore, the lower the species diversity value, the more diverse the plant community.

The methodology for calculating the species diversity is included below. The formula for species diversity follows Simpson (1949):

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

where N = total number of occurrences for all species in all plots.

n = number of occurrences (or frequency) for each individual species. This value combines data from all strata (herbaceous, shrubs, and trees) of the same species into a single value for that species.

3.1.7 Floristic Quality Assessment (FQA)

A Floristic Quality Analysis (FQA) of the each mitigation site is also conducted annually. The FQA is comprised of two different calculations: the mean c-value and the floristic quality index (FQI). The mean c-value is the average of the c-values from the plant species identified in the sampling unit. The mean c-value provides a measure of the botanical quality of a site that can be compared from year to year. However, 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 sampling unit.

Higher mean c-values and FQI numbers correspond to more natural sites that have a higher quality and species diversity. Lower mean c-values and FQI numbers imply a more disturbed or lower quality site.

FQI is calculated using the following formula:

$$Floristic\,Quality\,Index\,(FQI) = \bar{c}\sqrt{n}$$

where $\bar{c}$ = mean or average c-value.

n = count or number of native species in a given area.

3.1.8 Mean Weighted Average (WA_M)

The mean weighted average (WA_M) provides an indication of the wetness of an area and can be used to determine if that area has the hydrophytic vegetation necessary to qualify as a wetland. The calculated WA_M will be a value between zero and five. It should be equal to or less than 3.0 in order for a specific site to meet the criteria for wetland vegetation. In transitional areas, a WA_M may approach 3.5, depending on landscape position, hydrology, and other related features. A WA_M greater than 3.5 is likely an upland area.

The WA_M is calculated using the following formula:

$$\text{Mean Weighted Average}\,(WA_M) = \frac{\sum I\,E}{\sum I}$$

I = the importance value for the species – for this Project, the importance value is the percent cover for the species in the sample plot.

E = the ecological index for the species – for this Project, the ecological index is a value between one and five that corresponds to the wetland indicator status for the given

species. (An ecological index value of one corresponds to an obligate or wetland plant and a value of five corresponds to an upland plant.)

3.2 VEGETATION SAMPLING RESULTS

The following sections provide some of the data analysis results for the wetland mitigation sites that were sampled during the 2010 monitoring efforts. The complete set of data (figures, summary tables, ground photographs, and raw data sheets) is contained in Appendices I and II.

3.2.1 Wet Meadow Mitigation Site (WM-1)

The Wet Meadow mitigation site, when combined with the adjacent WM-2, consists of approximately 22 acres of former cropland located in the District's Saunders County well field (Figure 1, Appendix I-A). Within the 22 acres, 3.6 acres have been restored to emergent wetland WM-1, 4.7 acres have been converted to emergent wetland WM-2, and the remaining 13.7 acres have been converted to upland buffer. The vegetation in WM-1 has been sampled using a total of 3 transects, 6 gradsects, and 30 sample plots. An additional gradsect was added to Transect 1 in Spring 2008 because the creation of WM-2 occurred in the former location of an upland gradsect (WM1-1-1); gradsect WM1-1-1 is no longer monitored. This new upland gradsect was established to the west of WM-1 (WM1-1-3).

The dominant species in WM-1 during 2010 was Canadian horseweed (*Conyza canadensis*). Japanese bristlegrass (*Setaria faberi*), Canada goldenrod (*Solidago canadensis*), and bald spikerush (*Eleocharis erythropoda*) were also abundant species. Dominant species in the adjacent upland buffer included prairie cordgrass (*Spartina pectinata*), switchgrass (*Panicum virgatum*), and sawtooth sunflower (*Helianthus grosseserratus*).

WM-1 (excluding the upland gradsects) had a WA_M of 2.58 in the spring and 3.58 in the fall (Table 3-1); these values indicate that the mitigation site may be transitioning to drier vegetation, indicative of an upland. This wetland also contained an average of 83.5 percent native species and 43.5 percent invasive species. The average FQI for this wetland in 2010 was 14.06, which was a large increase from 2008 and 2009. Conditions at WM-1 continue to appear drier compared to previous years and the vegetation began to reflect that during the fall 2010 monitoring effort. Cattail control at WM-1 was very successful in 2009 and additional control was not necessary in 2010. Species richness and diversity continue to increase at WM-1

compared to previous levels. Some of this can be attributed to successful cattail control, but some can also likely be attributed to a drier moisture regime and more upland plant species becoming established. The mean c-value at WM-1 was 2.96 in the spring and 2.57 in the fall. Maintenance efforts at WM-1 occurred in 2010 and are explained in detail in Section 4.0 and Appendix III of this report. As indicated by the increase of the WA_M, and as observed during the monitoring 2010 monitoring efforts, WM-1 appears to be getting drier. It may be necessary to explore options for improving hydrology at WM-1 (and WM-2) in 2011, including introducing water to the sites and/or adjusting pumping schedules at nearby production wells to pump as little as possible during the early growing season. Tables 1 and 2 in Appendix I-A contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-1: Data Analysis Summary for WM-1 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	2.58	3.58
Species Richness	30	32
Species Diversity (D)	19.82	15.68
Floristic Quality Index (FQI)	14.78	13.33
Mean c-value	2.96	2.57
Percent Native Species	83	84

3.2.2 Wet Meadow Expansion Mitigation Site (WM-2)

The Wet Meadow Expansion mitigation site (WM-2) is an approximately 4.7-acre PEM wetland created adjacent to WM-1 in the District's Saunders County well field (Figure 1, Appendix I-B). A 13.7-acre upland buffer has been established around WM-2 and WM-1. The vegetation in WM-2 was sampled using a total of 3 transects, 6 gradsects, and 30 sample plots. The dominant species in this wetland were Kentucky bluegrass (*Poa pratensis*), black medick (*Medicago lupulina*), and foxtail barley (*Hordeum jubatum*). The dominant species in the upland buffer adjacent to WM-2 were switchgrass and black medick.

WM-2, as a whole (excluding the upland gradsects), had a WA_M of 3.09 in the spring and 3.41 in the fall (Table 3-2); these values indicate that the mitigation site may be transitioning to drier vegetation, indicative of an upland. This wetland also contained an average of 72 percent native species and 55.5 percent invasive species. The average FQI for this wetland in 2010 was 13.35.

The mean c-value at WM-2 was 2.83 in the spring and 2.86 in the fall. As mentioned above for WM-1, it is possible that adjustments will be necessary in 2011 to improve the chance for success development of wetland vegetation at WM-2. Maintenance efforts to remove cattails at WM-2 occurred in 2010 and are described in Section 4.0 and Appendix III of this report. Invasive species will continue to be monitored and controlled as necessary at WM-2 in future years. Tables 1 and 2 in Appendix I-B contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-2: Data Analysis Summary for WM-2 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	3.09	3.41
Species Richness	29	32
Species Diversity (D)	19.96	24.35
Floristic Quality Index (FQI)	12.67	14.03
Mean c-value	2.83	2.86
Percent Native Species	69	75

3.2.3 Douglas County Backwash Drain Line Mitigation Site (WM-3)

The Douglas County Backwash Drain Line mitigation site (WM-3) is located on approximately 80 acres of former cropland in the District's Douglas County well field (Figure 1, Appendix I-C). Of the 80 acres, 15.4 acres have been converted to emergent wetland and 64.6 acres to upland buffer. A series of drainage swales were developed within the upland buffer to route water around the wetland. These are developing successfully into wetland swales. The vegetation in WM-3 was sampled using a total of 4 transects, 8 gradsects, and 40 sample plots. The dominant species in this wetland was broadleaf cattail (*Typha latifolia)*. Other abundant species in WM-3 included bearded beggartick (*Bidens aristosa*), witchgrass (*Panicum capillare*), and annual ragweed (*Ambrosia artemisiifolia*). The dominant species in the upland buffer adjacent to WM-3 were big bluestem (*Andropogon gerardii*), Canada wildrye (*Elymus canadensis*), and Kentucky bluegrass.

WM-3 (excluding the upland gradsects) had a WA_M of 2.80 in the spring and 2.45 in the fall (Table 3-3). This wetland contained an average of 80.5 percent native species and 39 percent invasive species. The average FQI for this wetland in 2010 increased to a value of 11.24, up from

the 2008 value of 6.08 and the 2009 value of 7.29. The mean c-value at WM-3 was 2.33 in the spring and 2.88 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. Maintenance efforts at WM-3 occurred in 2010 and are explained in detail in Section 4.0 and Appendix III of this report. Invasive species will continue to be monitored and controlled as necessary at WM-3 in future years. Tables 1 and 2 in Appendix I-C contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-3: Data Analysis Summary WM-3 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	2.80	2.45
Species Richness	21	25
Species Diversity (D)	13.91	16.26
Floristic Quality Index (FQI)	9.62	12.86
Mean c-value	2.33	2.88
Percent Native Species	81	80

3.2.4 Water Treatment Plant Mitigation Sites

The District completed the construction of the Water Treatment Plant mitigation sites in May of 2009. The Water Treatment Plant mitigation sites consist of six emergent wetland areas that total 3.78 acres of wetlands. Additionally, the District created 175 linear feet of stream mitigation to compensate for the 38 feet of ephemeral stream impacts resulting from construction of the water treatment plant. This will allow for some additional stream mitigation beyond what is required for known stream impacts at this point.

Monitoring efforts at the Water Treatment Plant mitigation sites began in fall 2009; 2010 marked the first year with two sampling seasons. A discussion of the 2010 monitoring effort at each wetland mitigation site is in the following sections.

3.2.4.1 Water Treatment Plant Mitigation Site WM-4

Wetland mitigation site WM-4 is located near the northeast corner of the water treatment plant property (Figure 1, Appendix I-D). The constructed area of WM-4 was measured using GPS in June of 2009 and calculated to be 0.69 acre. The vegetation in WM-4 was sampled using a total

of 1 transect, 2 gradsects, and 10 sample plots. The dominant species in this wetland were annual ragweed and largeleaf pondweed (*Potamogeton amplifolius*). The dominant species in the upland buffer adjacent to WM-4 were redtop (*Agrostis gigantea*) and tall fescue (*Schedonorus phoenix*).

WM-4, as a whole (excluding the upland gradsect), had a WA_M of 3.02 in the spring and 2.70 in the fall (Table 3-4). This wetland contained 76 percent native species and 65 percent invasive species, an increase and decrease, respectively compared to 2009. The average FQI for this wetland in 2010 was 8.77, which is a relatively low value, but greatly increased from a value below one in 2009. The mean c-value at WM-4 was 2.25 in the spring and 3.10 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary at WM-4 in future years. Tables 1 and 2 in Appendix I-D contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-4: Data Analysis Summary WM-4 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	3.02	2.70
Species Richness	13	17
Species Diversity (D)	27.14	36.14
Floristic Quality Index (FQI)	6.36	11.18
Mean c-value	2.25	3.10
Percent Native Species	62	76

3.2.4.2 Water Treatment Plant Mitigation Site WM-5

Wetland mitigation site WM-5 is located in the north-central portion of the water treatment plant property (Figure 1, Appendix I-E). The constructed area of WM-5 was measured using GPS in June of 2009 and calculated to be 0.57 acre. The vegetation in WM-5 was sampled using a total of 1 transect, 2 gradsects, and 10 sample plots. The dominant species in this wetland were barnyard grass (*Echinochloa crus-galli*) and sedge (*Carex* sp.). The dominant species in the upland buffer adjacent to WM-5 were tall fescue and alfalfa (*Medicago sativa*).

WM-5 (excluding the upland gradsect) had a WA_M of 2.68 in the spring and 2.74 in the fall (Table 3-5). This wetland contained 75 percent native species and 50 percent invasive species, an

increase and decrease, respectively, compared to 2009. The average FQI for this wetland in 2010 was 11.64, representing a significant increase from the value of 1.06 calculated in 2009. The mean c-value at WM-5 was 3.08 in the spring and 3.27 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary in future years. Tables 1 and 2 in Appendix I-E contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-5: Data Analysis Summary WM-5 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	2.68	2.74
Species Richness	21	16
Species Diversity (D)	41.33	23.88
Floristic Quality Index (FQI)	11.94	11.34
Mean c-value	3.08	3.27
Percent Native Species	71	75

3.2.4.3 Water Treatment Plant Mitigation Site WM-6

Wetland mitigation site WM-6 is located in the southwest corner of the water treatment plant property (Figure 1, Appendix I-F). The constructed area of WM-6 was measured using GPS in June of 2009 and calculated to be 0.78 acre. The vegetation in WM-6 was sampled using a total of 1 transect, 2 gradsects, and 10 sample plots. The dominant species in this wetland were barnyard grass and witchgrass. The dominant species in the upland buffer adjacent to WM-6 was tall fescue.

WM-6 (excluding the upland gradsect) had a WA_M of 2.44 in the spring and 2.65 in the fall (Table 3-6). In the fall 2010, this wetland contained 75 percent native species and 83 percent invasive species. The average FQI for this wetland in 2010 was 5.12, a low value, but an increase from a value of zero in 2009. The mean c-value at WM-6 was 1.75 in the spring and 1.57 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary at WM-6 in future years. Tables 1 and 2 in Appendix I-F contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-6: Data Analysis Summary WM-6 in 2010		
	Spring 2010	**Fall 2010**
Mean Weighted Average (WA_M)	2.44	2.65
Species Richness	14	12
Species Diversity (D)	17.77	13.15
Floristic Quality Index (FQI)	5.53	4.71
Mean c-value	1.75	1.57
Percent Native Species	71	75

3.2.4.4 Water Treatment Plant Mitigation Site WM-7

Wetland mitigation site WM-7 is located in the southwest portion of the water treatment plant property, immediately east of WM-6 (Figure 1, Appendix I-G). The constructed area of WM-7 was measured using GPS in June of 2009 and calculated to be 0.58 acre. The vegetation in WM-7 was sampled using 1 transect, 2 gradsects, and 10 sample plots. The dominant species in this wetland were barnyard grass and witchgrass. The dominant species in the upland buffer adjacent to WM-7 were tall fescue and redtop.

WM-7 (excluding the upland gradsect) had a WA_M of 2.36 in the spring and 2.05 in the fall (Table 3-7). In the fall 2010, this wetland contained 91 percent native species and 64 percent invasive species. The average FQI for this wetland in 2010 was 8.3, an increase from an FQI of zero in 2009. The mean c-value at WM-7 was 4.33 in the spring and 2.88 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary at WM-7 in future years. Tables 1 and 2 in Appendix I-G contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-7: Data Analysis Summary WM-7 in 2010		
	Spring 2010	**Fall 2010**
Mean Weighted Average (WA_M)	2.36	2.05
Species Richness	4	11
Species Diversity (D)	1.00	12.21
Floristic Quality Index (FQI)	7.51	9.09
Mean c-value	4.33	2.88
Percent Native Species	75	91

3.2.4.5 Water Treatment Plant Mitigation Site WM-8

Wetland mitigation site WM-8 is located in the south-central portion of the water treatment plant property, immediately east of WM-7 (Figure 1, Appendix I-H). The constructed area of WM-8 was measured using GPS in June of 2009 and calculated to be 0.74 acre. The vegetation in WM-8 was sampled using 1 transect, 2 gradsects, and 10 sample plots. The dominant species in this wetland were leafy pondweed (*Potamogeton foliosus*) and yellow sweetclover (*Melilotus officinalis*). The dominant species in the upland buffer adjacent to WM-8 were Kentucky bluegrass and tall fescue.

WM-8 (excluding the upland gradsects) had a WA_M of 3.25 in the spring and 2.24 in the fall (Table 3-8). In the fall 2010, this wetland contained 79 percent native species and 53 percent invasive species. The average FQI for this wetland in 2010 was 9.08, an increase from an FQI of zero in 2009. The mean c-value at WM-6 was 2.88 in the spring and 2.46 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue to increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary at WM-8 in future years. Tables 1 and 2 in Appendix I-H contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-8: Data Analysis Summary WM-8 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	3.25	2.24
Species Richness	11	19
Species Diversity (D)	39.00	42.86
Floristic Quality Index (FQI)	8.63	9.53
Mean c-value	2.88	2.46
Percent Native Species	82	79

3.2.4.6 Water Treatment Plant Mitigation Site WM-9

Wetland mitigation site WM-9 is located in the southeast corner of the water treatment plant property (Figure 1, Appendix I-I). The constructed area of WM-9 was measured using GPS in June of 2009 and calculated to be 1.90 acres. Of the 1.90 acres, 1.48 acres are open water habitat while 0.42 acre was constructed as emergent wetland and was included in the total acreage of the

Water Treatment Plant mitigation sites. The vegetation in WM-9 was sampled using a total of 2 transects, 4 gradsects, and 20 sample plots. The dominant species in this wetland were prairie cordgrass and prairie ironweed (*Vernonia fasciculata*). The dominant species in the upland buffer adjacent to WM-9 was tall fescue.

WM-9 (excluding the upland gradsects) had a WA_M of 3.04 in the spring and 3.07 in the fall (Table 3-9). In the fall 2010, this wetland contained 57 percent native species and 67 percent invasive species. The average FQI for this wetland in 2009 was 8.32, an increase from an FQI of 4.41 in 2009. The mean c-value at WM-9 was 2.50 in the spring and 2.42 in the fall. It is anticipated that FQI and mean c-value of the wetland will continue increase as the wetland develops. In addition, invasive species will be monitored and controlled as necessary at WM-9 in future years. Tables 1 and 2 in Appendix I-I contain a summary of the monitoring data and the complete species list from the 2010 monitoring effort.

Table 3-9: Data Analysis Summary WM-9 in 2010

	Spring 2010	Fall 2010
Mean Weighted Average (WA_M)	3.04	3.07
Species Richness	16	21
Species Diversity (D)	38.50	24.67
Floristic Quality Index (FQI)	8.29	8.37
Mean c-value	2.50	2.42
Percent Native Species	69	57

3.2.4.7 Water Treatment Plant Stream Mitigation Site

As mentioned above, approximately 175 feet of stream mitigation was created as part of the Water Treatment Plant mitigation sites. The stream mitigation site is located in the southeast corner of the water treatment plant property, immediately south of WM-9. No quantitative monitoring efforts occurred at the stream mitigation site in 2010. However, natural color photographs were taken during the spring and fall 2010 monitoring efforts and are provided in Appendix J. Hydrology at the stream mitigation site is provided by connection with WM-9 via a culvert as well as via surface water runoff from portions of the property. Shrubs consisting of dogwood (*Cornus* sp.) and pussy willow (*Salix discolor*) were planted on the northern bank of the stream channel during 2009. The stream channel was treated with herbicide for cattail in 2010, but few were observed. The channel was mowed prior to the early June maintenance effort.

3.3 HYDROLOGICAL MONITORING

Several different types of hydrological data were collected as part of the 2010 monitoring effort. These collected data have been analyzed; the results are discussed below and included in Appendix II.

3.3.1 Piezometers

Four piezometers were installed in WM-1 in the Saunders County well field in October 2005. The elevation of the local water table at each piezometer has been graphed over time to allow for comparison amongst the piezometers and with other monitoring data. Two additional piezometers were installed in WM-2 in May 2009. The piezometer data from the 2010 monitoring effort is included in Appendix II-A.

3.3.2 Other Hydrological Data

Additional hydrological data collected as part of the 2010 monitoring effort includes monthly total precipitation, monthly average ambient air temperature, and stream gauge data. The 2010 monthly total precipitation and monthly average ambient air temperature are both obtained from the weather station at Fremont Municipal Airport in Fremont, Nebraska. The 2010 precipitation and temperature data and the historical average monthly precipitation and temperature are graphed over time; the graphs are included as Figures 2 and 3, respectively in Section B of Appendix II.

Stream gauge data is obtained from the USGS stream gauge stations on the Platte and Elkhorn rivers. Platte River data is 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 presented in Figure 4 in Section B of Appendix II. The Elkhorn River data is obtained from the stream gauge near Waterloo, Nebraska (USGS Stream Gauge No. 06800500). Data collected from this stream gauge is presented in Figure 5 (Section B, Appendix II).

Project operation of the production wells in the well fields occurred throughout 2010, the second full year of operation. Pumping occurred on a somewhat limited basis as demand did not necessitate full operation at this time. Production increased slightly in 2010 compared to 2009; an increase in average daily production of approximately two million gallons per day. On average, approximately 70 percent of the total production came from the Saunders County well

field with the remainder produced from Douglas County. It is important to note that Project operation is occurring, but not at full capacity due to demand.

4.0 DISCUSSION AND RECOMENDATIONS

The goal of the monitoring program is to document the establishment of the wetland mitigation sites and to observe whether the mitigation sites develop similar functions and values as those wetlands and waters of the United States affected by Project construction and operation. While most of the mitigation sites are developing as anticipated, a few recommendations for improvement are included below.

4.1 INVASIVE SPECIES CONTROL

Burns & McDonnell conducted three maintenance visits to the mitigation sites in 2010 to assess the presence of invasive species. Herbicide applications to control cattail and purple loosestrife (*Lythrum salicaria*) at the mitigation sites continued in 2010 with some success. The majority of the dense cattail populations in WM-1 and WM-2 were eradicated in 2009 by a combination of maintenance activities coupled with much drier conditions in those mitigation sites. Maintenance continued in 2010 at WM-1 and WM-2, but it only included minor efforts to treat a few cattail volunteers and small numbers of musk thistle (*Carduus nutans*) plants in the surrounding upland buffer area. Additionally, herbicide was applied in 2010 at WM-3, WM-5, and WM-7 in an attempt to control observed cattail at those locations.

Maintenance efforts to control an increasing purple loosestrife presence at the Douglas County sites (WM3-WM9) continued in 2010. During each of the three 2010 maintenance efforts, purple loosestrife plants were either hand-pulled and removed or sprayed in an attempt to control the invasive species. Purple loosestrife was found and treated at each Douglas County mitigation site except for WM-5. It was most abundant in WM-6, WM-7, and WM-8. As in 2009, purple loosestrife was also uprooted and removed and in some instances sprayed at the floodway mitigation area adjacent to WM-3 during the 2010 maintenance efforts.

Maintenance efforts at all mitigation sites will continue in 2011 with particular attention paid to occurrences of purple loosestrife, cattails, and thistles. Memorandums detailing the invasive species control measures implemented during the maintenance visits are provided in Appendix III.

4.2 WETLAND HYDROLOGY

When analyzing the WA_M of the two Wet Meadow mitigation sites (WM-1 and WM-2), the 2010 values suggest the sites are trending toward drier vegetation communities. Field observations support this conclusion. It is possible that the 15-foot-thick clay lens that underlies the mitigation site is more permeable that its nature would suggest or the production wells operating near the Wet Meadow mitigation sites are able to pull the perched water table off of the clay lens. Measures to improve hydrology at WM-1 and WM-2 in 2011 should be evaluated. Possible remedial measures could include alteration of the pumping schedules at nearby production wells to reduce the pumping during spring months to allow water to collect in the wetlands or pumping water into the wetlands using the production wells.

Wetland hydrology in the Backwash Mitigation Site (WM-3) in Douglas County may also require some modifications. Much of the central portion of WM-3 is higher in elevation than the surrounding wetland. Possible remedial measures at WM-3 could include lowering the elevation at the center of the wetland by mechanically removing fill material; this would alter the hydrology of the wetland to direct more water to the center of the wetland and prevent its accumulation along the western edge, where it tends to accumulate. Additionally, another water control devise could be installed at the southern end of the site. An evaluation of these and other additional options is recommended in 2011.

4.3 2011 MONITORING

The 2011 monitoring efforts at the mitigation sites are targeted to take place in June and September. Since the monitoring methods, as implemented during the 2006 monitoring effort, continue to yield what is considered to be good, usable data, the methods described in this report will be repeated during the 2011 monitoring effort. No changes are recommended at this time. As mentioned above, the growth of invasive species such as cattail, purple loosestrife, and thistle will continue to be closely monitored during 2011 and control measures will be continued as necessary. Additionally, remedial measures to improve the hydrology at the Wet Meadow (WM-1 and WM-2) and Backwash (WM-3) mitigation sites will be evaluated.

5.0 REFERENCES

Bailey, A.W. and C.E. Poulton. 1968. *Plant Communities and Environmental Relationships in a Portion of the Tillamook Burn, Northwest Oregon.* Ecology 49: 1-13.

Burns & McDonnell. 2005a. *Bathymetric Evaluation and Monitoring of Ponds Within the Cones of Depression – Douglas and Saunders Counties, Nebraska*. Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. January.

---------- 2005b. *Wetland Monitoring Plan*. Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. July.

---------- 2005c. *Mitigation Plan for Wetland Impacts – Phase I*. Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. August.

---------- 2007a. *Wetland Mitigation Site Selection Study*. Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. November.

---------- 2007b. *Mitigation Plan for Wetland Impacts – Phase II*. Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. November.

---------- 2007c. *As-Built Report for the Wet Meadow Mitigation Site.* Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. February.

---------- 2008a. *As-Built Report for the Phase II Wetland Mitigation Sites.* Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. January.

---------- 2009. *As-Built Report for the Phase I Water Treatment Plant Wetland Mitigation Site.* Platte West Water Production Facilities Project. Prepared for Metropolitan Utilities District. December.

Daubenmire, R. 1959. *A Canopy-Coverage Method of Vegetational Analysis.* Northwest Science 33: 43-64.

Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1*, U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

Environmental Law Institute. 2004. *Measuring Mitigation: A Review of the Science for Compensatory Mitigation Performance Standards*. Washington, DC.

Federal Interagency Committee for Wetland Delineation. 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service. Washington, D.C. Cooperative Technical Publication.

Greig-Smith, P. 1983. *Quantitative Plant Ecology.* University California Press, Berkeley, CA.

Rolfsmeier, S. and G. Steinauer. 2003. *Vascular Plants of Nebraska (Ver. I).* Nebraska Natural Heritage Program. Nebraska Game and Fish Commission, Lincoln, NE.

Streever, B. 1999. *Examples of Performance Standards for Wetland Creation and Restoration in Section 404 Permits and an Approach to Developing Performance Standards.* WRP Technical Notes Collection (TN WRP WG-RS-3.3). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Taylor, T.J. and L.D. Krueger, eds. 1997. *Mitigation Guidelines for Nebraska's Eastern Saline Wetlands.* Prepared for the Eastern Saline Wetlands Interagency Study Project.

Tiner, R.W. 1999. *Wetland Indicators: A Guide to Wetland Identification, Delineation, and Mapping*. Lewis Publishers, Boca Raton, FL.

U.S. Army Corps of Engineers. 2003. Section 404 Permit (Number 199910085) for the Platte West Water Production Facilities Project. Issued May 16, 2003.

U.S. Department of Agriculture Natural Resource Conservation Service. 2010. *The PLANTS Database* (http://plants.usda.gov, accessed multiple times in 2010). National Plant Data Center, Greensboro, NC.

U.S. Environmental Protection Agency. 2002. *Methods for Evaluating Wetland Condition: Using Vegetation to Assess Environmental Conditions in Wetlands.* Office of Water, US Environmental Protection Agency, Washington, DC. EPA-822-R-02-020.

U.S. Geological Survey. *NWIS Water Data for the Nation* (http://waterdata.usgs.gov/nwis, accessed January 2011.