Appendix H

Rio Bosque Wetlands Park Aquatic Habitat Restoration Project Monitoring and Adaptive Management Plan

November 2020

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1. Authority and Purpose

This Monitoring and Adaptive Management Plan for the El Paso Rio Bosque Wetlands Section 206 Aquatic Ecosystem Restoration Project ("Project") describes a framework for post-project effectiveness monitoring, evaluating project success, and taking corrective measures if necessary to achieve the desired restoration outcome. The U.S. Army Corps of Engineers, Albuquerque District (USACE) proposes to implement the Project as described in the Detailed Project Report/Environmental Assessment (DPR/EA), in cooperation with the Project Sponsor, El Paso Water Utilities.

USACE guidance for ecosystem restoration projects requires that a plan be developed, and described in the decision document, for monitoring the success of ecosystem restoration. As stated in USACE implementation guidance for Section 1161 of the Water Resources Development Act of 2016 (WRDA 2016), this monitoring plan shall include a description of:

a. *Types and number of restoration activities to be carried out;*
b. *Physical actions to be undertaken to achieve project objectives;*
c. *Functions and values that will result from the restoration plan;*
d. *Monitoring activities to be carried out;*
e. *Criteria for ecosystem restoration success;*
f. *Estimated cost and duration of the monitoring; and*
g. *A contingency plan for taking corrective actions in cases in which the monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan.*

The Monitoring and Adaptive Management Plan for the Project must establish criteria for success, and monitoring should provide data that will determine when these success criteria are met. Success should be measured by comparing post-project conditions to the restoration project purpose and needs and to pre-project conditions.

USACE guidance also states that a contingency (adaptive management) plan will be developed for all ecosystem restoration projects. The adaptive management plan "will guide decisions for refining or revising restoration activities and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect restoration success."

Monitoring provides the feedback needed to evaluate project success, to confirm that features constructed under the project perform as designed, and to make adjustments when necessary to achieve the desired results. Post-project effectiveness monitoring is a crucial requisite of the adaptive management process, providing a basis for determining the necessity or feasibility of subsequent operational modifications.

2. Goals of the Project

The first step in designing a Monitoring and Adaptive Management plan for the Rio Bosque Project is to define the goals and objectives of the project. As stated in the current Draft DPR/EA (July 2020), the overall project goals are to provide a mosaic of habitat types, with an emphasis on wetland habitats, within the El Paso Rio Bosque Wetlands Park ("Park"); to provide the diverse habitats that would have been present prior to channelization and modification of the

Rio Grande; and to provide easily accessible, high visibility wetlands for public visitation and education.

Specific planning objectives identified in the DPR/EA are:

- To increase the water quantity in the Park.
- To increase the diversity of native riparian and wetland habitat
- To increase the diversity of native wildlife.
- To increase the availability of passive recreational and educational opportunities.

3. Types and number of restoration activities to be carried out

Specific restoration features proposed to accomplish Project objectives include:

- Enhance 55.1 acres of existing seasonal wetlands so that they would remain wet throughout the year and provide open water habitat;
- Create 4.9 acres of new emergent wetlands and 34.3 acres of seasonal shallow marsh wetlands;
- Restore 45 acres of cottonwood-willow riparian habitat;
- Plant native grasslands in drier areas;
- Selectively remove invasive saltcedar from 31.1 acres of saltcedar-dominated habitat.

4. Physical actions to be undertaken to achieve project objectives

- Existing wetlands would be enhanced by deepening parts of the wetlands to 5 feet so they would retain water for a longer period and provide open water habitat; lining as needed to reduce loss of water through infiltration; and planting native wetland plants.
- New wetlands would be created by excavating and lining these areas and planting native wetland plants. New connections to water sources would be installed.
- Riparian habitat would be restored by planting cottonwoods, willows and other riparian shrubs. These areas would be connected to water sources as needed to provide water for plant establishment.
- Native grasslands would be seeded with minimal disturbance to existing vegetation. Non-native shrubs would be removed from these areas prior to seeding with native grasses and forbs.
- Saltcedar would be removed mechanically and herbicide would be applied to cut stumps to prevent regrowth.

5. Functions and values that will result from the restoration plan

- Wetland seasonality will increase in duration and variability as deeper open water areas and shallow marshes are established. The existing wetlands that have been temporarily or seasonally flooded in the past will transition to semipermanently flooded. Open water habitats created by deepening the existing wetlands and excavating new wetlands will hold water longer in the season and may be permanent in years with adequate irrigation water supply. The new shallow marshes will be seasonally flooded. Together, these will provide a greater variety of wetland types and seasonality throughout the project area.

- Cover and height of emergent wetland vegetation will increase. Existing native wetland vegetation will respond to the increased water supply. Plantings of native wetland plants in the new wetlands and marshes will increase in cover and height as wetland vegetation matures.
- Riparian tree and shrub cover will increase. As riparian plantings mature, canopy cover, diameter of trees, and shrub stem counts will increase.
- Native grass and forb cover will increase.
- Saltcedar and other invasive plants will decrease in cover, height and/or stem counts due to selective removal. Native shrubs will have increased recruitment in these areas. However, saltcedar is likely to resprout and require retreatment.

6. Monitoring activities to be carried out

A. Implementation and Duration of Monitoring

USACE will conduct monitoring before, during and after construction in collaboration with the Park Manager, the University of Texas at El Paso (UTEP) Center for Environmental Resource Management. Monitoring carried out within a period of ten years from completion of construction of an ecosystem restoration project is a cost-shared project cost. For this project, we anticipate that success criteria will be met approximately five years from completion of construction. USACE guidance requires monitoring to continue until ecological success criteria are met. After that time, monitoring may continue and would be the responsibility of the local sponsor. Due to the nature of the Park as an educational facility, it is anticipated that some forms of monitoring may continue for the life of the project.

This Monitoring and Adaptive Management Plan primarily addresses effectiveness monitoring after construction is complete. Implementation monitoring during construction will be conducted by USACE to ensure that construction specifications are adhered to and impacts to wildlife and plants are minimized. The Periodic Site Assessment form contains some items that may be monitored during construction as well as post-construction.

B. Reporting

USACE will prepare annual reports that include specific information pertaining to each of the monitoring elements. These reports will include information about equipment and techniques used for monitoring purposes and any adaptive management actions needed or taken. Annual reports will be submitted to the Sponsor and other interested parties by December 31 of each monitoring year.

C. Photographic Documentation

In 1999, UTEP established 28 permanent photographic stations at Rio Bosque to help document the vegetation changes taking place at the park. The locations of these photos stations are illustrated below (Figure 1). Every few years, 3 to 5 photos are taken at each station, using the same bearings each time. In all, there are 103 distinct views captured in these photos. The most recent photos were taken in 2017.

As part of project monitoring, UTEP would take photos at these stations before and after construction. Photos would be used to evaluate changes in vegetation structure and composition. Photography would be repeated annually during the growing season for five years after construction is complete and biannually thereafter until the ecological success criteria have been met.

D. Vegetation Monitoring within Restoration Features

Vegetation monitoring plots or transects would be established in each restoration feature. Monitoring would occur annually during the growing season. Survival of planted species, growth of woody species and percent cover of herbaceous species would be monitored. Example monitoring forms are included in Appendix A.

E. Avian point counts

UTEP collects monthly data on avian species and abundance from monitoring point count stations (Figure 2). Avian monitoring would continue throughout the monitoring period.

F. Depth to water table

Groundwater monitoring wells have been established within the Park. Depth to groundwater is especially important for riparian vegetation. The map below shows existing monitoring wells and one proposed new well in relation to proposed habitat restoration features. A new well is proposed in riparian area R3 because the existing wells in that area are too shallow. The new well would be monitored in coordination with existing wells on a weekly or more frequent basis. Existing wells are monitored monthly, or almost daily for wells RB-1B, RB-2, RB-3B and RB-8. Depth to groundwater and groundwater surface elevation would be reported.

G. Water Quality in the Wetlands

UTEP has monitored water quality within both wetland cells and the N and S segments of the channel monthly during the growing season using discrete methods for several years prior to the Project. Field measurements have included water temperature, dissolved oxygen (DO), pH, and specific conductance. Laboratory analyses have included nutrients (total phosphorus, total nitrogen, and ammonium), other major cations and anions (e.g. chloride), dissolved organic carbon (DOC), and chlorophyll-*a* (indicator of algae abundance and primary production).

In wetland systems, especially those that lack a surface water outflow including this Project, nutrients and carbon are retained and recycled through successive seasons of plant growth, death, and decay. Over time, the accumulation of nutrients and carbon is likely. In addition, the nutrient uptake rates of the wetlands will likely decrease over time as phosphorus and other nutrients become saturated. Prolonged nutrient loading can have negative effects on the nutrient dynamics of the wetland, leading to shifts from one stable state to the next, often involving structural changes in the vegetation and losses of plant species diversity.

Water quality and chlorophyll-*a* data collected post-construction will be used to document and evaluate impacts of the Project, using pre-construction data and State criteria as benchmarks. The monitoring of major ions, especially chloride, as it is a particularly good indicator of wastewater inputs, would continue. The magnitude and proportion of major ions can also be used to generate piper diagrams, which are useful to assess multiple samples, spatial and temporal trends, and identify contributing water sources. Monitoring of nitrogen and phosphorus species, the two most influential nutrients in terms of regulating phytoplankton and aquatic macrophyte growth is also required. Excessive inputs of nutrients can lead to excessive algal growth and eutrophication. Consistent monitoring of chlorophyll-*a* concentrations, which are indicators of change in a lake's trophic status, is also required. WWTP effluent (the primary water source of this Project) and algae (both from extracellular leakage and via decomposition) will contribute DOC to the wetlands. Monitoring of DOC will continue post-construction, due its important role in biogeochemical processes within the wetland.

Discrete monitoring of temperature, pH, dissolved oxygen, and specific conductance will continue post-construction. In addition, a measure of water clarity (Secchi depth or transparency tube depth), which is a surrogate for light penetration, and is an important regulator of rate of primary production and plant species composition, including the balance between phytoplankton and macrophyte production in shallow ponds and lakes is required. Continuously deployed multi-parameter water quality sensors (e.g., temperature, DO, pH, conductivity, turbidity, and algae (chlorophyll & phycocyanin)) could be deployed to validate discrete field measurements and laboratory measurements and also to assess diurnal variability of water quality parameters.

A sampling and analysis plan will be developed by USACE in collaboration with CERM to document water quality sampling locations, sample frequency, sample collection, calibration of sensors, document analytical methods, method detection limits (MDLs), containers, preservation methods, and holding times. A quality assurance/quality control (QA/QC) plan, to ensure that the water quality data collected for a project are meaningful, representative, complete, precise, accurate, comparable, and scientifically defensible will also be developed.

H. Invertebrates (optional)

In the past, monitoring of aquatic invertebrates has occurred in the wetlands (UTEP, unpublished data), as discussed in Appendix C. The abundance and diversity of aquatic invertebrates is an important contributor to biodiversity. It is recommended that invertebrate monitoring be continued following established protocol with additional sites in the new wetlands. An observed increase in aquatic invertebrate species richness, abundance of "late successional" or passively dispersing species, or species that are less tolerant of poor water quality would indicate a positive trend for biodiversity and wetland function.

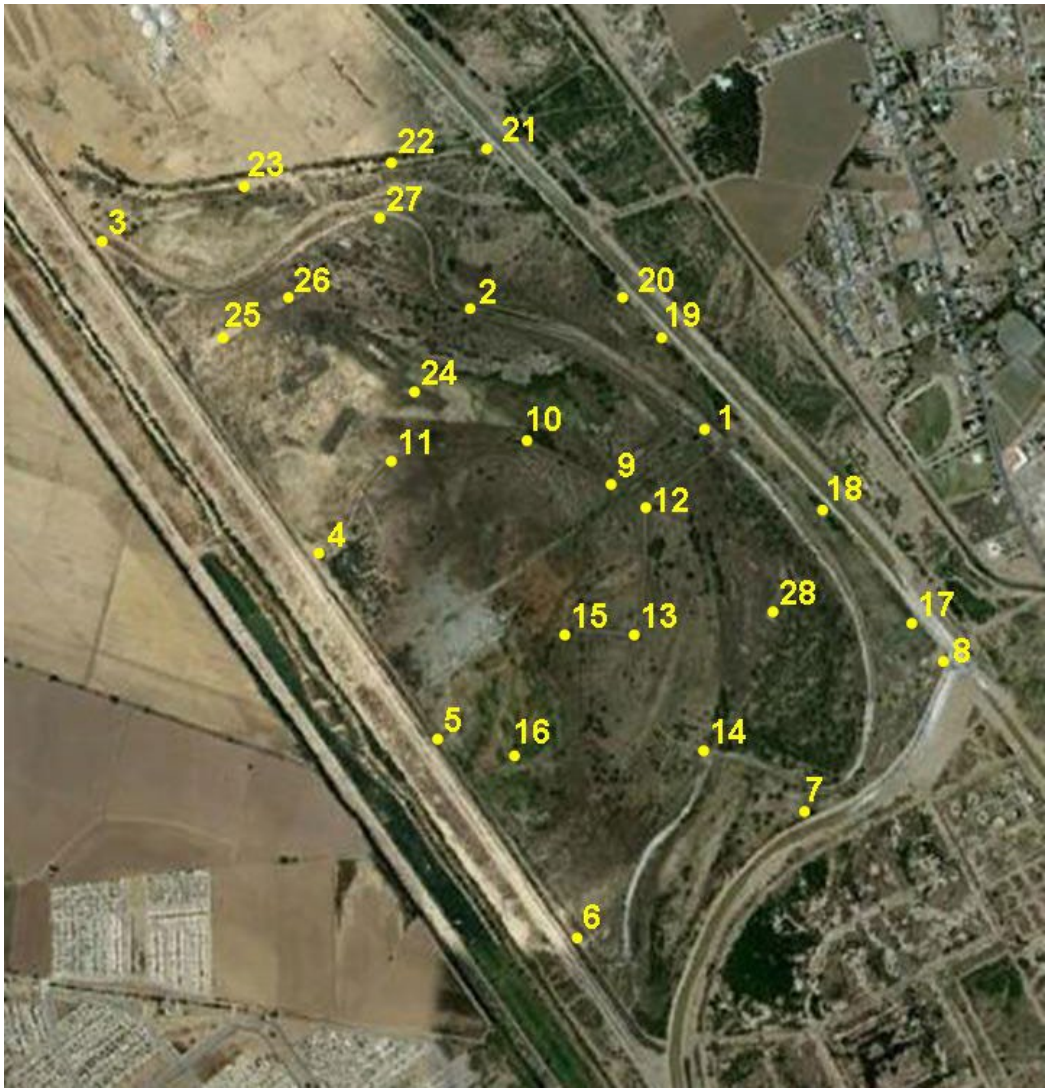

Figure 1: Map showing location of photographic monitoring points.

Rio Bosque Photo Station Coordinates

Station	Coordinates	
1	N 31° 38' 33.9"	W 106° 18' 23.2"
2	N 31°38' 43.2"	W 106°18' 43.9"
3	N 31° 38' 47.3"	W 106°19' 11.7"
4	N 31° 38' 26.2"	W 106° 18' 54.7"
5	N 31° 38' 14.8"	W 106° 18' 45.7"
6	N 31° 37' 59.2"	W 106° 18' 33.0"
7	N 31° 38' 08.0"	W 106° 18' 14.7"
8	N 31° 38' 18.9"	W 106° 18' 03.6"
9	N 31° 38' 31.1"	W 106° 18' 30.5"
10	N 31° 38' 33.4"	W 106° 18' 37.2"
11	N 31° 38' 32.2"	W 106° 18' 48.6"
12	N 31° 38' 29.1"	W 106° 18' 27.4"
13	N 31° 38' 20.1"	W 106° 18' 29.0"
14	N 31° 38' 11.8"	W 106° 18' 22.5"
15	N 31° 38' 20.5"	W 106° 18' 34.5"
16	N 31° 38' 14.1"	W 106° 18' 37.9"
17	N 31° 38' 21.8"	W 106° 18' 06.3"
18	N 31° 38' 28.9"	W 106° 18' 13.1"
19	N 31° 38' 40.3"	W 106° 18' 26.0"
20	N 31° 38' 43.8"	W 106° 18' 29.7"
21	N 31° 38' 53.9"	W 106° 18' 40.0"
22	N 31° 38' 52.4"	W 106° 18' 47.6"
23	N 31° 38' 50.9"	W 106° 18' 59.4"
24	N 31° 38' 36.5"	W 106° 18' 46.0"
25	N 31° 38' 40.7"	W 106° 19' 01.7"
26	N 31° 38' 43.0"	W 106° 18' 57.2"
27	N 31° 38' 49.3"	W 106° 18' 50.0"
28	N 31° 38' 19.3"	W 106° 18' 19.7"

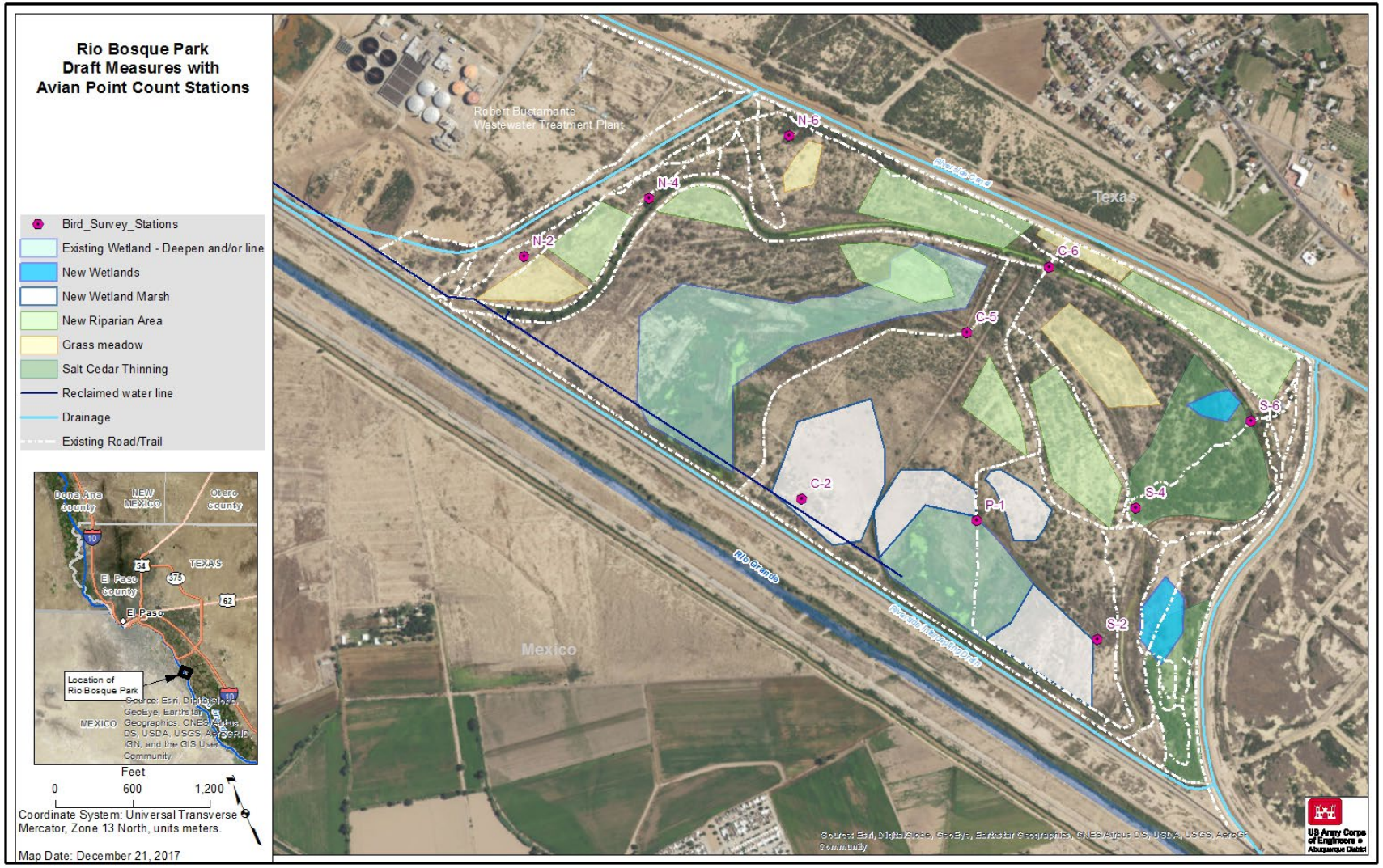

Figure 2: Map of avian point count stations at Rio Bosque.

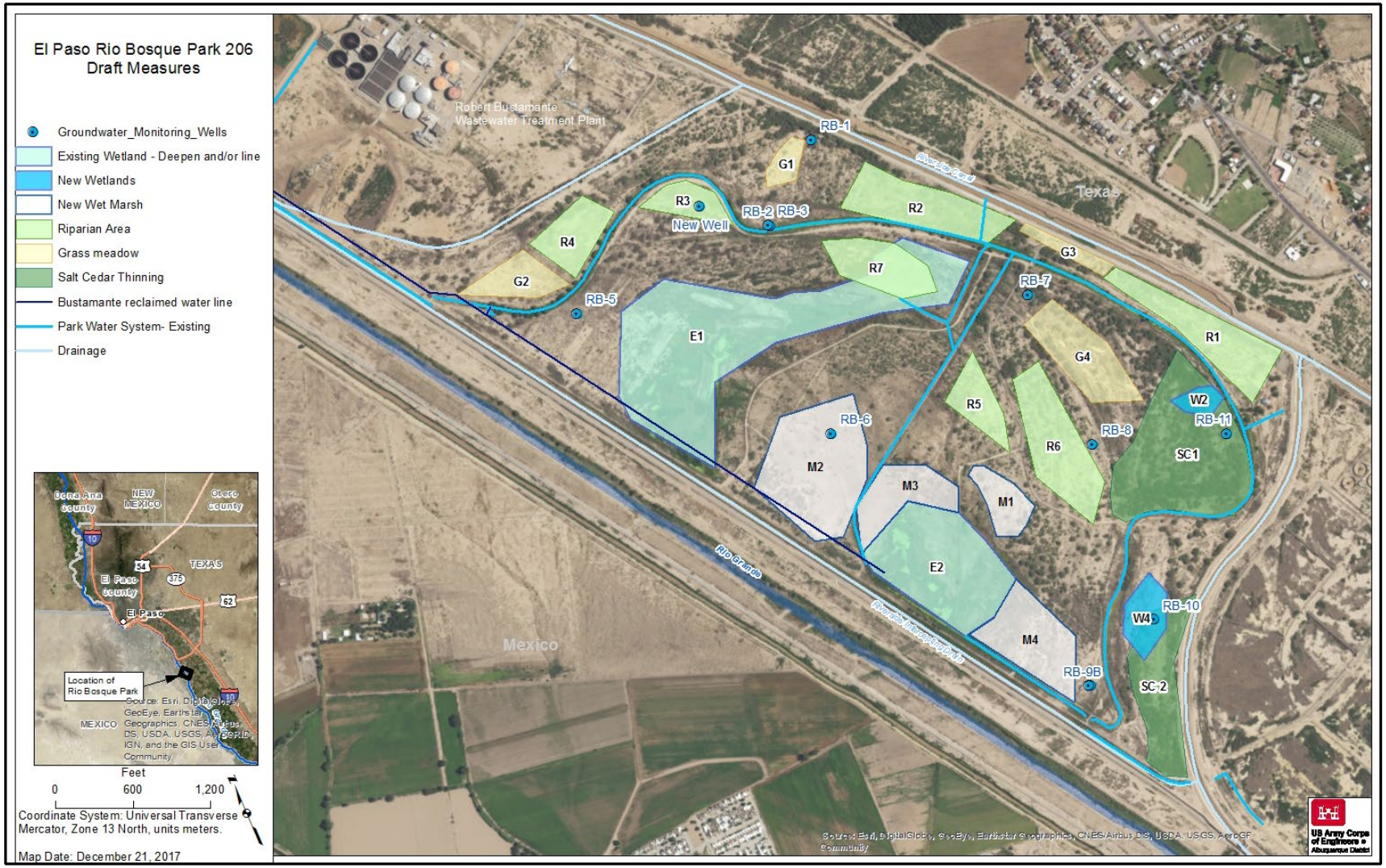

Figure 3: Map showing groundwater monitoring wells at Rio Bosque with proposed ecosystem restoration measures.

7. Criteria for ecosystem restoration success

Project objectives and associated success criteria are listed here. Table 1 below lists potential monitoring components, criteria for success, and adaptive management measures that could be taken if monitoring indicates that features are not meeting project objectives and success criteria.

Project objectives as stated in the DPR/EA are as follows. Specific objectives for the Monitoring Plan have been added under each Project objective.

1) To increase the water quantity in the Park.
Water availability in general has already improved due to actions of the Sponsor to construct the reclaimed water pipeline and to acquire water rights. However, water is still being lost through infiltration of unlined wetlands. Further, the distribution of water in the Park will be improved by construction of the Project. The specific monitoring objective is to provide consistent water delivery to wetlands. The criteria for success are:

- All gates, wells, and other structural components are functioning as designed;
- The Park Manager is able to provide water to each wetland and riparian feature.

2) To increase the diversity of native riparian and wetland habitat.
Monitoring objectives associated with this goal are: restore and enhance native wetland plant communities, reduce dominance of saltcedar, and restore native riparian plant communities while maintaining areas of open water. Criteria for success are:

- Survival of plantings is at least 75% of individual plants and 90% of planted species;
- Cover of native wetland species is at least 25% in the monitoring plots in "edge" and shallow to intermediate depth areas by year 5;
- Open water is maintained in deeper areas of the wetlands. Encroachment of emergent vegetation (such as cattails) would be limited to less than 20% of these areas.
- Cover of non-native species in the wetland and riparian areas is less than 10%.
- In the saltcedar removal areas, resprouting should be less than 20% of individuals with cover of less than 10% of the area.
- Vegetation stature and density observed from repeat photography should increase over time with a shift from short lived and "early successional" to longer lived species, and development of canopy-understory structure.

3) To increase the diversity of native wildlife.
Monitoring objectives associated with this goal are: to improve habitat for, and increase habitat use by riparian and wetland birds. Other taxonomic groups may be monitored by educational institutions or other partners.
The criteria for success are:

- Avian species richness is maintained or increases.
- Abundance or number of detections of bird species that depend on riparian habitat (listed in Table 2) increases 10% or more.

A list of avian species that have been observed at Rio Bosque, and depend on riparian and wetland habitats, appears below (Table 2). Many of these species are only detected a few times a

year or have not been detected every year, making trend detection challenging. However, an increase in the frequency of detections or the number of individuals present is expected.

4) **Maintain water quality of the wetland habitat areas.**

Monitoring objectives associated with this goal are: 1) ensure water quality does not degrade as a result of the Project (e.g., lining wetlands or increased WWTP effluent inputs), 2) ensure the wetlands do not turn eutrophic, and 3) ensure algae do not overwhelm the open-water habitat.

UTEP has developed a quantitative water quality monitoring program during the growing season. The continuation of this program will provide the data to document post-construction conditions, identify degradation, and propose adaptive management practices to improve water quality.

5) To increase the availability of passive recreational and educational opportunities.

This project goal is also a monitoring goal. Success criteria are:

- Increase of at least10% in one or more visitation measures such as public visitation, use by educational groups or volunteer hours worked.
- Minimal/ no damage to restoration features.

The Park maintains qualitative (informal observations of use) and quantitative visitation records and tracks volunteer work day participation and school group use. Although fluctuating yearly visitation makes trend detection challenging, an increase in use is expected after construction of the Project.

The overall project goal, to **provide a mosaic of native riparian, wetland and upland habitats**, is addressed by monitoring objectives 1-3.

Table 1: Monitoring Objectives, Success Criteria, and Potential Adaptive Management Measures.

Monitoring Objectives	Monitoring Component	Success Criteria	Potential Adaptive Management
Provide consistent water delivery to wetlands	Inspection of water system components, gates, wells. Biweekly verification of wetland inundation.	All gates, wells, and other structural components functioning. Manager is able to provide water to each wetland and riparian feature.	Potential repair or changes to flow management structures; additional water delivery system connections.
Restore and enhance native wetland plant communities	Vegetation plot monitoring of emergent wetland species	Survival of plantings > 75% of individuals and >90% of planted species Cover of native wetland species > 25% of monitoring plots in "edge" and shallow or intermediate depth areas by year 5. Cover of non-native species < 10%	Treatment of non-native regrowth and/or weeds, additional plantings. Management of native species to maintain open water areas if wetlands become overgrown. Techniques could include draw-down, mowing and flooding, mechanical removal, or herbivory (muskrats).
Restore native riparian plant communities.	Plot or transect monitoring of woody species and understory Monitor depth to groundwater	Survival of plantings > 75% of individuals and >90% of planted species Growth of plantings: DBH, stem counts or cover should increase at least 200% in 5 years	Treatment of non-native regrowth and/or weeds, additional plantings. Irrigating riparian areas as needed when depth to groundwater is too deep for plants to access during establishment
Reduce dominance of saltcedar	Plot or transect monitoring of woody species and understory	Saltcedar resprouting <20% of individuals and cover <10% of area	Treatment of non-native regrowth and/or weeds, additional plantings
Provide a mosaic of native riparian, wetland and upland habitats	Development of vegetation (stature, density, species composition) as observed through repeat photography	Vegetation stature and density increase over time with shift from short lived to longer lived species. Development of canopy-understory structure.	Treatment of non-native regrowth and/or weeds, additional plantings.
Improve habitat for, and increase habitat use by riparian birds	Avian species richness and abundance as detected in point counts	Species richness is maintained or increases. Abundance or number of detections of species that depend on riparian habitat increases 10%.	Potential changes to water management (to increase water availability in riparian planting areas) or additional plantings.
Ensure wetlands stay aerobic.	24-hour range of DO flux, hydrogen sulfide, and carbon dioxide (indicator of anaerobic bacteria production)	Daily mean DO > 3 mg L^{-1} during the growing season. Minimal rotten egg smell.	Add appropriately sized and permanent aeration of the wetland cells through the infusion of air or by surface agitation from a fountain or spray-like device; periodically drain and remove organic material

Ensure algal growth does not reduce open-water habitat	chlorophyll-*a*, water clarity	All measurements remains < 5.00 µg L^{-1}, the State criteria and/or post-construction annual mean value remain within the 90th percent confidence interval for the pre-construction period.	Aeration (see above), addition of barley straw bales, physical remove of algae, nutrient removal using vegetation prior to entering the wetland cells, discouraging geese and other resident waterfowl from establishing
Ensure salinity and/or eutrophication does not impact wetland function and health.	Bioavailable nitrogen and phosphorus species, salinity, chloride, water clarity, chlorophyll-*a* data; visual monitoring (e.g., algal blooms, stressed or dead vegetation, salt precipitation)	Post-construction annual mean value remain within the 90th percent confidence interval for the pre-construction period. Visual confirmation of algal blooms, stressed or dead vegetation not associated with another cause, excess salt accumulation on the edges of wetland cells	Periodic draining and removal of organic matter, flushing with water source of lower salinity and nutrient concentration (e.g., riverside canal)
Ensure mosquito populations remain within acceptable levels	Qualitative – perceived nuisance level	Visitors, volunteers and Park staff reports or observations	Adding western mosquito fish or biological control agents to wetlands; ensuring aeration (see above).
Increase the availability of recreational and educational opportunities	Visitor logs and records (qualitative and quantitative)	* Increase of >10% in visitation, use by educational groups, or volunteer hours worked * Minimal/ no damage to restoration features	Alter placement of recreational features. Closure of specific areas during sensitive time periods.

Table 2: Rio Bosque wetland (marsh) and riparian breeding bird species

Species	Status and Habitat
Yellow-billed Cuckoo	Riparian; migration, potential breeding
Southwestern Willow Flycatcher	Riparian; migration, potential breeding
Black Phoebe	Riparian, Marsh; breeding confirmed
Vermillion Flycatcher	Riparian; winter non-breeding
Bell's Vireo	Riparian - mesquite and willow thickets; breeding confirmed
Marsh Wren	Marsh; migration and winter non-breeding
Virginia Warbler	Riparian; migration
Yellow Warbler	Riparian; migration
Lucy's Warbler	Riparian & adjacent mesquite; migration, potential breeding
Virginia's Warbler	Riparian; migration
Common Yellowthroat	Marsh and Riparian; breeding confirmed
Yellow-breasted Chat	Riparian; breeding confirmed
Song Sparrow	Marsh, Riparian; non-breeding; wintering and migration
Summer Tanager	Riparian, large cottonwoods; migration & summer, potential breeding
Western Tanager	Riparian, large cottonwoods; migration
Indigo Bunting	Riparian; open, brushy habitat near streams; potential breeding
Lazuli Bunting	Riparian; migration
Painted Bunting	Riparian - scattered large trees; breeding confirmed
Blue Grosbeak	Riparian- brushy, more open; breeding confirmed
Black-headed Grosbeak	Riparian; migration
Bullock's Oriole	Riparian; uncommon migrant, summer; breeding suspected but not confirmed
Red-winged Blackbird	Marsh; breeding confirmed
Yellow-headed Blackbird	Marsh; Migration & winter, occasional in summer
Northern Mockingbird	Riparian & brushy, open areas; breeding confirmed
Great Blue Heron	Marsh; Historic nesting in region; winter & migration
Least Bittern	Marsh; potential breeding
Great Egret	Marsh; formerly nested in summer
Snowy Egret	Marsh; formerly nested in summer

8. Estimated cost and duration of the monitoring

The estimated cost of this Plan is 245,961 with a duration of five years. The cost estimate includes an annual site assessment, soil testing and amendment, hydrologic adjustments and changes to flow management structures, replanting or reseeding, and beaver exclusion devices.

9. Adaptive Management Plan

Adaptive management is a systematic approach for improving resource management by learning from management outcomes. It promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process (Williams, Szaro, and Shapiro. 2009).

Monitoring and reporting activities will inform USACE and the Sponsor whether or not mitigation activities have been successful to date. Based on monitoring field data and the ecological performance standards, the biologist performing monitoring will report whether a change in management is needed. Adaptive management measures for the ecosystem restoration features could include, but are not limited to:

- Replanting or reseeding areas of the restoration features to improve species cover or diversity, or to re-establish vegetation after drought, flooding or inadvertent disturbance.
- Invasive species control within the wetlands, riparian areas and grasslands.
- Soil testing or amendment, if soils are an issue for plant growth in the restoration features.
- Hydrologic adjustments such as seasonal adjustments of the water surface elevation or draw-down to facilitate vegetation management or other maintenance needs
- Irrigating riparian areas as needed when depth to groundwater is too deep for plants to access during establishment.
- Installation of permanent aeration system to prevent anoxic conditions
- Managing algae via physical, chemical, and biological methods.
- Managing mosquito populations by adding mosquitofish to the wetlands, improving aeration, or biological control.
- Flushing the wetland cells with irrigation water to reduce salinity and nutrient loading.
- Installation of non-lethal exclusion devices to address beaver activity
- Repairs or changes to flow management structures; additional water delivery system connections.

Each year, USACE in consultation with the Sponsor will evaluate Project success. Should the ecological performance standards not be met, the reasons for failure to meet standards will be evaluated and appropriate management actions taken. USACE and the Sponsor will investigate why plantings were not successful, what could be done differently to improve success rates, what environmental factors could be contributing to a decline in success, whether there have been unacceptable structural changes such as failure of water delivery system components, and what

actions are recommended to improve success or remedy an unacceptable situation. For example, if plantings fail, the cause would be evaluated before planting new plants to replace those that die. Did the depth to water table change so the plants' roots failed to reach water? Was herbivory or disease a factor? Was the soil too saline or otherwise unsuitable? Any replacement plants will be monitored for the duration of the monitoring period.

If water quality or algae are identified as an issue, the Corps and local sponsor will use the adaptive management framework to mitigate those impacts. For example, monitoring of DO along with hydrogen sulfide and carbon dioxide, could be used to determine if the wetland cells go into a prolonged anaerobic state (DO < 3 mg L^{-1}). Aanaerobic bacteria produce carbon dioxide and hydrogen sulfide when digesting organic material, giving the pond a rotten egg smell. To address this issue, appropriately sized and permanent aeration of the wetland cells through the infusion of air or by surface agitation from a fountain or spray-like device may be required. Water aeration encourages the colonization of aerobic bacteria, which may also improve water clarity and reduction in algae. Another alternative for algal management is an addition of barley straw bales (3x per year, 225 pounds (or 4–5 bales) per surface acre of water). The physical remove of algae, nutrient removal using vegetation prior to entering the wetland cells, discouraging geese and other resident waterfowl from establishing are additional measures that could be undertaken if algae issues remain. Salinity and chloride data will be used to assess the accumulation of salts that may result in reduced or inhibition of plant growth. Similarly, nutrient and chlorophyll-*a* data will be used to asses eutrophication. To address these issues, it is recommended that the wetland system be flushed with a water source of lower salinity and nutrient concentration (e.g., riverside canal) as needed.

10. References

USACE. 2007. *Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007), Monitoring Ecosystem Restoration.*

USACE. 2017. *Implementation Guidance for Section 1161 of the Water Resources Development Act of 2016 (WRDA 2016, Completion of Ecosystem Restoration Projects.*

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. *Adaptive Management: The U.S. Department of the Interior Technical Guide.* Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

APPENDIX A
EXAMPLE SITE ASSESSMENT FORMS

Sample Format for Periodic Site Assessment Form
Rio Bosque Wetlands Park

Restoration feature:
Plot or Photopoint number:
Personnel:
Date:

Item No.	Description	Response	
		Yes	No
1	Water supply and control structures functioning as specified? If no, describe problem and provide a map of affected structure(s)/ area(s).		
2	Survival of native vegetation plantings at least 80%?		
3	Regrowth of non-native vegetation observed?		
4	Natural damage to vegetation (dying off for natural reasons)?		
5	Water damage to vegetation or other site features?		
6	Wind damage to vegetation or other site features?		
7	Herbicide damage to desired vegetation?		
8	Herbicide damage to invasive vegetation (as desired)?		
9	Wildlife damage to desired vegetation?		
10	Vandalism to desired vegetation?		
11	Vandalism to other site features (e.g., signs)?		
12	Debris or refuse present?		
13	Access roads reclaiming as specified?		
14	Trails and boardwalk being maintained as specified?		
15	Volunteer establishment of desired species observed?		
16	Wetland feature(s) currently inundated? If yes, describe/ map extent of flooding.		
	Other items?		
Comments:			

Cottonwood and Riparian Shrub Monitoring Field Data
Rio Bosque Wetland Park

Planting Location (select one):	Sample Unit (select one):	Field Crew:	Date:	Time:
☐R1 ☐R5 ☐R2 ☐R6 ☐R3 ☐R7 ☐R4	☐1 ☐4 ☐2 ☐5 ☐3			

Photo Log (note photo numbers, directions and descriptions here):
1
2
3
4

Plant ID refers to the unique number on each tree tag.
Plant Condition is healthy, stressed, or dead.
DBH is the diameter of the tree at 1.4 m from the ground.
Shrub height to nearest 0.1m if below 2m, then to nearest 0.5m

Plant ID	Plant Condition	DBH (trees)/ Height (shrubs)	Wetland Indicator Status	Comments

Are weeds or invasive species present? ☐Yes ☐No
If so, what species?

Estimated percent cover: ☐1-25% ☐26-50% ☐51-75% ☐76-100%

Wildlife Observations: Signs of mammal use present? ☐Yes ☐No If so, what signs observed? Riparian Birds present? ☐Yes ☐No If so, what species? Waterfowl present? ☐Yes ☐No If so, what species? Aquatic Herptiles present? ☐Yes ☐No If so, what species? Aquatic Invertebrates present? ☐Yes ☐No If so, what taxa?
General comments, notes, site descriptions.

Wetland Monitoring Field Data
El Paso Rio Bosque Wetlands

Restoration Feature:	Sample Unit (select one):	Field Crew:	Date:	Time:
☐E1 ☐W2 ☐M1 ☐E2 ☐W4 ☐M2 ☐ ☐M3 ☐M4	☐1 ☐4 ☐2 ☐5 ☐3			

Photo Log (note photo numbers, directions and descriptions here):
1
2
3
4

Genus-species	Common name	Cover %	Wetland Indicator Status and Comments

Percent cover in general area: ☐0-25% ☐26-50% ☐51-75% ☐76-100%

Are weeds or invasive species present? ☐Yes ☐No

If so, what species?

Estimated percent cover: ☐0-25% ☐26-50% ☐51-75% ☐76-100%

Wetland Indicator Observations:
Hydric soil indicators present? ☐Yes ☐No
If so, what indicators observed?

Wetland hydrology indicators present? ☐Yes ☐No
If so, what indicators observed?

Wildlife Observations:
Signs of mammal use present? ☐Yes ☐No
If so, what signs observed?

Riparian Birds present? ☐Yes ☐No
If so, what species?

Waterfowl present? ☐Yes ☐No
If so, what species?

Aquatic Herptiles present? ☐Yes ☐No
If so, what species?

Aquatic Invertebrates present? ☐Yes ☐No
If so, what taxa?

General comments, notes, site descriptions.