Wetland Program Development Grant (WPDG) FFY 2019

Evaluating Playas in Western Kansas: Recharge to the High Plains aquifer and Economics of Cropping.

Report Date: 13 April 2020 Report 1 (R1)

Report Period: December 5, 2019 – March 5, 2020

Grant Recipient: Kansas Water Office

Grant Number: CD –9770301

Submitted by: Kirk Tjelmeland, Kansas Water Office

Progress: There has been little work on this grant; the original Principle Investigator relocated to another university, completing a contract with Kansas University was been slow however work has started on the QAPP.

Project Title: Evaluating Playas in Western Kansas: Recharge to the High Plains aquifer and Economics of Cropping.

This is a **Track One** application with one project supporting implementation of the approved Kansas Wetland Program Plan (WPP).

EPA Core Elements: Voluntary Restoration and Protection, Monitoring and Assessment, Water Quality Standards. Eight actions from the WPP (detailed in narrative below) will be addressed through this project.

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Location: Playa Lakes, High Plains aquifer region in Groundwater Management District #1 in central-west Kansas.

Total Project Cost: **Total Federal Funds requested:** **Total Project Match:**

Total Cost $372,913 **Federal $277,615** **State $95,298**

Abstract/summary: Playas of the High Plains provide critical ecosystem services, including providing wildlife habitat, supporting regional biodiversity, and contributing recharge to the High Plains aquifer. Yet, more than 80% of the over 22,000 playas in Western Kansas are completely farmed over and have lost substantial ecological functionality, with unquantified effects on recharge. This project seeks to explore the interactions between agriculture and playas by determining the degree to which different physical factors control recharge rates through playas, and how playas influence producer economic outcomes. If it is demonstrated that degraded playas reduce recharge, restored playas enhance recharge, and/or that farmed playas have reduced economic value compared to non-playa farmland, this could enhance producer buy-in for playa preservation and existing programs for playa restoration and protection.

PROJECT DESCRIPTION:

Program Priorities: The Kansas Water Office (KWO) has just updated our Wetland Program Plan (WPP) using EPA Grant CD-97763601 (Appendix 1). The new WPP will cover 2019-2023 and was approved by EPA Region 7 in April 2019. The proposed project addresses eight of the planned actions in the WPP. This proposal addresses three of the Core Elements: *Voluntary Restoration and Protection, Monitoring and Assessment, and Water Quality Standards for Wetlands*. The relevant WPP goals, associated planned activities contained in the WPP that these proposals address and relationship to the EPA Core Elements are discussed below. Page numbers refer to the WPP.

WPP GOAL 1. Increase the knowledge base about Kansas' wetland systems through surveying, monitoring, research and assessment to establish wetland condition, identify trends, and the causes and sources affecting wetland change. (*EPA Monitoring & Assessment Core Elements*) Action 1: Continue monitoring of public and private wetlands (p. 11). Action 2: Utilize potential wetland area locations in WRAPS watersheds to achieve TMDL and other WRAPS goals; direct resources to priority areas (p.15). **WPP GOAL 2.** Promote public awareness about the value and importance of wetlands through coordinated programs of education and information (*EPA Voluntary Restoration Core Element*). Action 1: Provide technical and financial assistance to private landowners for protection, enhancing or restoring wetlands (p.4). Action 2: Attain no net loss of remaining wetland resources considering acreage, function and value (p 6.) Action 3: Support development of Best Management Practices to protect and restore wetlands (p.8). Action 4: Optimize sustainable and multipurpose uses of wetland areas (p.9). Action 5: Continue to support efforts to Protect Playa Wetlands through Partnership with Play Lakes Joint Venture and others (p. 10). **WPP GOAL 5**. Provide effective and responsible levels of protection and restoration of Kansas' wetlands through continued implementation of the existing regulatory program (*EPA Water Quality Standards Core Element).* Action 1: Continue to compile data from public and private wetlands to be available as reference data should the state decide to develop wetland specific water quality standards (p. 9).

The proposed project will further the state's knowledge of these planned actions: We will explore the interactions between agriculture and the Playas, specifically the controls on recharge rates through Playas. Physical and biological data from approximately 15 Playas in west-central Kansas will be collected, compared and analyzed. This project will result in better understanding of recharge rates and economic values of these and other Playas.

Given the number of Playas that have been altered, knowledge gap on potential recharge rates and groundwater shortages this project is essential. Evaluation of these 15 Playas located in west-central Kansas specifically addresses WPP Goal #1, Action 1 and also Goal #5, Action 1 with fringe benefits on the remaining 6 Actions. The data collected from these few Playas could be extrapolated the Playas in the remainder of the state.

Description of Need: Functioning playas of the High Plains provide critical ecosystem services, including providing wildlife habitat, supporting regional biodiversity, and contributing recharge to the High Plains aquifer (HPA), as demonstrated in our previous project, CD-97746601. However, western Kansas, where more than 22,000 playas are located (http://pljv.org/for-habitat-partners/maps-and-data/data-downloads/), is intensively cultivated with more than 80% of the playas farmed-over (http://kars.ku.edu/research/2005-kansas-land-cover-patterns-level-iv/). The majority of playas have been continuously cultivated for years to decades, potentially resulting in substantially degraded ecological and hydrological function. With cultivation, sedimentation to playas increases. In the Southern High Plains, playa sedimentation has been shown to reduce the water storage volume, bury hydric soils which provide pathways for recharge, and increase evapotranspiration rates. This is expected to reduce recharge rates, but the effects of this impairment are currently unquantified. Further, in many parts of western Kansas, depth to groundwater in the HPA has increased dramatically due to excessive groundwater extraction. In areas with significant water table declines, it is unknown if playas actually serve as recharge conduits to the HPA due to the thick vadose zones. Finally, anecdotal evidence suggests that cultivated playas provide reduced crop yields on average relative to adjacent non-playa farm ground.

Demonstrating that degraded playas reduce recharge and/or that farmed playas have reduced economic value compared to non-playa farmland could enhance landowner buy-in for playa preservation and existing programs for playa restoration and protection. The HPA is the "largest, most economically important ground water source in Kansas" (p. 9, "Vision for the Future of Water in Kansas") and agriculture is the primary industry in the area. Results from this project could have a great affect on local thinking and help reinforce a growing attitude that the Playas might hold more value when not in agriculture production. This investigation supports four of the five goals and several Activities in the Kansas WPP. Within the *Voluntary Restoration* Core element, this includes all six Activities listed under the Actions: "Continue support of Playa Lakes Joint Venture (PLJV) efforts to gain more understanding about Playa Lake benefits and functions" (p.10) and "Increase efforts to protect playa wetlands through partnership with PLJV and others" (p.10-11). In addition, this work will enable future developments of the PLJV Decision Support System (p. 10) to include crop yield/profitability and recharge considerations.

Here, we seek to explore the interactions between agriculture and playas by examining the degree to which different physical factors control recharge rates through playas, and how the choice to farm or preserve playas effects producer economic outcomes. We will build on our previous projects and explore the interactions between agriculture and playas, specifically the controls on infiltration (water movement from the surface into the subsurface) and recharge (water reaching the water table) through playas (Objectives 1 & 2), and how playas affect producer economic outcomes (Objective 3). We will conduct a field investigation of infiltration, recharge, and sedimentation in a number of playas (10-15) across Kansas Groundwater Management District #1 (GMD1) Figure #1.

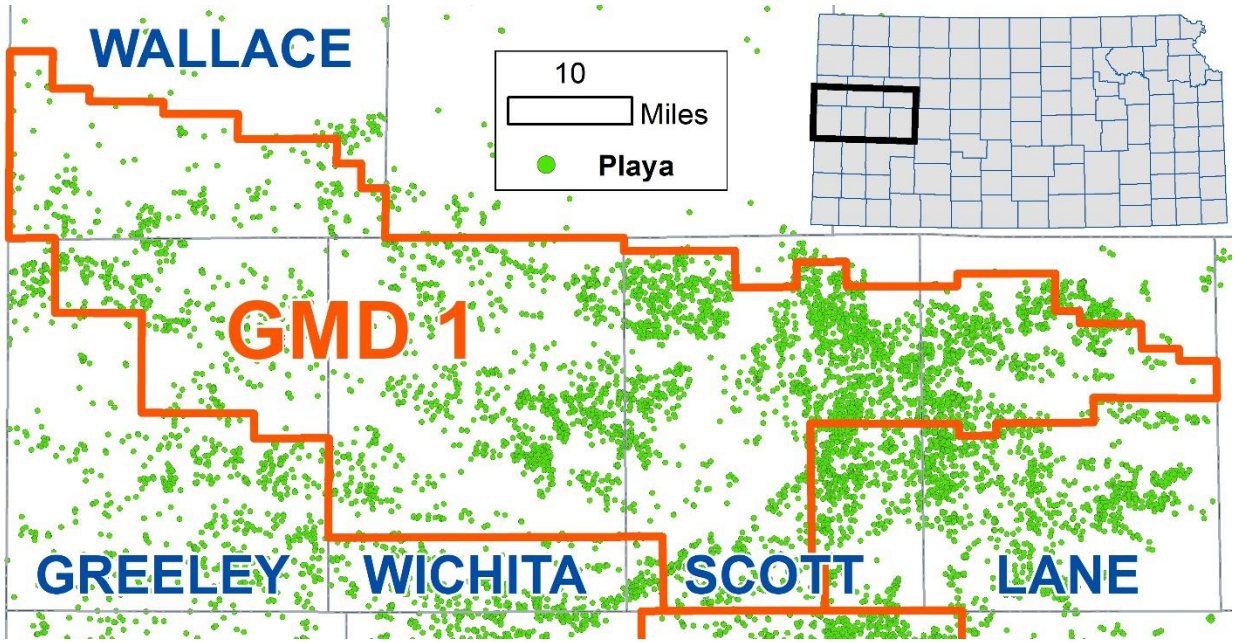

Figure #1.

We will conduct biological surveys, similar to those conducted during CD-97743401 and CD-97763601, coupling infiltration, recharge, and sedimentation measurements with other changes to ecological function across the impairment spectrum. We will expand our field results to a larger area by leveraging existing datasets (e.g., EPA STORET, USGS NWIS, USDA STEWARDS) to estimate and model playa recharge contributions across a spectrum of playa conditions for the study region. Finally, we will also investigate producer-provided yield maps from twenty different farm fields harboring playas to evaluate agricultural productivity and profitability of farming through playas.

Outputs and Outcomes: *Outputs* – Data collected during this project will reflect playa ecological function, infiltration, recharge, water quality, and economic values. Field assessments completed on the Playas will include collection of: ecological function/water quality (presence of hydric soil, macroinvertebrate richness, plant/animal communities and land use),

infiltration/recharge (sediment cores, use of chemical tracers and water-table piezometers) and economic values (producer provided yield maps). All of this information will be used to develop simulations across an impairment spectrum for the HPA. *Outcomes* - This project will enhance the knowledge of Playas while providing stakeholders with information to help them better understand the impacts and costs of farming Playa wetlands on the resources they need (i.e., HPA water) and their profitability.

TRANSFER OF RESULTS: Geochemical data will be uploaded and stored on the EPA STORET database. Presentations will be given at local (GMD1, Playa Lake Technical Workshops and Tours [p. 11]), state (Governor's Water Conference), and national conferences to transfer results and knowledge gained during this project. The final report will be developed as a KGS Open File Report, and made available on the KGS website. In addition, two journal articles will be developed featuring the key findings from the study. Attendance and presentations by Principal Investigators at the EPA Wetland/Enhancing State and Tribal Programs (ESTP) workshops. Communication of project information will be completed through: emails, phone conversations, face-to-face meetings and possibly webinars. Other opportunities will be utilized as they are identified.

Link to EPA Strategic Plan: Collectively, the core elements, goals, actions and planned activities described in the Program Priorities section support EPA Strategic Plan Goal 1: A Cleaner, Healthier Environment, Objective 1.2 Provide for Clean and Safe Water. Our goal is to focus wetland protection, restoration and management activities on watershed needs and characteristics including TMDLs, habitat, sediment and nutrient cycling and potential mitigation

siting, among other factors. We recognize that wetlands must be protected within the context of healthy watersheds. This project will provide a better understanding of the value of Playas to their watershed.

With better information about Playa recharge rates and profitability we will be able to more effectively target resources for restoration and protection, increasing wetland function, protection and acres.

We will *measure and track progress* in achieving these outputs and outcomes as we continue to implement our WPP over this year and into the future with the newly revised WPP, 2019-2023 time frame.

PARTNERSHIP INFORMATION: The Playa Lakes Joint Venture (PLJV) supports this project because it has the potential to catalyze Playa conservation work in Kansas by providing a better understand of the recharge contribution of the Playas as well as the economic considerations for Playas in production. Kansas Department of Health and Environment (KDHE) believes this project would dovetail nicely with their current project, the reduction of nitrates in public water supplies using Playas as natural filters. Kansas Department of Wildlife, Parks and Tourism (KDWPT) feels this project will provide valuable data to aid in addressing resource concerns and conservation issues identified with the Kansas State Wildlife Action Plan. The United States Fish and Wildlife Service (USFWS) believes that restoring and conserving Playas is vital to preclude the future listing of many species of plants, invertebrates and migratory birds under the Endangered Species Act. The Kansas Alliance for Wetlands and Streams (KAWS) believes this project could provide a better understanding of the Playas recharge contribution to the High Plains aquifer as well as economic for Playas in production. Ducks Unlimited (DU), The Kansas Forest Service (KFS), Ground Water Management (GMD) District #1, The Kansas Department of Agriculture,

Division of Conservation (DOC), The Nature Conservancy (TNC) and the United State Department of Agriculture (USDA) all believe this work will provide similar benefits. (Appendix 2).

PROJECT GOALS AND OBJECTIVES:

Accomplishments for this reporting period are in red in the following text.

Goal 1. Evaluate ecological condition of the playas - It is important to evaluate the ecological condition of the playas. In addition to expanding and enhancing the state's digital playa inventory, we expect the outputs from this project to be used in support of playa identification and prioritization efforts directed toward restoration or preservation, or for basic estimation of essential playa characteristics.

Action 1 - Field assessment: Individual Playa water chemistry (water temperature, pH, DO, turbidity, specific conductance, salinity, and ORP) will be measured with a Horiba U-52. From each dry playa, a composited soil sample consisting of four sub-samples will be collected and cultured in the lab to check for macroinvertebrates in diapause (dormancy). Year 1: Jun - Oct. 2020.

Progress:

Action 2. Calculate playa index. The playa index takes into account presence of hydric soil, macroinvertebrate richness, plant wetland indicator status, and land use. Year 2. Oct - Apr. 2021.

Progress:

Goal 2. Investigate infiltration and recharge through playas in GMD 1 across a spectrum of impairment.

Action 1. Obtain playa core, obtain vadose zone cores using the Kansas Geological Survey (KGS) hollow-stem auger and shallower sedimentation cores with a Giddings soil probe. Year 1: Oct.-Nov. 2019, Year 2: Sept.-Oct.2020.

Progress:

Action 2. Determine Playa impairment, determined by excavating small shovel pits in the center of the hydric soil footprint and at ½ the radius at the four cardinal and four ordinal directions. Year 1: Jan 2020-Mar. 2020, Jul. 2020, Year 2: Sept. 2020-Dec. 2020.

Progress:

Action 3. Determine infiltration and recharge rates through playas, will be measured using a dual-head infiltrometer. Recharge rates will be determined primarily using chemical tracers, such as chloride mass balance and ^{36}Cl. In a subset of the playas, water-table piezometers will allow us to sample groundwater for environmental age tracers and monitor changes in water level for recharge. Year 1: Oct. 2019 – May 2020, Year 2: Sept. 2020 – April 2021.

Progress:

Action 4. Use historic daily rainfall data and playa catchment hydrology to estimate cumulative infiltration for the field-studied playas. Year 1: May 2020 – Jun. 2020, Mar. 2021 - Apr. 2021.

Progress:

Goal 3. Upscale the results of playa recharge, and evaluate the effects of different scenarios of playa degradation and restoration.

Action 1. Mine existing data for evidence for playa recharge, mine the data from these databases and published studies from the High Plains region. Year 1: Jun. 2020 – Sept. 2020.

Progress:

Action 2. Simulate effects of impairment on playa recharge, a combination of the 2-m LiDAR terrain data, data collected during this study, and simulations of individual playas, we will extrapolate our results up from individual playas to the GMD-1 scale to evaluate the effects of different levels of impairment on recharge to the HPA . Year 1 and Year 2: Nov. 2020 – June 2021.

Progress:

Goal 4. Assess the agricultural value of farmed playas.

Action 1. Obtain and evaluate field-level gridded yield data, using producer contacts and connections of the research team in the GMD1 area, we will acquire point, zonal, or gridded yield data from multiple field sites. Year 1: Oct. 2019-Mar. 2020.

Progress:

Action 2. Assess the operational costs of farming around playas, perform an economic analysis of the cost per-acre cost of farming the field with and without playas. Following the methods described in Smith et al. (2013), planting, harvesting, and spray operations will be simulated for field coverage efficiency and path overlap, for scenarios with playas included with the fields and for scenarios where they are excluded. Year 1: Oct. 2019-Sep. 2020, Year 2: Sept. 2020-Mar. 2021.

Goal 5. Project management

Action 1. Prepare quarterly reports. Jan. 2020, Apr. 2020, Jul. 2020, Oct. 2020, Jan. 2021, Apr. 2021, Jul. 2021.

Progress:

Action 2. Keep partners informed of progress. Oct. 2019 – Sept. 2021.

Progress:

Action 3. Meet at least annually with EPA to review results.

Progress:

Action 4. Write final report. Jul.-Sept. 2021.

Progress:

Action 5. Submit final report. Sept. 2021.

Progress:

Action 6. Attend National Conference either 2020 or 2021.

Progress:

OBSTACLES/REMEDIES:

CHANGES IN PERSONNEL:

EQUIPMENT PURCHASED IN CURRENT QUARTER:

UPCOMING ACTIVITIES:

ACCOMPLISHMENTS MEASURED AGAINST THE WORK PLAN:

EXISTING AND POTENTIAL PROBLEM AREAS:

CUMULATIVE EFFECTIVENESS OF THE WORK PERFORMED:

SUGGESTIONS FOR IMPORVEMENT INCLUDING, WHERE FEASIBLE, SCHEDULES FOR MAKING IMPORVEMENTS: