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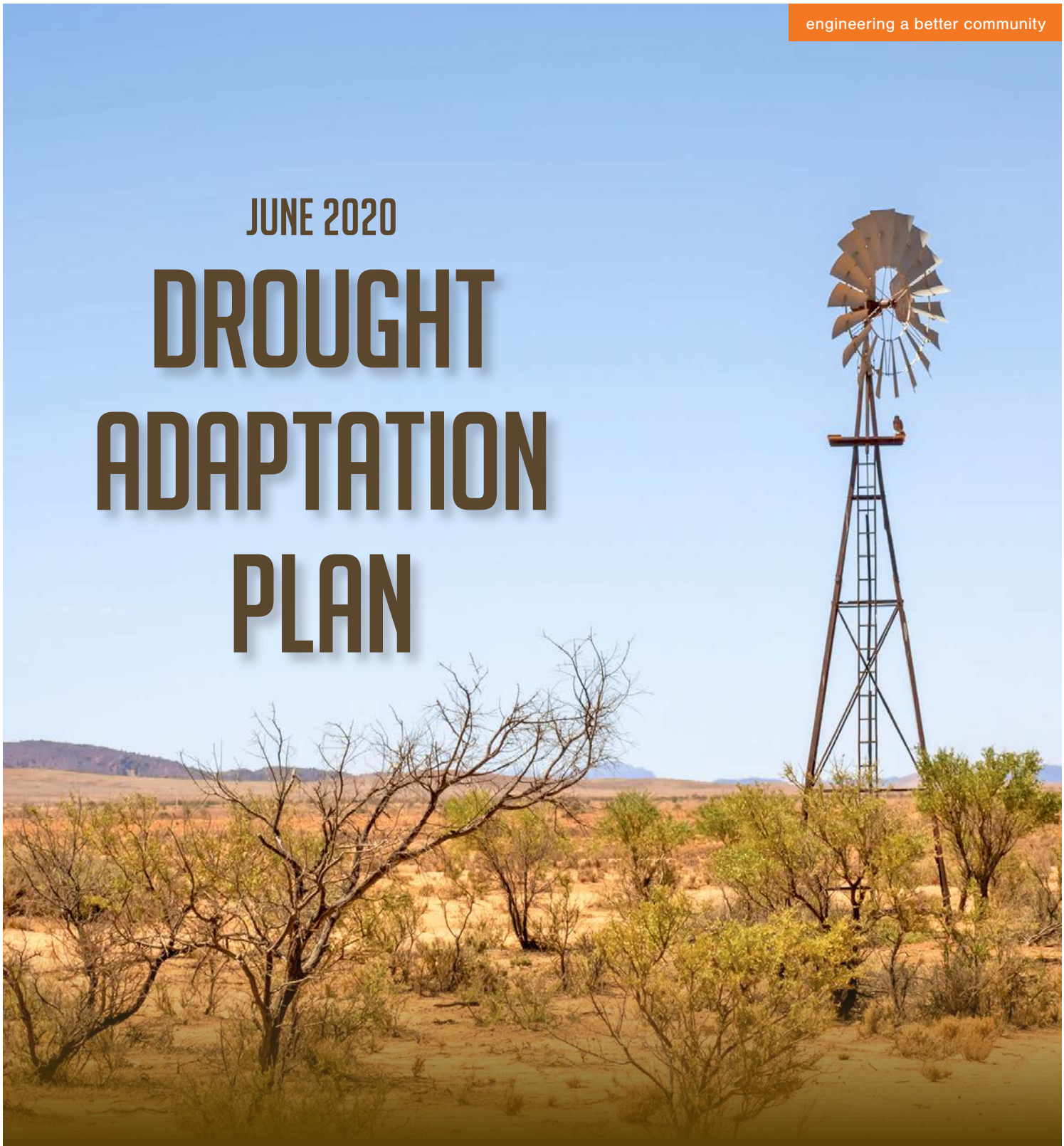
JUNE 2020

DROUGHT ADAPTATION PLAN



PREPARED FOR
The People of Oglala Sioux Tribe
Pine Ridge Indian Reservation

PREPARED BY
Great Plains Tribal Water Alliance

BANNER
engineering a better community

Drought Adaptation Plan

PREPARED FOR

The People of Oglala Sioux Tribe
Pine Ridge Indian Reservation

Prepared in collaboration with

Great Plains Tribal Water Alliance

June 2020

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EXECUTIVE SUMMARY

The Great Plains Tribal Water Alliance (GPTWA) consults member tribes on water resources and water related issues. The GPTWA serves as an advisory board to the Great Plains Tribal Chairman's Association. The GPTWA is comprised of four tribes, the Flandreau Santee Sioux Tribe, the Rosebud Sioux Tribe, the Oglala Sioux Tribe, and the Standing Rock Sioux Tribe. The GPTWA assisted in submitting two Bureau of Indian Affairs (BIA) grants to develop a Category 2 Drought Adaptation Plan (DAP) for each member tribe.

The DAP will assist the tribes in developing drought resiliency procedures and was based on research, field visits, questionnaires, surveys, and follow-up meetings. The previous Drought Vulnerability Assessment (DVA) was created to identify sector specific vulnerabilities that are susceptible to drought. The sectors included: legal rights and infringements, Tribal lifeways, water, land, wildlife, agriculture, public health, and Tribal data monitoring. In addition to the DVA, scholarly research and field visits with Tribal leaders were conducted to identify five specific vulnerabilities and mitigation strategies, shown below:

Vulnerabilities

1) General infrastructure is old and outdated (water, wastewater, and roads)
2) Private wells are high in arsenic
3) Volunteer fire departments are few and far between
4) Tree regeneration is significantly reduced
5) There is an increase in invasive plant species.

Mitigation Strategies

1) Identifying all water demands
2) Maintenance and repair programs on distribution infrastructure
3) Catching and use of rainwater
4) Improving efficiency standards in buildings
5) Identifying new water sources before approving proposed development

After preliminary research and field visits, the DAP and drought mitigation projects were created to assist the tribe in planning and mitigation.

The DAP was developed from research on climate and recommended actions during drought, based on the needs of each sector. The DAP requires diligent monthly monitoring of drought conditions using drought indices that track the severity of flash drought and long-term drought. Indices used include the Evaporative Demand Drought Index (EDDI) and the U.S. Drought Monitor (USDM). There are also four categories that detail current drought severity based on both EDDI and USDM:

- Normal (No USDM or EDDI
- Alert (USDM of D0, 1-month EDDI of ED 1-4)
- Warning (USDM of D1-2)
- Emergency (USDM of D3-4)

Each category has a specified set of proactive and reactive actions for the Tribal government to take.

Ten mitigation projects were developed and are based directly on the top five mitigation strategies and range in scope from implementing flood control levees to starting a composting facility and include educational awareness concepts. The mitigation projects are meant to aid the tribe in developing adequate infrastructure that will minimize the effects of drought. Some projects, like those dealing with water demand and restriction, require partnerships with private entities

that are responsible for water distribution. Federal funding opportunities for each of the projects were also identified, detailing both the grant opportunity as well as the federal agency responsible for its distribution.

The success of this DAP depends on the local government effort to make the necessary structural changes to ensure the DAPs diligent enactment. It is recommended that the DAP be updated every five years for successful and continued implementation.

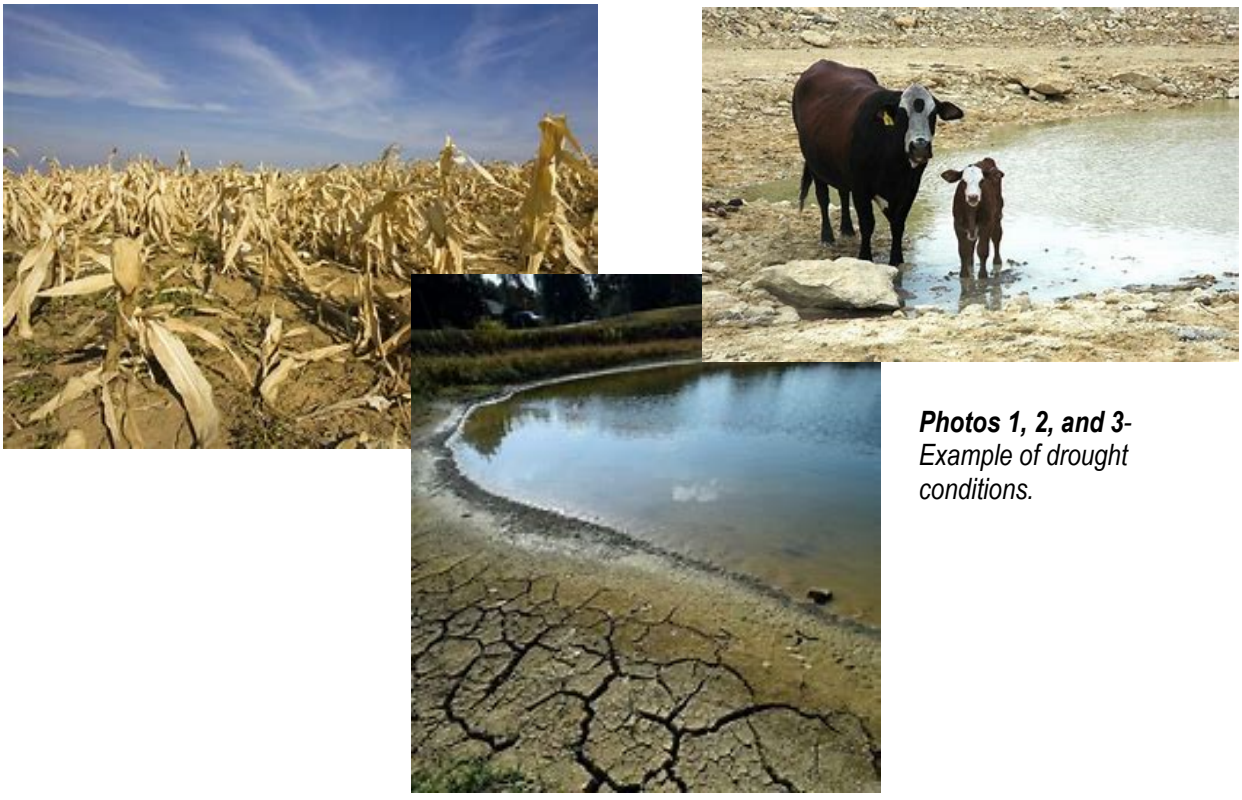
1.0 INTRODUCTION

The Drought Adaptation Plan (DAP) was developed as a planning tool to identify and prioritize Oglala Sioux Tribe (OST) government responses before, during, and after drought. The recommendations in the DAP were created by understanding the important Tribal resources and the vulnerabilities of those resources to drought. Key Tribal program directors, staff, council members, government officials, and members met to identify and prioritize strategies and plans most beneficial for the Tribe.

Three other Tribes, active in the Great Plains Tribal Water Alliance (GPTWA), worked collectively in developing the DAP. The GPTWA Tribes include Flandreau Santee Sioux Tribe, Rosebud Sioux Tribe, and Standing Rock Sioux Tribe. The DAPs were funded by the Bureau of Indian Affairs (BIA) FY17 and FY18 Tribal Resilience Program, Adaptation Planning Grant: Category 2. The Tribes worked collectively in learning about drought adaptation through the joint water conferences and workshops. Although the Tribes worked together on overarching drought adaptation concepts, each Tribe has a unique DAP, tailored for the respective reservation.

The OST DAP is the third resource document in a series, documenting drought vulnerabilities and baseline resource conditions. Each report builds on information and data documented in the previous one.

- *OST Integrated Environmental Management Plan for Cultural, Natural, and Water Resources (IEMP)*
- *OST Drought Vulnerability Assessment (DVA)*

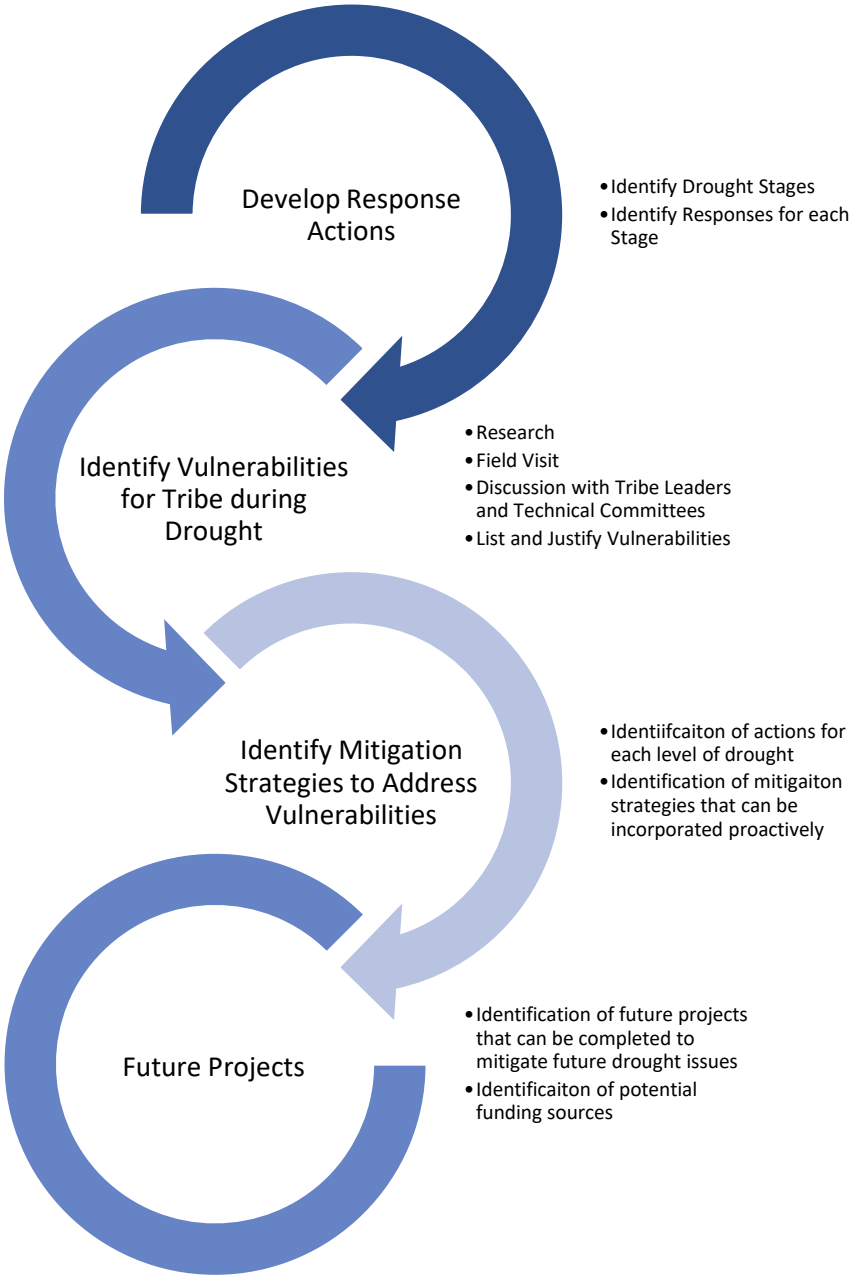


***Photos 1, 2, and 3**- Example of drought conditions.*

The objectives of this DAP are to:

- Coordinate with Tribal leaders to develop a list of drought vulnerabilities, previously determined from the DVA, that need to be addressed immediately,
- Identify drought mitigation strategies that would best resolve the vulnerabilities, and
- Identify the projects that would meet the mitigation strategy and identify potential funding sources for the top two priority projects.

The process to achieve the objectives for this DAP is shown in the flow chart.

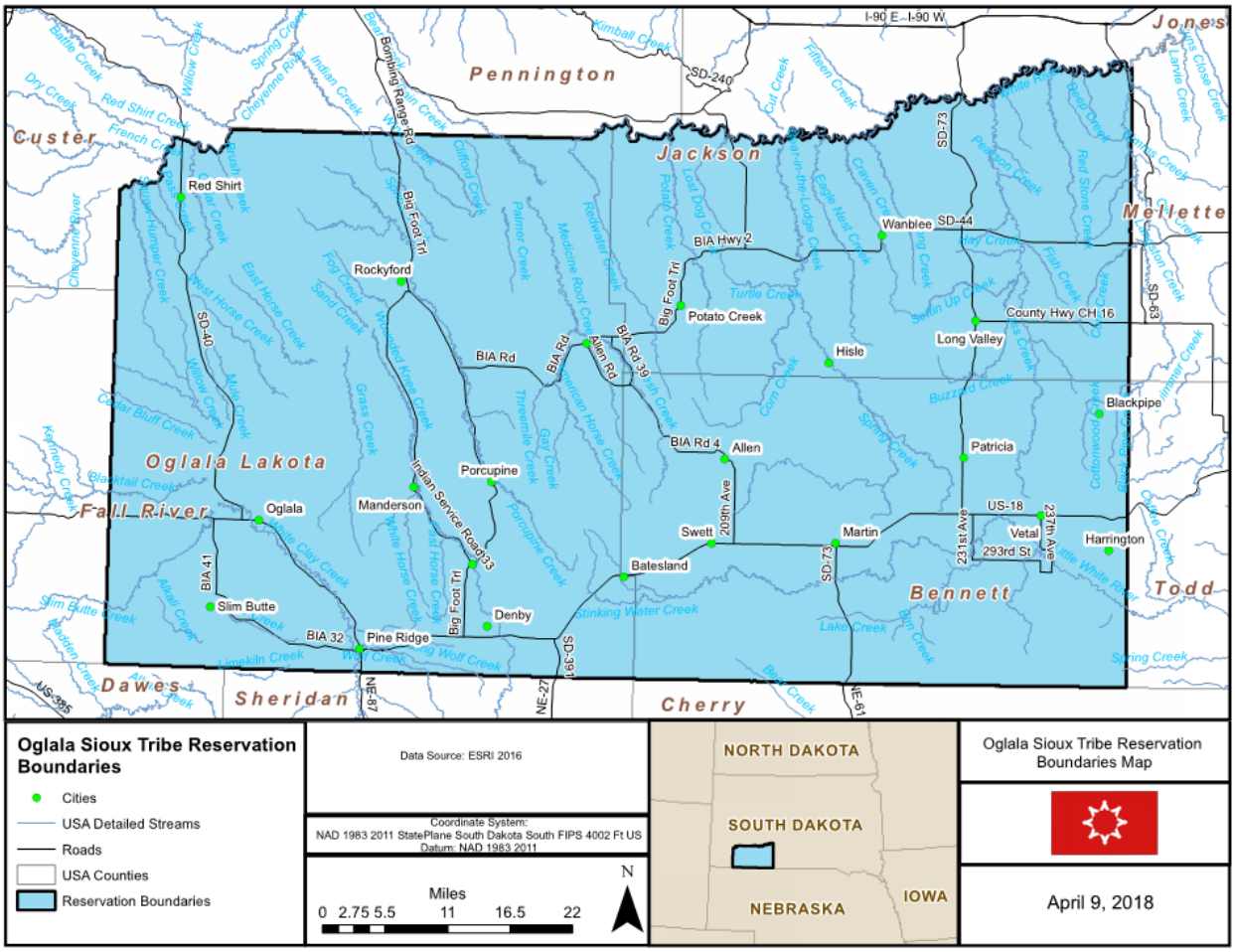


1.1 Pine Ridge Reservation Location

The OST reside on the Pine Ridge Indian Reservation (Reservation). The Reservation lies in southwestern South Dakota along the Nebraska state line, primarily in Oglala Lakota, Bennett, and the southern half of Jackson Counties. This area of South Dakota is semi-arid, with Oglala Lakota County generally more arid than Bennett or Jackson Counties (Wikipedia 2020). The Pine Ridge Reservation is a partition of the Great Sioux Reservation, which was established by the Fort Laramie Treaty of 1868.

The Reservation is 3,469 square miles in size and has nine designated districts throughout the Reservation, including Eagle Nest, Pass Creek, LaCreek, Wounded Knee, Porcupine, Wakpamni, Medicine, Pine Ridge, and Oglala. The Tribal Headquarters are located in Pine Ridge, South Dakota, near the southern border of the Reservation, less than two miles from the Nebraska state line. A map of the current reservation trust lands can be seen in *Figure 1.*

Figure 1. *Pine Ridge Indian Reservation Boundaries*



1.1.1 OST Government

The OST's government is comprised of a council with 20 elected officials, four of which are officers. There is one elected official for every 1,000 tribal members. Sixteen of the 20 officials directly represent a specific community within the boundaries of the reservation. The communities represented include the districts of Eagle Nest, LaCreek, Medicine Root, Oglala, Pass Creek, Pine Ridge, Porcupine, Wakpamni, and Wounded Knee. Two-year terms are set for all council members. The four officers are elected at large, meaning any tribal member living within the boundaries of the

reservation can vote for and elect officers. The elected officer positions include the Tribal president, vice president, secretary, and treasurer.

1.1.2 OST Land Description

The Reservation is the entirety of Oglala Lakota and Bennett Counties. Oglala Lakota County lies on the south side of South Dakota. Its south boundary line abuts the north boundary line of the state of Nebraska. The Cheyenne River flows northeastward along the northwest boundary of Oglala Lakota County. The White River flows northeastward through the central part of the county. The county terrain is composed of arid rolling hills spotted with small mountain crests, oriented northeast to southwest. The terrain slopes to the northeast; its highest point is on the south boundary line, close to the southwest corner. Bennett County lies on the south line of South Dakota. Its south boundary line abuts the north boundary line of the state of Nebraska. The Little White River flows eastward through the lower central part of the county. The highest point on the county's terrain is the southwest corner. The terrain consists of rolling hills cut with drainage gullies, sloping to the east-northeast (Wikipedia 2020).

1.1.3 Climate

The western half of South Dakota is semi-arid. The Reservation annually receives between 19 and 24 inches of precipitation and has an average annual temperature is 47.05°F. With high temperatures and low rainfall, the soil's moisture content decreases causing low forage production. The Reservation commonly experiences drought, wildfires, and flooding (Weather Underground 2020).

1.1.4 OST Demographics

The demographics of Pine Ridge were estimated by the Census Bureau and published in 2016 and can be found on Black Hills Knowledge Network website (Black Hills Knowledge Network 2020). The population of Pine Ridge is estimated to be 19,698 people. It is important to note that Tribal nations are regularly misrepresented by the Census due to multiple factors. The factors include residential mobility, language and literacy barriers, concealment of information because of a disbelief in census confidentiality, fear of retribution from authorities for violation of housing codes or other regulations, irregular and complex household arrangements, and resistance as a strategy for dealing with outsiders, particularly government representatives (NBC News 2019). Although this research was completed for the Rosebud Sioux Tribe, the same conclusions can apply to the OST as well. The average annual income in Pine Ridge is estimated at $30,908. When compared to South Dakota's overall average annual income of $54,126, 42.4% of Pine Ridge's population is estimated to live below the poverty line as compared to South Dakota's overall percentage of 14% (Black Hills Knowledge Network 2020).

1.1.5 DAP Partners

The grant proposal that was submitted by the OST had identified project partners that would be participating in the work. The partners included GPTWA and their interns, each Tribe, the National Drought Mitigation Center, and the National Oceanic and Atmospheric Administration. Banner Associates was hired to complete the DAP. The partners and their specific roles are described below and can also be found in *Table 1.*

- **Oglala Sioux Tribe**- The OST is the project lead. Helping project participants coordinate field visits, interviews, and offering guidance and feedback on the DAP throughout the project. The OST team is led by the Reno Red Cloud. Reno has worked with the Tribe for nearly 30 years and brings a variety of experience including previously working for Oglala Sioux Water System.

- **Great Plains Tribal Water Alliance-** The GPTWA is the original founding coalition for preserving the prior reserved water rights of the Missouri River under aboriginal title, the 1851 Fort Laramie Treaty, the 1868 Fort Laramie Treaty, and other judicially established territories in North Dakota, South Dakota, and Nebraska. The

GPTWA was established in 2006 by the Standing Rock Sioux Tribe, Oglala Sioux Tribe, and the Rosebud Sioux Tribe, and now includes the Flandreau Santee Sioux Tribe. All Tribes within the Great Plains Region are welcome to participate in the GPTWA. The public outreach, research, and education offered by GPTWA is dedicated to protecting and preserving the Great Sioux Nation Indian Water Rights for the use of water in the Missouri River, tributaries, and all aquifers and ground water sources located within the exterior boundaries of the Great Plains Region. As its sacred obligation, the GPTWA will provide technical and policy recommendations for the protection of all water resources for the next seven generations.

The GPTWA serves as the organizing vehicle to collaborate with the Tribes, BIA, and relevant federal and state agencies to develop DAPs in a phased approach. This multi-Tribal approach follows the model for the Mni Wiconi Rural Water System (MWRWS), where federal and state governments worked with several Tribes to build, monitor, and maintain their water infrastructure. This partnership builds on historical and cultural networks to support and sustain water resource planning efforts after the grant period.

- **GPTWA Interns-** The project team worked with the South Dakota School of Mines and Technology and Oglala Lakota College in Rapid City, South Dakota, to identify two engineering or science students entering their upperclassmen years to work on this project. The students that were hired for the project are enrolled members of South Dakota Tribes. Their goal was to work with the Tribe's technical staff and other key resource personnel to assist in the development of a DAP for each Tribe. The interns acted as a team, sharing important methods and processes that helped them tailor plans for the Tribes. These students developed important skills and acquired knowledge about drought vulnerabilities and mitigation strategies to assist the Tribes in the future.

- **National Drought Mitigation Center-** The National Drought Mitigation Center's primary task was to offer professional and technical guidance to the GPTWA Interns, offer insight on field visit coordination, participate in field visits and surveys, and to offer guidance on development of the DAP.

- **National Oceanic and Atmospheric Administration-** NOAA was tasked to participate as a conference speaker and to offer information to the partnering Tribes of the GPTWA. Concurrently two of their interns accompanied GPTWA Interns and Banner Associates on field visits. NOAA had also included cost-match with $10,000 for Tribal Technical Team Members to travel to the GPTWA Fall Conference.

Table 1. *Drought Adaptation Partners*

Agency	Partners
Great Plains Tribal Water Alliance	Oglala Sioux Tribe Rosebud Sioux Tribe Flandreau Santee Sioux Tribe Standing Rock Sioux Tribe
GPTWA Interns	Amanda Booton-Popken Elisha Yellow Thunder
National Oceanic and Atmospheric Administration	Doug Kluck, Central Region Climate Services Director Emily Bamford, Graduate Student Marianne Shiple, Graduate Student
National Drought Mitigation Center	Cody Knutson, Water Resource Scientist
Oglala Sioux Tribal Leaders	Reno Red Cloud, Water Resources Amos Young Dog, Water Management

Agency	Partners
	Mike Catches Enemy, Presidential Legislative Liaison Louis R. Janis, OST Utilities Office Steve Pourier, OST Utilities Office Delaine Killeback, Environmental Protection Program Tracy Zacher, Bureau of Land Management Robert Pille, OST Water and Sewer

1.2 Method to Identify Vulnerabilities and Mitigation Strategies

To identify the vulnerabilities and mitigation measures, research, field visits, and coordination with OST and other identified experts and stakeholders was completed. The sections below discuss each further. During the original research effort, several online sources were used to develop the mitigation strategies list. The DVA was used to identify the vulnerabilities for each Tribe and tailor the mitigation strategies to these. The IEMP was also used in preliminary research. The mitigation strategies were gained through the work of other Tribes and through sources based in arid areas of the world. The field visit data that was gathered was primarily the viewpoints of Tribal leaders and their professional opinions on the Tribe's needs. The project partners also provided online articles, sources, background documents, and more.

1.2.1 Research

Preliminary research was completed for the OST for both an IEMP and DVA. The DVA utilized available research and became a guide on how to conduct adaptation planning for drought conditions. Extensive scholarly research was also completed using the databases ProQuest, EBSCO, and Google Scholar. Journals, publications, government documents, and articles regarding climate change, drought mitigation and planning, and Tribal, federal, and state political land interactions were read, notated, and cited in an annotated bibliography. This research was conducted to establish baseline information on types of drought adaptation and mitigation management practices that have been done in the past. This research allowed for specific practices and other methods to be considered for the Great Plains Tribes.

Climate change resilience and adaptation research were completed to establish base knowledge regarding how Tribal councils, programs, and members are building resilience and adapting to extreme weather events caused by current climate change trends. The drought mitigation and planning research was completed to obtain examples of how other areas, such as Tribal nations and states, are identifying drought vulnerabilities within their communities. It was also conducted to see how indigenous nations are using drought mitigation to prepare and alleviate potential threats to their ancestral territories and cultural resources. Land and legal interactions, both historical and current, were examined to better understand the environment Tribal nations must navigate to develop and implement a drought adaptation plan.

1.2.2 Field Visits

An initial field visit was made to Rosebud to present potential drought vulnerabilities and mitigation strategies to Tribal leaders and closely associated government officials. Interviews with key Tribal program directors, staff, Tribal council, government officials, and Tribal members were scheduled ahead of time, with confirmation calls and reminder emails made the week before appointments. The interviews were conducted at the Justice Center Building in Pine Ridge and used questionnaires created prior to the field visit. Meeting in this central location ensured access and availability for Tribal leaders, members, GPTWA project leaders, and interns. If interviewees were not able to meet at the Justice Center Building, the project team met them at a desired location. The goal of the field visit was to gain Tribal input on drought vulnerabilities and preferred mitigation strategies to help determine potential future drought mitigation projects.

A follow up visit was scheduled during the OST Environmental Health Technical Team Annual Conference to further discuss ranked vulnerabilities and mitigation strategies. The visit took place in Rapid City, SD at the Ramkota Hotel and Conference Center. Scheduling the second field visit during the annual conference resulted in a higher attendance with more feedback regarding preferred projects and their ranking.

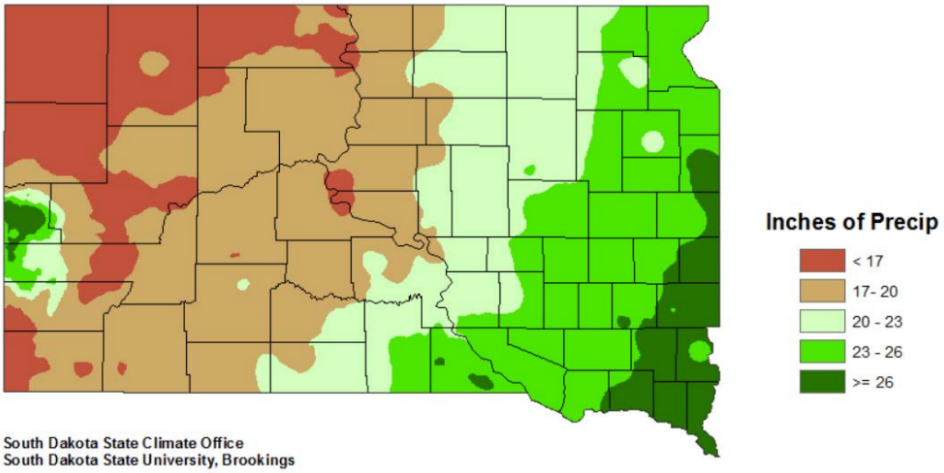
DAP update meetings occur every third week of the month during the Tribe's Technical Health Tech-Team Meetings, allowing DAP updates to be presented and feedback received. The meeting locations are in Pine Ridge or Rapid City, with attendees varying between Reservation department personnel, Banner employees, Tribal leaders, and residents. The goals of the meetings are to move projects forward and to address issues or items of importance.

2.0 Drought Occurrence Assessment for OST

2.1 Drought Concern

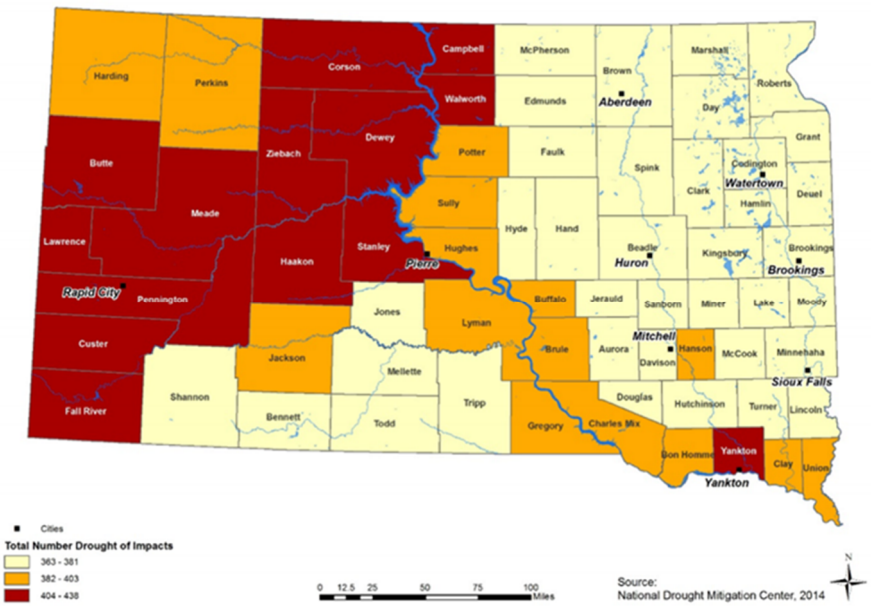
The OST often experiences issues with drought and flood in cycles and experiences less precipitation than Eastern South Dakota, as shown in *Figure 2*. The OST is in the south-west region and receives approximately 17-20 inches of precipitation per year (South Dakota Department of Emergency Management 2015).

Figure 2. *Average Annual Precipitation for South Dakota*



South Dakota's Drought Mitigation Plan also provides a Drought Impact Reporter, shown in *Figure 3*. The Drought Impact Reporter indicates that the Reservation (comprised of Oglala Lakota (Shannon), Bennett, and Jackson Counties) is one of the areas that experiences drought less frequently than other areas of the state. Over 35 years, there have been somewhere between 360 and 400 recorded incidents of drought (South Dakota Department of Emergency Management 2015).

Figure 3: *Drought Impact Reporter for South Dakota*



2.2 Drought Prediction and Identification

Drought impacts are typically spread over large areas. There are many parameters and indices to choose from when predicting and identify drought. Some measurable parameters include temperature, precipitation, soil moisture, reservoir/lake levels, streamflow, groundwater, snowpack, snow water equivalent, evapotranspiration, vegetation health/stress, and environmental and socioeconomic impacts. Indices exist that utilized the parameters noted to show the drought's severity. Common indices include the percent of normal precipitation, deciles, Standardized Precipitation Index (SPI/SPEI), Palmer Drought Severity Index (PDSI, SC-PDSI), and Aridity Index. Hydrologic drought indices include the Palmer Hydrological Drought Index (PHDI) and Surface Water Supply Index (SWSI) (World Meteorological Organization & Global Water Partnership 2016).

Drought indices play an important role in understanding drought. They simplify complex relationships and provide good communication tools for diverse audiences/users. They are a quantitative assessment of anomalous climatic conditions: intensity, duration, and spatial extent. They provide a historical reference showing the probability of recurrence, assisting in planning and design applications.

It is important to take careful consideration into choosing indicators and triggers for drought. Droughts are very dynamic and are not specific to one indicator. Precipitation alone is only part of the equation when assessing drought conditions. Soil moisture, humidity, and temperature also have a huge impact on drought and can exacerbate drought conditions. Indices, like the PDSI, estimate the movement of water in in the air, ground, and on the surface. However, calibrating a PDSI to a desired location is a process that requires extensive knowledge of soil properties and statistical analysis. Indices, like the PDSI, also come with a lag in data that could be weeks, or even months, meaning that actual notification of a drought may come too late. So, when choosing drought indices or indicators, it is imperative that its risk, lag, and ease of use are all considered.

For drought, it is important to start with creating adaptation plans. Once adaptation plans have been developed, the plan components should be followed and monitored to confirm an early warning system is initiated. Ideally, the early warning system is initiated before the drought occurs. After the drought occurs, an assessment should be done to develop the best response possible. The response initiated will eventually lead to a recovery of the situation. Reconstruction and mitigation follow recovery and allow for better preparation for the next situation. Once the cycle is complete, planning must start again to prepare for the next drought.

2.3 Drought Hazard Profile

A drought hazard profile is a way to analyze the various aspects of drought. For the drought hazard profile of the OST, the history of drought and related impacts were assessed, along with the probability of recurrent drought. Drought history (in the form of drought severity) can be obtained from the United States Drought Monitor (USDM). Drought severity is displayed on a scale of no drought, D0 (Abnormally Dry), D1 (Moderate Drought), D2 (Severe Drought), D3 (Extreme Drought), and D4 (Exceptional Drought). The data are also normalized by the percent area of the selected location that is affected by drought. For OST, Oglala Lakota County was selected. The USDM has been made available on the internet on a weekly basis since January 4, 2000.

Along with the USDM, drought history can also be obtained using a PDSI and SC-PDSI. The PDSI is an effective index at determining long term drought. It uses precipitation, temperature, as well as evaporation and transpiration data to create an index that numerically represents the severity of a drought. However, when this index was created, soil conditions in Kansas and Iowa were utilized, which creates error for other parts of the country. The SC-PDSI corrects for different local conditions so that values below -3, which represent extreme drought, occur roughly 10 percent of the time. SC-PDSI data is available from a period of 1936 to 2014 for the community of Long Valley, located approximately 75 miles northeast from the town of Pine Ridge.

2.4 Drought Hazard Profile

The drought history for the OST has been developed by using the USDM, Drought Risk Atlas, and the Drought Impact Reporter. The data used were from the weather station located in Long Valley, South Dakota. *Table 2* shows the station information from the weather station in Long Valley.

Table 2. *Drought Risk Atlas Station Data for Long Valley, South Dakota*

394983: LONG VALLEY	Latitude: 43.46	Longitude: -101.496
Elevation: 2470 ft.	State: South Dakota	County: Jackson
Climate Division: 5	Time Period: 1936 - 2014	Years on Record: 76

Figure 4 shows the SC-PDSI history for the Long Valley station from the Drought Risk Atlas.

Figure 4: *Drought Risk Atlas SC-PDSI History for Long Valley, South Dakota*

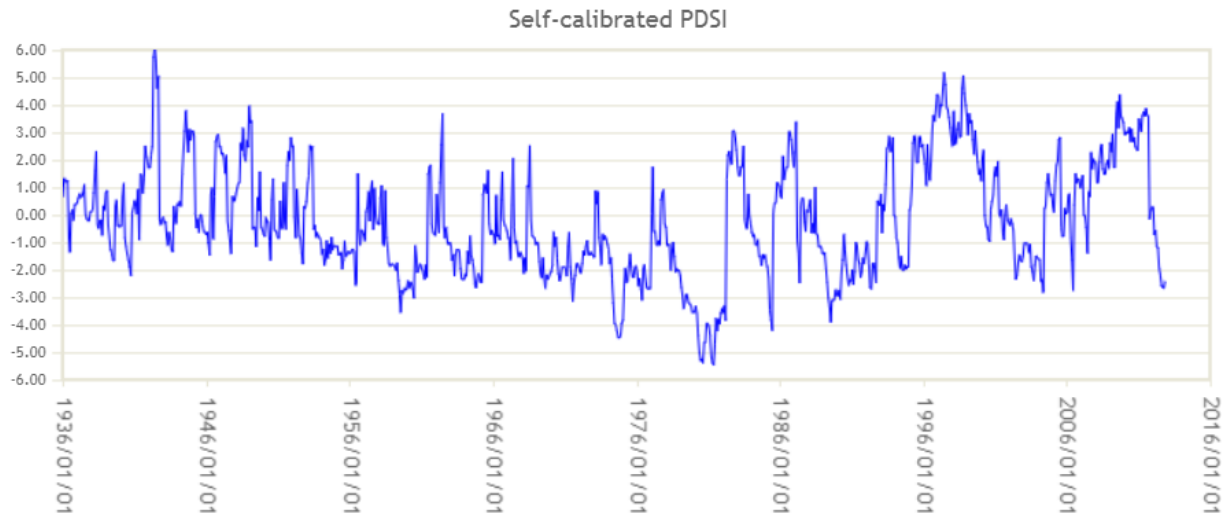
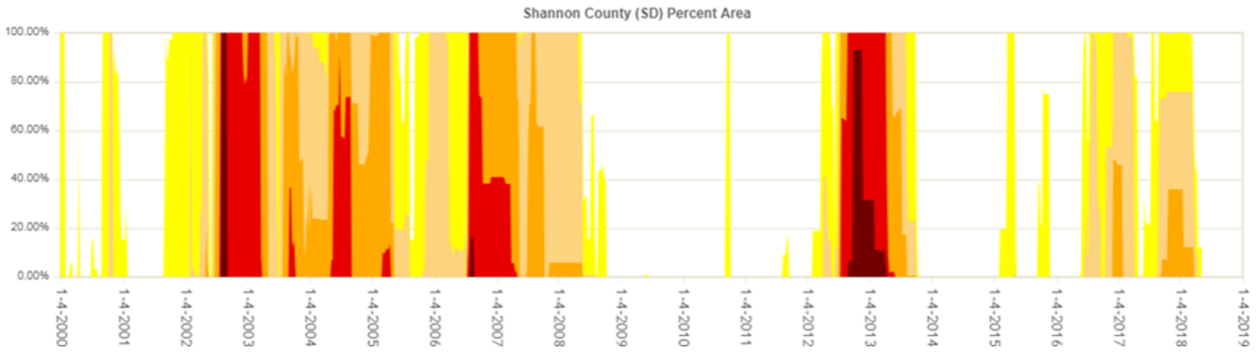


Figure 5 shows the USDM percent area statistics for each category of the instances of recorded drought for Oglala County, South Dakota from 2000 to 2019.

Figure 5: United States Drought Monitor SC-PDSI History for Oglala Lakota County



Historical occurrences of drought in Oglala Lakota County have also been documented in the following years:

- **1958–1961-** The first recorded drought of significance had a Self-calibrated Palmer Drought Severity Index (SC-PDSI) of -3.57, measured in August of 1959.

- **1968–1972-** The second recorded drought of significance had a SC-PDSI of -4.48 in November of 1974.

- **1978–1982-** The third recorded drought occurred in the fall of 1978 and lasted until 1982. It was the worst recorded drought in the area's history with the lowest recorded SC-PDSI of -5.41 in April of 1981.

- **1987–1992-** The second worst drought on record with a SC-PDSI of -3.91 during November of 1989.

- **2001–2008-** A drought occurred between 2001 and 2008 with a recorded SC-PDSI of -3.94 and resulted in many impacts. As a result, emergency programs were developed by the State of South Dakota, including the Drought Relief Hay Exchange. The exchange was developed to help farmers in need of hay locate farmers with available hay. The counties most in need of hay during the 2001–2008 drought were Oglala Lakota, Fall River, and Custer. The service focused on aiding farmers in counties west of the Missouri River and operated with the support of west river county extension offices. The exchange accepted hay listings from across the state.

- **2002-** Fireworks were banned over the Fourth of July weekend for much of western South Dakota because of the danger for drought-induced wildfires across the region. In 2002, Governor Janklow requested a drought disaster designation for all but two South Dakota Counties, which created low-interest emergency loan opportunities for South Dakota farmers and ranchers affected by continued drought conditions.
  USDA Secretary Mike Johanns declared a disaster for 24 counties in South Dakota because of drought, frost, high winds, insect damage, and hail. As a result, farmers and ranchers in those counties were eligible for low-interest emergency loans. In addition, 24 adjoining counties also qualified for relief. South Dakota received $4.3 million from the Livestock Assistance Grant Program to help producers who lost forage due to drought. Eligible producers that applied for the grant received $3 per head for cattle and about 50 cents per head for sheep (USDA 2020).

- **2003-** Governor Rounds announced that the USDA designated 55 South Dakota counties as primary or contiguous disaster areas because of persistent drought during 2003. The following counties were designated as primary disaster areas: Beadle, Bennett, Bon Homme, Brule, Buffalo, Butte, Campbell, Charles Mix, Corson, Deuel, Dewey, Grant, Gregory, Haakon, Hamlin, Hand, Harding, Hughes, Hyde, Jackson, Jones, Meade, Mellette, Perkins, Potter, Oglala Lakota, Spink, Stanley, Sully, Todd, Tripp, Walworth and Ziebach. The following counties were included as contiguous disaster areas: Aurora, Brookings, Brown, Clark,

Codington, Custer, Day, Douglas, Edmunds, Fall River, Faulk, Hutchinson, Jerauld, Kingsbury, Lawrence, Lyman, McPherson, Miner, Pennington, Roberts, Sanborn, and Yankton.

- **2012–2013-** The data from the Drought Impact Reporter aligns directly with the data produced by the USDM and shows the severe, but short drought, during 2013. Secondary impacts of this drought included many cattle being sold at auction when water supplies were low, and pastures were bare.
  Entering the 2013 growing season, the U.S. Department of Agriculture began declaring counties as primary and secondary disaster areas related to drought in January. Farmers in affected counties had eight months from the date of the declaration to apply for low-interest emergency loans. Laura Edwards, the State Climatologist, said that much of the southern South Dakota corn crop during these years was affected by drought, leading farmers to cut it for silage.

- **2017-** In 2017, another severe drought occurred across the Reservation. In 2017, the Governor of South Dakota declared a state of emergency and activated the South Dakota Drought Task Force. Ponds and creeks were low, as was grass and crop production. USDA authorized early haying of Conservation Reserve Program acres beginning on July 16, 2017, to help farmers and ranchers in the Dakotas and Montana. Farmers and ranchers in counties experiencing drought severity of D2 or greater on the USDM or within 150 miles of a county in D2 were eligible for early haying. Conservation Reserve Program contract holders who hayed their acreage were able to donate their hay or take a 25 percent loss to their annual Conservation Reserve Program payment if they chose to sell it (FEMA 2017).

  On Friday June 16, 2017, Governor Dennis Daugaard announced a statewide drought emergency as crops and livestock continued to suffer without enough rain. Transport restrictions were eased, allowing the movement of oversized loads of hay and feed with proper signage and reflectors. Landowners adjacent to highways were able to mow and bale hay along state highways. The governor also activated the state Drought Task Force to monitor rapidly developing drought in South Dakota. Task force members monitored drought information relating to agriculture, fire, and water supplies.

  The sectors that demanded the largest uses of water were firefighting, human consumption, and agriculture. During this time, the MWRWS system was not able to meet demands during peak water use, and 30 percent reductions on water use were issued to all communities connected to the system.

2.4.1 Probability of Future Droughts

The National Climate Assessment of the Northern Great Plains includes Nebraska, South Dakota, North Dakota, Montana and Wyoming. The basis of the assessment to analyze current available resources and the use of modeled projections determine what will happen to those resources over the next half century. The assessment is analyzed in various sections: water, agriculture, recreation and tourism, energy, as well as indigenous peoples. These analyses discuss the increased probability of extreme events, like flooding and drought, through 2050 (National Climate Assessment2014).

The National Climate Assessment states that changes in precipitation in the winter and spring months will have an impact on the current climate. In the winter and spring, more precipitation is projected, with an increase in extreme events, in both volume and intensity. In the summer, no change precipitation is projected. Agriculturally, the growing season will be extended, and spring will begin earlier. However, higher temperatures are also projected for the region and more extreme daytime highs and nighttime lows will stress crops. Increased temperatures will result in higher evaporative demand, which is a measure of how thirsty the atmosphere is. This increase will result in more frequent drought and heatwaves across the region, which will reduce crop yields and quality of livestock forage. Additionally, increased temperatures will increase the range of pests within the region (National Climate Assessment 2018).

The key message of the assessment is that rising temperatures are leading to increased demand for water and energy. In parts of the region, this increase in temperatures is expected to constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs. Changes to crop growth cycles due to warmer winters, and alterations in the timing and magnitude of rainfall events have already been observed; as these trends continue, they will require new agriculture and livestock management practices.

Additionally, landscape fragmentation is increasing in the context of energy development activities in the northern Great Plains. A highly fragmented landscape will hinder adaptation of species when climate change alters habitat composition and timing of plant development cycles. Communities that are already the most vulnerable to weather and climate extremes will be stressed even further by more frequent extreme events occurring within an already highly variable climate system (National Climate Assessment 2018).

The magnitude of expected changes will exceed those experienced in the last century, resulting increased strain on available water resources. This strain may signal increased competition for communities struggling to meet water demand. Existing adaptation and planning efforts are often inadequate to respond to these projected impacts. Although projections suggest more frequent and more intense droughts, heavy downpours, and heat waves, people can reduce vulnerabilities with new technologies, community-driven policies, and the judicious use of resources. Changing extremes in precipitation are projected across all seasons, including higher likelihoods of both increasing heavy rain and snow events and more intense droughts. Winter and spring precipitation and heavy downpours are both projected to increase in the north, leading to increased runoff and flooding that will reduce water quality and erode soils (National Climate Assessment 2018).

Projected climate change will have both negative and positive consequences for agricultural productivity in the Northern Plains. Increases in winter and spring precipitation will benefit productivity by increasing water availability through soil moisture reserves during the early growing season; however, this can be offset by fields too wet to plant. Also, rising temperatures will lengthen the growing season, possibly allowing a second annual crop when and where feasible. A goal of planning will be to capitalize on positive aspects and minimize negative impacts of future climate variability.

3.0 Drought Vulnerability Analysis

The vulnerability, or risk, of a society to drought may be defined generally as the extent to which it will be affected by periods of natural water shortages. The DVA that was previously completed determined the drought vulnerabilities specific to OST. The DVA utilized a division of vulnerabilities regarding the following sectors: Legal Rights and Infringements, Tribal Lifeways, Water, Land, Wildlife, Agriculture, Public Health, and Data Monitoring. This information from the DVA and further coordination completed for this project was utilized to analyze the existing water sources and uses of water by the OST. The following further discusses the water sources for the OST and water uses of the OST. This analysis is followed by the determination of the main drought vulnerabilities for the OST.

3.1 Water Sources

In 2017, South Dakota experienced a major drought that directly affected the water supplies of the Reservation, Lower Brule Reservation, and Rosebud Reservation. In 1988, Congress approved the Mni Wiconi Project Act of 1988 which allocated funds to build the Mni Wiconi Rural Water System (MWRWS) (Govtrack 2020). The MWRWS is a wholesale operation, pumping the water directly out of the Missouri River. It is chemically treated and distributed through the core system supplying three Tribal reservations and one non-Tribal entity, Oglala Sioux Tribe Rural Water System, Lower Brule Sioux Tribe Rural Water System, Rosebud Sioux Tribe Rural Water System, and West River/Lyman-Jones Rural Water Systems. They in turn, deliver and maintain their systems, on an individual basis with their customers (Oglala Sioux Rural Water Supply System 2020). In addition to pumping from the Missouri River, the MWRWS also has wells in the High Plains Aquifer, which includes the Ogllala and Arikaree Aquifers (The Guardian 2019).

Currently, the MWRWS's total service area is approximately 12,500 square miles, with a total of 4,200 pipeline miles. It serves a total population of approximately 52,000 with the primary objective of bringing water to the Tribal communities of OST, Rosebud Sioux Tribe, the West River/Lyman Jones, Inc. Rural Water users, and the Lower Brule Sioux Tribe. The system has an intake capacity of 14 million gallons/day (MGD) and can treat up to 13.4 MGD (Oglala Sioux Rural Water Supply System 2020).

Much of the Reservation is underlain by the Arikaree and Ogllala Aquifers. Due to the dispersed population base, many people on the Reservation relay on groundwater through both private wells and rural water system supply. Volcanic ash within the geological strata in the Arikaree Group acts as a source of uranium and arsenic, causing elevated levels of both in the groundwater on the Reservation. Heavy-metal contamination in groundwater is typically attributed to activities such as mining operations and their industrial use. However, groundwater contamination can also occur by natural mineral dissolution, leaching, and transport in areas with localized high concentrations of uranium or arsenic in bedrock and/or soils. Elevated levels of these metals can have adverse health effects on the liver, heart, and kidneys, and are carcinogenic (Swift Bird 2018).

The Ogallala aquifer extends from southern South Dakota to northern Texas, covering an area of 179,000 square miles. Water-level declines began in parts of this aquifer soon after the onset of substantial irrigation with groundwater (about 1950). In response to water-level declines, Congress directed the USGS to monitor water levels since 1987 (USGS 2017). In 2020, results of a baseline future forecast indicated groundwater levels declined overall for this aquifer. By 2049, the amount of groundwater in storage in the aquifer would be 2,372 million acre-ft, or 56 million acre-ft less than the 2000 to 2009 average (USGS 2020).

In addition to the groundwater resources noted on the Reservation, the surface water resources include the White River watershed. The Reservation is primarily within the White River watershed, with a small portion occurring in the Niobrara River watershed. The White River basin is the southernmost of the five major west-river drainages in SD. The total drainage area of the basin with SD is 8,246 square miles. USGS has water quality monitoring sites in the basin. SD Department of Environment and Natural Resources (SDDENR) continue to sample uranium, and other parameters associated with uranium mining, at one location on the White River near Oglala. This location was selected due to the

in-situ uranium mining upstream in Nebraska and the naturally occurring uranium in the highly erodible soils in the White River basin. The basin receives the majority of the runoff and drainage from the western Badlands. The exposed Badlands a major natural source of both suspended and dissolved solids to the river. Severe erosion and leaching of soils occur in the Badlands and throughout the entire length of the basin. The river is listed as impaired for *E.Coli* and SAR (SDDENR 2020).

A Water Code (Code), as designed by the Oglala Sioux Tribal Council, also provides provide guidance and technical assistance in the assertion of treaty and reserved rights with regard to compliance with Tribal law in the protection, conservation management, and preservation of health, diversity, and productivity of the Oglala Sioux Tribe's natural and water resources to meet the needs of present and future generations. The purposes of this Code are as follows:

(1) To secure water for the permanent homeland for the Oglala Sioux Tribe for present and future generations;
(2) To protect the health, welfare, and economic security of the citizens of the Reservation;
(3) To develop, manage, and preserve the water resources of the Pine Ridge Indian Reservation;
(4) To secure a just and equitable distribution of the use of water within the exterior boundaries of the Reservation through a uniform and coherent system of regulations;
(5) To protect from over-appropriation, degradation, contamination, and any acts injurious to the quantity, quality, integrity, or rights of the Oglala Sioux Tribe's water resources;
(6) To ensure that the Oglala Sioux Tribe has sufficient water quantity and quality, now and into perpetuity, for cultural, domestic, fisheries, economic development, agricultural, stock, ecological flow, municipal, industrial, and other uses;
(7) To ensure equitable and culturally appropriate water allocation in a time of water shortage; and
(8) To provide for the exercise of the inherent sovereign power of self-government by the Oglala Sioux Tribe with regard to water rights and regulation.

The Code notes the beneficial uses noted by the OST for the tribal waters. All waters of the Reservation are the property of the OST and the right of the use of that water may be acquired by appropriation as provided for in this Code. Beneficial use refers to a reasonable quantity of water applied to a non-wasteful use. Beneficial uses for water of the OST are as follows:

(1) Domestic (including drinking, sanitary, and limited irrigation);
(2) Livestock watering;
(3) Industrial;
(4) Commercial;
(5) Agriculture irrigation;
(6) Sand and gravel extraction;
(7) Fishery;
(8) Wildlife maintenance and enhancement;
(9) Recreational;
(10) Fire protection; and
(11) Dust suppression.

Beneficial uses reserved for the OST are as follows:

(1) Preservation of environmental and aesthetic values;
(2) Cultural; and
(3) All other uses compatible with the goals and priorities of the Oglala Sioux Tribal Counsel.

Water shall be appropriated for and the use of such water shall be permitted for only these beneficial uses (OST 2020).

3.2 Water Use

3.2.1 Domestic and Municipal

Water system infrastructure is critical to the success of the OST. Native American tribal populations are known to face greater health concerns compared to other population groups in the US. Part of this disparity is access to safe drinking water. 8.9 percent of tribal homes lack access to safe drinking water, compared to 0.6 percent of non-Native American homes (Swift Bird 2018). Two issues for OST water distribution are critical and include the lack of a safe water distribution system and lack of connection to safe drinking water to each residence.

For the distribution system, the MWRWS provides water to the communities, from that point the distribution is part of the Oglala Sioux Tribe Rural Water System and is the responsibility of the OST and communities. Portions of the water distribution system on the Reservation has been replaced, but the other half is the original, outdated system. Parts of the water supply system still in use also have cement pipes that contain asbestos. Asbestos is a known carcinogen and can leach into the drinking water from the pipes (Mesothelioma Center 2020). The residents of the Reservation have a 40% higher cancer mortality rate than the rest of the US population (Swift Bird 2018). Although the mortality rate cannot be completely attributed to the metal contamination in the groundwater and cement pipelines, both are concerns for safe drinking water and public health.

Most of the Reservation is now connected to the MWRWS. Due to the population dispersed across the Reservation, there are still families that are not connected on waiting lists for non-profits organizations to hopefully help to connect to the rural water system or afford a private well. In the Reservation, the towns and villages receive water from MWRWS pipeline, but it feeds into old community water systems. Many of these systems date to the 1960s, which pipes were made of potentially hazardous asbestos-cement. In the MWRWS service area, 53 community water systems need replacement across three reservations. In 2014, the Bureau of Reclamation estimated the cost to replace all the systems at $42 million (The Guardian 2019).

Due to the reliance on the MWRWS, any water quality issues on the Missouri River would cause a major shortage of water supply to the tribes. Major water restrictions and large transportation hauling of water would need to occur, and the Tribe would need to rely upon the two aquifers present.

3.2.2 Tribal Lifeways

Water is the lifeblood of the living and holy Earth and a vital link between all natural and living systems, requiring the utmost care in the allocation of use and protection from pollution to sustain the natural communities and ecosystems and provide for the basic needs of the OST. Inherent in this care and protection is the need to control and regulate the use of the scarce water resources of the OST through the OST's sovereign right to the use and protection of these water resources (OST 2020).

3.2.3 Agricultural Practices

> "The American Indian is of the soil, whether it be the region of forests, plains, pueblos, or mesas. He fits into the landscape, for the land that fashioned the continent also fashioned the man for his surroundings. He once grew as naturally as the wild sunflowers; he belongs just as the buffalo belonged . . ."
>
> - Luther Standing Bear, Oglala Sioux Chief, 1905-1939

The most recent USDA Census of Agriculture was completed in 2017. The census definition of a farm is any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold. The census reported 1,416,104 acres of farm on the Reservation. A total of 380 farms are located on the Reservation, with 223 of those operated by natives (USDA 2017).

According the USDA 2012 Census of Agriculture for American Indian Reservations, the market value of agricultural commodities produced on reservations in 2012 totaled $87 million. Yet, less than 1/3 ($24 million) of that income went to Native American producers (SAHC). Agriculture on OST is a contentious issue when it comes to water. Livestock producers that use Tribal range units rely on the water that comes from the MWRWS, which has played an important role in water supply during times of drought. However, some believe the water should be prioritized for human consumption before livestock or agricultural use. This prioritization has always been the goal of the MWRWS, but when the system started to have restrictions, some users were unable to use it as a water source.

Drought impacts to agriculture also include poor or no crop growth, low yields, thefts of hay, increases in invasive species, and disease. In cases where excess water is needed to fight large fires, the Tribe will take water from stock dams with permission. In these situations, there is no reimbursement for the water or land losses to the leaseholders.

The land-use patterns on reservations today are the result of historical lending practices, disjointed and discontinuous land ownership, and federal policies over the last century that have excluded native land owners from the ability to use their lands, while opening them up to non-native farmers and ranchers. Court discriminatory lending practices, as argued, in court cases such as Keepseagle vs. Vilsack, demonstrated that Native Americans have been denied roughly $760 million (Cohenmilstein 2018). Another significant obstacle to jurisdictional definitions is the high degree of fractioning of reservation lands caused by the General Allotment Act of 1887. More than a century of unplanned inheritance by the BIA has created a situation where reservation lands have become severely disjointed and discontinuous, leaving the landowners with few options other than leasing their lands as part of the federal government's leasing program (Village Earth).

These land-use patterns leave Tribal members at a disadvantage during droughts if non-native producers declare bankruptcy and abandon a lease mid-term. When non-native producers are not leasing lands from Tribal members, these members and their allottee heirs lose money. In addition, carrying capacities for the range units do not change during droughts, leaving the pastures overgrazed during a vulnerable time.

3.2.4 Fish and Wildlife/Recreation

Some of the big game animal species native to the Reservation include elk, mule and white-tailed deer, buffalo, wild turkeys, antelope, and mountain lion. Small game animal species include pheasants, prairie grouse, geese, prairie dog, bobcat, and coyote. Fish species on the Reservation include minnows, trout, bass, crappie, walleye, perch, and paddlefish.

Drought impacts to wildlife on the reservation include Epizootic Hemorrhagic Disease (EHD) and bluetongue (BVD) in wildlife populations, increasing abundance of nonnative plants, reduced forage production and impacts to wildlife and buffalo, fire, plague in prairie dog towns, and degraded water quality leading to reduced fish populations. Additionally, mild winters may be increasing the risk of EHD and Bluetongue. Drought alters plant communities and increases the abundance of non-native and invasive plant species to the detriment of environmentally and culturally significant plants.

Drought also reduces plant growth, reducing forage production available to wildlife, buffalo, and livestock. Lower forage production often leads to buffalo and cattle sales, which reduce producer's incomes.

Tree regeneration is stunted by several things including lack of water, lack of nutrients, and increased damage due to drought. During times of drought on the reservation, hailstorms can be even more devastating, destroying the protective layering on trees that retains moisture and keep trees alive when water is scarce. Cottonwoods are of high cultural importance to tribal members on Pine Ridge and grow best in marshy wetlands, which tend to dry up during drought periods causing a lack of cottonwood regeneration. Trees and root systems serve as a wind buffers, help to prevent soil erosion, and provide shelter for wildlife. For these reasons, tee loss has negative impacts on agricultural lands and wildlife population sustainability.

Invasive plants are an issue throughout the reservation. During drought, native plants struggle to absorb enough water to sustain themselves, while invasive species are often heartier in times of drought. On the Reservation, people have noticed that native plants are becoming more difficult to find. When found, native plants tend to be drastically smaller and less healthy than what they typically are. Invasive plants are a major issue for the reservation as they may outcompete and prevent culturally significant plants from growing.

3.2.5 Fire Suppression

There are limited structural fire departments operating on or near the Reservation. The Kyle Volunteer Fire Department, located in Kyle, SD is a two-bay structure with two (2) small fire response vehicles, each having water tanks and tool storage (SDSMT 2020). A station in Batesland, SD is listed in the fire station directory on firedepartment.net, though no other information about it is provided. Long Valley, SD, Interior, SD, and Rushville, NE all have stations that lay outside of the Reservation boundaries. However, each one provides fire response to nearby areas of the reservation. Other fire stations located throughout the reservation belong to the Bureau of Indian Affairs (BIA) and are strictly limited to fighting wildland fires. *Figure 4* shows the fire response coverage the BIA supplies for wildfire suppression. Each red plus (+) outlines an operating BIA station, and the areas highlighted in green are where the BIA can reach and fight wildfires within an adequate response time of 14 minutes (SDSMT 2020).

Figure 6. *Fire Department Response Time*

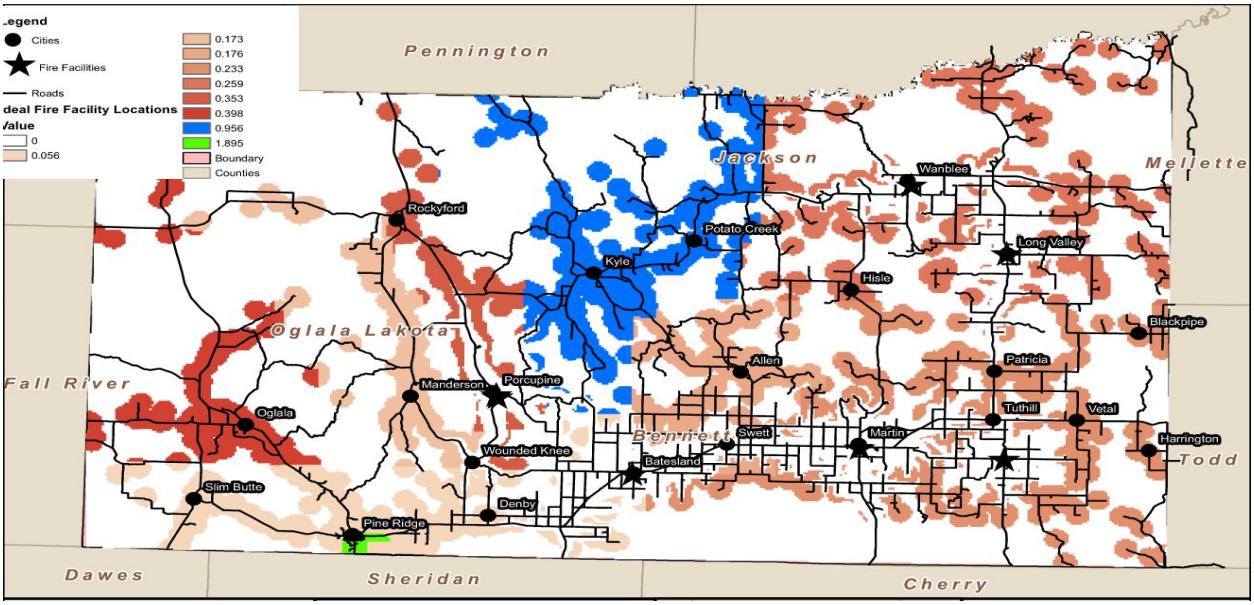


Table 3. *Fire Department Response Time*

Water Use Sector	Surface Water Supply	Groundwater Supply	Water Management	Drought Risk
Domestic and Municipal	MWRWS serves the Reservation. Water supply from Missouri River and Ogallala Aquifer.	MWRWS serves the Reservation. Water supply from Missouri River and Ogallala Aquifer. Private wells utilize Arikaree and Ogallala Aquifers.	MWRWS provides potable water to Oglala Sioux Tribe Rural Water System. Communities and cities with jurisdiction over water supply systems. Private well owners.	HIGH RISK- For quantity, aging infrastructure in communities and remaining population in rural areas that needs to connect to MWRWS or be able to HIGH RISK- Quality is a concern with uranium and arsenic contamination known in the Arikaree Aquifer. So back up options to MWRWS can be contaminated.
Tribal Lifeways	Surface waters across the Reservation water vegetation that has significance to the Tribe.	Groundwater seepages can water vegetation that has significance to the Tribe.	Not applicable.	MEDIUM RISK for loss of plants that are significant for ceremonies and medicinal.
Agriculture	Potential for ranchers to pull water from surface water systems; the number of systems that do is unknown.	Some ranchers do utilize rural water to provide water to livestock herds.	Managed by individual ranchers.	MEDIUM RISK for quantity- the Reservation is in a more arid area, so ranching is limited by water sources for the herds. Water sources are even more limited during droughts.
Fish and Wildlife/Recreation	Rivers, tributaries, lakes, stock ponds, oxbows and wetlands in the area.	Springs and wells, in some cases livestock water sources pumped from wells is utilized by wildlife.	OST Natural Resources Department manages the natural resources on the Reservation. Recreation areas managed by cities and communities.	MEDIUM RISK- water is available at many sources for fish and wildlife.
Fire Suppression	Not applicable.	MWRWS can be utilized, limited during times of drought and water use restrictions.	BIA manages the current wildland and non-structural fire station on the Reservation. The source of water was not located. OST is currently proposing a fire station in Pine Ridge, the water source has not been identified.	HIGH RISK- Several sources need to be identified due to limited water from MWRWS and the potential for large fires.

4.2.6 Priority Drought Vulnerabilities

Drought vulnerabilities were identified in the previous DVA. Please refer to *Appendix A.* The appendix shows the results of the responses, as well as their specified rank. A lower score represented what interviewees perceived to be the biggest vulnerabilities. In addition to this ranking process of the previous vulnerabilities, additional coordination occurred during the finalization of this report with RST. The information previously gathered in the DVA, research, and coordination for this project identified the following vulnerabilities as priorities for RST to focus upon:

Vulnerability #1: Inventory of Water System and Sources on the Reservation

Vulnerability #2: Conservation of Water Sources

Vulnerability #3: Contamination of Aquifers

Vulnerability #4: Lack of Water Supply for Fire Suppression

Vulnerability #5: Lack of Water Supply for Agricultural Practices

4.0 Drought Monitoring and Response Actions

There are various methods and indices that track current drought conditions across the country. Many include different variables, like precipitation, soil moisture, and humidity. For FSST, two monitoring indices will be utilized, the US Drought Monitor (USDM) and the Evaporation Demand Drought Index (EDDI).

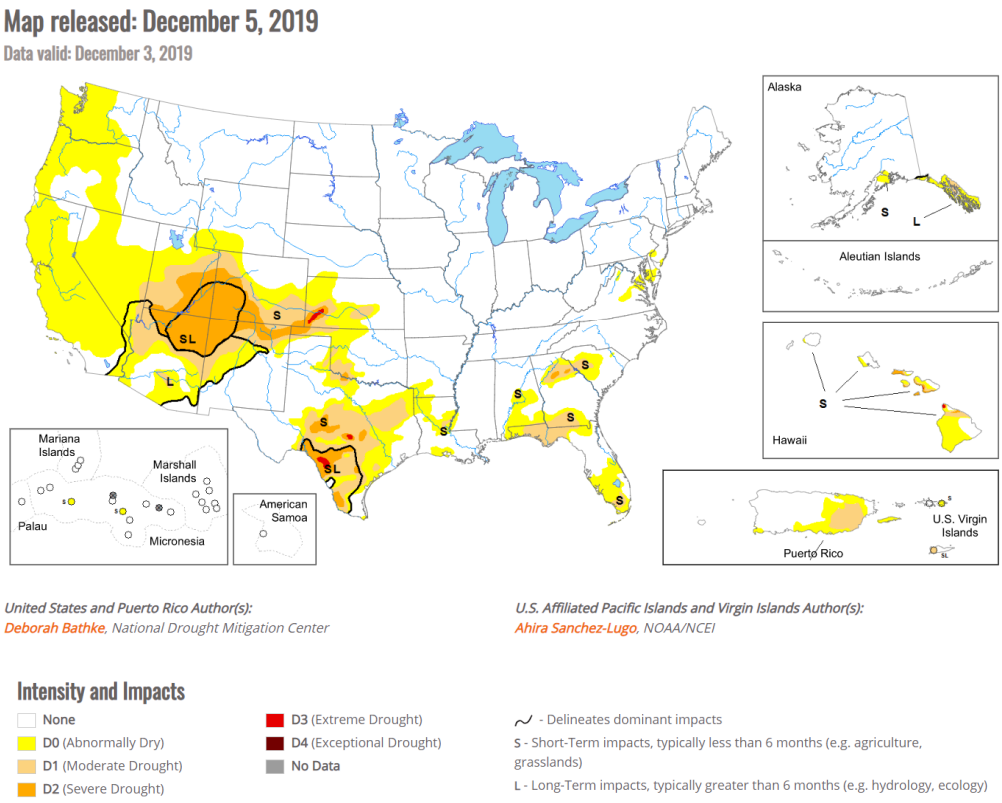
4.1 Drought Monitoring

4.1.1 USDM

The USDM is a semi-objective drought index that brings together several experts from the National Drought Mitigation Center, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, and the National Integrated Drought Information System. Using a variety of different tools, including indices like the PDSI, they determine current drought conditions throughout the U.S. There are four levels of intensity to which they classify: D0 (abnormally dry), D1 (moderate drought), D2 (severe drought, D3 (extreme drought), and D4 (exceptional drought). *Figure 7* shows the USDM for the continental U.S (USDM 2020). The online USDM map has been available since January 4, 2000.

A potential downside to using the USDM is the lack of data in areas like Pine Ridge. If there is little to no data recorded for Pine Ridge, the USDM can interpolate data from surrounding areas, but this becomes an estimate rather than a recorded observation, leaving room for error in the interpolation. Because of this, it is important to take considerations beyond the USDM, whether it be self-observations by residents of the area, or using other available drought indices to more accurately determine the state of the region in question.

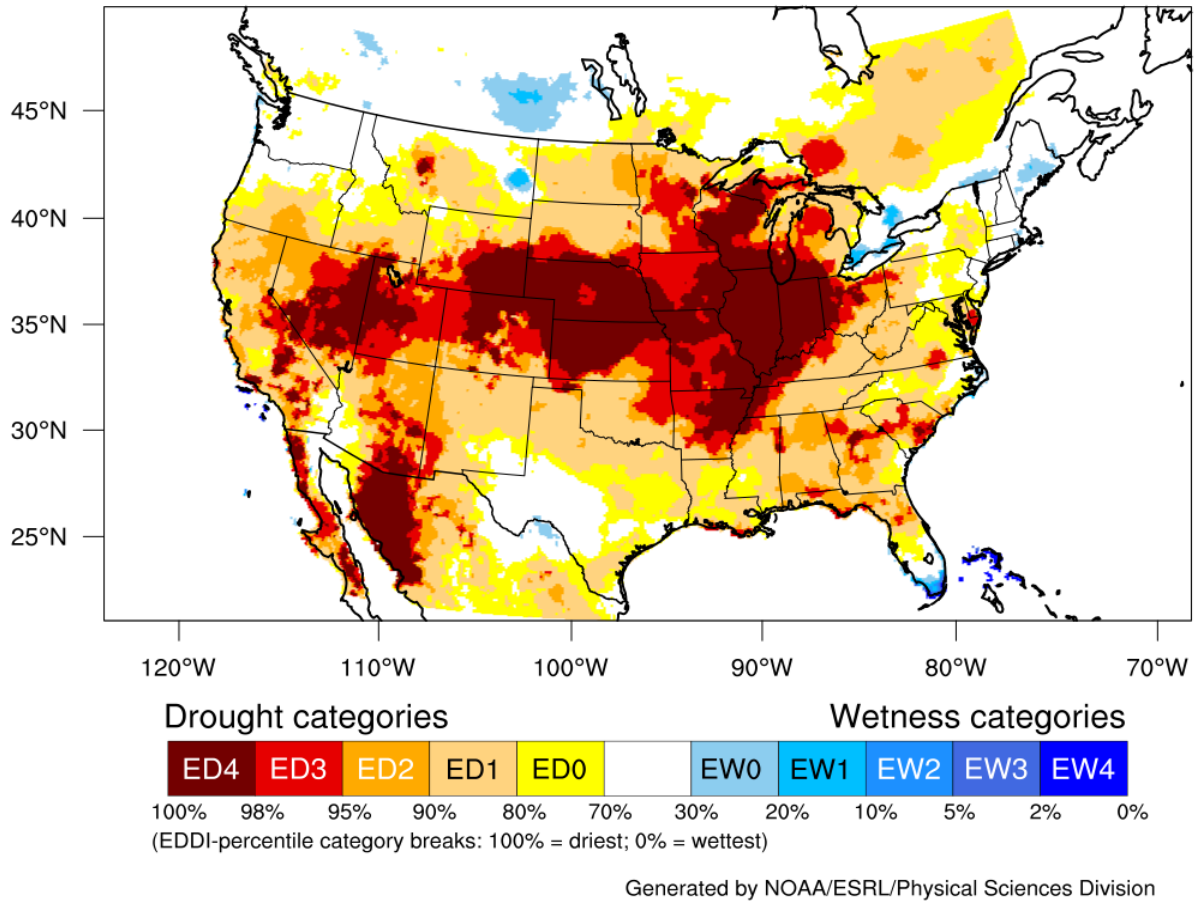
Figure 7. *USDM for the United States (December 5, 2019)*



4.1.2 Evaporative Demand Drought Index

The EDDI is an experimental drought monitoring tool developed by climate scientists at NOAA. It is an index based on "evaporative demand", which is basically a measure of how thirsty the atmosphere is. It uses measurements of temperature, humidity, windspeed, and solar radiation; all of which both contribute to and reflect the dying out of soil and vegetation. It is measured at different levels of intensity, similar to the USDM to the effect that: ED0 = D0, ED1 = D1, ED2 = D2 etc. However, it is not equivalent to the USDM because it does not measure soil conditions. What makes EDDI unique compared to the USDM is that it can measure "flash droughts", which are short, intense periods of drying that can take a major toll on crop yields when they occur. EDDI can also show the early signs of a developing long term term drought. This is due to the fact that EDDI only has a 5-day lag in data compared to the USDM, which has a lag of over a month. *Figure 8* provides a sample map showing the drought versus wetness categories across the United States (NOAA 2020)

Figure 8. *EDDI Map Example*



4.2 Drought Conditions Monitoring

Drought monitoring should occur after the end of each month and should show both the final 1-month EDDI conditions and USDM conditions for that month. Current conditions should be classified in four different categories with the criteria shown in *Table 3*. Both current EDDI and USDM conditions can be found at the links below.

USDM: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?SD

EDDI: https://www.esrl.noaa.gov/psd/eddi/

4.3 Drought Adaptation Actions

With each set of drought conditions, certain actions are suggested to be taken by local governments. Drought response actions are meant to allow local governments to adjust to the impacts of a drought. Even during a normal or wetter period, actions can be taken to further prepare for a potential drought. *Table 4* shows recommended drought adaptation actions under normal, alert, warning, and emergency conditions. All actions are broken down into each water use sector.

Table 4. *Drought Monitoring Conditions and Response Actions*

	Normal (No Drought)	Alert (Mild Drought)	Warning (Moderate Drought)	Emergency (Severe to Extreme Drought)
Drought Stage Parameters	No USDM Classification	D0 USDM Classification or one-month ED3-ED4 EDDI Classification	D1 and D2 USDM Classification	D3 and D4 USDM Classification
All Water Use Sectors	- Identify agencies that will head actions and plans. - Identify all water demands - Monthly or quarterly report detailing current drought conditions to be made public.	- Coordinate with fire management regarding wildfire response. - Establish fire restrictions Monthly or quarterly report detailing current drought conditions to be made public. - Monthly or quarterly report detailing current drought conditions to be made public.	- Prepare Drought Emergency Declaration. - Prepare letters to secretaries for drought determination. - Monthly or quarterly report detailing current drought conditions to be made public.	- Establish water use restrictions - Declare Drought Emergency. - Send letters to secretaries for drought determination and assistance. - Support actions and resolutions for drought assistance funding. - Monthly or quarterly report detailing current drought conditions to be made public.
Domestic and Municipal Use	- Identify voluntary and non-voluntary restrictions to be implemented by drought stage. - Identify current water capacity in existing system. - Identify water sources for residences that are currently not connected to MWRWS. Identify if residences should have a private well, options for well infrastructure, or if a MWRWS connection is feasible. - Continue to identify ways to update water systems in communities. - Continue to issue permits regularly.	- Monitor water use within the system, voluntary restrictions requested. - Continue to issue permits regularly.	- Monthly or quarterly report detailing current drought conditions to be made public. - Monitor water use within the system, restrictions implemented. - Wait to issue new permits.	- Monthly or quarterly report detailing current drought conditions to be made public. - Monitor water use within the system, restrictions implemented. - Wait to issue new permits.
Tribal Lifeways	- Identify methods to maintain traditional plants and foods during drought.	- Identify methods to preserve traditional plants for times during drought. - Community gardens or plots to grow traditional plants.	- Community gardens or plots to grow traditional plants. Utilized efficient watering methods such as drip irrigation.	- Community gardens or plots to grow traditional plants. Utilized efficient watering methods such as drip irrigation.
Agriculture	- Develop individual ranch/bison herd drought plans. - Identify water sources for livestock. - Encourage use of planting drought resistance grasses.	- Encourage use of planting drought resistance grasses. - Encourage drought resistant landscaping. - Encourage pasture rotation for cattle. - Develop individual ranch drought plans.	- Graze livestock on rangeland to trim fuels. - Encourage drought resistant landscaping. - Encourage utilizing individual ranch/bison herd drought plans to make decisions on reduction of livestock.	- Graze livestock on rangeland to trim fuels. - Encourage drought resistant landscaping. - Encourage utilizing individual ranch/bison herd drought plans to make decisions on reduction of livestock. - Encourage federal disaster assistance programs for livestock.
Fish and Wildlife/Recreation	- Develop wildlife habitat management plan - Continue management of hunting and fishing licenses.	- Monitor conditions for fish wildlife. - Monitor drought common disease outbreaks in big game. - Continue management of fishing and hunting licenses.	- Monitor conditions for fish wildlife. - Monitor drought common disease outbreaks in big game. - Adjust hunting licenses to increase harvest, reducing impact on available forage. - Encourage prairie dog control to reduce competition for rangeland.	- Monitor conditions for fish wildlife. - Monitor drought common disease outbreaks in big game. - Adjust hunting licenses to increase harvest, reducing impact on available forage. - Encourage prairie dog control to reduce competition for rangeland.
Fire Suppression	- Identify sources of water for structural fire and wildfire response. - Check availability of water carrying equipment.	- Coordinate with fire management regarding wildfire response. - Limit firework displays. - Graze livestock on rangeland to trim fuels.	- Coordinate with fire management regarding wildfire response. - Establish fire restrictions	- Coordinate with fire management regarding wildfire response. - Establish fire restrictions.

5.0 Drought Mitigation Strategies and Potential Future Projects

The purpose of this plan component is to develop mitigation strategies for this implementing long-term measures to reduce drought risk. As in dealing with any type of disaster, this type of strategic approach is referred to as risk management. *Table 4* shows the vulnerabilities identified and the mitigation strategy that addresses those vulnerabilities to reduce the risk to FSST during drought. Several projects are identified for each mitigation strategy and potential project funding.

The following sections discuss the mitigation strategies and the potential projects identified.

5.1 Identification of Sustainable Water Sources for all Residences on the Reservation

Many different resources and studies have been completed on the Reservation. Currently, many different departments and entities are gathering information. OST needs the information compiled to be able to understand their current status of the water sources, quality of those sources, and the water system infrastructure. The first recommended project is to create a GIS database that contains all this information. Coordination would occur to request data from all departments and entities on the Reservation. The database would then be created having many different layers, including water quality sampling and water system infrastructure. For water system infrastructure, an updated database could be utilized to identify failing system that need replacement. The system would be updated as each project occurs, so replacement projects can be identified easily.

Another recommended project is conducting a water capacity study of the MWRWS, allowing the identification of the current water capacity and demands, allowing for future planning of water sources. It is important to know what the Reservation's current water capacity and demands are, as it will provide a better insight into what the current water system can handle before new developments are approved of and constructed. This could also provide proof that a new water source would be needed to sustain the reservation during drought periods, especially if new development is desired.

Identifying new water sources before approving future development would require the accurate accounting of the current water demands. Once the current demands have been identified and the budget is complete, Identification of new water sources could begin. New water sources could include any unused waterways and potential wells (private and public) that may be sources for additional water. Current residential water use should be quantified, and future use should be estimated with a new development taken into consideration to determine the feasibility of an adequate water supply. It is recommended that all water rights be filed through OST and the State of South Dakota to ensure water budgets will allow for the amount of water requested.

A groundwater monitoring program is needed to take samples of the aquifers throughout the Reservation. In addition, OST should have a weather station installed, there is currently no station on the Reservation.

5.2 Improving Water Use Efficiency in Buildings

Poor efficiency standards are a major problem for buildings and the environment. Low efficiency buildings allow more water use. To improve efficiency standards for Tribal buildings and homes, it is recommended to start with focusing the construction of future buildings towards sustainability. Suggestions include high efficiency appliances such as dishwashers, toilets, etc, and capturing and reusing rainwater and grey water. Once all future buildings are focused

on sustainability, updating old tribal buildings to higher efficiency appliances can be explored, followed by home renovations for efficiency. Existing homes should be the last focus due to the number of upgrades needed.

5.3 Catching and Utilizing Rainwater and Grey Water

Rainwater is an excellent source of non-potable water. Catching and using rainwater could be excellent for use in activities outside of the home, including watering a garden, grass, or for livestock use. To approach this project, it is recommended to seek funding through the EPA. Once funding is secured, educational classes, brochures, posters, etc. would be recommended. It is also recommended to use the funding to provide rain barrels to low income residents who are interested, as well as making rain catching methods available for government buildings to water and maintain their landscaping.

Setting up educational programs about reusing gray water for other applications stems from the third ranked mitigation strategy: catching and using rainwater. There is potential conflict with capturing rainwater due to a lack of legislation stating that it is a tribe-endorsed activity. An alternative to capturing rainwater that does not interfere with legal rights is the reuse of gray water. Gray water is considered lightly used water that isn't contaminated with potentially harmful or hazardous substances, such as urine or feces. Gray water may have been used to wash hands, wash dishes, bathe, etc. Learning how to capture and safely reuse this water in other applications such as wastewater systems, plant irrigation, and livestock watering can help reduce the overall demand of water across the reservation and may help reduce the impact of water restrictions during drought conditions.

5.4 Replace Water Systems, Prioritizing Asbestos-Cement Pipelines.

The current maintenance and repair unit for the OST is underfunded and understaffed. The future of the maintenance and repair program depends upon hiring more staff and skilled workers. From the interviews with tribal leaders, it was learned that the maintenance and repair program doesn't have skilled workers for repairing the pumps for distribution and does an excellent job of repairing large leaks, but not small ones. Funding should be sought for training of OST Tribal Members to increase technical capacity and to create permanent jobs for maintenance of the pumps and for replacement of old piping. Some areas are using cement piping that is known to contain asbestos which should be replaced as soon as possible.

Detecting water losses and leaks in pipes is part of the second mitigation strategy: maintenance and repair programs on distribution infrastructure. With outdated pipe networks and water infrastructure, leaks are a source of major water loss, reducing the overall capacity for the Reservation. A method for detecting leaks, especially major leaks, would be beneficial in reducing water loss.

5.5 Protection of Groundwater Recharge Zone and Focus on Quality Drinking Water

Due to the reliance on limited water sources, protection of those sources from pollutants needs to continue. OST is active in commenting on future projects and noting their concerns for projects such as uranium mining. This coordination and noting concerns should continue. OST could also look for opportunities to incorporate best management practices at recharge zones to the aquifers and at waterways. For example, a riparian buffer to a stream that is approximately 50 foot of vegetation can provide filtration of pollutants. Many programs exist that would provide financial assistance for taking those areas out of production.

In addition, OST could implement education programs on the protection of aquifer recharge zones by producing informational materials, coordinating with the Tribal leaders to distribute information, and coordinating with schools for education opportunities.

5.6 Identification of Water Sources for Fire Suppression

As noted, OST is currently working on setting up fire departments. As these departments and stations are designed, a consideration for the water sources should be completed. Water could be pulled from MWRWS but during large fire events, additional sources should be utilized. Sources can include streams, wells specifically for fire suppression, oxbows, irrigation wells, and any other identified water sources. OST can work to put agreements in place with landowners to prepare for drought.

5.7 Livestock Management

Drought can affect the amount of forage available. A specific drought plan for each ranch/rancher can be completed by local NRCS, Conservation District or Extension. Solutions such as working planted forage resources into the feeding strategy can be established. In addition, an evaluation of the reduction options to your herd can also be considered. This might create a better balance of the forage available and keep the herd healthy. The herd reduction strategies can include: 1) Selling feeder animals early, 2) Selling replacement breeding animals, 3) Reduce breeding animal numbers, 4) Selling the herd and ceasing production, and 5) Selling the heard and restocking later (National Drought Mitigation Center 2020). In addition, water sources to the herd need to be considered. A private or water line from MWRWS can also be provide for water to encourage options for watering. In addition, a review of any stock dams could be completed and if any maintenance activities (i.e. removing sedimentation) can be completed. OST can encourage or require the ranchers to complete these pasture improvement assessments and analyze the different water sources provided.

***Table 5**. Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding*

Vulnerabilities	Mitigation Strategy	Potential Project	Potential Funding
#1: Inventory of Water System and Sources on the Reservation	Identification of sustainable water sources for all residences on the Reservation	GIS database that notes the water sources, water quality information, and water system infrastructure.	DHHS Community Services Block Grant (CSBG) Rural Community Development Program (RCD) Water and Wastewater Treatment Systems Training and Technical Assistance Project. (HHS 2020) Rural Community Development (RCD) discretionary grant funds. RCD funds must be used to provide training and technical assistance to: Increase access for low-income families to water supply and waste disposal services, preserve affordable water and waste disposal services in low-income rural communities, increase local capacity and expertise to establish and maintain needed community facilities, increase economic opportunities for low-income rural communities by ensuring they have basic water and sanitation, utilize technical assistance to leverage additional public and private resources, and promote improved coordination of Federal, state, and local agencies and financing programs to benefit low-income communities. SD DENR Water and Waste Funding Program Small Community Planning Grant. This program provides small communities with funds to hire an engineering consultant to develop a project specific engineering report. The engineering report's level of detail will be on par with the facilities plan required for SRF projects, The project sponsor must be an entity of government (county, municipality, or township), or a special purpose district with the authority to construct a water or wastewater project (sanitary, water user, watershed, or water project). Nonprofit organizations are also eligible provided they were formed for the primary purpose of supplying water or sanitary service. Nonprofit water systems applying for this grant must meet the definition of a community water system (a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents). Department of Interior - Bureau of Reclamation (DOI-BOR) – WaterSMART Drought Response Program: Drought Resiliency Projects. (DOI BOR 2020) The objective is to invite states, tribes, irrigation districts, water districts, and other organizations with water or power delivery authority to leverage their money and resources by cost sharing with Reclamation on D4rought Resiliency Projects that will increase the reliability of water supplies: improve water management and
		Develop a long-term strategic plan for future development. Identify areas that has access to water.	
		Study to identify the residences of the Reservation that are not served by MWRWS. Identify sustainable water source for those residences. Provide resources (well construction) for these residences to access the groundwater.	
		Update the MWRWS water capacity study. Identify potential shortages and current capacities. Determine plan for sustainability of water supply.	
		Review of permitting jurisdiction for new wells within the Reservation. Enforcement of water codes.	
		Groundwater monitoring to monitor pollutant levels in the aquifers.	
	Improving water use efficiency in buildings	Promote green construction – water and material conservation, passive energy.	
		Implement green certification into all new developments.	
	Catching and utilizing rainwater and grey water	Set up educational programs about reusing gray water for other applications.	
		Update legislation to include rainwater catchment as a Tribal-endorsed activity.	
		Implement a reforestation of cottonwood tree project utilizing rainwater as a water source.	

***Table 5**. Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding*

Vulnerabilities	Mitigation Strategy	Potential Project	Potential Funding
			provide benefits for fish, wildlife, and the environment to mitigate impacts caused by drought. US EPA Water Pollution Control Section 106 Supplemental Grant. Provides support for state, interstate and eligible tribal recipients of Section 106 grants for Water Pollution Control Programs. Covers activities, water quality standards, water quality monitoring, impaired waters listing and total maximum daily loads development, National Pollutant Discharge Elimination System permitting and enforcement and compliance. (US EPA 2020)
#2: Conservation of Water Sources	Replace water systems, prioritizing asbestos-cement pipelines. Maintain existing systems.	Identify system losses and replace those systems with upgrades. Prioritize the systems that have asbestos-cement pipelines. Establish a work force to inspect, repair, and maintain pipe networks.	Department of Interior - Bureau of Reclamation (DOI-BOR) – WaterSMART Drought Response Program: Drought Resiliency Projects. (DOR BOR 2020) The objective is to invite states, tribes, irrigation districts, water districts, and other organizations with water or power delivery authority to leverage their money and resources by cost sharing with Reclamation on Drought Resiliency Projects that will increase the reliability of water supplies: improve water management and provide benefits for fish, wildlife, and the environment to mitigate impacts caused by drought.
#3: Contamination of Aquifers	Protection of Groundwater Recharge Zone and Focus on Quality Drinking Water	Advocate with local agencies, state agencies and federal agencies to protect the recharge areas for the aquifer. Education on protection of water sources and aquifer recharge zones.	US EPA-Wetland Program Development Grant. The primary focus of these grants is to develop/refine state and tribal wetland programs. A secondary focus is to develop/refine local (e.g. county or municipal) programs.
#4: Lack of Water Supply for Fire Suppression	Identification of water sources for fire suppression	Connect to MWRWS for source. Construct water towers for storage. Identify stock ponds, oxbows, or wetlands that could be available for water source for fire suppression. Creating or determining locations and putting agreements in place with landowners.	USDA NRCS Conservation Innovation Grants (CIG)-The purpose of CIG is to stimulate the development and adoption of innovative conservation approaches and technologies in conjunction with agricultural production.

***Table 5**. Vulnerabilities, Mitigation Strategies, Potential Projects, and Potential Funding*

Vulnerabilities	Mitigation Strategy	Potential Project	Potential Funding
#5: Lack of Water Supply for Agricultural Practices	Livestock Management	Complete individual rancher or tribal herd drought plans.	Department of Interior, Bureau of Land Management Montana/Dakotas Rangeland Resource Management Funding opportunity to better support land management decisions regarding grazing and other range management treatments, soils management, and invasive species, the BLM will place a priority on collecting data through the use of consistent, comparable, and common indicators, consistent methods, and an unbiased sampling framework which will allow for analyses that are repeatable and comparable across a region, and decisions based on science and data that are legally defensible.
		Identify alternative water sources for livestock.	

6.0 Drought Adaptation Plan Maintenance

It is recommended that the Tribe continuously update the Drought Adaptation Plan. The updates should come every 5 years and it is recommended that the OST Natural Resources Department monitor the consistent updates. This will confirm that the Drought Adaptation Plan is consistently up-to-date and is beneficial during major droughts. To facilitate consistent updating on major plans, such as the Drought Adaptation Plan, the Federal Emergency Management Agency (FEMA) has funding sources available.

The Tribal department that oversees this plan can change based on both the needs of the Tribe and the most applicable projects to complete. It is also recommended that once a project is complete, a note or updated page be written to reflect the project completion and to ensure that one project is not repeated unnecessarily.

The Drought Adaptation Plan is written to be used to update the Tribe's Hazard or Multi-Hazard Mitigation Plan.

7.0 Data/Process Gaps and Needs

The most important developmental tool for a DAP is a response from the affected people, the government leaders, and the experts of the area. To create a well-rounded plan, the differences in responses and professional opinions develop a solid understanding of the goals and needs of the Tribe. In a perfect scenario, all Tribal program directors, staff, Tribal council, government officials, and Tribal members invited would be able to attend and determine the exact projects and plans that the Tribe should pursue.

The DAP had excellent responses and follow-up responses, but the quantity of responses was low. When the DAP is updated, it is recommended that more time be dedicated to retrieving responses and seeking follow-up from the Tribal program directors, staff, Tribal council, government officials, and Tribal members. The original DAP was created to only use a two-day meeting to receive feedback, but because of the availability of Tribal program directors, staff, Tribal council, government officials, and Tribal members, it would've been more beneficial to meet individually with each person.

In addition, future version of this DAP could include drought projections, further modeling and consideration of how often the Reservation experiences drought. Modeling should also look at potential durations and how natural resources would be affected by the different durations. The projections could be utilized to expand the response plan in Table 3 to show the longer effects of a longer in length drought. The response intensity could be increased.

8.0 Conclusions and Next Steps

The information contained within this Drought Adaptation Plan should be implemented and used to seek funding for identified projects. *Table 5* notes the specific funding that can be utilized by project. Each project had specific grants noted that OST can pursue. The projects that are in this report were identified through the leadership of the Tribe. The future of the Tribe's resiliency to drought is dependent on the use of this report to work on the identified adaptation plan and projects. Subsequent action steps to the DAP should be seeking funding sources and pursuing the completion of each project outlined within.

Two priority projects were selected for OST to coordinate:

1. *GIS System and Database*- Create a GIS system that includes water system infrastructure and water quality information. Create an interface that OST officials can view and utilized for planning and infrastructure projects. The GIS program has free resources through the company, ESRI, for tribes:

In addition, funding may be available through the MidAmerican GIS Consortium, through their grant program. The following site has additional information: https://www.magicgis.org/GRANTS

2. *Study to identify the residences of the Reservation that are not served by MWRWS. Identify sustainable water source for those residences. Provide resources (well construction) for these residences to access the groundwater*- Utilize the GIS database to identify the residents on the Reservation, the MWRWS and Oglala Rural Water System connections, and private wells. Having this information will allow OST to identify needed water sources for residents that currently do not have either a rural well or connection to MWRWS.

For future, attempts should be made to reach all Tribal leaders. In the next iteration of the Drought Adaptation Plan, it is recommended to have longer field visits and individual meetings with each Tribal leader to better understand every leader's perspective.

9.0 Resources

Resources for information, outside of online sources, books, articles, journals, etc., was primarily interviews and discussions with Tribal program directors, staff, Tribal council, government officials, and Tribal members. The following sections describe the interviews and the interviewees. The interview questions section describes the field visit and follow-up interviews and the Tribal leaders interviewed identifies the specific leaders that were asked for their professional opinions.

9.1 Tribal Leaders Interviewed

OST's field visit yielded excellent responses and had most of the invited tribal leaders in attendance. The tribal leaders and federal government employees that attended were: Reno Red Cloud (Water Resources), Amos Young Dog (Water Management), Mike Catches Enemy (Presidential Legislative Liaison), Louis R. Janis (OST Utilities Office), Steve Pourier (OST Utilities Office), Delaine Killeback (Environmental Protection Program), Tracy Zacher (Bureau of Land Management), and Robert Pille (OST Water and Sewer). All the tribal leaders who were in attendance had many ideas and thoughts on drought and drought mitigation strategies.

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Appendix A. Field Visit Agendas, Sign-In Sheets and Feedback

AGENDA
OGLALA SIOUX TRIBE
Great Plains Tribal Water Alliance: Drought Adaptation Planning
Thursday and Friday, June 26 & 27, 2019
Justice Center Building

Wednesday, June 26th

8:30 AM – Welcome/Opening Prayer

9:00 AM – Identify Key Drought Vulnerabilities from 2017 Drought Vulnerability Assessment

12:00 AM – Lunch

1:00 PM – Identify Mitigation Actions, Action Plan, and Funding Sources

4:00 PM – Adjourn

Thursday, June 27th

8:00 AM – Locate and Interview Department Directors Missed

10:00 AM – Meet with Tribal Leaders and Program Directors

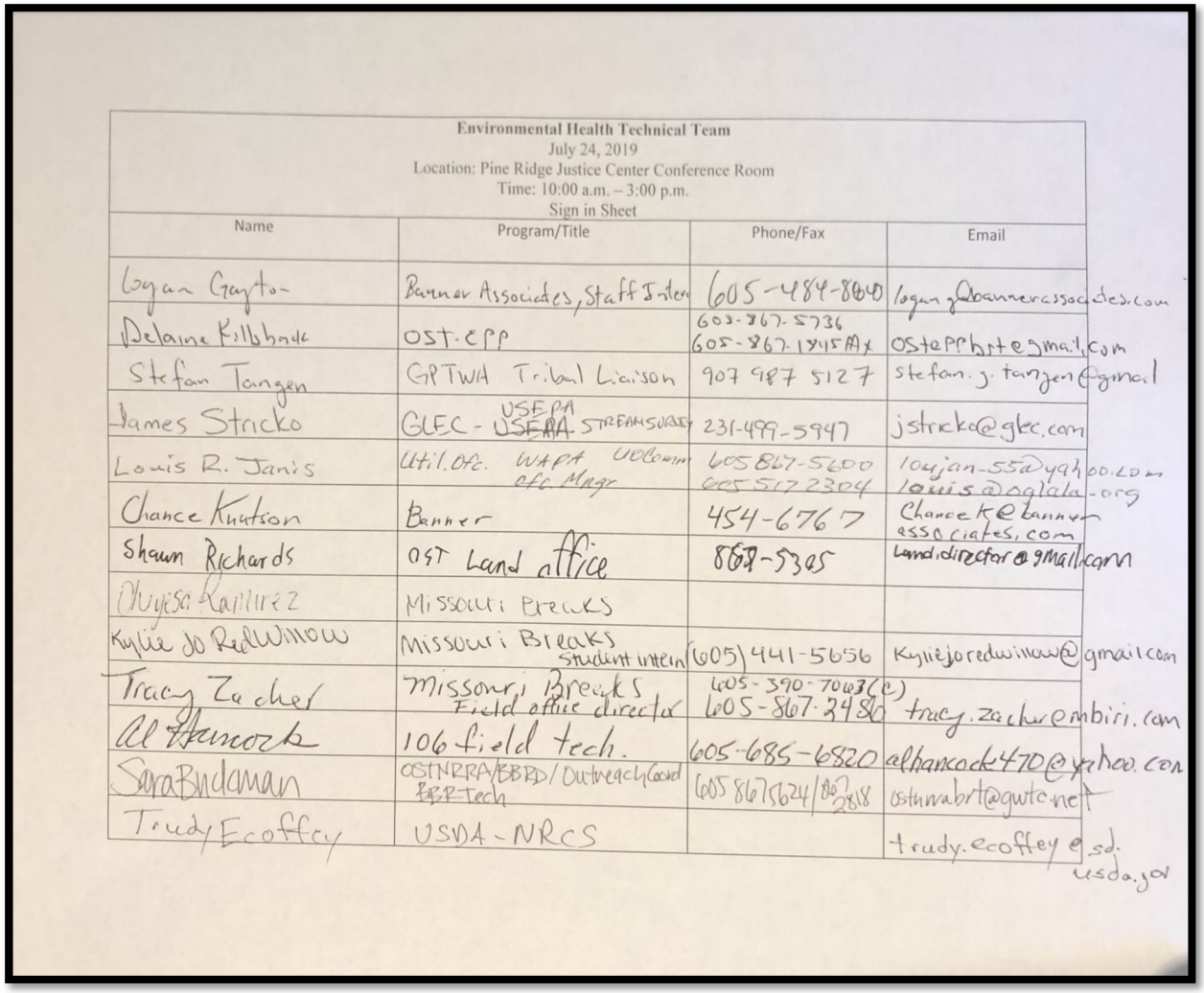
12:00 AM – Lunch

1:00 PM – Interview with Tribal Leaders

2:00 PM – ADJOURN

Next Steps:

- Develop STAPLEE Survey
- Draft Drought Adaptation Plan
- Tribal Review for Comments
- Develop Final Draft Plan



Environmental Health Technical Team
July 24, 2019
Location: Pine Ridge Justice Center Conference Room
Time: 10:00 a.m. – 3:00 p.m.
Sign in Sheet

Name	Program/Title	Phone/Fax	Email
Logan Grayton	Banner Associates, Staff Intern	605-484-8640	logan@bannerassociates.com
Delaine Kilbride	OST-EPP	605-867-5736 605-867-1945 Fax	ostepphr@gmail.com
Stefan Tangen	GPTWA Tribal Liaison	907 987 5127	stefan.j.tangen@gmail
James Stricko	GLEC - USEPA STRFANSURVEY	231-499-5947	jstricko@glec.com
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Chance Knutson	Banner	454-6767	Chance K@bannerassociates.com
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Kylie Jo RedWillow	Missouri Breaks Student Intern	(605) 441-5656	Kyliejoredwillow@gmail.com
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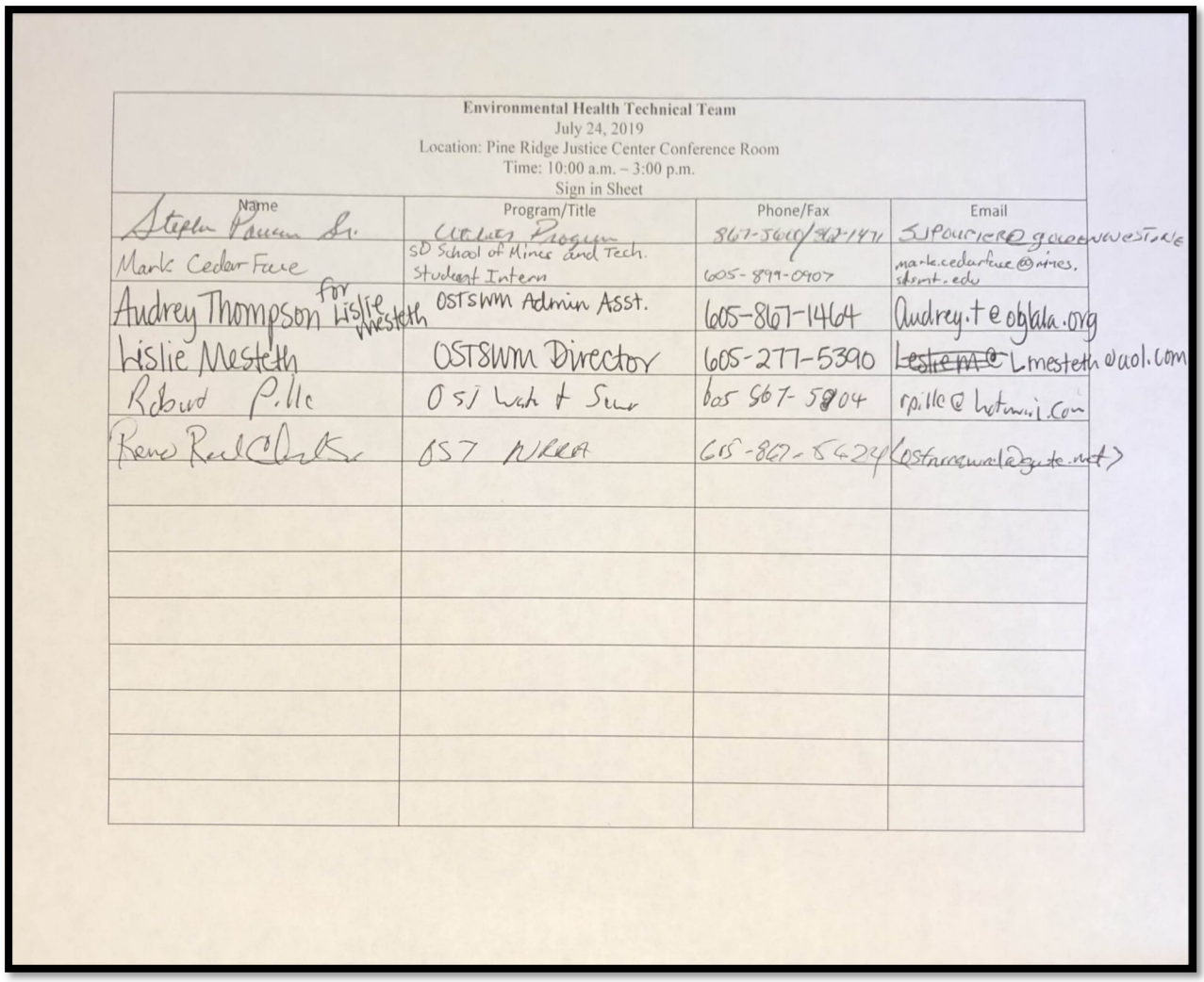
Sara Buchanan	OSTNRRA/EBRD/Outreach Coord P&R Tech	605 867 5624/867 2818	ostnrabrt@gwtc.net
Trudy Ecoffey	USDA-NRCS		trudy.ecoffey@sd.usda.gov



Environmental Health Technical Team
July 24, 2019
Location: Pine Ridge Justice Center Conference Room
Time: 10:00 a.m. – 3:00 p.m.
Sign in Sheet

Name	Program/Title	Phone/Fax	Email
Stephen Pourier Sr.	Utilities Program	867-5600/342-1471	SJPourier@gocougarwest.net
Mark Cedar Face	SD School of Mines and Tech. Student Intern	605-899-0907	mark.cedarface@mines.sdsmt.edu
Audrey Thompson for Lislie Mesteth	OSTSWM Admin Asst.	605-867-1464	Audrey.t@oglala.org
Lislie Mesteth	OSTSWM Director	605-277-5390	~~Lesteme~~ Lmesteth@aol.com
Robert Pille	OSJ Water & Sewer	605 867-5804	rpille@hotmail.com
Rene Real Chief	OST NRRA	605-867-5424	(ostnrraewa@gwtc.net)

Suggested Vulnerabilities Not Included in Questionnaire:	Suggested Mitigation Strategies Not Included in Questionnaire:
- Dam and Tree Damage/Regeneration	- Public Outreach
- Implementation of Hemp Industry	- Education
- Hemp Soil Health	- Training
- Lagoons	- Funding for Climate Change Projects
- Wells high in Radium	- Spring Wells Updated Study
- Hail Damage to Trees Encourages Beetles	- West Nile Study
- Overgrown Forests - More Fire Fuel	- Solid Waste/Waste Water Updated Report
- Dust During Droughts Affecting Human Health	- Rangeland Dam Permits and Ground Water Regeneration
- Pollen Travels Further During Drought - Increased Allergies	- Recycling
- Identifying Recharge Sites	- Implementing Natural Insect Competition
- TCP - Traditional Plants	- Reusing Irrigated Water w/ Ditch Recollection
- TCP - Animal Habitats and Riperian Areas	- Weather Stations to Record and Warn Residents of Weather Related Issues
	- Land Use Controls
	- Incentives for Reusing and Recycling
	- Wastewater Repairs

Drought Vulnerability Survey

Vulnerabilities	Rank
General infrastructure is old and outdated (water, wastewater, and road)	
Less fish available in streams	
Mni Wiconi reached capacity in 2017 during the drought	
Tree regeneration is significantly reduced	
Reservation has developed a spring fire season	
Volunteer fire departments are few and far between	
Animals exposed to Epizootic Hemorrhagic Disease and Bluetongue disease during drought	
Increased invasive plants	
Reduced forage production	
Plague in prairie dog towns	
Overselling of hunting licenses and animal tags could cause overharvest of animal species	
Agricultural producers unable to implement long-term mitigation strategies to remediate effects of drought due to having temporary leases	
People stealing hay	
Private wells are high in arsenic	
High concentration of *E.coli* in water source	
Fire hydrants do not have enough pressure to work during emergency situations	

Mitigation Strategy Survey

Mitigation Strategies	Rank
Encouragement of crops that need less water	
Encourage drought resistant landscaping	
Water use restrictions	
Encourage dry land farming	
Maintenance and repair programs on distribution infrastructure	
Improving efficiency standards in buildings	
Catching and use of rainwater	
Encouraged use of water efficient appliances	
Use of a plastic-like material to keep moisture near plants	
Drip irrigation	
Incentive pricing on water use	
Peer pressure (sending comparisons of water use)	
Using cover crops (like barley)	
Irrigation scheduling	
Grazing management plans	
Cross fencing	
Reduce water use in food production (full washers, low flow)	
Display water use to encourage low usage	
Composting	
Weatherizing homes and buildings	
Putting wastewater into the ground to encourage groundwater replenishment	
Reservoir augmentation	
Identifying new water sources before approving proposed development	
Identifying all water demands	
Update the wastewater drinking plant	
Stormwater management – retaining basin or dry basin	

OST Drought Vulnerability Survey Results

Drought Vulnerablilities	Total Score	Rank
General infrastructure is old and outdated (water, wastewater and roads)	24	**1**
Private wells are high in arsenic	31	**2**
Volunteer fire departments are few and far between	33	**3**
Tree regeneration is significantly reduced	34	**4**
Increased invasive plants	34	**4**
Agricultural producers are unable to implement long-term mitigation strategies to remediate effects of drought due to having temporary leases	34	**4**
Reduced forage production	43	**7**
Mni Wiconi reached capacity in 2017 during drought	44	**8**
High concentration of E. Coli in water source	47	**9**
Fire hydrants do not have enough pressure to work during emergency situations	50	**10**
Less fish available in streams	50	**10**
Reservation has developed a spring fire season	52	**12**
Plague in prairie dog towns	53	**13**
Animals exposed to Epizootic Hemorrhagic Disease and Bluetongue disease during drought	54	**14**
People stealing hay	57	**15**
Overselling of hunting licenses and animal tags could cause overharvest of animal species	61	**16**

To identify mitigation strategies that would be most helpful for the OST to pursue, a list of mitigation strategies was presented to Tribal leaders and other field visit attendees. The Tribal leaders were asked which mitigation strategies were most helpful and if there were any mitigation strategies that were missed. *Error! Reference source not found.* shows the top five strategies selected from the survey. A lower score represented what interviewees perceived to be the most important mitigation strategy.

OST Mitigation Strategy Rankings

Mitigation Strategies	Total Score	Rank
Identifying all water demands	27	1
Maintenance and repair programs on distribution infrastructure	25	2
Catching and use of rainwater	31	3
Improving efficiency standards in buildings	24	4
Identifying new water sources before approving proposed development	29	5
Weatherizing homes and buildings	31	6
Drip Irrigation	32	7
Grazing management plans	32	7
Water use restrictions	35	9
Stormwater management – retaining basin or dry basin	33	10
Encourage the use of water efficient appliances	39	11
Composting	39	11
Display water use to encourage low usage	40	13
Encourage dryland farming	43	14
Putting wastewater into ground to encourage groundwater replenishment	42	15
Cross fencing	42	16
Irrigation scheduling	44	17
Updated the wastewater drinking plant	47	18
Use of plastic-like material to keep moisture near plants	46	19
Reduce water use in food production	48	20
Reservoir augmentation	49	21
Encouragement of crops that need less water	50	22
Using cover crops (like barley)	50	22
Encourage drought resistant landscaping	51	24
Incentive pricing on water use	54	25
Peer pressure water use comparisons	54	25