# URNRD Soil Moisture Probe Program

**Close Out Report, January 2025**

*DNR Contract 1231, Application #5301*

The Upper Republican Natural Resources District (URNRD) was awarded a $123,840 Water Sustainability Fund (WSF) grant by the Natural Resources Commission in November 2020 to incentivize the use of soil moisture probes within the URNRD. All grant funds have been expended. Following is a summary of the project.

## Project Demand

The project was intended eliminate unnecessary water applications on irrigated cropland in the three counties (Perkins, Chase, Dundy) that comprise the URNRD through the use of telemetry-enabled soil-moisture sensors that inform farmers of moisture content relative to crop root zones. Much of the URNRD has experienced significant groundwater declines since the 1960's when largescale irrigation development began and before URNRD lacked the authority to control the density of irrigation wells.

The URNRD restricts groundwater use on all irrigated lands through use of an allocation system that allots farmers a certain number of acre inches of water they can apply over a five-year period. The current allocation for the 2023- 2027 allocation period is 62.5" per acre, the annualized average of which is 12.5". Research by the University of Nebraska-Lincoln using 50 years of weather data to estimate evapotranspiration rates indicates the average amount of

irrigation needed to fully irrigate corn within the URNRD is 13.5". This higher irrigation requirement than what the allocation allows, especially in dry years, now requires significant restraint and precision from farmers when making irrigation decisions. This creates demand for technology that reduces instances of over-watering, such as information available from soil-moisture probes cost-shared under the program.

Demand for probes cost-shared using WSF funds was strong and more were installed using the funds than we anticipated. At the time WSF funds were applied for, we estimated that approximately 260 probes could be installed on approximately 34,000 acres assuming an average probe cost of $1,600 apiece. After the WSF grant was approved, the cost of some probes on the market appears to have decreased. From 2021 through 2024, WSF funds incentivized the installation of 380 probes on approximately 49,000 acres – 120 more probes and about 15,000 more acres than we originally anticipated. For perspective, 49,000 acres represents about 11 percent of the total irrigated acres within the URNRD.

Following are the number of probes WSF funds were used to cost-share by year during the grant period:

**2021** – 117

**2022** – 100

**2023** – 125

WSF funds were also used to provide cost share for 38 probes in 2024. Demand for probes in 2024 was on par with previous years, but the remaining WSF balance going into 2024 was only enough to fund 38; a new federal grant helped fund more probes used in 2024 that could not be funded by WSF.

The lower-than-anticipated cost of probes which significantly increased the number that could be installed under the WSF program also increased the program timeframe. We originally expected all WSF funds would be used in 2021-2022; instead, it provided funding for 2023 and some probes in 2024. Our hope and belief is that this exposed more people to the benefits of using probes and they will continue to use them in the future, increasing benefits to groundwater resources in the district.

The following rules were established for the cost-share program:

- Reimbursement from the NRD covers half the cost of a probe, with reimbursement capped at $1,300 per probe.
- Each landowner or farmer can receive cost share for a maximum of three probes.
- Applications are accepted until all funds have been obligated on a first-come, first-serve basis.
- Cost share can be applied to all probe-related services so long as the cost of the probe is included.
- Participants cannot receive cost share from NRCS on the same probes cost-shared by the URNRD.
- Probes must be used within Perkins, Chase, or Dundy Counties, the three counties that comprise the URNRD.
- Participants must make data from the probes available to the URNRD if requested.

Grant funds were only used for the reimbursable portion of project costs. For example, if a probe cost $1,400, the irrigator was responsible for half the cost. The remaining half, $700, was split between the URNRD (60%) and WSF (40%). Using that example, WSF paid $420 for a $1,400 probe, or 30%. The URNRD paid 20%, and the participating farmer paid 50%.

## Project Objectives and Outcomes

Before describing project outcomes, it may be helpful to describe in more detail how many of the probes that were cost-shared work. Manually operated soil-moisture probes have been used for decades to extract soil so moisture content can be observed and, if desired, measured. None of the units cost shared under the WSF program were this type. We did not dictate what types/brands of probes must be used, but most of the probes chosen by participants in the program are what are commonly referred to as capacitance-type probes that measure the charge-storing capacity of the soil. Of all the components in soil, water has the most capacity to store charge. When measurements of the charge-storing capacity of soil is measured, therefore, it can be related to volumetric water content. Most probes are around 4' in length, with sensors installed roughly every 4" along the length of the probe. Data is transmitted via telemetry systems, often cellular-based, to probe users; software programs offered by most vendors of the probes then compare actual moisture content to suggested moisture content levels and recommendations on whether or not water needs to be applied to the crop. Continuous soil-moisture data and irrigation recommendations are displayed on web-based dashboards.

A variety of studies have concluded that using soil-moisture probes can improve irrigation scheduling and reduce water use. While we can observe the behavior of an individual farmer when he uses a probe for irrigation decisions, we can't definitively know what the same farmer's behavior would have been had he not used a probe. Year-to-year comparisons (same field with a probe used one year, not used the next) are difficult because precipitation patterns are never the same year to year. However, many farmers in the URNRD who have experience using probes and following their irrigation recommendations have estimated the use of them reduces irrigation applications by 1"-3" per acre annually. These estimates align with studies on the impact of using soil moisture probes. A significant portion of this reduction, they report, is due to less watering shortly after crop emergence and late in the season after plants have matured.

During the three-and-a-half year program, 380 probes were installed on approximately 49,000 acres (1 probe per field was cost-shared). In the project application, we estimated average, per-acre reductions in irrigation applications would be 2" and that total water savings due to the project would be approximately 67,000 acre inches, or 5,600 acre feet. This assumed probes would be installed on 33,540 acres. Due to the higher-than-expected number of probes and acres enrolled in the program, the total, estimated water reduction under the program was approximately 98,000 acre inches, or 8,166 acre feet. Overall then, total water savings under the project were approximately 37% more than what was anticipated at the outset of the project due to the lower cost of probes that allowed more to be cost-shared with the WSF grant.

One outcome we've desired is for the program to be an entryway to probe use that will continue after the cost-share program has ended. Should 75% of the probes cost-shared from 2021- 2024

continue to be used over a five-year period, total saved water assuming 2" of reduced water use per acre will be about 30,600 acre feet during that time period.

While probes cost-shared under the program were installed in each of the URNRD's three counties, more were installed in Perkins County than Chase or Dundy Counties. We believe this is due to the fact that there are more dealers of probes in Perkins than the other two counties. Chase County had the second-most probes installed, and Dundy County the least.

The average water use in the district is approximately 12 inches per acre. The average, approximate price of corn during the 3.5-year project period was approximately $5.40/bushel. Generally speaking within the URNRD, irrigated corn has a yield of roughly 100 more bushels per acre than dryland corn. The per acre value of irrigated corn, then, is $540 more than dryland corn, making the value of each inch of irrigation water applied approximately $45 assuming 12"/acre of water applied. The total value of the 98,000 acre inches of water saved under the two-year program, then, is approximately $4.4 million.

Due to the WSF grant, many farmers across the URNRD integrated soil-moisture probes into their irrigation scheduling program. It's a concrete way to reduce water use in a region of the state that has experienced significant groundwater declines over the years. Using soil-moisture data creates a science-based approach to irrigation scheduling that farmers have learned to appreciate and will make them more comfortable adopting other water-saving technology. Thank you for helping advance this approach to water management that will help our corner of the state, and Nebraska as a whole.

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