WaterSMART Grant Proposal

Small Scale Water Efficiency Projects for Fiscal Year 2017

Roosevelt Irrigation District Canal Spill Reduction

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ROOSEVELT
RID
IRRIGATION DISTRICT

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Executive Summary

The Roosevelt Irrigation District (RID) is located in Maricopa County, Arizona, just West of Phoenix. RID's office is in Buckeye, Arizona. RID on April 4, 2017, proposes a Water Smart Grant to the Bureau of Reclamation (Reclamation) to reduce spills from their main canal by automating a check structure and reservoir inflow and outflow at a site near the downstream end of their main canal. This project will assist RID operators by maintaining constant water levels in the furthest downstream pools in their main canal. This will help RID operators manage the canal more precisely, and thus provide more constant water deliveries and save water. Data will be transmitted to the RID office through radio communications and stored there for analysis.

Average spills are roughly 5,000 ac-ft/yr, but can vary from 2,000 to 9,000 ac-ft/yr. During low spill years, a higher percentage of the spill can be recovered. During high spill years, variable water demands will make capturing spills more difficult. Still, the expectation is that about 80% of the spill will be recovered, or 4,000 ac-ft/yr on average.

If funded in the fall of 2017, the equipment will be installed during the winter of 2017/2018. The controls will be tested in the spring of 2018, and evaluated during the remainder of 2018 and 2019. The estimated completion date is September 1, 2019. This project is not located on a Federal facility.

Background Data

The Roosevelt Irrigation District (RID) is an irrigation district duly organized and existing under the laws of the State of Arizona. A location map is provided in Figure 1. RID was originally organized in the 1920s. It consists of 35,000 acres of irrigated land near the town of Buckeye, Arizona. Recent water demands have averaged 136,000 ac-ft/yr.

RID has 102 permitted wells which pump into concrete-lined irrigation canals. The RID Main Canal is 52 mile long and serves 230 miles of Lateral Ditches (lined). Water is delivered to 470 agricultural customers through 1420 field delivery points. RID divides its well fields into 5 units. These units and the associated discharge are as follows:

- Collection Canal 1 (CC1): 172 cfs
- Collection Canal 2 (CC2): 25 cfs
- Salt Canal: 45 cfs
- Westside Main Canal: 25 cfs
- Westside District Wells: 76 cfs

Water is generally supplied to agricultural customers, with a small amount for construction dust suppression. The main crop grown in the area is cotton, with alfalfa, wheat, etc. as additional crops. During summer months, demand exceeds supply, so water is prorated to supply 0.317 ac-ft/ac over a 21 day period. This provides an average of 0.18 in/day of water for consumptive use, which is less than half the maximum cotton evapotranspiration of 0.4 in/day. These are supplemented with privately owned Farm wells and sump ponds that collect water off of the end of the farm fields and then pump it back for reused. Thus capacity is severely limited. RID occasionally gets spill water from the downstream end of SRP canals, but this has not happened for several years.

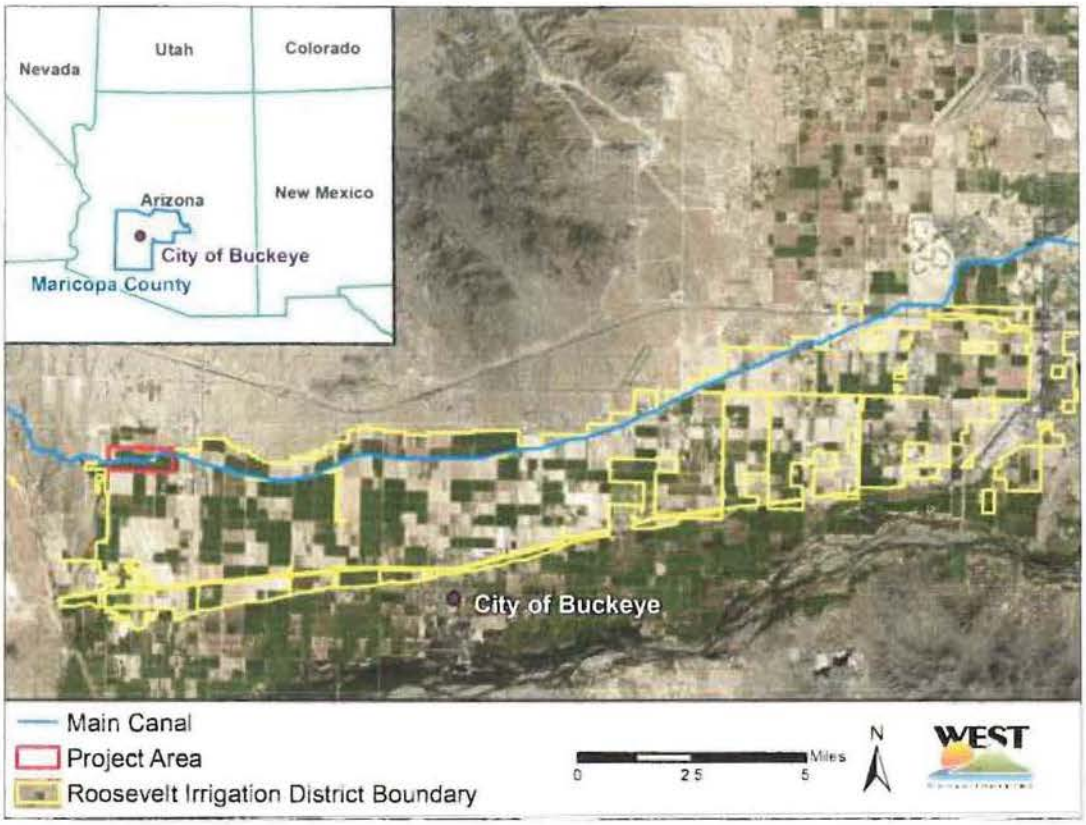

Figure 1. Roosevelt Irrigation District location map.

In the past, water deliveries were to open laterals. Recently more of the open laterals were converted to pipelines. With these pipelines there is increasing pressure for RID to provide more constant deliveries at farm outlets. RID's canal system is operated manually by operators in the field. RID does not have a SCADA system nor any automatic gates or pumps.

RID gets additional water from the City of Phoenix 23rd Avenue Treatment Plant through an exchange agreement between the Salt River Project (SRP), Pima Maricopa Indian Community and the City of Phoenix. Treated effluent is supplied to RID from the City of Phoenix. The City of Phoenix gets surface water in exchange from SRP of which a portion is then available for the Pima Maricopa Indian Community.

Project Description

The intent of the project is to automate the input and output from an existing buffer reservoir near the downstream end of the Roosevelt Irrigation District's Main Canal to eliminate spills from the end of the main canal. The project will also control one check gate and help RID staff to maintain constant flows, thus improving their overall operations and potentially saving water.

Activities and Milestones

The main project activities and milestones include:

1. Run electrical power to check gates

2. Install fencing around automated gates
3. Install new gate to reservoir
4. Install water-level sensors, radio masts, and equipment cabinets
5. Install gate motors and actuators, control panels and gate position sensors
6. Create a hydraulic model of the downstream end of the canal with HEC-RAS
7. Conduct tests with the model to determine canal response
8. Develop control algorithms for maintaining the downstream water levels in the last two canal pools
9. Program field stations to provide needed processes
10. Program base station to communicate with field stations and store required data
11. Install electronic field hardware and test basic functionality
12. Test operations
13. Train operators to run and maintain the system
14. Evaluation of results

The Problem

Because of the lag time in the main canal, it is not possible for operators to match supply and demand with manual operations. RID currently spills about 5,000 acre-feet of water per year, or roughly 3.3% of their annual supply. RID constructed a small regulating reservoir toward the downstream end of the main canal (upstream from Check #23). Water spills over a weir into the reservoir when the water level in the canal is high. When demand downstream exceeds supply, a pump is turned on to pump water back into the canal. This does not directly reduce the spill, which occurs at the next check structure downstream (Check #24). RID staff has not been able to eliminate spills from Check Structure #24 at Johnson Road with manual operation of this reservoir. Figure 2 shows the location of the spill at Check #24 (Johnson Road) at the downstream end of the main canal.

Figure 2. Check Structure #24 at the tail end of the main canal (Johnson Road).

The Solution

This project will control the water levels in the canal to eliminate the spill. The water level at the downstream end of the canal, where the spill occurs, will be monitored and controlled by the operation of the gates at the Check Structure #23, the next check upstream (at Bruner Road).

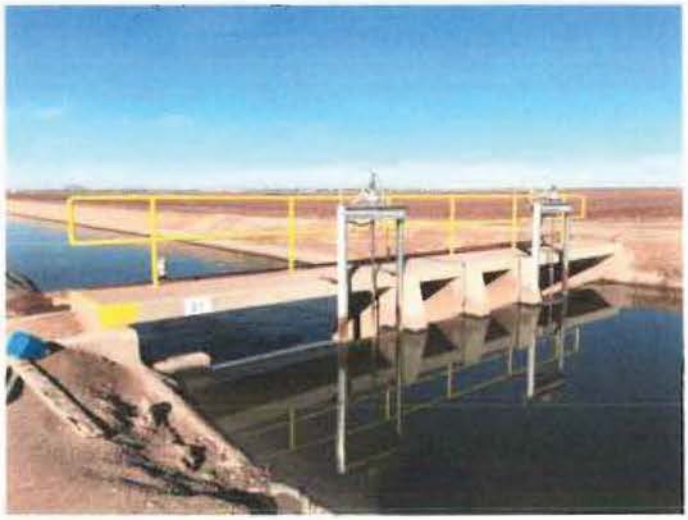

Figure 3. Check Structure #21 (similar to check #23 at Bruner Road which is to be automated.

Figure 4. Inlet to the reservoir, over spillway (submerged in photo) and through the gate. Pumps from reservoir to canal are shown in background.

The water level upstream from Check #23 will be controlled with the inflow and outflow to the reservoir. Currently water spills into the reservoir over a weir if the water level is sufficiently high. There is currently a gate that controls inflow to the reservoir (Figure 4). If the gate is closed, no water can enter the reservoir. Under this project, a new automated gate will be installed for flow into the reservoir. If the water level is too high, the gate will be opened and water will flow into the reservoir (by gravity). If necessary, the overflow spillway crest will be lowered to allow better control into the reservoir with the gate that will be automated.

If the water level is too low, the pump (Figure 5) will turn on to provide additional flow necessary to satisfy the demand downstream, and thus maintain the desired water level. There are two pumps that can pump water from the reservoir into the canal.

Figure 5. Pump station for pumping from reservoir (right) to canal (left).

The site for the overall system is shown in Figure 6. The water level at Check #24 is controlled by the gates at Check #23. The water level at Check #23 is controlled by the combination of the inflow and outflow to the reservoir. Control with the reservoir is limited by the flow rates of the two pumps and restrictions of gravity flow into the reservoir (e.g., if the reservoir is too high, flow into the reservoir will be restricted). This system will be able to control minor fluctuations in flow. Larger fluctuations or long- term fluctuations will need to be controlled by District personnel further upstream. The capacity of the reservoir is roughly 400 ac-ft. It is roughly 15 ft deep. Long-term plans suggest a larger reservoir further upstream, which will be considered in the future (i.e., not part of this project).

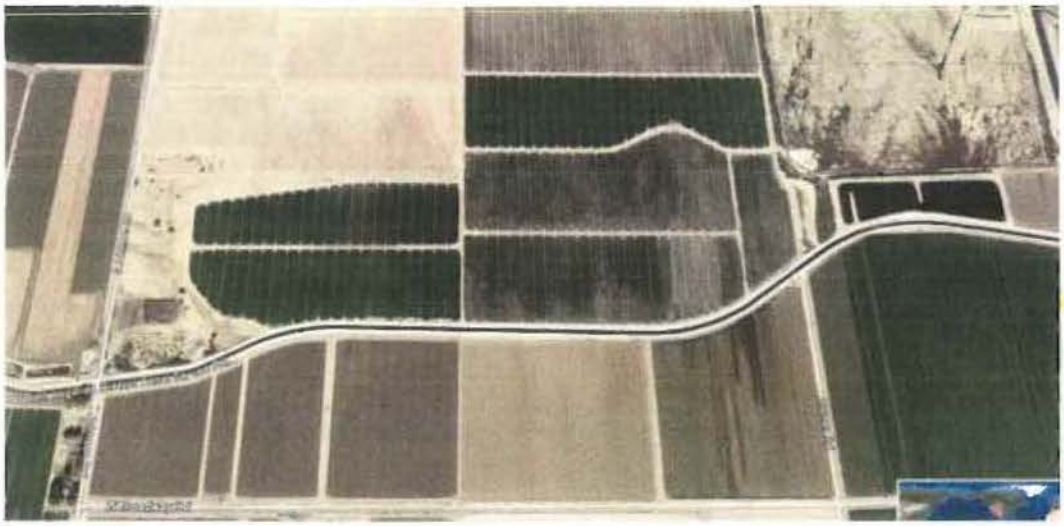

Figure 6. Layout of automation site. Flow is from right to left.

The Outcome

The expect outcome is nearly zero operational spills out of the canal. Total elimination of the spill may not be possible because of the lag time in the last canal pool. If large changes in demand occur in the downstream pool, the controller upstream can change the flow immediately, but it takes time for this change to propagate to the end of the pool. So instead of a canal spill occurring over a 6 -8 hour period, the spill might not occur at all or perhaps it will only occur for 15-20 minutes and at a reduced flow rate.

Spills may also occur if the fluctuations are too large to be handled by the reservoir or are too long in duration such that the reservoir is full. Since the water supply to RID is limited, this is not likely since farmers are readily available to accept their water sooner than scheduled.

Evaluation Criteria

Evaluation Criterion A – Planning Efforts Supporting the Project (35 points)

RID has developed a list of projects to help them improve their operations, which provides better consumer service and improves their customer's ability to save water. Improved operations can both reduce spills and reduce unaccounted-for water that is supplied to users but can't be used effectively (i.e., if the flow rate is too low, can't be shut off when they are done, etc.) This list of potential projects was developed by the RID Board of Director and RID staff through on-going planning efforts.

The RID Board and staff have put together the following list of potential projects to explore.

1. Automate the existing downstream reservoir to reduce (or eliminate) spills out of the system. (The subject of this grant).
2. Adding a buffer reservoir to their system to improve operational flexibility and to eliminate spills entirely. (Added benefit to existing grant, but have not explored feasibility).
3. Re-lining the main canal. All of RID's canals are currently lined but some are in really bad shape. No data exists on the amount of water that could be saved by relining nor the improvement in operations that would result.
   a. Cost estimates:
      i. Repairing a ¼ mile stretch of their main canal cost $67,000.
      ii. Removing and replacing a ¼ mile stretch of their main canal cost $132,000.
   b. RID main canal has a 12-foot bottom width and is 9 feet deep with 1:1 side slopes.
2. Repair/replace groundwater pumps. Purchase pumps with VFDs or add VFDs to existing.
3. Piping additional wells to their main canal. RID has several isolated pumps that just serve farms in the area of the pump. RID would like to install pipelines to these pumps so they can deliver the water to the main canal.
4. Groundwater recharge project in conjunction with the Central Arizona Project (CAP). Perhaps in future.

In 1980, Arizona made a commitment to the long-term management of its limited groundwater supplies through the passage of The Arizona Groundwater Code. The goals of the Code are to eliminate severe groundwater overdraft in areas of the state where groundwater supplies have been rapidly diminishing and to provide the means for allocating Arizona's limited groundwater resources to most effectively meet the state's changing water needs. The Code limits withdrawals of groundwater within Active Management Areas (AMAs) to holders of grandfathered rights, service area rights, groundwater withdrawal permits, and small domestic users. Under the Code,

groundwater uses existing at some time between 1975 and 1980 were allowed to continue within the limits established under a new water rights system, and new uses were required to be consistent with AMA management plans and goals.

RID is one of several irrigation districts with the Phoenix Active Management Area (AMA). The Phoenix AMA is one of the groundwater management district established by the Arizona Groundwater Code. The Phoenix AMA is tasked by Statute to achieve safe-yield by the year 2025 through the increased use of renewable water supplies and decreased groundwater withdrawals in conjunction with efficient water use. Achieving safe-yield, as defined in the Code, means "to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial groundwater recharge in the active management area." The Code requires that each management plan include a continuing mandatory conservation program for all persons withdrawing, distributing, or receiving groundwater designed to achieve reductions in withdrawals of groundwater.

The water supply of RID is primarily groundwater. This project will reduce groundwater withdrawals through more efficient water use, so it directly works toward to Phoenix AMA goal. The project was chosen as a priority since it will have immediate water savings that are observable. Since the small reservoir exists, implementation of the project will be straightforward and relatively inexpensive (i.e., it is "shovel ready").

Evaluation Criterion B – Project Benefits (35 points)

The primary benefit of this project is reduced operations spills and improved service to customers (agricultural water users). This is an overall benefit to the delivery system since it allows for better control over water delivered to the canal. Implementation of this system will assist RID with identifying there inflow outflow mismatches which can be used to identify future projects for further improvements in operations. With this project, RID operations should become more cost effective. Improved operations and delivery performance should make the overall agricultural enterprises within RID also more cost effective which has an overall positive impact on the local economy.

Average spills are roughly 5,000 ac-ft/yr, but can vary from 2,000 to 9,000 ac-ft/yr. During low spill years, a higher percentage of the spill can be recovered. During high spill years, variable water demands will make capturing spills more difficult. Still, the expectation is that about 80% of the spill will be recovered, or 4,000 ac-ft/yr on average.

This project is relatively small and will not have a major impact on the groundwater basin, but the groundwater code calls for "a continuing conservation program designed to achieve reductions in withdrawals of groundwater." This project improves efficiency which reduces groundwater pumping.

RID is a relatively small irrigation district and does not have a Supervisory Control and Data Acquisition (SCADA) System nor automatic control of gates. There are many small districts in the area that are similar to RID. The project could demonstrate the advantages of some form of small-scale automation to the operation of small water districts.

Evaluation Criterion C – Project Implementation (15 points)

This project requires installation of Remote Terminal Units (RTUs) and communication at two check structures and at the inlet and outlet of the reservoir. It requires motorized gates and electric gate

controllers at one check structure and the reservoir inlet. It requires pump motor control at the reservoir outlet. Electronic controllers within the RTUs will send signals to the electrical gate controls and pump controls. It requires the development of control logic for these controls and programming in the RTU to implement control. Finally, the control system will be tested and the results recorded and evaluated.

Before these components can be installed and tested, electrical power needs to be run to two sites, and fencing needs to be installed around the RTU and gate hardware to reduce potential vandalism. Special mounting brackets and attachment may need to be constructed to mount all the gate motors, motor controllers, RTUs, radio antennae, etc. All this needs to be done while the canal is still in service. Some of the main tasks are listed below.

1. Run electrical power to check gates. This will be done by district staff.
2. Install fencing around automated gates. This will be done by district staff.
3. Install new gate to reservoir. The current gate is cast iron and takes too much lifting force. It will be replaced with an aluminum or stainless steel gate. This will be done by district staff.
4. Install stilling wells, water-level sensors, radio masts, and equipment cabinets. This is relatively routine work and can primarily be done by district staff, with support/advice from consultant.
5. Install gate motors and actuators, control panels and gate position sensors. This is also relatively routine, although it may require some staff training.
6. Create a hydraulic model of the downstream end of the canal with HEC-RAS. This work will be performed by a consultant with logistic support from district staff.
7. Conduct tests with the model to determine canal response (more specifically canal pool properties). Simulation test of unsteady flow will be used to determine how the canal responds to a disturbance. This worked will be performed by a consultant. Field tests will be conducted to verify canal response, if operational conditions allow it.
8. Develop control algorithms for maintaining the downstream water levels in the last two canal pools. The work will be performed by a consultant.
9. Program field stations to provide needed processes:
    a. To read water level
    b. To read gate positions
    c. To control gate position
    d. To control pump
    e. To communicate with base station

    This work will be conducted by an electrical contractor.
10. Program base station to communicate with field stations and store required data. This work will be conducted by an electrical contractor
11. Install field hardware and test basic functionality
    a. Install field units in an enclosure
    b. Install base station at district office
    c. Install masts and radio antennas
    d. Install water level sensors
    e. Install gate position sensors, gate motors and gate relay control boards
    f. Install pump control board

    This work will be conducted by an electrical contractor.
12. Test operations (i.e., feedback control). This work will be performed by RID staff, the consultant and the electrical contractor.
13. Train operators to run and maintain the system. This work will be performed by both RID senior staff and the consultant.
14. Evaluation of results. District staff will evaluate canal spills during the 2018 irrigation season, with the project in place, and compare to prior years to determine water saved as a result of this project.

Evaluation Criterion D – Nexus to Reclamation (15 points)

RID is not a Reclamation project, however has a water exchange agreement with SRP (a federal reclamation project) and the City of Phoenix to provide water to the Salt River Pima Indian Community east of Phoenix.

This project satisfies the following Reclamation priorities:

- C.3.1.1 Task A – Water Conservation: Supervisory Control and Data Acquisition and Automation
- C.3.1.2 Task B – Energy-Water Nexus: Increasing Energy Efficiency in Water Management

The project will provide benefits to all water users within the Phoenix Active Management Area, which includes Indian Reservations and Reclamation Projects. The water supply for the AMA is augmented by the Central Arizona Project. Thus there are direct connections to both Tribe and Reclamation Projects.

Performance Measures

This project will measure the water spilled into and the water pumped out of the reservoir, and the water spilling over the last check structure. It will be assumed that the water entering the reservoir would have spilled, and thus it is water saved by the project. The water spilled divided by the water pumped from the reservoir will give the ratio of the amount of spill saved by the project. These numbers will also be compared to the estimates of water spilled historically.

Environmental and Cultural Resources Compliance

This project will occur on District Right-of-Ways and so has no direct environmental or cultural resource issues.

Letters of Project Support

This project is funded entirely by RID and Reclamation. No other agencies are cooperating nor are they providing funding support, so no letters of support are required.

Required Permits and Approvals

No external permits or approvals required.

Official Resolution

Letter from RID Board is attached.

Project Budget

Funding Plan

This project is funded by the RID Board of Directors and by Reclamation. RID staff will fund the project with their existing operating funds, with reimbursement from Reclamation for ½ of the project costs.

Budget Narrative

Salaries and Wages

Ken Craig, Operations Manager, will coordinate and manage the project. This will require 40 hrs to manage the project. He will spend additional time on other work items listed below.

Key work items are listed below along with estimates of time that will be spent:

Work Item	Estimated Time
Prepare reports and provide project support, clerical staff	60 hrs total
Install electric power to Check #23 and reservoir inlet, 2 staff members	40 hrs each
Install fenced enclosures around controlled gate, maintenance crew	120 hrs total
Install new gate and gate motors, 2 staff members	40 hrs each
Build and install bubbler lines and protective covers, 2 staff members	30 hrs each
Install gate position sensors, 2 staff members	20 hrs each
Install enclosures for RTUs, three staff members	25 hrs each
Install masts for radio antennas, three staff members	20 hrs each
Install computer, base station and antenna at District Office, 2 staff members	20 hrs each
Install RTUs, two staff members	30 hrs each
Arrange and supervise test of controls, 2 staff members	20 hrs each
Train operators on automatic controls, 2 staff members	20 hrs each
Compile spill results for automatic control, 2 staff members	40 hrs each
Provide details on canal for modeling, 2 staff members	10 hrs each
Build and fabricate necessary stands for controls, 3 staff member	10 hrs each
Equipment operators to support installations, 5 staff members	46 hrs total

Fringe Benefits

Fringe benefits were computed for 2016. These included workmen compensation fund, vacation, health insurance, payroll tax and the Arizona State Retirement System. The fringe benefits were 45% of total labor costs.

Travel

There are no travel costs for this project.

Equipment

The budget includes 5 Remote Terminal Units (RTUs) for 5 sites. Power is available at two sites and will be provided at two sites as part of this contract. One site will be run with solar powered batteries.

- RTU to measure water level at Check #24, solar power with an enclosure and a bubbler
- RTU to control gates at Check #23 with an enclosure, a gate relay control board and a gate control panel
- RTU to control reservoir inlet and measure canal water level with an enclosure, a gate relay control board, a gate control panel and a bubbler
- RTU to control pumps and measure reservoir water level with an enclosure, a relay control board and a bubbler
- RTU as base station at District office

These sites will each require a radio modem and an antenna kit.

The current reservoir inlet gate will be replaced with an aluminum gate with a gate motor and actuator. The two sluice gates at Check #23 will be equipped with new gate motors and actuators. This may include additional stiffening for the gate and frame.

Materials and Supplies

Supplies and materials will be required for running new electrical wires from the electrical power available at the pumps from the reservoir to both the Check #23 and the reservoir inlet. These new power lines will be installed by RID staff. Chain link fencing will be purchase so that the electronics at the various sites can be protected from vandalism. Metal conduit will be used for antenna masts. Various brackets may be needed to adapt gates for gate motor and to mount enclosures for electronic equipment. Concrete may be required for securing chain-link fencing.

Contractual

A contract will be awarded to a consulting electronics firm to install the electronic equipment and to enter tuning constants into the controllers.

A contract will be awarded to a consulting engineering firm to provide feedback control logic for the controllers. An unsteady model of the canal reach will be used to determine how the canal water levels will respond to the gate and pump controls. This firm will also oversee installation of equipment by RID staff and the electronics firm to assure that the end product is useful to RID operations.

RID staff and both consulting firms will test the control system.

Environmental and Regulatory Compliance Costs

No environmental compliance costs are anticipated.

Other Expenses

Equipment will be required to support the installation of the power and automation equipment. The equipment charges are the standard charges for district equipment or equipment rental.

Indirect Costs

No indirect costs are included.

Total Costs

Total project costs are $131,520.

ROOSEVELT IRRIGATION DISTRICT BOARD OF DIRECTORS
RESOLUTION TO PURSUE WATERSMART GRANT

WHEREAS, Roosevelt Irrigation District ("RID"), an irrigation district in Maricopa County, Arizona organized under the laws of the State of Arizona is pursuing a Small Scale Water Efficiency Project WaterSmart Grant from the United States Bureau of Reclamation; and

WHEREAS, the Board of Directors desires greater operational efficiency within its irrigation system,

THEREFORE, BE IT RESOLVED, that RID pursue said grant for a project with a budget not to exceed a total cost of $150,000.

FURTHER RESOLVED that the Board of Directors authorizes staff to commit efforts and funds to undertake this endeavor.

3/7/17
Date

W. Bruce Heiden
W. Bruce Heiden, President

K. C. Gingg
K. C. Gingg

Brandon Leister