BLUE STONE DITCH ASSOCIATION 2024 WATER MANAGEMENT PLAN

Blue Stone Ditch Association
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1 WATER MANAGEMENT PLAN UPDATE

1.1 Executive Summary

The Blue Stone Ditch Association (Association) operates and maintains the 12-mile-long Bluestone Ditch (Ditch) and open laterals that provide irrigation and stock water to service a portion of the agricultural area of De Beque, Colorado. Major infrastructure along the Ditch includes a diversion structure, measurement flumes, a check structure, and an undershot. Frequent ditch infrastructure repairs and improvements are necessary to address infrastructure issues and to deliver irrigation water safely and efficiently to users within the service area.

The Association engaged in a planning effort in the past with the publication of "The Blue Stone Ditch Company Water Management Plan" in 2009 (RHN, 2009). This effort focused on historical ditch administration and water conveyance with the goal of achieving long-term and lasting improvements in water use efficiency for the Bluestone Ditch. An infrastructure improvement program encompassing the Ditch's long term infrastructure goals was drafted for projects including planning and funding. These projects aimed to provide efficient delivery and accurate measurement of irrigation water. The management plan was intended to be updated on a five-year cycle but has not received a review since the first publication.

This Water Management Plan intends to update the previous planning effort with any changes to infrastructure conditions and Association priorities. Additional emphasis on infrastructure projects and prioritization based on Association consultation will build on the infrastructure improvement program included within the previous planning document. An inventory of projects was developed based on infrastructure assessments and ranked in consultation with the Association using multi-criteria of safety concern, operational benefit, project cost, and project fundability. Top priority projects include necessary delivery and measurement improvements that will contribute to the Ditch's delivery efficacy and water use efficiency. The prioritized infrastructure project list aims to facilitate the Association's decision-making process and future project implementation.

2 WATER RESOURCES INVENTORY

2.1 Distribution System Overview

2.1.1 System Overview

The Bluestone Ditch is an approximately 12-mile-long canal that delivers irrigation water to approximately 1,500 acres in De Beque, Colorado. The Ditch diverts water from the Colorado River and utilizes laterals to deliver water to customers before terminating at a wash south of De Beque through a spill pipe. The irrigation laterals utilized by the Ditch are owned and maintained by private owners. The Ditch has faced issues that interfere with irrigation service such as large rock falls, ditch blowouts, a lack of consistent measurement, and excessive seepage areas. Major Ditch infrastructure includes flume structures, a compromised undershot for Little Horsethief Creek, and a check structure.

The existing earthen ditch is prone to delivery losses from seepage, evaporation, and phreatophyte uses that reduce the amount of diverted water that can be delivered to irrigation users. Delivery losses that occur along the canal could be calculated using measurement devices throughout the Ditch system; however, existing measurement infrastructure is not adequate to accurately estimate these losses.

Appendix A contains a mapbook illustrating ditch infrastructure features and areas prone to seepage and rockfalls.

2.1.2 Water Rights

The Bluestone Ditch is decreed for a total water right of 106 cfs. 81 cfs of the Ditch's water rights are decreed for irrigation use and the remaining 25 cfs are for stock use outside of the irrigation season. The Ditch's appropriation and adjudication dates for its decreed water rights are 1895 and 1912, respectively.

The downstream senior calls to the Bluestone Valley Ditch and their respective appropriation dates are illustrated in Table 1. The Bluestone Ditch is senior to all but the 625.81 cfs senior rights held by the Grand Valley Canal, The Larkin Ditch, and Palisade Irrigation District. These three water rights are a portion of the "Cameo Call" which is a conglomeration of water rights in the Grand Valley totaling 1950 cfs during the irrigation season. A call on the lower Colorado River of sufficient depth to require curtailment of the Bluestone is unprecedented.

Water Right	Net Amount (cfs)	Appropriation Date	Use
The Grand Valley Canal	520.81	August 22, 1882	Irrigation
The Larkin Ditch	25	April 1, 1888	Irrigation
Palisade Irrigation District	80	October 1, 1889	Irrigation
The Bluestone Valley Ditch	39.11	January 1, 1895	Irrigation

Table 1: Bluestone Valley Ditch Senior Water Rights

2.1.3 Water Use Analysis

To estimate the overall Bluestone Ditch (Ditch) system efficiency, a preliminary water use analysis of historic ditch diversions and available evapotranspiration data was completed over an 18-year period. Total annual diversion records were gathered from Colorado's Decision Support Systems (CDSS) as system inflows. Although water was likely diverted, CDSS reported zero diversions for 2009, 2014, and 2016. Delivery losses along the system were conservatively estimated at 35% from seepage, runoff, and other system losses to calculate the total applied irrigation amount that travels from the Ditch to headgates. An application efficiency of 33% was assumed due to a CDSS estimation of 60% furrow irrigation and 40% flood irrigation to calculate the total water available to irrigated crops. Figure 1 shows the contrast between diversion totals and system delivery losses over time. Evapotranspiration data from Colorado State University's (CSU) CoAgMET database was collected from the CSU Orchard Mesa Research Station as representative evapotranspiration data to model crop water use for De Beque, Colorado. The total Bluestone Ditch 2020 irrigated acres from CDSS were multiplied by the evapotranspiration amount to estimate the annual total crop water demand. An analysis of crop water demand over time is illustrated in Figure 2.

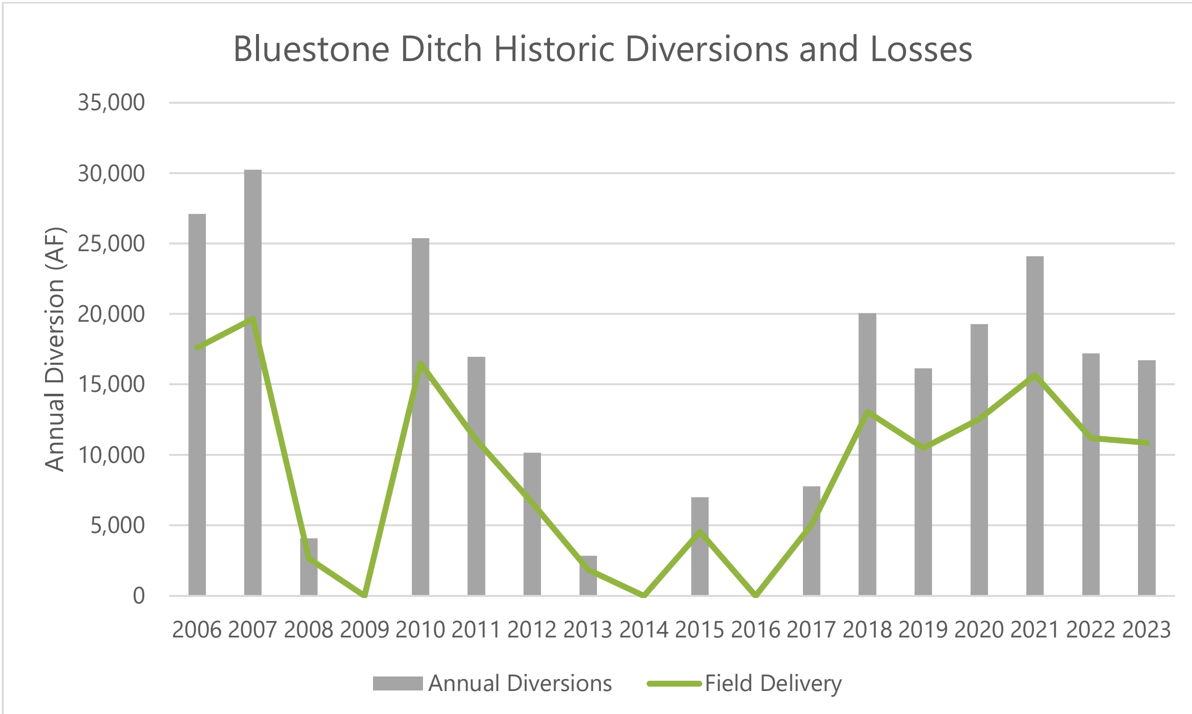

Figure 1: Bluestone Ditch Historic Diversions and Losses

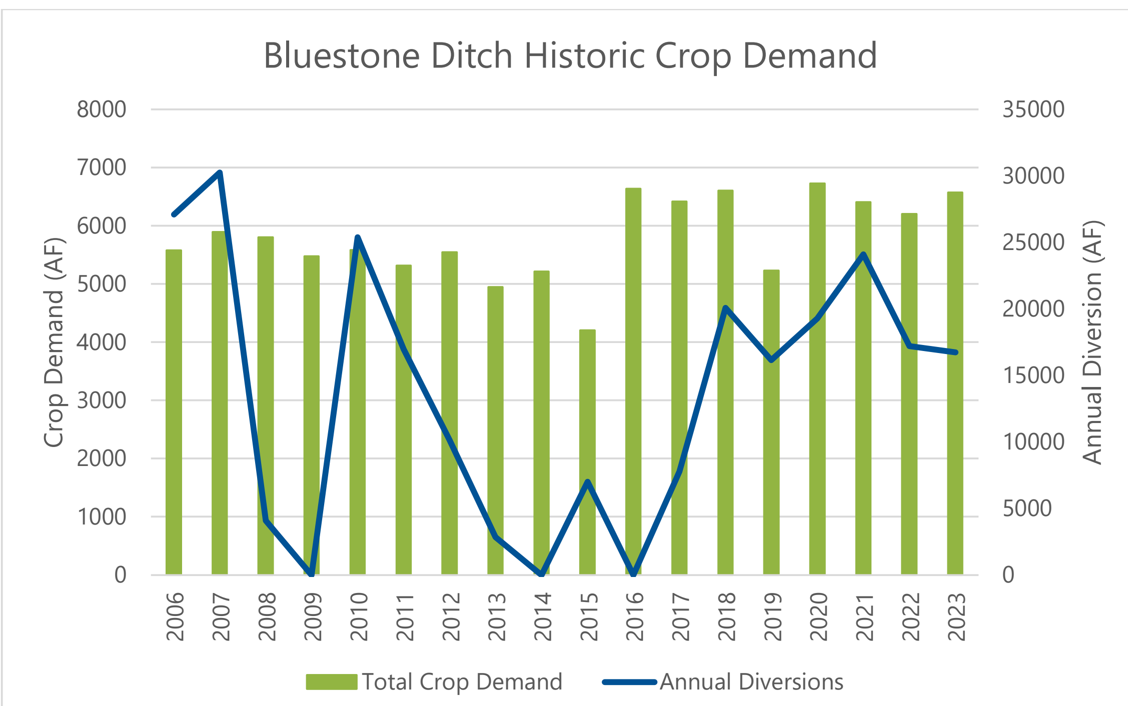

Figure 2: Bluestone Ditch Historic Evapotranspiration

Completing a preliminary water use analysis allows for the calculation of the overall system efficiency and more granular efficiencies such as delivery and on-farm efficiency. Overall system efficiency is defined as the crop consumptive use compared to the total diversions. This comparison demonstrates how efficiently the system delivers water to irrigated crops. Delivery efficiency is calculated by comparing the ditch water available after lateral and delivery losses to the total diversions. Without adequate ditch measurement infrastructure, delivery losses through the system must be estimated; therefore, the delivery efficiency is an assumed percentage. A similar assumption must be made for the farm efficiency calculation which compares the applied irrigation amount to the water available to crops by factoring in irrigation method efficiencies. A review of the overall, delivery, and farm efficiencies is useful in determining specific areas for system improvements. Table 2 summarizes the Ditch's efficiencies over the studied period.

Year*	Diversion Total (ac-ft)	Delivery to Farm (ac-ft)	Crop Irrigation (ac-ft)	Approx. Consumptive Use (ac-ft)	Overall Efficiency	Delivery Efficiency	Farm Efficiency
2023	16,712.97	10,863.43	3,584.93	6,569.27	39.31%	65%	33%
2022	17,200.91	11,180.59	3,689.60	6,201.90	36.06%	65%	33%
2021	24,081.67	15,653.09	5,165.52	6,404.88	26.60%	65%	33%
2020	19,267.72	12,524.02	4,132.93	6,724.84	34.90%	65%	33%
2019	16,129.82	10,484.38	3,459.85	5,226.21	32.40%	65%	33%
2018	20,057.15	13,037.15	4,302.26	6,600.62	32.91%	65%	33%
2017**	7,763.58	5,046.33	1,665.29	6,414.48	82.62%	65%	33%
2015**	6,989.85	4,543.40	1,499.32	4,200.23	60.09%	65%	33%
2012**	10,153.54	6,599.80	2,177.93	5,544.10	54.60%	65%	33%
2011	16,958.93	11,023.30	3,637.69	5,312.97	31.33%	65%	33%
2010	25,370.95	16,491.12	5,442.07	5,583.13	22.01%	65%	33%
2007	30,243.02	19,657.96	6,487.13	5,891.49	19.48%	65%	33%
2006	27,084.69	17,605.05	5,809.67	5,578.91	20.60%	65%	33%
				Average:	37.92%	65%	33%

*Years with low or no reported diversion records due to infrastructure issues were removed from the efficiency analysis

**High overall efficiency years likely due to underreported diversions

Table 2: Overall Ditch Efficiency

An overall ditch efficiency of approximately 30% is expected for a ditch system with minimal system improvements such as the Blue Stone Ditch. Implementation of ditch measurement and infrastructure projects listed within Table 3 will provide a more accurate Ditch system water balance and an increased delivery efficiency percentage through improved lined or piped canal sections. An increased delivery efficiency will contribute to a higher overall system efficiency and a more effective system of delivering irrigation water to Ditch users.

3 PROJECT PRIORTITIES

3.1 Project Prioritization

A project inventory was developed from the infrastructure improvement program outlined in the previous planning document and recent infrastructure issues described by Ditch personnel. Prioritization of the list was completed using multiple-criteria and consultation with the Association.

3.1.1 Prioritization Multiple Criteria

An evaluation of the project list based on multiple criteria helps illustrate the Association's priorities and assists in the decision-making process of project implementation. The criteria incorporated into ranking included safety concerns, operational benefit, project cost, and project fundability. After a multiple-criteria analysis was completed, a final ranking assignment was completed by the Association.

Rank	Mapbook Label	Project Description	Priority	Project Timeline
1	N/A	Structural improvements to the diversion structure wheel	High	Near term
2	Red circle	Replacement of compromised, wooden undershot at Little Horsethief Creek	High	Near term
3	Square symbol throughout mapbook	Headgate replacement, turnout structure, and weir measurement structure	High	Intermediate term
4	Square symbol throughout mapbook	Headgate maintenance includes vegetation removal, punch plate installation, and headgate marking. See Appendix C	High	Near term
5	N/A	Diversion structure modernization	Medium	Intermediate term
6	N/A	Ditch easement investigation and improvements	Medium	Intermediate term
7	RF-X	Ditch piping of the approximately 13,000 feet to mitigate rock fall issues	Medium	Long term
8	SP-X	Canal lining of the approximately 3,400 feet that has been identified as high seepage areas	Medium	Long term

Table 3: Prioritized Project List

3.1.2 Canal Lining Projects

Installing concrete lining on sections of the Ditch could provide significant seepage reduction. Long-term improvements to delivery efficiency and overall ditch safety are a result of canal lining projects. Structural and safety improvements to canal embankments through canal lining projects reduce embankment erosion and the encroachment of vegetation that can decrease hydraulic capacity and increase system losses.

Approximately 3,400 feet of the Ditch has been identified as high seepage areas and the USBR typical canal lining section is recommended for seepage reduction along the Ditch. This lining section is a cost-effective option that starts with a canal lining base consisting of six-inches of free-draining pit run and an underdrain to reduce groundwater damage to the lining. This base is topped by two layers of geotextile fabric with a PVC geomembrane separating the fabric layers and creating an impervious section. The liner section is overlayed with a three-inch layer of shotcrete that creates a rigid section and protects the geomembrane. It should be noted that the shotcrete liner is not sufficient to mitigate damage from large rocks and boulders falling into the canal. A standard shotcrete lining cross-section detail is illustrated in Figure 3.

Canal lining costs vary based on liner type, length, cross section dimensions, and canal features. A project cost breakdown for a 1,000-foot stretch of canal lining can be found in Appendix B.

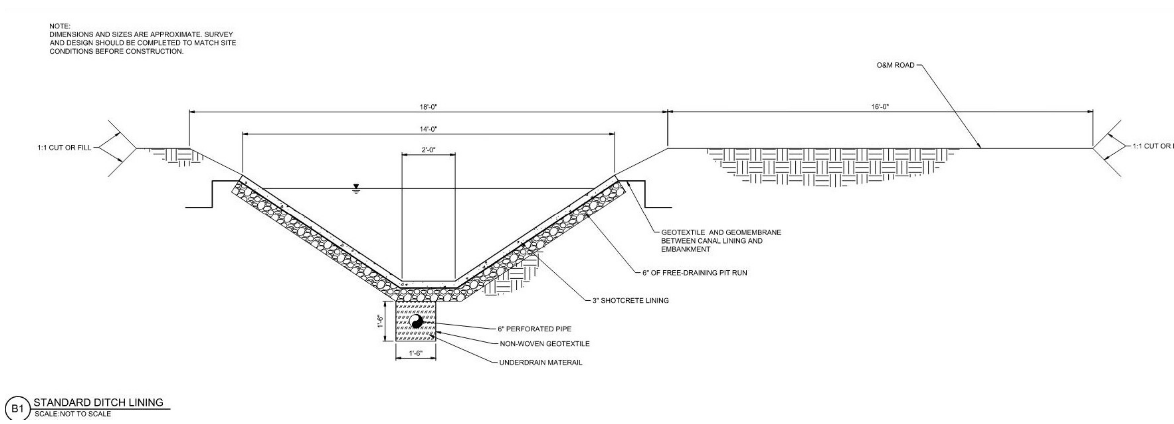

Figure 3: Standard Canal Lining Detail

3.1.3 Canal Piping Projects

Canal piping achieves the same system improvements as canal lining but with the removal of delivery losses due to evaporation from the water surface increasing conveyance efficiency. A preliminary, standard ditch piping section consisting of 60” dual wall corrugated HDPE pipe with a minimum cover of 24 inches is shown in Figure 4.

Approximately 13,000 feet of the Ditch is subject to major rock falls and ditch piping is recommended through these sections. Ditch piping mitigates infrastructure damage and service interruptions in the case of a rock fall while also reducing seepage. A project cost breakdown for a 1,000-foot stretch of canal lining can be found in Appendix B and rock fall sections are illustrated in Appendix A.

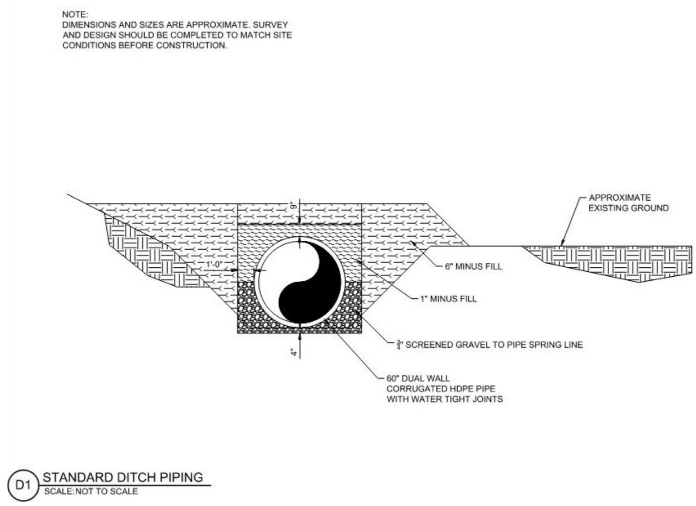

Figure 4: Standard Canal Piping Detail

3.1.4 Canal Box Culvert Projects

Canal enclosure utilizing a box culvert is an option for reducing seepage and service interruptions due to rockfalls in areas of significant concern or undershots. Pre-cast and cast-in-place options exist for box culverts depending on project parameters such as flow rate, required strength, construction timeline and location. Figure 5 illustrates a standard box culvert detail for canal enclosure.

Pre-cast box culverts are manufactured off-site to meet a project's design flow rate and strength requirement. Pre-cast box culverts are typically shipped to the project site in 8 feet section lengths depending on the box's dimensions. Sections contain tongue and groove joints that can be connected and made watertight with joint treatments during construction. Freight costs are generally expensive and can make up a large portion of the project cost.

The cast-in-place option for box culverts requires forming, pouring, and curing of the concrete onsite. Finishing the concrete onsite reduces shipping costs, overall project costs, and the number of joints between sections. Fewer joints are required with cast-in-place because formed sections can be lengthened beyond 8 feet during construction. This reduces the potential for seepage through joints as the project ages. The main disadvantage with cast-in-place is the time required to form, pour, and cure all the concrete sections; however, the freight savings associated with cast-in-place make it more competitive on longer box culvert projects.

Due to the significant cost associated with box culverts compared to ditch lining or piping, a box culvert structure is only recommended for the replacement of the Little Horsethief Creek Undershot. A cast-in-place undershot is also recommended to reduce project costs. The existing Little Horsethief Creek Undershot is wooden and approximately 75 feet long. Replacement of the undershot is a high priority due to its proximity to an undersized county bridge and the high potential for the wooden structure to become compromised.

A project cost breakdown for a 75- foot and 1,000-foot stretch of box culvert can be found in Appendix B and the compromised undershot location is illustrated in Appendix A.

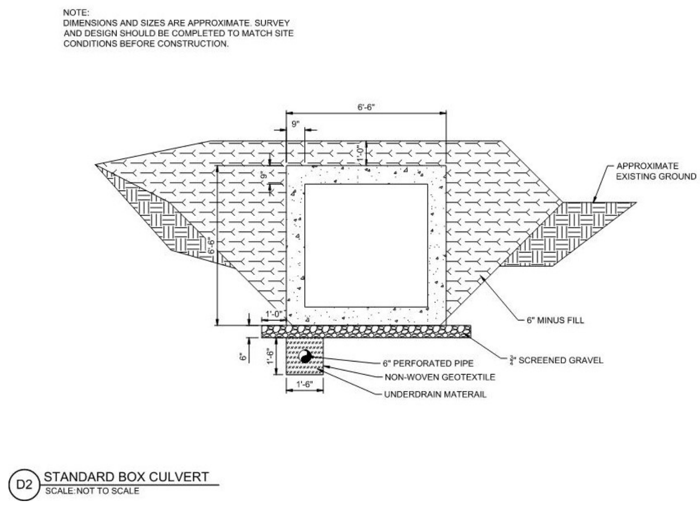

Figure 5: Standard Box Culvert Detail

3.1.5 Headgate Maintenance and Replacement

The Bluestone Ditch contains 73 headgates of varying age and condition. Headgate replacement projects will require the installation of a new turnout structure and a measurement structure. Turnout structures will consist of a simple concrete structure, a new headgate, and piping from the headgate to the downstream measurement structure. A punch plate is mounted to the front of the structure to prevent debris from entering the orifice and an open-air vent is connected to the pipe leading to the measurement device to release any trapped air and increase hydraulic capacity. A measurement component is essential to the turnout structure as it ensures the user receives their total delivery and it assists in calculating system delivery losses. The options for a measurement structure downstream of the turnout include a weir structure and a flowmeter. The flow rate through the weir structure is manually measured with a staff gauge and the flowmeter utilizes a propeller flowmeter that provides an instantaneous flow rate indicator and a flow totalizer. Piping downstream of the measurement appurtenance will complete the water delivery to the user.

The standard turnout structure detail is illustrated in Figure 6 and Figures 7 and 8 contain the measurement structure details. A project cost breakdown for each of the structures can be found in Appendix B.

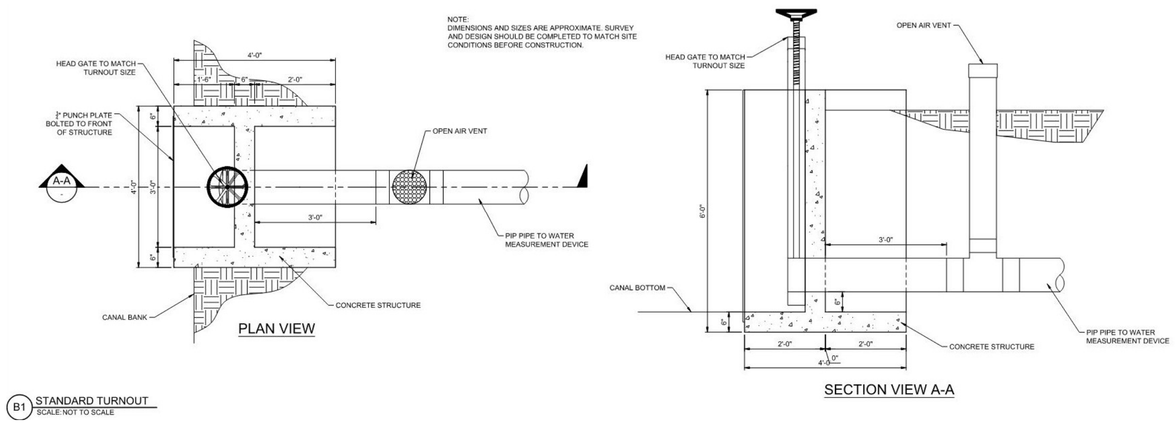

Figure 6: Standard Turnout Detail

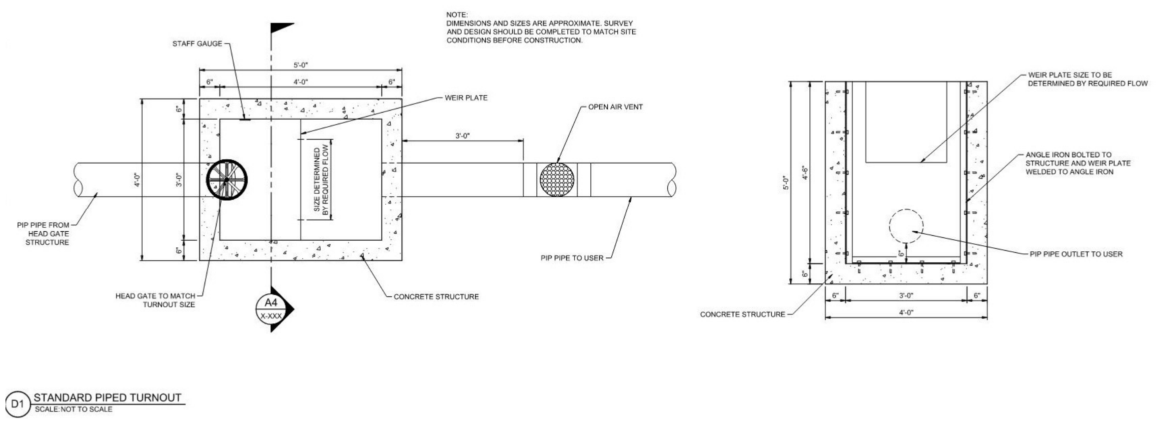

Figure 7: Standard Piped Turnout Detail

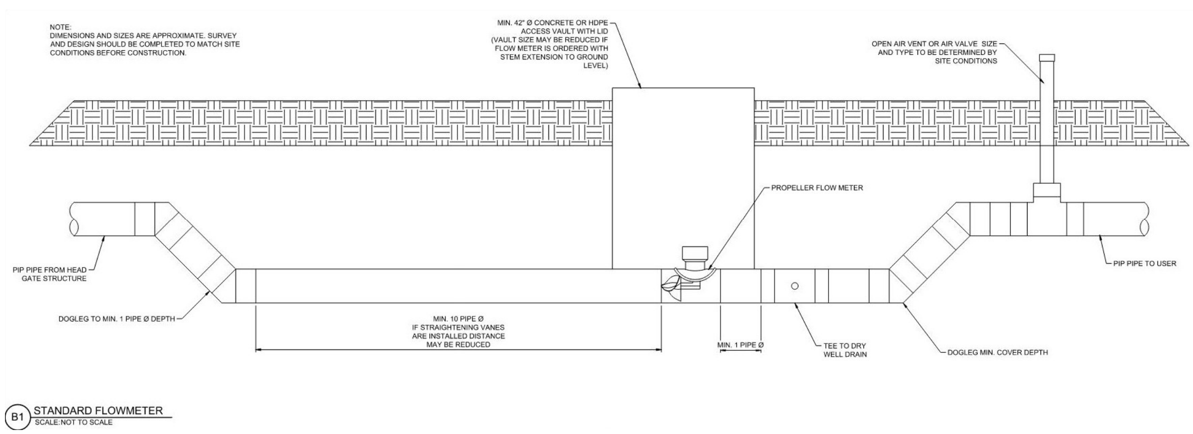

Figure 8: Standard Flowmeter Detail

3.1.6 Diversion Structure Wheel Improvements

Safety concerns have been raised by Ditch personnel regarding the structural integrity of the diversion structure's headgate wheel. It is anticipated that the diversion structure will require approximately $5,000 of welding efforts to improve wheel operation and worker safety.

3.1.7 Easement Investigation and Improvements

Ditch easement extents for operational and maintenance purposes along the 12 miles of canal are currently unknown to the Association. An analysis of the Association's existing prescriptive easements and potential acquisition of any necessary easements are valuable projects to the Association and would help ensure delivery of irrigation water is uninterrupted. Easement analysis is expected to cost approximately $50,000 and physical improvements such as gravel overlay along the canal road are expected to cost approximately $15 per linear foot.

3.1.8 Diversion Structure Modernization

The Bluestone diversion structure is responsible for diverting water from the Colorado River for the irrigation of approximately 1,500 acres along the Ditch making it a crucial piece of infrastructure within the Bluestone Ditch system. The existing diversion structure requires frequent repairs and consists of a headwall structure, a single headgate, and a diversion wheel. Modernization of the existing diversion structure will ensure reliable diversions and accurate flow measurement. The diversion structure modernization project will include a new headwall structure, two 48"x48" slide gates with gate actuation, and a downstream flume measurement structure with a level sensor for flow measurement. The grade control structure within the Ditch approach channel will be armored with boulders. Grout will be installed within boulder voids to reduce the porosity of the structure and achieve the required water surface elevation. Appendix B contains a cost breakdown for the diversion structure modernization project.

4 FUNDING SOURCES

4.1 Available Funding Sources for Prioritized Improvement Projects

Water supplies across the west are stressed due to drought, increased population, and insufficient infrastructure. The implications of these challenges have resulted in an increased allocation of funding to water resource projects. Grant eligibility varies based on project scope, cost, and potential benefits. Available grant programs pertaining to the prioritized projects are described below.

4.1.1 United States Bureau of Reclamation

The Bureau provides numerous funding opportunities for projects that ensure adequate and safe water supplies within their WaterSMART program. The Water and Energy Efficiency Grant program is commonly used for ditch infrastructure projects and includes a 50% matching requirement.

4.1.2 Colorado Water Conservation Board (CWCB)

CWCB offers low-interest loans and grant options for projects ranging from planning documents, water infrastructure construction, studies, and public education and outreach. These options include the CWCB Water Project Loan Program, CWCB Water Plan Grants (CWP), and Water Supply Resource Fund (WSRF) Programs.

The CWCB Water Project Loan Program provides low-interest loans to assist in meeting the matching requirements for awarded grants. Low-interest loan applications require a loan feasibility study and a $100,000 minimum request. Large project matching requirements and low agricultural project interest rates make the Loan Program a fitting option for the prioritized infrastructure projects.

The prioritized projects outlined for the Association would likely be eligible under the Colorado Water Plan Grant (CWP) and Water Supply Resource Fund (WSRF) programs. CWP grants are available state-wide and require a minimum 50% matching requirement. The CWP grant program includes six funding categories that align with the Colorado Water Plan. An environmental nexus component of a project is necessary to qualify for the multi-beneficial requirement of the CWP grant program. Eligible projects can use awarded grant funds for feasibility studies, permitting, environmental compliance, project design engineering, and construction. A grant application, accompanied with a budget, project schedule, and any Basin Roundtable letters of support, is submitted to the CWP portal.

WSRF grants are awarded by one of Colorado's nine Basin Roundtables based on local priority and available funding. The WSRF grant application process and list of eligible projects is similar to the CWP grant program. WSRF grant requests require a lower 25% matching minimum compared to CWP grants; however, WSRF grant funds are limited by Basin available funding and the Basins currently aim to distribute $300,000 annually.

4.1.3 Colorado River Conservation District

The Colorado River Conservation District's Community Funding Partnership (CFP) began in 2021 after Western Colorado residents voted to approve program funding in 2020. CFP grants are awarded to projects that prioritize water resource benefits for residents across the Western Slope and grant funding can extend up to $1 million dollars.

The CFP program expanded in 2022 to create Accelerator Grants which are typically used as precursors to Federal grants. The Accelerator Grant application process is streamlined and can be useful for funding feasibility or preliminary design of larger projects.

4.1.4 Natural Resources Conservation Service (NRCS)

The Natural Resources Conservation Service (NRCS) is a federal agency under the United States Department of Agriculture (USDA) and offer a variety of programs that provide incentive payments for agricultural projects. There are two main groups of funding opportunities, watershed program funding and Environmental Quality Incentives Program (EQIP) funding.

Examples of watershed programs are PL-566 and Regional Conservation Partnership Program (RCPP). Applications and more information can be obtained from the nearest NRCS Field Office.

The Environmental Quality Incentives Program (EQIP) has initiatives for individual landowners, groups of landowners, and Water Management Entities (WME), among others. This program evaluates resource concerns on a smaller scale and identifies the practices that will help the individual landowner, small group of landowners, or the WME. Applications and more information can be obtained from the nearest NRCS Field Office.

NRCS contracts typically cover between 50% and 75% of project costs through incentive payments. The incentive payment is not issued until the project is installed and certified. NRCS can provide plans and specifications at no cost, although it may take up to two years depending on office workload. For those who choose not to wait, NRCS can add Technical Service Provider (TSP) money to the contract to help pay for private engineering, construction management, and certification.